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Wonders of the Air-Pump;

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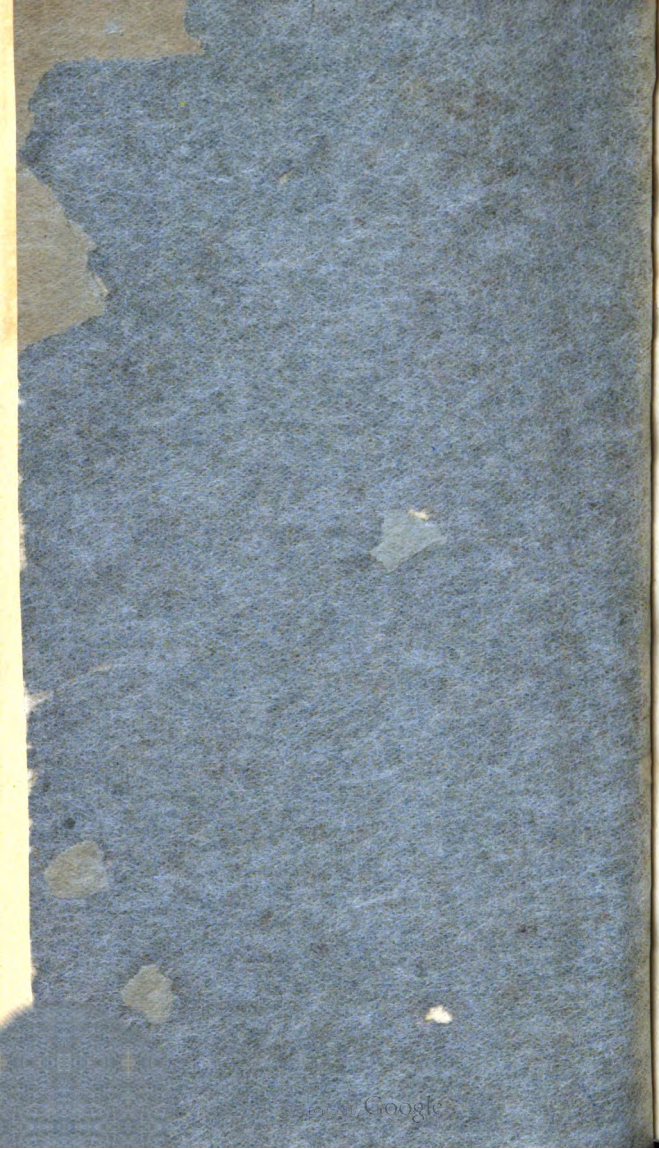

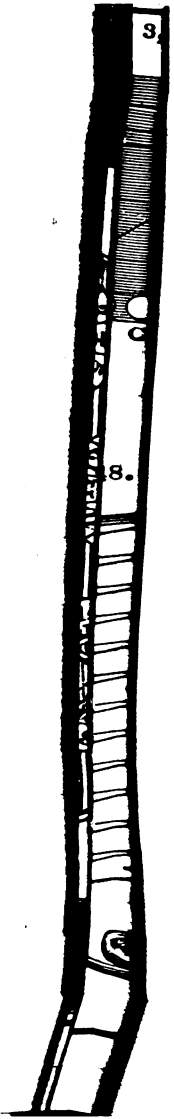

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ADDRESS.

THE Editor of the following pages lays very slight claims to merit on the grounds of originality. Many of the sources from whence he has gathered the materials of his work will no doubt be recognised by those whose attainments have been superior to the general class of readers; but even to them no apology will be necessary on that account; they will acknowledge that it requires nearly as great a share of judgment to *select* as to *write;* and on this ground the Editor rests his claim to public approbation. He is sensible that his endeavours to simplify the path of science, and unite the useful with the entertaining, will be justly appreciated by all his readers, and particularly by those, who know the difficulty of expressing in simple language subjects hitherto treated learnedly and scientifically; and the trouble attending the selection of those portions of science which can be easily and satisfactorily demonstrated by the reader himself.

Thus, though the apparent object of this little work is amusement, it may lay claim to the higher

merit of instruction; and while diverting a tedious hour by its perusal, or in trying any of the various experiments it describes, the reader will find he is adding very considerably to his own stock of useful knowledge.

The works from which the greater part has been selected, are many of them so scarce as to be attainable by few; while others are so voluminous and expensive, that they are not within the reach of the ordinary reader, and if they were, would require more time and patience to wade through their pages than many persons possess. All these circumstances must tend to heighten the value of a work, which has collected the beauties from the intricacies of science, and which offers facilities to useful instruction and rational amusement, not heretofore possessed by any work of its size and price.

In a word, whether viewed as a vehicle of amusement or instruction, the Editor confidently relies on public patronage; and when its comparative cheapness is considered, which presents upwards of 200 closely printed pages, besides an expensive frontispiece, to his reader, at so low a price, he is sure that patronage will be more generally extended, as its perusal increases, and its merits become known.

CONTENTS.

ENDLESS
AMUSEMENT.

To produce Fire by the Mixture of two cold Liquids.

TAKE half a pound of pure dry nitre, in powder, put it in a retort that is quite dry; add an equal quantity of highly rectified oil of vitriol, and distilling the mixture in a moderate sand heat, it will produce a liquor like a yellowish fume; this, when caught in a dry receiver, is *Glauber's Spirits of Nitre*; probably the preparation, under that name, may be obtained at the chemist's, which will of course save much time and trouble.

You then put a drachm of distilled oil of cloves, turpentine, or carraways in a glass vessel; and if you add an equal quantity, or rather more, of the above spirit, though both are in themselves perfectly cold, yet, on mixing them together, a great flame will arise and destroy them both, leaving only a little resinous matter at the bottom.

The Exploding Bubble.

IF you take up a small quantity of melted glass with a tube, (the bowl of a common tobacco pipe will do,) and let a drop fall into a vessel of water, it will chill and condense with a fine spiral tail, which being broken, the whole substance will burst with a loud explosion, without injury either to the party that holds it, or him that breaks it; but if the *thick* end is struck, even with a hammer, it will not break.

The Magic Picture.

TAKE two level pieces of glass, (plate glass is the best,) about three inches long and four wide, exactly of the same size; lay one on the other, and manage to leave a space between them by pasting a piece of card, or two or three small pieces of thick paper at each corner.

Join these glasses together at the edges by a composition of lime slacked by exposure to the air, and white of an egg. Cover all the edges of these glasses with parchment or bladder, except at one end, which is to be left open to admit the following composition:

Dissolve by a slow fire six ounces of hog's-lard, with half an ounce of white wax; to which you may add an ounce of clear linseed oil.

This must be poured in its liquid state, and before a fire, between the glasses, by the space left in the sides, and which you are then to close up. Wipe the glasses clean, and hold them before the fire, to see that the composition will not run out at any part.

Then fasten with gum a picture or print, painted on very thin paper, with its face to one of the glasses, and if you like, you may fix the whole in a frame.

While the mixture between the glasses is cold, the picture will be quite concealed, but become transparent when held to the fire; and as the composition cools, it will gradually disappear.

Artificial Lightning.

PROVIDE a tin tube that is larger at one end than it is at the other, and in which there are several holes. Fill this tube with powdered resin; and when it is shook over the flame of a torch, the reflection will produce the exact appearance of lightning.

Artificial Thunder.

MIX two drachms of the filings of iron, with one ounce of concentred spirit of vitriol, into a strong bottle that holds about a quarter of a pint; stop it close, and

in a few minutes shake the bottle; then taking out the cork, put a lighted candle near its mouth, which should be a little inclined, and you will soon observe an inflammation arise from the bottle, attended with a loud explosion.

To guard against the danger of the bottle bursting, the best way would be to bury it in the ground, and apply the light to the mouth by means of a taper fastened to the end of a long stick.

Another Way.

MIX three ounces of saltpetre, two ounces of salt of tartar, and two ounces of sulphur; roll the mixture up into a ball, of which take a quantity, about the size of a hazel nut, and placing it in a ladle or shovel over the fire, the explosion will resemble a loud clap of thunder.

You will produce a much more violent commotion if you double or treble the quantity of the last experiment; suppose you put two or three ounces of the mixture into the shovel. For fear of accidents, it should not be done in the house, but by placing the shovel over a chaffing dish of very hot coals, and performing the experiment in the open air, standing a great distance off.

Common prudence will dictate the necessity of using great care in the above experiments, as an accident will soon happen, if a person does not use great precaution in getting out of the way before the composition explodes.

Money augmented by an Optical Illusion.

IN a large drinking glass of a conical shape, (small at the bottom and wide at the top,) put a shilling, and let the glass be half full of water; then place a plate on the top of it, and turn it quickly over, that the water may not escape. You will see on the plate a piece of coin the size of half-a-crown; and a little higher up, another, the size of a shilling.

It will add to the amusement this experiment affords, by giving the glass to any one in company, (but who of course has not witnessed your operations,) and desiring

him to throw away the water, but save the two pieces; he will not be a little surprised at finding only one.

Three Objects, discernible only by the use of both Eyes.

If you fix three pieces of paper against the wall of a room at equal distances, at the height of your eye, placing yourself directly before them, at a few yards distance, and close your right eye, and look at them with your left, you will see only two of them, suppose the first and second; alter the position of your eye, and you will see the first and third; alter your position a second time, you will see the second and third, but never the whole three together; by which it appears, that a person who has only one eye can never see three objects placed in this position, nor all the parts of one object of the same extent, without altering the situation of his eye.

To construct the Camera Obscura.

Make a circular hole in the shutter of a window from whence there is a prospect of some distance; in this hole place a magnifying glass, either double or single, whose focus is at the distance of five or six feet; no light must enter the room but through this glass. At a distance from it, equal to its focus, place a very white pasteboard, (what is called a Bristol board, if you can procure one large enough, will answer extremely well;) this board must be two feet and a half long, and eighteen or twenty inches high, with a black border round it: bend the length of it inward to the form of part of a circle, whose diameter is equal to double the focal distance of the glass. Fix it on a frame of the same figure, and put it on a moveable foot, that it may be easily placed at that distance from the glass, where the objects appear to the greatest perfection. When it is thus placed, all the objects in front of the window will be painted on the paper in an inverted position, with the greatest regularity, and in the most natural colours. If you place a swing looking-glass outside the window, by turning it more or

less, you will have on the paper all the objects on each side the window.

If, instead of placing the looking-glass outside the window, you place it in the room above the hole (which must then be made near the top of the shutter), you may have the representation on a paper placed horizontally on a table, and draw at your leisure all the objects reflected.

Observe, the best situation is directly north; and the best time of the day is noon.

Another pleasing Experiment with the Camera Obscura.

LET the rays of light that pass through the magnifying glass in the shutter be thrown on a large concave mirror, properly fixed in a frame. Then take a thin strip of glass, and stick any small object on it; hold it in the intervening rays at a little more than the focal distance from the mirror, and you will see on the opposite wall, amidst the reflected rays, the image of that object, very large, and beautifully clear and bright.

To tell by a Watch Dial, the Hour when a Person intends to rise.

THE person is told to set the hand of his watch at any hour he pleases, which hour he tells you; and you add in your own mind 12 to it. You then desire him to count privately the number of that addition on the dial, commencing at the next hour to that at which he intends to rise, and including the hour at which he has placed the hand; which will give the answer: for example,

A intends to rise at 6 (this he conceals to himself); he places the hand at 8, which he tells B, who, in his own mind, adds 12 to 8, which makes 20. B then tells A to count 20 on the dial, beginning at the next hour at which he proposes to rise; which will be 7, and counting backwards, reckoning each hour as 1, and including in his addition the number of the hour the hand is placed

at, the addition will end at 6, which is the hour proposed; thus,

The hour the hand is placed at is	8
The next hour to that which A intends to rise at is 7, which counts for	1
Count back the hours from 6, and reckon them at 1 each, there will be 11 hours, viz. 4, 3, 2, 1, 12, 11, 10, 9, 8, 7, 6, ...	11
Making	20

A Person having an even number of Shillings in one hand and an odd number in the other, to tell in which hand the odd or even number is.

You desire the person to multiply the number in his right hand by an odd figure, and the number in his left by an even one; and tell you if the products, added together, be odd or even. If even, the even number is in the right hand; if odd, the even number is in the left. For instance,

I. Number in the right hand is *even*	18
Multiply by	3
Product	54
Add the Product of the left hand ..	14
Which produces a total of	68

In the left hand *odd* ...	7
Multiply by	2
Product	14

II. Number in the right hand is *odd*	7
Multiply by	3
Product	21
Add the Product of the left hand ..	36
Which produces a total of	57

In the left hand *even* ..	18
Multiply by	2
Product	36

Secret Correspondence.

To carry on a correspondence, without the possibility of the meaning of the letter being detected, in case it should be opened by any other person, has employed the ingenuity of many. No method will be found more effectual for this purpose, or more simple, than the following.

Provide a piece of square card or pasteboard, (see Fig. 1 in the frontispiece) and draw a circle on it, which circle is to be divided into 27 equal parts, in each of which parts must be written *one* of the capital letters of the alphabet, and the &, as in the figure. Let the centre of this circle be blank. Then draw another circle, also divided into 27 equal parts, in each of which write one of the small letters of the alphabet and the &. This circle must be cut round, and made exactly to fit in the blank space in the centre of the larger circle, and must run round a pivot or pin. The person with whom you correspond must have a similar dial, and at the beginning of your letter you must put the capital letter, and at the end the small letter, which answer to each other when you have fixed your dial.

Suppose what you wish to communicate is as follows: *I am so watched I cannot see you as I promised; but I will meet you to-morrow in the park, with the letters, &c.*

You begin with the letter *T*, and end with the letter *m*, which shews how you have fixed the dial, and how your correspondent must fix his, that he may decipher your letter. Then, for *I am*, you write *b uf*, and so of the rest, as in the frontispiece.

Another Way.

TAKE two pieces of card, pasteboard, or stiff paper, through which you cut long squares at different distances. One of these you keep yourself, and the other you give to your correspondent. You lay the pasteboard on a paper, and in the spaces cut out write what you would have understood by him only, then fill the intermediate spaces with any words that will connect the whole together, and make a different sense. When he receives it, he

lays his pasteboard over the whole, and those words which are between crotchets [ ] form the intelligence you wish to communicate. For example: suppose you want to express these words,

"*Don't trust Robert: I have found him a villain.*"

"[Don't] fail to send my books. I [trust] they will be ready when [Robert] calls on you. [I have] heard that you have [found] your dog. I call [him a villain] who stole him." You may place a pasteboard of this kind three other ways,—the bottom at top,—the top at bottom, or by turning it over; but in this case you must previously apprize your correspondent, or it may give him some trouble to decipher your meaning.

Secret Correspondence by Music.

FORM a circle like Fig. 2, divided into twenty-six parts, with a letter of the alphabet written in each. The interior of the circle is moveable, like that in Fig. 11, and the circumference is to be ruled like music paper. Place in each division a note different in figure or position.

Within the musical lines place the three keys, and on the outer circle the figures to donote time. Then get a ruled paper, and place one of the keys, (suppose *ge re sol*) against the time, 2/4ths, at the beginning of the paper, which will inform your correspondent how to place his circle. You then copy the notes that answer to the letters of the words you intend to write, in the manner expressed at the bottom of the figure.

The Magic Vessel.

ON the bottom of a vessel, (see Fig. 3 in the Frontispiece,) lay three pieces of money, the first at A, the second at B, and the third at C. Then place a person at D, where he can see no farther into the vessel than E. You tell him, that by pouring water in the vessel you will make him see three different pieces of money; and bid him observe, that you do not convey any money in with the water. But be careful that you pour the water

in very gently, or the pieces will move out of their places, and thereby destroy the experiment.

When the water rises up to F, the piece at A will be visible; when it reaches G, both A and B will be visible; and when it comes up to H, all three pieces will be visible.

Artificial Earthquake and Volcano.

GRIND an equal quantity of fresh iron filings with pure sulphur, till the whole is reduced to a fine powder. Be careful not to let any wet come near it. Then bury about thirty pounds of it a foot deep in the earth, and in about six or eight hours the ground will heave and swell, and shortly after send forth smoke and flames like a burning mountain. If the earth is raised in a conical shape, it will be no bad miniature resemblance of one of the burning mountains.

Artificial Illuminations.

A VERY pleasing exhibition may be made with very little trouble or expence, in the following manner: Provide a box, which you fit up with architectural designs cut out on pasteboard; prick small holes in those parts of the building where you wish the illuminations to appear, observing, that in proportion to the perspective, the holes are to be made smaller; and on the near objects the holes are to be made larger. Behind these designs thus perforated, you fix a lamp or candle, but in such a manner, that the reflection of the light shall only shine through the holes; then placing a light of just sufficient brilliance to shew the design of the buildings before it, and making a hole for the sight at the front end of the box, you will have a very tolerable representation of illuminated buildings

The best way of throwing the light in front is to place an oiled paper before it, which will throw a mellow gleam on the scenery, and not diminish the effect of the illumination. This can be very easily planned, both not to obstruct the sight, nor be seen to disadvantage. The

lights behind the picture should be very strong; and if a magnifying glass was placed in the sight-hole, it would tend greatly to increase the effect. The box must be covered in, leaving an aperture for the smoke of the lights to pass through.

The above exhibition can only be shown at candle-light; but there is another way of fixing small pieces of gold on the building instead of drilling the holes, which gives something like the appearance of illumination, but by no means equal to the foregoing experiment.

N. B. It would be an improvement if paper of various colours, rendered transparent by oil, were placed between the lights behind, and the apertures in the buildings, as they would then resemble lamps of different colours.

The Cameleon Spirit.

PUT into a decanter, volatile spirit, in which you have dissolved copper filings, and it will produce a fine blue. If the bottle is stopped, the colour will disappear; but when unstopped, it will return. This experiment may be often repeated.

Invisible Ink.

PUT litharge of lead into very strong vinegar, and let it stand twenty-four hours. Strain it off, and let it remain till quite settled; then put the liquor in a bottle. You next dissolve orpiment in quick lime water, by setting the water in the sun for two or three days, turning it five or six times a day. Keep the bottle containing this liquor well corked, as the vapour is highly pernicious if received into the mouth.

Write what you wish with a pen dipped in the first liquor; and to make it visible, expose it to the vapour of the second liquor. If you wish them to disappear again, draw a sponge or pencil, dipped in aquafortis, or spirit of nitre, over the paper; and if you wish them to re-appear, let the paper be quite dry, and then pass the dissolution of orpiment over it.

Another.

DISSOLVE bismuth in nitrous acid. When the writing with this fluid is exposed to the vapour of liver of sulphur, it will become quite black.

Another.

DISSOLVE green vitriol and a little nitrous acid in common water. Write your characters with a new pen.

Next infuse small Aleppo galls, slightly bruised, in water. In two or three days, pour the liquor off.

By drawing a pencil dipped in this second solution over the characters written with the first, they will appear a beautiful black.

Invisible Gold Ink.

PUT as much gold in as small a quantity of aqua regia as will dissolve it, and dilute it with two or three times the quantity of distilled water.

Next dissolve, in a separate vessel, fine pewter in aqua regia, and when it is well impregnated, add an equal quantity of distilled water.

Write your characters with the first solution; let it dry in the shade. To make them appear, draw a pencil or sponge, dipped in the second solution, over the paper, and the characters will appear of a purple colour.

Invisible Silver Ink.

DISSOLVE fine silver in aqua fortis; and after the dissolution, add some distilled water in the same manner as in the gold ink.

What is written with the above ink will remain invisible for three or four months if kept from the air; but may be easily read in an hour, if exposed to the fire, air, or sun.

Invisible Yellow Ink.

STEEP marygold flowers seven or eight days in clear distilled vinegar. Press the flowers and strain the liquor, which is to be kept in a bottle well corked. If you would have it still more clear, add, when you use it, some pure water.

To make the characters visible, which you write with this ink, pass a sponge over the paper, dipped in the following solution:

Take a quantity of flowers of pansy, or the common violet, bruise them in a mortar with water, strain the liquor in a cloth, and keep it in a bottle.

Invisible Red Ink.

To the pure spirit of vitriol or nitre, add eight times as much water.

Use the above solution of violets to make visible the characters written with this ink.

Invisible Green Ink.

DISSOLVE salt of tartar, clear and dry, in a sufficient quantity of river water. Use the violet solution to render it visible.

Another Invisible Green Ink.

DISSOLVE zaffre in powder, in aqua regia, for twenty-four hours. Pour the liquor off, add the same quantity of common water, and keep it in a bottle well corked.

This ink will not be visible till exposed to the fire or the sun; and will again be invisible when it becomes cold.

Invisible Violet Ink.

EXPRESS the juice of lemons, and keep it in a bottle well corked. Use the violet infusion to make the writing visible.

Invisible Grey Ink.

MIX alum with lemon juice. The letters written with this ink will be invisible till dipped in the water.

WE now present our readers with a variety of amusing experiments which may be performed by the foregoing inks; and they will, probably, suggest others equally amusing and useful.

A Secret Correspondence by means of Invisible Ink.

A person wishing to carry on a correspondence with another, and who is fearful of having his letter opened or intercepted, can adopt the following plan:

Write any unimportant matter with common ink, and let the lines be very wide apart: then between these lines, write the communication you wish to make, with any of the above invisible inks you can most readily procure.

Your correspondent is to be previously apprized of the method of making the characters visible; and writing in common ink will serve to lull the suspicions of those who might intercept the letter; and who not finding any thing important in it, will either forward or keep it. In either case there can be no danger, as the writing will not be visible without the proper application.

The Mysterious Writing.

WRITE on a piece of paper with common ink any question: then underneath it write the answer either in invisible silver ink, or the invisible green ink, made with zaffre and aqua regia, described in pages 22 and 23.

You give this paper to your friend, and tell him to place it against the wall, or on his dressing table, keeping the door locked, that he may be sure no person has entered his room: he will next day find the answer written on it.

The Restored Flowers.

MAKE a bouquet of artificial flowers; the leaves should be formed of parchment. Dip the roses in the red invisible ink, the jonquils in the yellow, the pinks in the violet, and the leaves in the green ink. They will all appear white; and you shew them to the company, observing, that you will restore them to their natural colours, and desiring any person to fix any private mark on them he pleases that he may be sure there is no deception. You then, unperceived by the company, dip them in the revivifying liquor, used to make the yellow ink visible, described in page 24, and drawing them gently out, that the liquor may drop, and the flowers have time to acquire their colours, you present them to the company, who will see, with surprise, that they each appear in their natural colours.

Winter changed to Spring.

TAKE a print that represents winter, and colour those parts which should appear green, with the second green invisible ink, described in page 24; observing, of course, the usual rules of perspective, by making the near parts deeper in colour than the others. The other objects must be painted in their natural colours. Then put the print into a frame with a glass, and cover the back with a paper that is pasted only at its extremities.

When this print is exposed to a moderate fire, or the warm sun, the foliage, which appeared covered with snow, will change to a pleasing green; and if a yellow tint be thrown on the lighter parts before the invisible ink is drawn over it, this green will be of different shades. When it is exposed to the cold, it will again resume its first appearance of winter.

The Silver Tree.

DISSOLVE an ounce of fine silver in three ounces of strong aqua fortis, in a glass bottle. When the silver is dissolved, pour the aqua fortis into another glass vessel (a decanter will be best), with seven or eight ounces of

mercury, to which add a quart of common water; to the whole add your dissolved silver, and let it remain untouched.

In a few days the mercury will appear covered with a number of little branches of a silver colour. This appearance will increase for a month or two, and will remain after the mercury is entirely dissolved.

Lead Tree.

A more modern invention, and an easier method by far than the above, is the following:

To a piece of zinc fasten a wire, crooked in the form of the worm of a still; let the other end of the wire be thrust through a cork. You then pour spring water into a phial or decanter, to which you add a small quantity of sugar of lead; thrust the zinc into the bottle, and with the cork at the end of the wire fasten it up. In a few days the tree will begin to grow, and produce a most beautiful effect.

To produce beautiful Fire Works in Miniature.

Put half a drachm of solid phosphorus into a large pint Florence flask; holding it slanting, that the phosphorus may not break the glass. Pour upon it a gill and a half of water, and place the whole over a tea-kettle lamp, or any common tin lamp, filled with spirit of wine. Light the wick, which should be almost half an inch from the flask; and as soon as the water is heated, streams of fire will issue from the water by starts, resembling sky-rockets; some particles will adhere to the sides of the glass, representing stars; and will frequently display brilliant rays. These appearances will continue at times till the water begins to simmer, when immediately a curious aurora borealis begins, and gradually ascends, till it collects to a pointed flame; when it has continued half a minute, blow out the flame of the lamp, and the point that was formed will rush down; forming beautiful illumined clouds of fire, rolling over each other for some time, which,

disappearing, a splendid hemisphere of stars presents itself: after waiting a minute or two, light the lamp again, and nearly the same phenomenon will be displayed as from the beginning. Let a repetition of lighting and blowing out the lamp be made for three or four times at least, that the stars may be increased. After the third or fourth time of blowing out the lamp, in a few minutes after the internal surface of the flask is dry, many of the stars will shoot with great splendour from side to side, and some of them will fire off with brilliant rays; these appearances will continue several minutes. What remains in the flask will serve for the same experiment several times, and without adding any more water. Care should be taken, after the operation is over, to lay the flask and water in a cool secure place.

Artificial Rain and Hail.

MAKE a hollow cylinder of wood; let it be very thin at the sides, about eight or ten inches wide, and two or three feet in diameter. Divide its insides into five equal parts by boards of five or six inches wide, and let there be between them and the wooden circle, a space of about one sixth of an inch. You are to place these boards obliquely. In this cylinder put four or five pounds of shot that will easily pass through the opening. When turned upside down, the noise of the shot going through the various partitions will resemble rain; and if you put large shot, it will produce the sound of hail.

Illuminated Writing.

IT is well known that if any words are written on a wall with solid phosphorus, the writing will appear as if on fire, but it is necessary to give this caution, lest accidents should occur:—In using it, let a cup of water be always near you; and do not keep it more than a minute and a half in your hand, for fear the warmth of your hand should set it on fire. When you have written a few words with it, put the phosphorus into the cup of water,

and let it stay a little to cool: then take it out, and write with it again.

A Lamp that will burn Twelve Months without replenishing.

TAKE a stick of phosphorus, and put it into a large dry phial, not corked, and it will afford a light sufficient to discern any object in a room when held near it. The phials should be kept in a cool place, where there is no great current of air, and it will continue its luminous appearance for more than twelve months.

Curious Transcolourations.

PUT half a table spoonful of syrup of violets, and three table-spoonfuls of water into a glass; stir them well together with a stick, and put half the mixture into another glass. If you add a few drops of acid of vitriol into one of the glasses and stir it, it will be changed into a crimson; put a few drops of fixed alkali dissolved into the other glass, and when you stir it, it will change to green. If you drop slowly into the green liquor, from the side of the glass, a few drops of acid of vitriol, you will perceive crimson at the bottom, purple in the middle, and green at the top; and by adding a little fixed alkali dissolved to the other glass, the same colours will appear in different order.

Another.

IF you put a tea-spoonful of a liquor composed of copper infused in acid of vitriol, into a glass, and add two or three table spoonfuls of water to it, there will be no sensible colour produced; but if you add a little volatile alkali to it, and stir it, you will perceive a very beautiful blue colour. Add a little acid of vitriol, the colour will instantly disappear upon stirring it; and by adding a little fixed alkali dissolved, it will return again.

Another.

PUT half a tea spoonful of a liquor composed of iron infused in acid of vitriol, into half a glass of water; and add a few drops of phlogisticated alkali, and a beautiful Prussian blue will appear.

Curious Account of the Electric Effects of a Russian Climate.

MR. ÆPINUS, in a letter to Dr. Guthrie, relates the following phenomena, which took place in Russia, when a severe frost had continued for several weeks.

Mr. Æpinus, was sent for to the palace to see an uncommon phenomenon. On going into the apartment of Prince Orloff, he found him at his toilet, and that every time his valet drew the comb through his hair, a strong crackling noise was heard; and on darkening the room, sparks were seen following the comb in great abundance, while the Prince himself was so completely electrified, that strong sparks could be drawn from his hands and face; nay, he was even electrified, when he was only powdered with a puff.

A few days after, he was witness to a more striking effect of the electric state of a Russian atmosphere. The Grand Duke of Russia sent for him one evening in the twilight, and told him, that having briskly drawn a flannel cover off a green damask chair in his bed-chamber, he was astonished at the appearance of a strong bright flame that followed; but considering it as an electrical appearance, he had tried to produce a similar illumination on different pieces of furniture, and could then shew him a beautiful and surprising experiment. His Highness threw himself on his bed, which was covered with a damask quilt, laced with gold; and rubbing it with his hands in all directions, the young prince, who had then reached his twelfth year, appeared swimming in fire, as at every stroke flames arose all around him, darted to the gold-lace border, ran along it, and up to that of the bed, and even to the very top.

While he was shewing this experiment, Prince Orloff

came into the room, with a sable muff in his hand, and shewed us, that by only whirling it five or six times round his head in the air, he could electrify himself so strongly, as to send out sparks from all the uncovered parts of his body.

Astonishing Power of Steam.

If you put a small quantity of water into a tea-kettle, and place it on the fire, it will disappear in a short time, having escaped in steam. But if its escape is prevented, by stopping up the spout and crevices, it will force its way, by bursting the vessel in which it was confined.

If the steam of boiling water be at liberty, the water never attains more than a certain degree of heat; but if confined in a close vessel, the additional fire not escaping, the power of the steam is increased, it re-acts upon the water, and raises the heat so much higher, that it would keep lead in a melting state; and so penetrating, that it would soften the marrow-bone of an ox, in a few minutes.

There is an instrument contrived for the foregoing purposes, called Papin's Digester, from the name of its inventor, and from its digestive powers on substances exposed to its action. It is a very strong vessel, made of copper, fitted with a thick close cover, and fastened down by several strong screws, so as to render it steam-tight in great degrees of heat. To render it safe, while being used, there is a valve on the cover to let out the steam, when it is too violent; this valve is kept down by a steely-ard, with a weight moveable upon it, to regulate the degrees of the steam within.

The following account of an accident with one of these instruments, will give some idea of the great force of steam:

Mr. Papin (the inventor) having fixed all things right, and included about a pint of water, with two ounces of marrow-bone, he placed the vessel horizontally between the bars of the grate, about half-way into the fire. In three minutes he found it raised to a great heat, and perceiving the heat in a very short time become more

raging, he stepped to a side-table for an iron to take the digester out of the fire, when it suddenly burst with the explosion of a musket. It was heard at a considerable distance, and actually shook the house. The bottom of the vessel that was in the fire gave way; the blast of the expanded water blew all the coals out of the fire into the room, the remainder of the vessel flew across the room, and hitting the leaf of an oak table, an inch thick, broke it all in pieces, and rebounded half the length of the room back again. He could not perceive the least sign of water, though he looked carefully for it; the fire was quite extinguished, and every coal black in an instant.

The following accident was attended with more fatal consequences:

A steam-engine was repairing at Chelsea, and as the workmen were endeavouring to discover the defect, the barrel suddenly exploded, and a cloud of steam rushing out at the fracture, struck one of the men who was near it, and killed him in a moment, like a blast of lightning: when his companions endeavoured to take off his clothes, the flesh came off with them from the bones.

Account of the wonderful Effects of two immense Burning Glasses.

MR. DE TSCHIRNHAUSEN constructed a burning glass, between three and four feet diameter, and whose focus was rendered more powerful by a second one. This glass melted tiles, slates, pumice-stone, &c. in a moment, pitch, and all resins, were melted even under water; the ashes of vegetables, wood, and other matters, were converted into glass; indeed, it either melted, calcined, or dissipated into smoke, every thing applied to its focus.

Mr. Parker, of Fleet-street, made a burning glass, three feet diameter; it was formed of flint-glass; and, when in its frame, exposed a surface of 2 feet 8½ inches to the solar rays. It had a small glass fitted to it, to converge the rays and heighten the effect. The experiments made by it were more powerful and accurate than those

performed by any other glass. The following is a brief epitome of its astonishing powers:

Substances melted, with their Weight; and the Time in Seconds, which they took in melting.	Weight in Grains.	Time in Seconds.
Pure gold	20	4
—— silver	20	3
—— copper	33	20
—— platina	10	3
Nickell	16	3
A cube of bar-iron	10	12
—— cast-iron	10	3
—— steel	10	12
Scoria of wrought-iron	12	2
Kearsh	10	3
Cank, or terra ponderosa	10	7
A topaz, or chrysolite	3	45
An oriental emerald	2	25
Chrystal pebble	7	6
White agate	10	30
Oriental flint	10	30
Rough cornelian	10	75
Jasper	10	25
Onyx	10	20
Garnet	10	17
White rhomboidal spar	10	60
Zeolites	10	23
Rotten stone	10	80
Common slate	10	2
Asbestos	10	10
Common lime-stone	10	55
Pumice-stone	10	24
Lava	10	7
Volcanic clay	10	60
Cornish moor stone	10	60

Fulminating Powder.

THIS powder is made by rubbing together, in a hot marble mortar, with a wooden pestle, three parts, by weight, of nitre, two of mild vegetable alkali, and one of flowers of sulphur, till the whole is accurately mixed. If a drachm of this powder be exposed to a gentle heat, in an iron ladle, till it melts, it will explode with a noise as loud as the report of a cannon.

A more powerful Fulminating Powder.

THE most wonderful instance of chemical detonation is formed by the combination of volatile alkali with silver. Gunpowder, or fulminating gold, are not to be compared with this invention, and the great danger attending its manufacture prevents us from giving a methodical account of its preparation to our readers, particularly as it can be purchased, properly prepared, at the chemists'.

The slightest agitation or friction is sufficient to cause its explosion. When it is once obtained, it can no longer be touched with safety. The falling of a few atoms of it, from a small height, produces an explosion; a drop of water falling on it has the same effect. No attempt, therefore, can be made to inclose it in a bottle, but it must be let alone in the capsule, wherein, by evaporation, it obtains this terrible property. To make this experiment with safety, no greater quantity than a grain of silver should be used; the last process of drying should be made in a metallic vessel, and the face of the operator defended by a mask with strong glass eyes.

To make the Phosphorus Match Bottles.

NOTHING more is necessary for this purpose, than to drop small pieces of dry phosphorus into a common phial; gently heat it till it melts; and then turn the bottle round, that it may adhere to the sides. The phial should be closely corked; and, when used, a common brimstone match is to be introduced, and rubbed against

the sides of the phial; this inflames the match when it is brought out of the bottle. Though there is no danger in phosphorus, till friction, or fire, is applied, yet persons cannot be too cautious in the use of it, as instances have been known of one of these bottles catching fire in the pocket, and very much endangering the person who carried it; likewise, if carelessly used, small particles are apt to get under the nails, or on the hand; and if, by accident, they are held to the fire, or rubbed together, a flame will presently kindle.

To make a Ring suspend by a Thread, after the Thread has been burned.

SOAK a piece of thread in urine, or common salt and water. Tie it to a ring, not larger than a wedding ring. When you apply the flame of a candle to it, it will burn to ashes, but yet sustain the ring.

To form Figures in relief on an Egg.

DESIGN on the shell any figure or ornament you please, with melted tallow or any other fat oily substance; then immerse the egg in very strong vinegar, and let it remain till the acid has corroded that part of the shell which is not covered with the greasy matter: those parts will then appear in relief, exactly as you have drawn them.

To give a ghastly Appearance to Persons in a Room.

DISSOLVE salt in an infusion of saffron and spirits of wine. Dip some tow in this solution, and having set fire to it, extinguish all the other lights in the room.

To change Blue to White.

DISSOLVE copper filings in a phial of volatile alkali: when the phial is unstopped, the liquor will be blue; when stopped, it will be white.

Magical Transmutations.

INFUSE a few shavings of logwood in common water, and when the liquor is sufficiently red, pour it into a bottle. Then take three drinking glasses, and rince one of them with strong vinegar; throw into the second a small quantity of pounded alum, which will not be observed, if the glass has been recently washed, and leave the third without any preparation. If the red liquor in the bottle be poured into the first glass, it will appear a straw colour; if into the second, it will pass gradually from blueish grey to black, if stirred with a key, or any piece of iron, which has been previously dipped in strong vinegar. In the third glass, the red liquor will assume a violet tint.

To make Pomatum with Water and Wax.

WATER and wax are two substances that do not unite together; therefore, to those who witness the following process, without knowing the cause, it will have the appearance of marvellous. Put into a new glazed earthen pot, six ounces of river water and two ounces of white wax, in which you must previously conceal a strong dose of salt of tartar. If the whole be then exposed to a considerable degree of heat, it will assume the consistence of pomatum, and may be used as such.

Iron transformed into Copper.

DISSOLVE blue vitriol in water, till the water is well impregnated with it; and immerse into the solution small plates of iron, or coarse iron filings. These will be attacked and dissolved by the acid of the vitriol, while the copper naturally contained in the vitriol will be sunk and deposited in the place of the iron dissolved. If the piece of iron be too large for dissolving, it will be so completely covered with particles of copper as to resemble that metal itself.

Iron transformed into Silver.

DISSOLVE mercury in marine acid, and dip a piece of iron into it, or rub the solution over the iron, and it will assume a silver appearance.

It is hardly necessary to say, that these transmutations are only apparent, though to the credulous it would seem that they were actually transformed.

Chemical Illuminations.

PUT into a middling sized bottle, with a short wide neck, three ounces of oil or spirit of vitriol, with twelve ounces of common water, and throw into it, at different times, an ounce or two of iron filings. A violent commotion will then take place, and white vapours will arise from the mixture. If a taper be held to the mouth of the bottle, these vapours will inflame, and produce a violent explosion; which may be repeated as long as the vapours continue.

The Philosophical Candle.

PROVIDE a bladder, into the orifice of which is inserted a metal tube, some inches in length, that can be adapted to the neck of a bottle, containing the same mixture as in the last experiment. Having suffered the atmospheric air to be expelled from the bottle, by the elastic vapour produced by the solution, apply the orifice of the bladder to the mouth of the bottle, after carefully squeezing the common air out of it, (which you must not fail to do or the bladder will violently explode). The bladder will thus become filled with the inflammable air, which, when forced out against the flame of a candle, by pressing the sides of the bladder, will form a beautiful green flame.

To make the Appearance of a Flash of Lightning, when any one enters a Room with a lighted Candle.

DISSOLVE camphor in spirit of wine, and deposit the vessel containing the solution in a very close room, where the spirit of wine must be made to evaporate by strong and speedy boiling. If any one then enters the room with a lighted candle, the air will inflame, while the combustion will be so sudden, and of so short a duration, as to occasion no danger.

To melt Iron in a moment and make it run into drops.

BRING a bar of iron to a white heat, and then apply to it a roll of sulphur. The iron will immediately melt, and run into drops.

This experiment should be performed over a bason of water, in which the drops that fall down will be quenched. These drops will be found reduced into a sort of cast-iron.

Never-yielding Cement.

CALCINE oyster shells, pound them, sift them through a silk sieve, and grind them on porphry till they are reduced to the finest powder. Then take the whites of several eggs, according to the quantity of the powder; and having mixed them with the powder, form the whole into a kind of paste. With this paste join the pieces of china, or glass, and press them together for seven or eight minutes. This cement will stand both heat and water, and will never give way, even if the article should, by accident, fall to the ground.

To remove Stains and Blemishes from Prints.

PASTE a piece of paper to a very smooth clear table, that the boiling water, used in the operation, may not acquire a colour which might lessen its success. Spread out the print you wish to clean, upon the table, and sprinkle it with boiling water; taking care to moisten it throughout

by very carefully applying a very fine sponge. After you have repeated this process five or six times, you will observe the stains or spots extend themselves; but this is only a proof that the dirt begins to be dissolved.

After this preparation, lay the print smoothly and carefully into a copper or wooden vessel, larger than the size of the print. Then cover it with a boiling ley of potash, taking care to keep it hot as long as possible. After the whole is cooled, strain off the liquor, take out the print with care, spread it on stretched cord, and when half dry, press it between leaves of white paper to prevent wrinkles.

By this process, spots and stains of any kind will be effectually removed.

To so fill a Glass with Water, that it cannot be removed without spilling the whole.

THIS is a mere trick; but may afford some amusement. You offer to bet any person that you will so fill a glass with water that he shall not move it off the table without spilling the whole contents. You then fill the glass, and laying a piece of paper or thin card over the top, you dextrously turn the glass upside down on the table, and then drawing away the paper, you leave the water in the glass, with its foot upwards. It will therefore be impossible to remove the glass from the table without spilling every drop.

Two Figures, one of which blows out and the other re-lights a Candle.

MAKE two figures, of any shape or materials you please. insert in the mouth of one a small tube at the end of which is a piece of phosphorus, and in the mouth of the other a tube containing at the end a few grains of gunpowder; taking care that each be retained in the tube by a piece of paper. If the second figure be applied to the flame of a taper, it will extinguish it; and the first will light it again.

A Vessel that will let Water out of the Bottom, as soon as the Mouth is uncorked.

PROVIDE a vessel of tin-plate, two or three inches in diameter, and five or six inches in height, having a mouth about three inches in width; and in the bottom several small holes, just large enough to admit a small needle. Plunge it in water with its mouth open, and when full, while it remains in the water, stop it very closely. You can play a trick with a person, by desiring him to uncork it; if he places it on his knee for that purpose, the moment it is uncorked, the water will run through at the bottom and make him completely wet.

A Powder which catches Fire when exposed to the Air.

PUT three ounces of rock alum, and one ounce of honey or sugar, into a new earthen dish, glazed, and which is capable of standing a strong heat; keep the mixture over the fire, stirring it continually till it becomes very dry and hard: then remove it from the fire, and pound it to a coarse powder. Put this powder into a long necked bottle, leaving part of the vessel empty; and having placed it in a crucible, fill up the crucible with fire sand, and surround it with burning coals. When the bottle has been kept at a red heat for about seven or eight minutes, and no more vapour issues from it, remove it from the fire, then stop it with a piece of cork; and having suffered it to cool, preserve the mixture in small bottles well closed.

If you unclose one of these bottles, and let fall a few grains of this powder on a bit of paper, or any other very dry substance, it will first become blue, then brown, and will at last burn the paper or other dry substance on which it has fallen.

Fulminating Gold.

PUT into a small long necked bottle, resting on a little sand, one part of fine gold filings and three parts of aqua regia, (nitro-muriatic acid). When the gold is dissolved, pour the solution into a glass, and add five or six times

the quantity of water. Then take spirit of sal ammoniac or oil of tartar, and pour it drop by drop into the solution, until the gold is entirely precipitated to the bottom of the glass. Decant the liquor that swims at the top, by inclining the glass; and having washed it several times in warm water, dry it at a moderate heat, placing it on paper capable of absorbing all the moisture.

If a grain of this powder, put into a spoon (it should be an iron one) be exposed to the flame of a candle, it will explode with a very loud report.

To melt a Piece of Money in a Walnut Shell, without injuring the Shell.

BEND any thin coin, and put it into half a walnut shell; place the shell on a little sand, to keep it steady, Then fill the shell, with a mixture made of three parts of very dry pounded nitre, one part of flowers of sulphur, and a little saw dust well sifted. If you then set light to the mixture, you will find, when it is melted, that the metal will also be melted in the bottom of the shell, in form of a button, which will become hard when the burning matter round it is consumed; the shell will have sustained very little injury.

A Liquor that shines in the Dark.

TAKE a bit of phosphorus, about the size of a pea; break it into small parts, which you are to put into half a glass full of very pure water, and boil it in a small earthen vessel, over a very moderate fire. Have in readiness a long narrow bottle, with a well fitted glass stopper, and immerse it, with its mouth open, into boiling water. On taking it out, empty the water, and immediately pour in the mixture in a boiling state; then put in the stopper, and cover it with mastich, to prevent the entrance of the external air.

This water will shine in the dark for several months, even without being touched; and if it be shaken in dry warm weather, brilliant flashes will be seen to rise through the middle of the water.

Luminous Liquor.

PUT a little phosphorus with essence of cloves, into a bottle, which must be kept closely stopped, Every time the bottle is unclosed, the liquor will appear luminous. This experiment must be performed in the dark.

The changeable Rose.

TAKE a common full blown rose, and having thrown a little sulphur finely pounded into a chaffing-dish with coals, expose the rose to the vapour. By this process the rose will become whitish; but if it be afterwards held some time in water, it will resume its former colour.

Golden Ink.

TAKE some white gum arabic, reduce it to an impalpable powder, in a brass mortar; dissolve it in strong brandy, and add a little common water to render it more liquid. Provide some gold in a shell, which must be detached, in order to reduce it to a powder. When this is done, moisten with the gummy solution, and stir the whole with a small hair brush, or your finger; then leave it for a night, that the gold may be better dissolved. If the composition becomes dry during the night, dilute it with more gum water, in which a little saffron has been infused; but take care that the gold solution be sufficiently liquid to flow freely in a pen. When the writing is dry, polish it with a dry tooth.

Another Way.

REDUCE gum ammoniac into powder, and dissolve it in gum arabic water, to which a little garlic juice has been added. This water will not dissolve the ammoniac so as to form a transparent liquid; for the result will be a milky liquor. With this liquor form your letters or ornaments on paper or vellum, with a pen or fine camel's-hair brush; then let them dry, and afterwards breathe on them some time, till they become moist; then apply a

few bits of leaf-gold to the letters, which you press down gently with cotton wool. When the whole is dry, brush off the superfluous gold with a large camel's-hair brush, and to make it more brilliant, burnish with a dog's tooth.

White Ink for writing on Black Paper.

HAVING carefully washed some egg-shells, remove the internal skin, and grind them on a piece of porphyry. Then put the powder into a small vessel of pure water, and when it has settled at the bottom, draw off the water, and dry the powder in the sun. This powder must be preserved in a bottle; when you want to use it, put a small quantity of gum ammoniac into distilled vinegar, and leave it to dissolve during the night. Next morning the solution will appear exceedingly white; and if you then strain it through a piece of linen cloth, and add to it the powder of egg-shells, in sufficient quantity, you will obtain a very white ink.

To construct Paper Balloons.

TAKE several sheets of silk paper; cut them in the shape of a spindle; or, to speak more familiarly, like the coverings of the sections of an orange, join these pieces together, into one spherical or globular body, and border the aperture with a ribbon, leaving the ends, that you may suspend them from the following lamp:

Construct a small basket of very fine wire, if the balloon is small, and suspend it from the aperture, so that the smoke from the flame of a few leaves of paper, wrapped together, and dipped in oil, may heat the inside of it. Before you light this paper, suspend the balloon in such a manner, that it may, in a great measure, be exhausted of air, and, as soon as it has been dilated, let it go, together with the wire basket, which will serve as ballast.

Water-Gilding upon Silver.

TAKE copper-flakes, on which pour strong vinegar: add alum and salt in equal quantities; set them on a fire, and when the vinegar is boiled till it becomes one-fourth part of its original quantity, throw into it the metal you design to gild, and it will assume a copper colour. Continue boiling it, and it will change into a fine gold colour.

A Water, which gives Silver a Gold Colour.

TAKE sulphur and nitre, of each an equal quantity; grind them together very fine, and put them into an unglazed vessel; cover and lute it well; then set it over a slow fire for 24 hours, put what remains into a strong crucible, and let it dissolve; put it into a phial, and whatever silver you anoint with it, will have a gold colour.

To make an old Gold Chain appear like new.

DISSOLVE sal ammoniac in urine, boil the chain in it, and it will have a fine gold colour.

To give Silver the Colour of Gold.

DISSOLVE in common aqua fortis as much silver as you please. To eight ounces of silver, take four ounces of hepatic aloes, six ounces of turmeric, and two ounces of prepared tutty, that has been several times quenched in urine. Put these to the solution of the silver; they will dissolve, but rise up in the glass like a sponge; this glass must therefore be large to prevent running over. Then draw it off, and you will have ten ounces of silver, as yellow as gold.

A Water, to give any Metal a Gold Colour.

TAKE fine sulphur and pulverize it; then boil some stale spring water; pour it hot upon the powder, and stir

it well together; boil it, and pour into it an ounce of dragon's blood. After it is well boiled, take it off, and filter it through a fine cloth; pour this water into a matrass (a chemical vessel), after you have put in what you design to colour; close it well, and boil it, and the metal will be a fine gold colour.

Another Way.

TAKE hepatic aloes, nitre and roman vitriol, of each equal quantities; and distil them with water, in an alembic, till all the spirits are extracted; it will at last yield a yellowish water, which will tinge any sort of metal of a gold colour.

To give Silver-Plate a Lustre.

DISSOLVE alum in a strong ley; scum it carefully; then mix it up with soap, and wash your silver utensils with it, using a linen rag.

The Fiery Fountain.

IF twenty grains of phosphorus, cut very small, and mixed with forty grains of powdered zinc, be put into four drachms of water; and two drachms of concentrated sulphuric acid, be added thereto, bubbles of inflamed phosphorated hydrogen gas will quickly cover the whole surface of the fluid in succession, forming a real fountain of fire.

To take Impressions of Coins, Medals, &c.

CUT fish-glue, or isinglass, into small pieces, immerse it in clear water, and set it on a slow fire; when gradually dissolved, let it boil slowly, stirring it with a wooden spoon, and taking off the scum. The liquor being sufficiently adhesive, take it off the fire, let it cool a little, and then pour it on the medal or coin you wish to copy, having first rubbed the coin over with oil. Let the composition lay about the thickness of a crown-

piece on the medal. Then set it in a moderate air, neither too hot nor too cold, and let it cool and dry. When it is dry, it will loosen itself; you will find the impression correct, and the finest strokes expressed with the greatest accuracy.

You may give a more pleasing effect to the composition, by mixing any colour with it, red, yellow, blue, green, &c. and if you add a little parchment size to it, it will make it harder and better. This size is made by gently simmering the cuttings of clear white parchment in a pipkin, with a little water, till it becomes adhesive.

To tell a Person any Number he may privately fix on.

When the person has fixed on a number, bid him double it and add 4 to that doubling; then multiply the whole by 5; to the product let him add 12, and multiply the amount by 10. From the total of all this, let him deduct 320, and tell you the remainder; from which, if you cut off the two last figures, the number that remains will be what he fixed on. For instance,

Suppose the number chosen is	7
Which doubled is.....	14
Add 4 to it, and it will make.....	18
Multiply 18 by 5, gives	90
To which add 12, is.....	102
Multiply that by 10, makes 1020	
From which deducting 320, the remainder is	700
And by striking off the two cyphers, it becomes the number thought on	7

To tell any Number a Person has fixed on, without asking him any Questions.

You tell the person to choose any number from 1 to 15; he is to add 21 to that number, and triple the amount. Then

1. He is to take the half of that triple, and triple that half.

2. To take the half of the last triple, and triple that half.

3. To take the half of the last triple.

4. To take the half of that half.

Thus, it will be seen there are four cases where the half is to be taken: the three first are denoted by one of the eight following Latin words, each word being composed of three syllables, and those that contain the letter I, refer to those cases where the half cannot be taken without a fraction; therefore, in those cases, the person who makes the deduction is to add 1 to the number divided. The fourth case shews which of the two numbers annexed to every word has been chosen; for if the fourth half can be taken without adding 1, the number chosen is in the first column; but if not, it is in the second column.

The words.	*The numbers they denote.*	
Mi-se-ris	8	0
Ob-tin-git	1	9
Ni-mi-um	2	10
No-ta-ri.....	3	11
In-fer-nos	4	12
Or-di-nes	13	5
Ti-mi-di.....	6	14
Te-ne-ant	15	7

For example:

Suppose the number chosen is.....	9
To which is to be added	1
	10
The triple of that number is	30
The half of which is.....	15
The triple of that half must be	45
And the half of that*	23
The triple of that half	69
The half of that*.....	35
And the half of that half*	18

* At all these stages, 1 must be added, to take the half without a fraction.

While the person is performing the operation, you remark, that at the second and third stages he is obliged to add 1; and, consequently, that the word *ob-tin-git*, in the second and third syllables of which is an *i*, denotes that the number must be either 1 or 9; and, by observing that he cannot take the last half without adding 1, you know that it must be the number in the second column. If he makes no addition at any one of the four stages, the number he chose must be 15, as that is the only number that has not a fraction at either of the divisions.

The Lamp Chronometer.

REFER to Fig. 4. It represents a chamber-lamp, A, consisting of a cylindrical vessel made of tin, in the shape of a candle, and is to be filled with oil. This vessel should be about three inches high and one inch diameter, placed in a stand, B. The whole apparatus, of lamp and stand, can be purchased ready made, at any tin-shop in London. To the stand B, is fixed the handle C, which supports the frame D, about 12 inches high, and four inches wide. This frame is to be covered with oiled paper, and divided into 12 equal parts by horizontal lines, at the end of which are written the numbers for the hours, from 1 to 12, and between the horizontal lines and diagonals, divided into halves, quarters, &c. On the handle C, and close to the glass, is fixed the style or hand, E.

Now, as the distance of the style from the flame of the lamp is only half an inch, then, if the distance of the frame from the style be six inches, while the float that contains the light descends by the decrease of the oil, one inch, the shadow of the style on the frame will ascend 12 inches, being its whole length, and show, by its progression, the regular increase of the hours, with their several divisions.

You must be careful always to burn the same oil, which must be the best; and the wick must never vary in size; if these precautions are not attended to, the dial never can be accurate.

The Phial of the Four Elements.

TAKE a phial, six or seven inches long, and about three-quarters of an inch in diameter. In this phial put, first, glass coarsely powdered; secondly, oil of tartar per deliquum; thirdly, tincture of salt of tartar; and lastly, distilled rock oil.

The glass and the various liquors being of different densities, if you shake the phial, and then let it rest a few moments, the three liquors will entirely separate, and each assume its place; thus forming no indifferent resemblance of the four elements, earth, fire, water, and air. The powdered glass (which should be of some dark colour) representing the earth; the oil of tartar, water; the tincture, air; and the rock oil, fire.

The Magic Bottle.

TAKE a small bottle, the neck of which is not more than the sixth of an inch in diameter. With a funnel, fill the bottle quite full of red wine, and place it in a glass vessel, similar to a shew glass, whose height exceeds that of the bottle about two inches; fill this vessel with water. The wine will shortly come out of the bottle, and rise in the form of a small column to the surface of the water; while, at the same time, the water entering the bottle will supply the place of the wine. The reason of this is, that as water is specifically heavier than wine, it must hold the lower place, while the other rises to the top.

An effect equally pleasing will be produced, if the bottle be filled with water, and the vessel with wine.

The Globular Fountain.

MAKE a hollow globe, of copper or lead, and of a size adapted to the quantity of water that comes from a pipe (hereafter mentioned), to which it is to be placed, and which may be fastened to any kind of pump; provided it is so constructed, that the water shall have no other means of escape than through the pipe. Pierce a num-

ber of small holes through the globe, that all tend towards its centre, and annex it to the pipe that communicates with the pump.

The water that comes from the pump, rushing with violence into the globe, will be forced out at the holes, and form a very pleasing sphere of water.

The Hydraulic Dancer.

PROCURE a little figure made of cork, which you may dress as your fancy dictates. In this figure place a small hollow cone, made of thin leaf brass.

When the figure is placed on a jet d'eau, that plays in a perpendicular direction, it will be suspended on the top of the water, and perform a great variety of amusing motions.

If a hollow ball, of very thin copper, of an inch diameter, be placed on a similar jet, it will remain suspended, turning round, and spreading the water all about it.

A Person having put a Ring on one of his Fingers, to name the Person, the Hand, the Finger, and the Joint on which it is placed.

LET a third person double the number of the order in which he stands who has the ring, and add 5 to that number; then multiply that sum by 5, and to the product add 10. Let him next add 1 to the last number, if the ring be on the right hand, and 2 if on the left, and multiply the whole by 10: to the product of this he must add the number of the finger, (counting the thumb as the first finger) and multiply the whole again by 10. Let him then add the number of the joint, and, lastly, to the whole join 35.

He is then to tell you the amount of the whole, from which you are to subtract 3535, and the remainder will consist of four figures; the first of which will express the rank in which the person stands, the second the hand, (number 1 signifying the right, and 2 the left)

the third number the finger, and the fourth the joint.—For example:

Suppose the person who stands the third in order has put the ring upon the second joint of the thumb of his left hand; then,

The double of the rank of the third person is	6
To which add	5
	11
Multiply the sum by	5
	55
To which add	10
And the number of the left-hand	2
	67
Which being multiplied by	10
	670
To which add the number of the thumb	1
	671
And multiply again by	10
	6710
Then add the number of the joint	2
And lastly, the number	35
	6747
From which deducting	3535
The remainder is	3212

Of which, as we have said, the 3 denotes the third person, the 2 the left-hand, the 1 the thumb, and the last 2 the second joint.

The Water Sun.

PROVIDE two portions of a hollow sphere, that are very shallow; join them together in such a manner that

the hollow between them be very narrow. Fix them vertically to a pipe from whence a jet proceeds. Bore a number of small holes all round that part where the two pieces are joined together. The water rushing through the holes will form a very pleasing water sun, or star.

The Magical Cascade.

PROCURE a tin vessel, shaped like fig. 5, about five inches high, and four in diameter, with a cover C closed at top. To the bottom of this vessel, let the pipe D E be soldered. This pipe is to be ten inches long, and half an inch in diameter, open at each end, and the upper end must be above the water in the vessel. To the bottom also fix five or six small tubes, F, about one eighth of an inch in diameter. By these pipes, the water in the vessel is to run slowly out.

Place this machine in a tin bason, GH, with a hole in the middle, about a quarter of an inch in diameter. Fix to the tube, DE, any sort of ornament that will keep the machine firm on the bason, observing, that these supports are sufficiently long to leave about a quarter of an inch between the end of the tube and the orifice in the bason; and let there be a vessel under the bason to catch the water that runs out.

As the small pipes discharge more water into the bason than can run out of the central orifice, the water will rise in the bason above the lower end of the pipe, and prevent the air from getting into the vessel, by which the water will cease to flow from the small pipes. But as the water continues to flow from the bason, the air will have liberty again to enter the vessel by the tube, and the water will again flow from the small pipes, and alternately stop and flow, while any water remains in the vessel.

As you can guess when the pipes will flow, and when they will stop; you may so manage it, that they will appear to act by word of command.

The illuminated Fountain, that plays when the Candles are lighted, and stops when they are extinguished.

PROVIDE two cylindrical vessels, AB and CD, (see Fig. 6). Connect them by four tubes open at each end, as HI, &c. so that the air may descend out of the higher into the lower vessel. To these tubes fix candlesticks, and to the hollow cover, EF, of the lower vessel, fit a tube, K, reaching almost to the bottom of the vessel. At G let there be an aperture with a screw, whereby water may be poured into CD, which, when filled, must be closed by the screw.

When the candles are lighted, the air in the upper cover and contiguous pipes will be thereby rarified, and the jet from the small tube, K, will begin to play: as the air becomes more rarified, the force of the jet will increase, and it will continue to play till the water in the lower vessel is exhausted. As the motion of the jet is caused by the heat of the candles, when they are extinguished the fountain will stop.

A Fountain which acts by the Heat of the Sun.

(Refer to the Frontispiece, Fig. 7).

GNS is a thin hollow globe of copper, eighteen inches diameter, supported by a small inverted bason, placed on a stand with four legs, ABCD, which have between them, at the bottom, a bason of two feet diameter. Through the leg C passes a concealed pipe, which comes from G, the bottom of the inside of the globe. This pipe goes by HV, and joins the upright pipe *u* I, to make a jet as I. The short pipe, *u* I, which goes to the bottom, has a valve at *u*, under the horizontal pipe HV, and another valve at V, above that horizontal pipe, under the cock at K. The use of this cock is to keep the fountain from playing in the day, if you think proper. The north pole, N, of the globe has a screw that opens a hole, whereby water is poured into the globe.

The machine being thus prepared, and the globe half filled with water, put it in an open place, when the heat of the sun, rarifying the air as it heats the

copper, the air will press strongly against the water, which coming down the pipe, will lift up the valve at V, and shut the valve at *u*. The cock being opened, the water will spout out at I, and continue to play a long while, if the sun shine.

Inflammable Phosphorus.

TAKE the meal or flower of any vegetable, put it into an iron pan over a moderate fire, and keep it stirring with an iron spoon till it changes to a black powder; to one part of this add four parts of raw alum. Make the whole into a fine powder, put it again into the iron pan, and keep stirring it till it almost catches fire, to prevent its forming into lumps, as it is apt to do when the alum melts, in which case it must be broke again, stirred about, and accurately mixed with the flower, till it emit no more fumes, and the whole appears a fine dry black powder.

Put this powder in a clean dry phial with a narrow neck, filling it to about one-third of the top. Then stop the mouth of the phial with loose paper, so as to let the air pass freely through it, and leave room for fumes to come through the neck. Place the phial in a crucible, encompassed on all sides with sand, so that it may not touch any part of the crucible, but a considerable space every where left between. The phial must be covered up with sand, leaving only a small part bare, by which you can discern whether the powder is ignited. In this state, the crucible is to be surrounded with coals, kindled slowly till it is well heated on all sides, and then the fire is to be raised, till the crucible and every thing in it is red hot; keep it in this state an hour; after this, the fire still burning as fiercely, close up the orifice of the phial with wax, to exclude the air. Leave it to cool, and you will find in it a black dusty coal formed of the flour and alum.

Shake a small quantity of this out of the phial into the cool air, and it will immediately take fire, but will not burn any thing Keep the bottle dry, as even the air will spoil it effectually.

The Magical Mirrors.

MAKE two holes in the wainscot of a room, each a foot high and ten inches wide, and about a foot distant from each other. Let these apertures be about the height of a man's head, and in each of them place a transparent glass in a frame, like a common mirror.

Behind the partition, and directly facing each aperture, place two mirrors, inclosed in the wainscot, in an angle of forty-five degrees.* These mirrors are each to be eighteen inches square: and all the space between them must be enclosed with pasteboard painted black, and well closed, that no light can enter; let there be also two curtains to cover them, which you may draw aside at pleasure.

When a person looks into one of these fictitious mirrors, instead of seeing his own face, he will see the object that is in front of the other; thus, if two persons stand at the same time before these mirrors, instead of each seeing himself, they will reciprocally see each other.

There should be a sconce with a lighted candle, placed on each side of the two glasses in the wainscot, to enlighten the faces of the persons who look in them, or the experiment will not have so remarkable an effect.

To cause a brilliant Explosion under Water.

DROP a piece of phosphorus, the size of a pea, into a tumbler of hot water; and, from a bladder furnished with a stop cock, force a stream of oxygen directly upon it. This will afford a most brilliant combustion under water.

Fulminating Mercury.

DISSOLVE 100 grains of mercury by heat, in an ounce and a half of nitric acid. This solution being poured cold upon two measured ounces of alcohol, previously

* That is, half-way between a line drawn perpendicularly to the ground and its surface.

introduced into any convenient glass vessel, a moderate heat is to be applied, till effervescence is excited. A white fume then begins to appear on the surface of the liquor, and the powder will be gradually precipitated when the action ceases. The precipitate is to be immediately collected on a filtre, well washed with distilled water, and cautiously dried in a heat not exceeding that of a water bath. Washing the powder immediately is material, because it is liable to the re-action of the nitric acid; and, while any of the acid adheres to it, it is very subject to the action of light. From 100 grains of mercury, about 130 of the powder are obtained.

This powder, when struck on an anvil with a hammer, explodes with a sharp stunning noise, and with such force as to indent both hammer and anvil. Three or four grains are sufficient for one experiment.

The Iron Tree.

DISSOLVE iron filings in aqua fortis, moderately concentrated, till the acid is saturated; then add to it, gradually, a solution of fixed alkali (commonly called oil of tartar per deliquum). A strong effervescence will ensue, and the iron, instead of falling to the bottom of the vessel, will afterwards rise so as to cover the sides, forming a multitude of ramifications heaped one upon the other, which will sometimes pass over the edge of the vessel, and extend themselves on the outside, with all the appearance of a plant.

To make any Number divisible by Nine, by adding a Figure to it.

IF (for example) the number named be 72,857, you tell the person who names it to place the number 7 between any two figures of that sum, and it will be divisible by 9; for if any number be multiplied by 9, the sum of the figures of the product will be either 9, or a number divisible by 9.

Arithmetical Magical Squares.

An arithmetical magical square consists of numbers so disposed in parallel and equal lines, that the sum of each, taken any way of the square, amounts to the same.

A Natural Square.

A			G		B
	1	2	3	4	5
	6	7	8	9	10
E	11	12	13	14	15 F
	16	17	18	19	20
	21	22	23	24	25
C			H		D

A Magical Square.

A				B
11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15
C				D

Any five of these sums taken in a right line make 65. You will observe that five numbers in the diagonals A to D, and B to C, of the magical square, answer to the ranks E to F, and G to H, in the natural square, and that 13 is the central number of both squares.

To form a magical square, first transpose the two ranks in the natural square to the diagonals of the magic square; then place the number 1 under the central number 13, and the number 2 in the next diagonal downward. The number 3 should be placed in the same diagonal line; but as there is no room in the square, you are to place it in that part it would occupy if another square were placed under this. For the same reason, the number 4, by following the diagonal direction, falling out of the square, it is to be put into the part it would hold in another square, placed by the side of this. You then proceed to numbers 5 and 6, still descending; but as the place 6 should hold is already filled, you then go back to the diagonal, and consequently place the 6 in the second case under the 5, so that there may remain an empty space between the two numbers. The same rule is to be observed, whenever you find a space already filled.

You proceed in this manner to fill all the empty cases in the angle where the 15 is placed; and as there is no space for the 16 in the same diagonal, descending, you must place it in the part it would hold in another square, and continue the same plan till all the spaces are filled. This method will serve equally for all sorts of arithmetic progressions composed of odd numbers; even numbers being too complicated to afford any amusement.

To find the difference between two Numbers, the greatest of which is unknown.

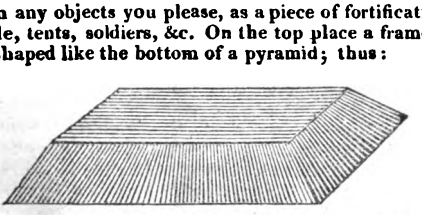
TAKE as many nines as there are figures in the smallest number, and subtract that sum from the number of nines. Let another person add that difference to the largest number, and taking away the first figure of the amount, add it to the last figure, and that sum will be the difference of the two numbers.

For example, Robert, who is 22, tells George, who is older, that he can discover the difference of their ages; he therefore privately deducts 22 from 99, and the difference, which is 77, he tells George to add to his age, and to take away the first figure from the amount, and add it to the last figure, and that last sum will be the difference of their ages. Thus, the difference between

Robert's age and 99, is	77
To which George adding his age	35
The sum.....	112
	12
	1
Then by taking away the first figure 1, and adding it to the last figure 2, the sum is	13
Which added to Robert's age.....	22
Gives George's age, which is.....	35

The Magic Mirrors.

TAKE a square box, about six inches long and twelve high, or of any other proportionate dimensions. Cover the inside with four flat pieces of looking glass placed perpendicular to the bottom of the box. Place at the bottom any objects you please, as a piece of fortification, a castle, tents, soldiers, &c. On the top place a frame of glass shaped like the bottom of a pyramid; thus:



and so formed as to fit on the box like a cover. The four sides of this cover are to be composed of ground glass or covered inside with gauze, so that the light may enter, and yet the inside be invisible, except at the top, which must be covered with transparent glass; when you look through this glass, the inside will prevent a pleasing prospect of a boundless extent; and if managed with care, will afford a deal of amusement.

To set Fire to a combustible Body by Reflection.

PLACE two concave mirrors at about twelve feet distance from each other, and let the axis of each be in the same line. In the focus of one of them place a live coal, and in the focus of the other some gunpowder. With a pair of strong bellows keep blowing the coal, and notwithstanding the distance between them, the powder will presently take fire.

The mirror may be either made of glass, metal or pasteboard gilt.

To find the Number of Changes that may be rung on Twelve Bells.

Multiply the numbers from 1 to 12 continually into each other, as follow; and the last product will give the number required.

1
2
—
2
3
—
6
4
—
24
5
—
120
6
—
720
7
—
5,040
8
—
40,320
9
—
362,880
10
—
3,628,860
11
—
39,916,800
12
—
479,001,600
—

To find how many square Yards it would require to write all the Changes of the Twenty-four Letters of the Alphabet, written so small that each Letter should not occupy more than the hundredth part of a square Inch.

By adopting the plan of the preceding article the changes of the twenty-four letters will be found to be

62,044,840,173,323,943,936,000

Now the inches in a square yard being 1,296, that number multiplied by 100 gives 129,600, which is the number of letters each square yard will contain, therefore if we divide the above row of figures, (the number of changes) by 129,600, the quotient, which is 478,741,050,720,092,160, will be the number of yards required, to contain the above mentioned number of changes. But as all the 24 letters are contained in every permutation, it will require a space 24 times as large, *viz.*

11,849,785,217,282,211,840.

Now as the surface of the whole globe only contains 617,197,435,008,000 square yards, it would require a surface 18,620 times as large as the earth to contain them.

The Enchanted Bottle.

Fill a glass bottle with water to the beginning of the neck; leave the neck empty, and cork it. Suspend this bottle opposite a concave mirror, and beyond its focus, that it may appear reversed. Place yourself still further distant from the bottle; and instead of the water appearing, as it really is, at the bottom of the bottle, the bottom will be empty, and the water seem at the top.

If the bottle be suspended with the neck downwards, it will be reflected in its natural position, and the water at the bottom; although, in reality, it is inverted, and fills the neck, leaving the bottom vacant. While the bottle is in this position, uncork it, and let the water run gradually out: it will appear, that while the real bottle is emptying, the reflected one is filling. Care must be taken that the bottle is not more than half of

three parts full, and that no other liquid is used but water, as in either of these cases, the illusion ceases.

The Solar Magic Lantern.

MAKE a box, a foot high, eighteen inches wide, and about three inches deep. Two of the opposite sides of this box must be quite open, and in each of the other sides let there be a groove wide enough to admit a stiff paper or pasteboard. You fasten the box against a window, on which the sun's rays fall direct. The rest of the window should be closed up, that no light may enter.

Next provide several sheets of stiff paper, blacked on one side. On these papers cut out such figures as your fancy may dictate; place them alternately in the grooves of the box, with their blacked sides towards you, and look at them through a large and clear glass prism; and if the light be strong, they will appear painted with the most lively colours. If you cut on one of these papers the form of a rainbow, about three-quarters of an inch wide, you will have a very good representation of the natural one.

For greater convenience, the prism may be placed on a stand on the table, made to turn round on an axis.

The Artificial Rainbow.

OPPOSITE a window into which the sun shines direct, suspend a glass globe, filled with clean water, by means of a string that runs over a pulley, so that the sun's rays may fall on it. Then drawing the globe gradually up, you will observe, when it comes to a certain height, and by placing yourself in a proper situation, a purple colour in the glass; and by drawing it up gradually higher, the other prismatic colours, blue, green, yellow, and red, will successively appear; after which, the colours will disappear, till the globe is raised to about fifty degrees, when they will again appear, but in an inverted order, the red appearing first, and the blue or violet last; on raising the globe a little higher, they will totally vanish.

The Æolipiles.

THE æolipile is a small hollow globe of brass, or other metal, in which a slender neck or pipe is inserted. This ball, when made red hot, is cast into a vessel of water, which will rush into its cavity, then almost void of air. The ball being then set on the fire, the water, by the rarefaction of the internal air, will be forced out in steam by fits, with great violence, and with a strange noise.

If to the necks of two or more of these balls, there be fitted those calls that are used by fowlers and hunters, and the balls placed on the fire, the steam rushing from them will make such a horrible noise, that it will astonish any person who is ignorant of the contrivance.

The Talking Busts.

PROCURE two busts of plaster of Paris, place them on pedestals, on the opposite sides of a room. Let a tin tube, of an inch diameter, pass from the ear of one head through the pedestal, under the floor, and go up to the mouth of the other; taking care that the end of the tube that is next the ear of the one head, should be considerable larger than that end which comes to the mouth of the other.

Now when a person speaks quite low into the ear of one bust, the sound is reverberated through the length of the tube, and will be distinctly heard by any one placing his ear to the mouth of the other. It is not necessary that the tube should come to the lips of the bust. If there be two tubes, one going to the ear, and the other to the mouth of each head, two persons may converse together, by whispers, without the knowledge of any person who may stand in the middle of the room.

The inanimate Oracle.

PLACE a bust on a pedestal in the corner of a room, and let there be two tubes, as in the preceding article, one to go from the mouth, and the other from the ear,

through the pedestal and the floor to an under apartment. There may be also wires, that go from the under jaw, and the eyes of the bust, by which they may be easily moved.

A person being placed in the room underneath, and applying his ear to one of the tubes at a signal given, will hear any question asked, and can immediately reply, by applying his mouth to the tube which communicates below, at the same time moving the eyes by the wire, to accompany his speech.

The Solar Concerto.

In a large case, similar to what is used for dials, and spring clocks, the front of which, or at least the lower part must be of glass, covered on the inside with gauze, place a barrel organ, which when wound up is prevented from playing by a catch that takes a toothed wheel at the end of the barrel. To one end of this catch, join a wire, at the end of which is a flat circle of cork, of the same dimensions with the inside of a glass tube, in which it is to rise and fall. This tube must communicate with a reservoir that goes across the front part of the bottom of the case, which is to be filled with spirits, such as is used in thermometers.

This case being placed in the sun, the spirits will be rarefied by the heat, and rising in the tube, will lift up the catch or trigger, and set the organ in play; which will continue as long as it is kept in the sun; for the spirits cannot run out of the tube, that part of the catch to which the circle is fixed being prevented from rising beyond a certain point, by a check placed over it. Care must be taken to remove the machine out of the sun before the organ runs down, that its stopping may be evidently effected by the cold.

In winter it will perform when placed before the fire.

CURIOUS EXPERIMENTS WITH THE MAGIC LANTERN.

THE construction of this amusing optical machine is so well known, that to describe it would be superfluous; particularly as it can now be purchased at a very reasonable expence, at any of the optician's: but as many persons who have a taste for drawing might not be pleased with many designs to be had at the shops, or might wish to indulge their fancy in a variety of objects, which to purchase would become expensive; we here present our readers, in the first place, with the method of drawing them, which will be succeeded by a plain description of some very diverting experiments.

Of Painting the Glasses.

YOU first draw on a paper, the size of the glass, the subject you mean to paint: fasten this at each end of the glass with paste, or any other cement, to prevent it from slipping. Then with some very black paint mixed with varnish, draw with a fine camel's hair pencil, very lightly, the outlines sketched on the paper, which, of course, are reflected through the glass. Some persons affirm that these outlines can be more readily traced with japan writing ink, and a common pen with a fine nib; but this, even if it succeeds in making a delicate black outline, is likely to be effaced by damp or wet.

It would add to the natural resemblance, if the outlines were drawn with a strong tint of each of the natural colours of the object: but in this respect you may please your own fancy. When the outlines are dry, colour and shade your figures; but observe, to temper your colours with strong white varnish. A pleasing effect will be produced, if you leave strong lights in some parts of the drapery, &c. without any colours. The best colours for this purpose are transparent ones; opaque or mineral colours will not do. The following are in most repute.

For Pink and crimson use ..	Lake or carmine.
Blue	Prussian blue.
Green	Calcined verdigris, or distilled ditto.
Yellow	Gumboge, or Chrome Yellow.

To represent a Storm at Sea.

PROVIDE two strips of glass, whose frames are thin enough to admit both strips freely into the groove of the lantern. On one of these glasses paint the appearance of sea from a smooth calm to a violent storm, (see Fig. 8.) Let these representations run gradually into each other, as in the figure; and you will of course observe that the more natural and picturesque the painting is, the more natural and pleasing will be the reflection.

On the other glass, (Fig. 9,) paint various vessels on the ocean, observing to let that end where the storm is, appear in a state of violent commotion, and the vessels as if raised on the waves in an unsettled position, with heavy clouds above them.

You then pass the glasses slowly through the groove, and when you come to that part where the storm is supposed to begin, move them gently up and down, which will give the appearance of the sea and vessels being agitated; increase the motion till they come to the height of the storm. You will thus have a very natural representation of the sea and ships in a calm and storm; and as you gradually draw the glasses back, the tempest will subside, the sky appear clear, and the vessels glide gently over the waves.

By the means of two or three glasses, you may also represent a battle on land, or a naval engagement, with a variety of other pleasing experiments.

To produce the appearance of a Spectre on a Pedestal in the Middle of a Table.

ENCLOSE a small magic lantern in a box, (see Fig. 10,) large enough to contain a small swing dressing-glass,

which will reflect the light thrown on it by the lantern in such a way that it will pass out at the aperture made in the top of the box, which aperture should be oval, and of a size adapted to the cone of light to pass through it. There should be a flap with hinges, to cover the opening, that the inside of the box may not be seen.

There must be holes in that part of the box which is over the lantern, to let the smoke out; and over this must be placed a chaffing-dish of an oblong figure, large enough to hold several lighted coals. This chaffing-dish, for the better carrying on the deception, may be inclosed in a painted tin box, about a foot high, with a hole at top, and should stand on four feet, to let the smoke from the lantern escape.

There must also be a glass planned to rise up and down in the groove *a b*, and so managed by a cord and pulley, *c d e f*, that it may be raised up and let down by the cord coming through the outside of the box. On this glass, the spectre, (or any other figure you please,) must be painted, in a contracted or squat form, as the figure will reflect a greater length than it is drawn.

When you have lighted the lamp in the lantern, and placed the mirror in a proper direction, put the box on a table, and setting the chaffing-dish in it, throw some incense in powder on the coals. You then open the trap door and let down the glass in the groove slowly, and when you perceive the smoke diminish, draw up the glass that the figure may disappear, and shut the trap door.

This exhibition will afford a deal of wonder; but observe, that all the lights in the room must be extinguished; and the box should be placed on a high table, that the aperture may not be seen, through which the light comes out.

There are many other pleasing experiments which may be made with the magic lantern, but the limits of our work will not permit us to specify them, without excluding many other equally interesting subjects of a different nature.

The Boundless Prospect.

PROCURE a box (see Fig. 11) of about a foot long, eight inches wide, and six inches high; or any other dimensions you please; so they do not greatly vary from these proportions. At each of its opposite ends, on the inside of this box, place a piece of looking-glass that shall exactly fit; but at that end where the sight-hole A is, scrape the quicksilver off the glass, through which the eye can view the objects.

Cover the box with gauze, over which place a piece of transparent glass, which is to be well fastened in. Let there be two grooves at each of the places C D E F, to receive two painted scenes as follow: On two pieces of pasteboard, let there be skilfully painted, on both sides, any subject you think proper, as woods, bowers, gardens, houses, &c. and on two other boards, the same subjects on one side only, and cut out all the white parts: observe also, that there ought to be in one of them some object relative to the subject placed at A, that the mirror placed at B may not reflect the hole on the opposite side.

The boards painted on both sides are to slide in the grooves C D E F, and those painted on one side are to be placed against the opposite mirrors A and B; then cover the box with its transpararent top. This box should be placed in a strong light, to have a good effect.

When it is viewed through the sight-hole, it will present an unlimited prospect of rural scenery, gradually losing itself in obscurity; and be found well worth the pains bestowed on its construction.

To draw, easily and correctly, a Landscape, or any other object, without being obliged to observe the rules of perspective, and without the aid of the Camera Obscura.

PROCURE a box of pasteboard, ABCD, (Fig. 12,) of about a foot and a half long, and made in the shape of a truncated pyramid, whose base, BDFG, is eight inches

wide, and six inches high. Fix to the other end of it a tube of four or five inches long, and which you can draw out from the box more or less. Line the inside of the box with black paper, and place it upon a leg or stand of wood, H, and on which it may be elevated or depressed by the hinge, I.

Take a small frame of wood, and divide it at every inch by lines of black silk drawn across it, forming forty-eight equal parts; divide these into still smaller equal parts, by lines of finer silk*: fix this frame at the end of BD, as the base of the pyramid.

Provide a drawing paper, divided into the same number of parts as is the frame, by lines lightly drawn in pencil. It is not material of what size these divisions are; that will depend entirely on the size you propose to draw the objects by this instrument.

Place this instrument opposite a landscape, or any other object that you want to draw, and fix the leg firmly on, or in the ground, that it may not shake: then turning it to the side you choose, raise or incline it, and put the tube further in or out, till you have gained an advantageous view of the object you intend to draw.

Place your eye, E, by the instrument, which you have adjusted to the height of your eye, and looking through the tube, carefully observe all that is contained in each division of the frame, and transpose it to the corresponding division in your paper: and if you have the least knowledge in painting, or even drawing, you will make a very pleasing picture, and one in which all the objects will appear in the most exact proportion.

By the same method you may draw all sorts of objects, as architecture, views, &c. and even human figures, if they remain some time in the same attitude, and are at a proper distance from the instrument.

* The different thicknesses of the silk serve to distinguish more readily the corresponding divisions.

Illuminated Prospects.

PROVIDE yourself with some of those prints that are commonly used in optical machines, printed on very thin white paper; taking care to make choice of such as have the greatest effect from the manner in which the objects are placed in perspective. Paste one of these on the borders of a frame, and paint it carefully with the most lively colours, making use of none that are terrestial. Observe to retouch those parts several times where the engraving is strongest*, then cut off the upper part or sky, and fix that on another frame.

The prints being thus prepared, place them in a box, ABCD, (Figs. 13 and 14,) the opening to which, EFGH, should be a little less than the print. Cover this opening with a glass, and paint all the space between that and the prints, which should be about two or three inches, black. The frame that contains the sky should be about an inch behind the other. In the back part of this box, which is behind the prints, and which may be about four inches deep, place four or five small candlesticks to hold wax lights, and cover that part entirely with tin, that it may be the more luminous.

When the print is placed between the wax lights and the opening in the front of the box, and there is no other light in the room, the effect will be highly pleasing; especially if the lights are at a sufficient distance from each other, and not too strong, that they may not occasion any blots in the print. Those prints that represent the rising or setting of the sun will have a very picturesque appearance. Such as represent conflagrations have also a striking effect.

There should be two grooves for the print next the glass, that you may insert a second subject before you draw away the first: and that the lights in the back of the box may not be discovered.

You must not, thinking to make the print more trans-

* When you colour a print, place it before you, against a piece of glass, in a position nearly erect, that it may be enlightened by the sun. You may also colour both sides of the print.

parent, cover it with varnish; for that will prevent the gradation of the colours from being visible. The frame should enter the side of a box by a groove, that a variety of subjects may be introduced.

EXPERIMENTS IN MAGNETISM.

The Magnetic Wand.

Bore a hole, three-tenths of an inch diameter, through a round stick of wood; or get a hollow cane about eight inches long, and half an inch thick. Provide a small steel rod, and let it be very strongly impregnated with a good magnet; this rod is to be put in the hole you have bored through the wand, and closed at each end by two small ends of ivory that screw on, different in their shapes, that you may better distinguish the poles of the magnetic bar.

When you present the north pole of this wand to the south* pole of a magnetic needle, suspended on a pivot, or to a light body swimming on the surface of the water (in which you have placed a magnetic bar), that body will approach the wand, and present that end which contains the south end of the bar; but if you present the north or south end of the wand, to the north or south end of the needle, it will recede from it.

The Mysterious Watch.

You desire any person to lend you his watch, and ask him if it will go when laid on the table. He will, no doubt, say it will; in which case, you place it over the end of the magnet, and it will presently stop. You then mark the precise spot where you placed the watch, and moving the point of the magnet, you give the watch

* For the more clearly explaining this, it is to be observed, that the two ends of a magnet are called its poles. When placed on a pivot, in just equilibrium, that end which turns to the north is called the north pole, and the other end the south pole.

to another person, and desire him to make the experiment; in which he not succeeding, you give it to a third (at the same time replacing the magnet) and he will immediately perform it.

This experiment cannot be effected, unless you use a very strongly impregnated magnetic bar, (which may be purchased at the optician's) and the balance of the watch must be of steel, which may be easily ascertained by previously opening it, and looking at the works.

The Magnetic Dial.

PROCURE a circle of wood or ivory, of about 5 or 6 inches diameter, which must turn quite free on a stand with a circular border; on the ivory or wood circle fix a pasteboard, on which you place, in proper divisions, the hours, as on a dial. There must be a small groove in the circular frame to receive the pasteboard circle, and observe, that the dial must be made to turn so free, that it may go round without moving the circular border in which it is placed.

Between the pasteboard circle and the bottom of the frame, place a small artificial magnet, that has a hole in its middle. On the outside of the frame, place a small pin, which serves to shew when the magnetic needle, is to stop. This needle must turn quite free on its pivot, and its two sides should be in exact equilibrio.

Then provide a small bag, with five or six divisions, like a lady's work bag, but smaller. In one of these divisions put small square pieces of pasteboard, on which are written the numbers from 1 to 12. In each of the other divisions put twelve or more similar pieces, observing that all the pieces in each division must be marked with the same number. The needle being placed upon its pivot, and turned quickly about, it will necessarily stop at that point where the north end of the magnetic bar is placed, and which you previously know, by the situation of the small pin in the circular border.

You then present to any person that division of the bag which contains the several pieces, on which is

written the number opposite to the north end of the bar, and tell him to draw any one he pleases. Then placing the needle on the pivot, you turn it quickly about, and it must necessarily stop at that particular number.

The Magnetic Cards.

DRAW a pasteboard circle; you then provide yourself with two needles, similar to those used in the foregoing experiment, (which you must distinguish by some private mark) with their opposite points touched with the magnet. When you place that needle, whose pointed end is touched, on the pivot described in the centre of the circle, it will stop on one of the four pips, against which you have placed the pin in the frame; then take that needle off, and placing the other, it will stop at the opposite point.

Having matters thus arranged, desire a person to draw a card from a piquet pack, offering that card against which you have placed the pin of the dial, which you may easily do, by having a card a little longer than the rest. If he should not draw it the first time, as he probably may not, you must make some excuse for shuffling them again, such as letting the cards fall, as if by accident, or some other manœuvre, till he fixes on the card. You then tell him to keep it close, and not let it be seen. Then give him one of the two needles, and desire him to place it on the pivot, and turn it round, when it will stop at the colour of the card he chose; then taking that needle off, and exchanging it unperceived for the other, give it to a second person, telling him to do the same, and it will stop at the name of the identical card the first person chose.

The Magnetic Orrery.

CONSTRUCT a round box, (Fig. 15) about eight inches diameter, and half an inch deep. On the bottom fix a circular pasteboard drawn like the figure. You are likewise to have another pasteboard, drawn exactly the

same, which must turn freely in the box, by means of an axis placed on a pivot, one end of which is to be fixed in the centre of the circle.

On each of the seven smaller circles on the pasteboard, which you have fixed at the bottom of the box, place a magnetic bar, two inches long, in the same direction with the diameters of those circles, and their poles, in the situations expressed in the figure.

There must be an index like the hour-hand of a dial, fixed on the axis of the central circle, by which the pasteboard circle in the box may be turned about; also a needle (forming in the figure the other hand) that will turn freely on the axis, without moving the circular pasteboard.

In each of the places where the word *question* is, write a different question; and in each of the seven circles where the planetary signs are, write two answers to each question; observing, that there must only be seven words in each answer: for instance,

In division No. 1, of the circle G, which stands opposite question No. 1, write the first word of the first answer. In the division No. 2, of the next circle, write the second word; and so on to the last, which will be in the seventh division of the seventh circle.

In the eighth division of the first circle, write the first word of the second answer; in the ninth, the second word of the same answer; and so on to the fourteenth division of the seventh circle, which must contain the last word of that answer.

The same must be done for all the seven questions, and to each of these must be assigned two answers, the words of which are to be dispersed through the seven circles.

At the centre of each of these circles place a pivot, and have two sets of magnetic needles like the hands of a watch, the pointed end of one set being north, and the other south.

Now the index of the central circle being directed to any one of the questions, if you place one of the two magnetic needles on each of the seven lesser circles, they will fix themselves according to the directions of the

bars on the corresponding circles at the bottom of the box, and consequently point to the seven words that compose the answer. If you place one of the other needles on each circle, it will point to the words that are diametrically opposite to those of the first answer, the north pole being in the place of the south pole of the other.

You therefore present this orrery to any person, and desire him to choose one of the questions there written. You then set the index of the central circle to that question; and putting one of the needles on each of the, seven circles, you turn it about, and when they all settle the seven words they point to compose the answer.

The moveable needle, whose point in the figure stands at September, is to place against the names of the months; and when the party has fixed upon a question, you place that needle against the month in which he was born, which will make the ceremony appear a sort of magic divination. The planetary signs are merely intended to aid this deception, and give it the appearance of astrology.

The Magic Verse.

THE eight words which compose this Latin verse

"*Tot sunt tibi dotes quot cœli sidera, virgo.*"*

being privately placed in any one of the different combinations, of which they are susceptible, and which are 40,320 in number, to tell the order in which they are placed.

Provide a box that shuts with hinges, and is eight inches long, three wide, and half an inch deep, (Fig. 16,) Have eight pieces of wood, about one-third of an inch thick, two inches long, and one and a half wide, which will therefore, when placed close together, exactly fill the box. In each of these pieces or tablets place a magnetic bar, with their poles as is expressed in Fig. 17. The bars being covered over, write on each of

* "Thy charms, Oh! Virgin! are as numerous as the stars of heaven."

the tablets, in the order they then stand, one of the words of the foregoing Latin verse.

On a very thin board of the same dimension with the box, draw the eight circles, (Fig. 17,) A B C D E F G H, whose centres should be exactly over those of the eight tablets in the box, when the board is placed upon it. Divide each of those circles into eight parts, as in the figure, and in each of those divisions write one of the words of the Latin verse, and in the precise order expressed in the plate, so that when the board is placed over the box, the eight touched needles placed at the center of the circles may be regulated by the poles of the bars in the box, and consequently the word that the needle points to in the circle be the same with that inscribed on the tablet. Cover the board with a glass to prevent the needles from rising off their pivots, as is done in the sea-compass.

Over the board place four plates of glass, I L M N, (Fig. 16,) which will give the machine the figure of a truncated pyramid, of eight inches high. Cover it with a glass, or rather a board, in which are placed two lenses O, of eight inches focus, and distant from each other about half an inch. Line the four plates of glass that compose the sides with very thin paper, that will admit the light, and at the same time prevent the company from seeing the circles on the board.

These preparations being made, you give the box to any one, and tell him to place the tablets on which the words are wrote privately, in what position he thinks proper, then to close the box, and if he please, to wrap it up in paper, seal it, and give it to you. Then placing the board with the pyramid upon it, you immediately tell him the order in which the tablets are placed, by reading the words to which the needles on the circles point.

INTERESTING EXPERIMENTS WITH THE AIR PUMP.

We shall not occupy the time of our readers by describing the form and nature of the air pump; since those persons whose circumstances will enable them to have it, can purchase it properly made at an optician's, at less expence, and with far less trouble, than they can construct, or cause it to be constructed themselves.

Bottles broken by Air.

Take a square bottle of thin glass, and of any size. Apply it to the hole in the air pump, and exhaust the air. The bottle will sustain the weight of the external air as long as it is able, but at length it will suddenly burst into very small particles, and with a loud explosion.

An opposite effect will be produced, if the mouth of a bottle be sealed so close that not any air can escape; then place it in the receiver, and exhaust the air from its surface. The air which is confined within the bottle, when the external air is drawn off, will act so powerfully as to break the bottle into pieces.

Glass broken by Air.

Lay a square of glass on the top of an open receiver, and exhaust the air. The weight of the external air will press on the glass, and smash it to atoms.

The Hand fixed by Air.

If a person hold his hand on an open receiver, and the air be exhausted, it will be fixed as if pressed by a weight of sixty pounds.

Water boiled by Air.

TAKE water made so warm that you can just bear your hand in it, but that has not been boiled; put it under the receiver, and exhaust the air. Bubbles of air will soon be seen to rise, at first very small, but presently become larger, and will be at last so great, and rise with such rapidity, as to give the water the appearance of boiling. This will continue till the air is let into the receiver, when it will instantly cease.

Aërial Bubbles.

TAKE a stone, or any heavy substance, and putting it in a large glass with water, place it in the receiver. The air being exhausted, the spring of that which is in the pores of the solid body, by expanding the particles, will make them rise on its surface in numberless globules which resemble the pearly drops of dew on the tops of the grass. The effect ceases when the air is let into the receiver.

The floating Stone.

To a piece of cork tie a small stone that will just sink it; and putting it in a vessel of water, place it under the receiver. Then exhausting the receiver, the bubbles of air will expand from its pores, and adhering to its surface, will render it, together with the stone, lighter than water, and consequently they will rise to the surface and float.

Withered Fruit restored.

TAKE a shrivelled apple, and placing it under the receiver, exhaust the air. The apple will immediately be plumped up, and look as fruit when first gathered; for this reason, that the pressure of the external air being taken off, the air in the apple extends it, so much indeed that it will sometimes burst. If the air is let into the

receiver, the apple will be restored to its pristine shrivelled state.

Vegetable Air Bubbles.

PUT a small branch of a tree with its leaves, or part of a small plant, in a vessel of water, and placing the vessel in the receiver, exhaust the air.

When the pressure of the external air is taken off, the spring of that contained in the air vessels of the plant, by expanding the particles, will make them rise from the orifices of all the vessels for a long time together, and produce a most beautiful appearance.

The Mercurial Wand.

TAKE a piece of stick, cut it even at each end with a penknife, and immerse it in a vessel of mercury. When the air is pumped out of the receiver, it will at the same time come out of the pores of the wood, through the mercury, as will be visible at each end of the stick. When the air is again let into the receiver, it falls on the surface of the mercury, and forces it into the pores of the wood to possess the place of the air.

When the rod is taken out it will be found considerably heavier than before, and that it has changed its colour, being now all of over a blueish hue. If cut transversely, the quicksilver will be seen to glitter in every part of it.

The Magic Bell.

FIX a small bell to the wire that goes through the top of the receiver. If you shake the wire, the bell will ring while the air is in the receiver; but when the air is drawn off, the sound will by degrees become faint, till at last not the least noise can be heard. As you let the air in again, the sound returns.

Feathers heavier than Lead.

AT one end of a fine balance, hang a piece of lead, and at the other, as many feathers as will poise it; then place the balance in the receiver. As the air is exhausted, the feathers will appear to overweigh the lead, and when all the air is drawn off, the feathers will preponderate, and the lead ascend.

The Self Moving Wheel.

TAKE a circle of tin, about ten inches in diameter, or of any other size that will go into the receiver, and to its circumference fix a number of tin vanes, each about an inch square. Let this wheel be placed between two upright pieces on an axis, whose extremities are quite small, so that the wheel may turn in a vertical position with the least possible force. Place the wheel and axis in the receiver, and exhaust the air. Let there be a small pipe with a cock; one end of the pipe to be outside the top of the receiver, and the other to come directly over the vanes of the wheel.

When the air is exhausted, turn the cock, and a current will rush against the vanes of the wheel, and set it in motion, which will increase, till the receiver is filled with air.

The Artificial Halo.*

PLACE a candle on one side of a receiver, and let the spectator place himself at a distance from the other side. Directly the air begins to be exhausted, the light of the candle will be refracted in circles of various colours.

Mercurial Shower.

CEMENT a piece of wood into the lower part of the neck of an open receiver, and pour mercury over it. After a few strokes of the pump the pressure of the air

* *Halo*, a circle of light round the sun.

on the mercury will force it through the pores of the wood in form of a beautiful shower. If you take care that the receiver is clear and free from spots or dust, and it is dry weather, it will appear like a fiery shower, if exhibited in a dark room.

Magic Fountain.

TAKE a tall glass tube, hermetically sealed both at top and bottom, by means of a brass cap screwed on to a stop cock, and that to the plate of the pump. When the air is exhausted, turn the cock, take the tube off the plate, and plunge it into a bason of mercury or water. Then the cock being again turned, the fluid, by the pressure of the air, will play upon the tube, in the form of a beautiful fountain.

The Exploded Bladder.

TAKE a glass pipe open at both ends, to one of which tie fast a wet bladder, and let it dry. Then place it on the plate of the pump. While the air presses the bladder equally on both sides, it will lie even and strait; but as soon as the air is exhausted, it will press inwards, and be quite concave on the upper side. In proportion as the air is exhausted, the bladder will become more stretched; it will soon yield to the incumbent pressure, and burst with a loud explosion. To make this experiment more easy, one part of the bladder should be scraped with a knife, and some of its external fibres taken off.

The Cemented Bladder.

TIE the neck of a bladder to a stop cock, which is to be screwed to the plate of the pump, and the air exhausted from the bladder; then turn the stop cock to prevent the re-entrance of the air, and unscrew the whole from the pump. The bladder will be transformed into two flat skins, so closely applied together, that the

strongest man cannot raise them half an inch from each other; for an ordinary sized bladder, of six inches across the widest part, will have one side pressed upon the other with a force equal to 396 pounds weight.

Cork heavier than Lead.

LET a large piece of cork be pendent from one end of a balance beam, and a small piece of lead from the other; the lead should rather preponderate. If this apparatus is placed under a receiver on the pump, you will find that when the air is exhausted, the lead, which seemed the heaviest body, will ascend, and the cork outweigh the lead. Restore the air, and the effect will cease. This phenomenon is only on account of the difference of the size in the two objects. The lead, which owes its heaviness to the operation of the air, yields to a lighter because a larger substance when deprived of its assistance.

The animated Bacchus.

CONSTRUCT a figure of Bacchus, seated on a cask; let his belly be formed by a bladder, and let a tube proceed from his mouth to the cask. Fill this tube with coloured water or wine, then place the whole under the receiver. Exhaust the air, and the liquor will be thrown up into his mouth. While he is drinking, his belly will expand.

The Artificial Balloon.

TAKE a bladder containing only a small quantity of air, and a piece of lead to it, sufficient to sink it, if immersed in water. Put this apparatus into a jar of water, and place the whole under a receiver. Then exhaust the air, and the bladder will expand, become a balloon lighter than the fluid in which it floats, and ascend, carrying the weight with it.

Curious Experiment with a Viper.

MANY natural philosophers, in their eagerness to display the powers of science, have overlooked one of the first duties of life, humanity; and, with this view, have tortured and killed many harmless animals, to exemplify the amazing effects of the air-pump. We, however, will not stain the pages of this little work by recommending any such species of cruelty, which in many instances can merely gratify curiosity; but as our readers might like to read the effect on animals, we extract from the learned Boyle, an account of his experiment on a viper.

He took a newly-caught viper, and shutting it up in a small receiver, extracted the air. At first, upon the air's being drawn away, it began to swell: a short time after it gaped and opened its jaws; it then resumed its former lankness, and began to move up and down within the receiver, as if to seek for air. After a while, it foamed a little, leaving the foam sticking to the inside of the glass: soon after, the body and neck became prodigiously swelled, and a blister appeared on its back. Within an hour and a half from the time the receiver was exhausted, the distended viper moved, being yet alive, though its jaws remained quite stretched; its black tongue reached beyond the mouth, which had also become black in the inside: in this situation it continued for three hours; but on the air's being re-admitted, the viper's mouth was presently closed, and soon after opened again; and these motions continued some time, as if there were still some remains of life.

It is thus with animals of every kind; even minute microscopical insects cannot live without air.

Experiments with Sparrows.

COUNT Morozzo placed successively several full-grown sparrows under a glass receiver, inverted over water. It was filled with atmospheric air, and afterwards with vital air. He found,

First,—That in *atmospheric* air,	HOURS.	MIN.
The first sparrow lived	3	0
The second sparrow lived	0	3
The third sparrow lived	0	1

The water rose in the vessels eight lines during the life of the first; four during the life of the second; and the third produced no absorption.

Second,—In *vital* air, or *oxygen*	HOURS.	MIN.
The first sparrow lived	5	23
The second	2	10
The third	1	30
The fourth	1	10
The fifth	0	50
The sixth	0	47
The seventh	0	27
The eighth	0	30
The ninth	0	22
The tenth	0	21

The above experiments elicit the following conclusions:—1. That an animal will live longer in vital than in atmospheric air.—2. That one animal can live in air, in which another has died.—3. That, independent of air, some respect must be had to the constitution of the animal; for the sixth lived 47 minutes, the fifth only thirty.—4. That there is either an absorption of air, or the production of a new kind of air, which is absorbed by the water as it rises.

AMUSING EXPERIMENTS IN ELECTRICITY.

The Animated Feather.

ELECTRIFY a smooth glass tube with a rubber, and hold a small feather at a short distance from it. The feather will instantly fly to the tube, and adhere to it for a short time; it will then fly off, and the tube can never be brought close to the feather till it has touched the side of the room, or some other body that communicates

with the ground. If, therefore, you take care to keep the tube between the feather and the side of the room, you may drive it round to all parts of the room without touching it; and what is very remarkable, the same side of the feather will be constantly opposite the tube.

While the feather is flying before the smooth tube, it will be immediately attracted by an excited rough tube or a stick of wax, and fly continually from one tube to the other, till the electricity of both is discharged.

The Artificial Spider.

CUT a piece of burnt cork, about the size of a pea, into the shape of a spider; make its legs of linen thread, and put a grain or two of lead in it to give it more weight. Suspend it by a fine line of silk, between an electrified arch and an excited stick of wax; and it will jump continually from one body to the other, moving its legs at the same time, as if animated, to the great surprise of the unconscious spectator.

The Miraculous Portrait.

GET a large print (suppose of the king) with a frame and glass. Cut the print out at about two inches from the frame all round; then with thin paste fix the border that is left on the inside of the glass, pressing it smooth and close; fill up the vacancy, by covering the glass well with leaf-gold or thin tin-foil, so that it may lie close. Cover likewise the inner edge of the bottom part of the back of the frame with the same tin-foil, and make a communication between that and the tin-foil in the middle of the glass; then put in the board, and that side is finished. Next turn up the glass, and cover the fore side with tin-foil, exactly over that on the back part; and when it is dry, paste over it the pannel of the print that was cut out, observing to bring the corresponding parts of the border and pannel together, so that the picture will appear as at first, only part of it behind the glass, and part before. Lastly, hold the print horizon-

tally by the top, and place a little moveable gilt crown on the king's head.

Now if the tin-foil on both sides of the glass be moderately electrified, and another person take hold of the bottom of the frame with one hand, so that his fingers touch the tin-foil, and with the other hand attempt to take off the crown, he will receive a very smart blow, and fail in the attempt. The operator, who holds the frame by the upper end, where there is no tin-foil, feels nothing of the shock, and can touch the face of the king without danger, which he pretends is a test of his loyalty.

The Cup of Tantalus.

You place a cup of any sort of metal on a stool of baked wood or a cake of wax. Fill it to the brim with any liquor; let it communicate with the branch by a small chain; and when it is moderately electrified, desire a person to taste the liquor, without touching the cup with his hands, and he will instantly receive a shock on his lips. The motion of the wheel being stopped, you taste the liquor yourself, and desire the rest of the company to do so; you then give your operator (who is concealed in an adjoining room) the signal, and he again charges the cup; you desire the same person to taste the liquor a second time, and he will receive a second shock.

Magical Explosion.

MAKE up some gunpowder, in the form of a small cartridge, in each end of which put a blunt wire, so that the ends inside of the cartridge be about half an inch of each other; then joining the chain that proceeds from one side of the electrifying battery, to the wire at the other end, the shock will instantly pass through the powder, and set it on fire.

Artificial Earthquake.

In the middle of a large bason of water, lay a round wet board. On the board place any kind of building, made of pasteboard, of separate pieces, and not fastened together. Then fixing a wire that communicates with the two chains of the electrifying battery, so that it may pass over the board and the surface of the water, upon making the explosion, the water will become agitated as in an earthquake, and the board moving up and down, will overturn the structure, while the cause of the commotion is totally concealed.

The Magic Dance.

From the middle of the brass arch suspend three small bells. The two outer bells hang by chains, and the middle one by a silk string, while a chain connects it with the floor. Two small knobs of brass, which serve as clappers, hang by silk strings, one between each two bells. Therefore, when the two outer bells, communicating with the conductor, are electrified, they will attract the clappers and be struck by them. The clappers being thus loaded with electricity will be repelled, and fly to discharge themselves upon the middle bell, after which they will be again attracted by the outer bells; and thus, by striking the bells alternately, the ringing may be continued as long as the operator pleases.

You next suspend a plate of metal from the same part of the arch to which the bells are connected; then, at the distance of a few inches from the arch, and exactly under it, place a metal stand *of the same size*. On the stand place several figures of men, animals, or what you please, cut in paper, and pretty sharply pointed at each extremity. When the plate that hangs from the arch is electrified, the figures will dance with astonishing rapidity, and the bells will keep ringing to the no small entertainment of the spectators.

The Electrical Fountain.

SUSPEND a vessel of water from the middle of the brass arch, and place in the vessel a small tube. The water will at first issue by drops only from the lower part of the tube; but when the wheel is put in motion, there will be one continued stream of water; and if the electrification be strong, a number of streams will issue, in form of a cone, the top of which will be at the extremity of the tube. This experiment may be stopped and renewed almost instantly, as if at the word of command.

The Self-moving Wheel.

THIS wheel is formed of a thin round plate of window-glass, 17 inches diameter, well gilt on both sides, except two inches next the edge. You then fix two small hemispheres of wood, with cement, to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire, eight or ten inches long, which together form the axis of the wheel. It turns horizontally, on a point, at the lower end of its axis, which rests on a bit of brass, cemented within a glass salt-cellar. The upper end of its axis passes through a hole in a thin brass plate, cemented to a long and strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on the top to keep in the fire.

In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about eleven inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the gilding of the upper surface of the wheel; and about six inches from it is another bullet, communicating in like manner, with the under surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface to the table.

When well charged it begins to move. The bullet

nearest to a pillar moves towards the thimble on that pillar, and passing by, electrifies it, and then pushes itself from it. The succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being electrified before by the other bullet, and thus the wheel increases its motion, till it is regulated by the resistance of the air. It will go half an hour, and make, one minute with another, 20 turns in a minute, which are 600 turns in the whole. The bullet of the upper surface gives, in each turn, 12 sparks to the thimbles, those bullets moving 2,500 feet in the same time. The thimbles are well fixed, and in so exact a circle, that the bullets may pass within a very small distance of them.

The Magic Chase.

On the top of a finely-pointed wire, rising perpendicularly from the conductor, let another wire, sharpened at each end, be made to move freely, as on a centre. If it be well balanced, and the points bent horizontally, in opposite directions, it will, when electrified, turn very swiftly round, by the re-action of the air against the current which flows from off the points. These points may be nearly concealed, and the figures of men and horses, with hounds, and a hare, stag or fox, may be placed upon the wires, so as to turn round with them, when they will appear as in pursuit. The chase may be diversified, and a greater variety of figures put upon them, by increasing the number of wires proceeding from the same centre.

The Unconscious Incendiary.

Let a person stand upon a stool made of baked wood, or upon a cake of wax, and hold a chain which communicates with the branch. On turning the wheel he will become electrified; his whole body forming part of the prime conductor; and he will emit sparks whenever he is touched by a person standing on the floor.

If the electrified person puts his finger, or a rod of iron, into a dish containing warm spirits of wine, it will

be immediately in a blaze; and, if there be a wick or thread in the spirit, that communicates with a train of gunpowder, he may be made to blow up a magazine, or set a city on fire, with a piece of cold iron, and at the same time be ignorant of the mischief he is doing.

The Inconceivable Shock.

PUT in a person's hand a wire that is fixed on to the hook that comes from the chain, which communicates with one side of the battery, and in his other hand put a small wire with a hook at the end of it, which you direct him to fix on to the hook which comes from the other chain. On attempting to do this, he will instantly receive a shock from his body, without being able to guess the cause.

Care should be taken, that the shock be not too strong; and regard should be had to the constitution and disposition of the party, as a shock that would hardly affect one person, might be productive of very serious consequences to another.

Much entertainment may be derived from concealing the chain that communicates with that which proceeds from the outside of the battery, under a carpet, and placing the wire that communicates with the chain from the inside, in such a manner, that a person may put his hand on it without suspicion, at the same time that his feet are upon the other wire.

The whole company may be made to partake of the shock, by joining hands, and forming a circle. The experiment may also be varied if they tread upon each other's toes, or lay their hands on each other's heads. It might happen, by the latter method, that the whole company would be struck to the ground; but it will be productive of no danger, and very little inconvenience; on the contrary, it has happened that they have neither heard nor felt this shock.

To exhibit the following amusements in Electricity, the chamber or room, in which they are performed, must be darkened.

The Miraculous Luminaries.

YOU must previous prepare the following phosphorus: Calcine common oyster-shells, by burning them in the fire for half an hour; then reduce them to powder; of the clearest of which take three parts, and of flowers of sulphur one part; put the mixture into a crucible, about an inch and a half deep. Let it burn in a strong fire for rather better than an hour; and when it is cool turn it out and break it in pieces; and taking those pieces into a dark place, scrape off those parts that shine brightest, which, if good, will be a white powder.

Then construct a circular board, of three or four feet diameter, on the centre of which draw in gum water, or any adhesive liquid, a half moon, of three or four inches diameter, and draw a number of stars round it, at different distances, and of various magnitudes. Strew the phosphorus over the figures, to the thickness of about a quarter of an inch, laying one coat over the other. Place this board behind a curtain, and when you draw the curtain up or back, discharge one electrifying jar or phial over each figure, at the distance of about an inch, and they will become illuminated, exhibiting a very striking resemblance of the moon and stars; and will continue to shine for about half an hour, their splendour becoming gradually more faint.

The Fiery Shower.

ON the plate put a number of any kind of seeds, grains of sand, or brass dust. The conductor being strongly electrified, those light particles will be attracted and repelled by the plate suspended from the conductor, with amazing rapidity, so as to exhibit a perfect fiery shower.

Another way is by a sponge that has been soaked in water. When this sponge is first hung to the conductor, the water will drop from it very slowly; but when it is

electrified, the drops will fall very fast, and appear like small globes of fire, illuminating the basin into which they fall.

The Illuminated Vacuum.

TAKE a tall receiver that is very dry, and fix through the top of it, with cement, a blunt wire; then exhaust the receiver, and present the knob of the wire to the conductor, and every spark will pass through the vacuum in a broad stream of light, visible through the whole length of the receiver, let it be as tall as it will. This generally divides into a variety of beautiful rivulets, which are continually changing their course, uniting and dividing again in the most pleasing manner.

If a jar be discharged through this vacuum, it presents the appearance of a very dense body of fire, darting directly through the centre of the vacuum, without touching the sides; whereas, when a single spark passes through, it generally goes more or less to the side, and a finger placed on the outside of the glass, will draw it wherever a person pleases. If the vessel be grasped by both hands, every spark is felt like the pulsation of a large artery; and all the fire makes towards the hands. This pulsation is even felt at some distance from the receiver, and a light is seen between the hand and the glass.

All this while the pointed wire is supposed to be electrified positively; if it be electrified negatively, the appearance is astonishingly different; instead of streams of fire, nothing is seen but one uniform luminous appearance, like a white cloud, or the *milky way* in a clear starlight night. It seldom reaches the whole length of the vessel, but generally appears only at the end of the wire, like a lucid ball.

If a small phial be inserted in the neck of a small receiver, so that the external surface of the glass be exposed to the vacuum, it will produce a very beautiful appearance. The phial must be coated on the inside, and while it is charging, at every spark taken from the conductor into the inside, a flash of light is seen to dart

at the same time from every part of the external surface of the phial, so as to quite fill the receiver. Upon making the discharge, the light is seen to return in a much closer body, the whole coming out at once.

The Illuminated Cylinder.

PROVIDE a glass cylinder, three feet long, and three inches diameter; near the bottom of it fix a brass plate, and have another brass plate, so contrived that you may let it down the cylinder, and bring it as near the first plate as you desire. Let this cylinder be exhausted and insulated, and when the upper part is electrified, the electric matter will pass from one plate to the other, when they are at the greatest distance from each other that the cylinder will admit. The brass plate at the bottom of the cylinder will also be as strongly electrified as if it was connected by a wire to the prime conductor.

The electric matter, as it passes through this vacuum, presents a most brilliant spectacle, exhibiting sparkling flashes of fire the whole length of the tube, and of a bright silver hue, representing the most lively exhalations of the aurora borealis.

The Electric Aurora Borealis.

MAKE a Torricellian vacuum* in a glass tube, about three feet long, and hermetically sealed†. Let one end of this tube be held in the hand, and the other applied to the conductor; and immediately the whole tube will be illuminated from one end; and when taken from the conductor will continue luminous, without interruption, for a considerable time, very often above a quarter of an

* A Torricellian vacuum is made by filling a tube with pure mercury, and then inverting it, in the same manner as in making a barometer; for as the mercury runs out, all the space above will be a true vacuum.

† A glass is hermetically sealed by holding the end of it in the flame of a candle, till it begins to melt, and then twisting it together with a pair of pincers.

hour. If, after this, it be drawn through the hand either way, the light will be uncommonly brilliant, and, without the least interruption, from one hand to the other, even to its whole length. After this operation, which discharges it in a great measure, it will still flash at intervals, though it be held only at one extremity, and quite still; but if it be grasped by the other hand at the same time, in a different place, strong flashes of light will dart from one end to the other. This will continue for twenty-four hours, and often longer, without any fresh excitation. Small and long glass tubes, exhausted of air, and bent in many irregular crooks and angles, will, when properly electrified, exhibit a very beautiful representation of vivid flashes of lightning.

AMUSEMENTS WITH CARDS.

MANY of the following recreations are performed by arithmetical calculations; and may consequently be considered, in one respect, as connected with science; but as it has been the aim of our work, to unite amusement with instruction, some experiments on this subject are introduced, the performance of which depends on dexterity of hand. As this is only to be acquired by practice, and after all is merely a mechanical operation, the study of it will produce little useful knowledge, though it may afford much entertainment; but as it must be gratifying to know the method by which they are performed by those persons skilled in these manœuvres, who publicly exhibit them to the astonishment of the spectator, they are presented to our readers, that when they recognise them at any of these exhibitions, their eyes may not be in danger of deceiving their judgment.

To tell the Number of Points on Three Cards, placed under Three different Parcels of Cards.

YOU first premise that the ace counts for eleven, the court cards ten each; and the others according to the number of their pips. You then propose to any person

in company to choose three cards, and to place over each as many as will make the number of the points of that card fifteen; take the remaining cards, and, under the appearance of looking for a particular card, count how many there are, and by adding sixteen to that number, you will have the amount of the pips on the three cards. For example:

Suppose a person choose a seven, a ten, and an ace: then over the seven he must place eight cards; over the ten, five cards; and over the ace, four cards. In this instance there will remain twelve cards; to which if you add sixteen, it will make twenty-eight; which is the amount of the pips on the three cards.

The Ten Duplicates.

SELECT any twenty cards; let any person shuffle them; lay them by pairs on the board, without looking at them. You next desire several persons, (as many persons as there are pairs on the table,) each to look at different pairs, and remember what cards compose them. You then take up all the cards in the order they lay, and replace them with their faces uppermost on the table, according to the order of the letters in the following words:

M	U	T	U	S
1	2	3	4	5
D	E	D	I	T
6	7	8	9	10
N	O	M	E	N
11	12	13	14	15
C	O	C	I	S
16	17	18	19	20

(These words convey no meaning.)—You will observe, that they contain ten letters repeated, or two of each sort. You therefore ask each person which row or rows the cards he looked at are in; if he say the first, you know they must be the second and fourth, there being two letters of a sort (two U's) in that row; if he say the second and fourth, they must be the ninth and nine-

teenth, (two I's,) and so of the rest. This amusement, which is very simple, and requires very little practice, will be found to excite, in those who are unacquainted with the key, the greatest astonishment.

The readiest way is to have a fac-simile of the key drawn on a card, to which you refer.

To tell how many Cards a Person takes out of a Pack, and to specify each Card.

To perform this you must so dispose a PIQUET pack of cards, that you can easily remember the order in which they are placed. Suppose, for instance, they are placed according to the words in the following line:

Seven Aces, Eight Kings, Nine Queens, and Ten Knaves;

and that every card be of a different suite, following each other in this order: spades, clubs, hearts, and diamonds. Then the eight first cards will be the seven of spades, ace of clubs, eight of hearts, king of diamonds, nine of spades, queen of clubs, ten of hearts, and knave of diamonds, and so of the rest.

You shew that the cards are placed promiscuously, and you offer them with their backs upward to any one, that he may draw what quantity he pleases; you then dexterously look at the card that precedes, and that which follows those he has taken. When he has carefully counted the cards, which is not to be done in your presence; and, in order to give you time for recollection, you tell him to do it twice over, that he may be certain; you then take them from him, mix them with the pack, shuffle, and tell him to shuffle.

During all this time you recollect, by the foregoing line, all the cards he took out; and as you lay them down, one by one, you name each card.

Unless a person has a most excellent memory, he had better not attempt the performance of the above amusement, as the least forgetfulness will spoil the whole, and make the operator appear ridiculous.

A Hundred different Names being written on the Cards, to tell the particular Name any Person thought of.

WRITE on ten cards a hundred different names, observing, that the last name on each card begins with one of the letters in the word INDROMACUS, which letters, in the order they stand, answer to the numbers 1 to 10, thus:

I N D R O M A C U S
1 2 3 4 5 6 7 8 9 10

On ten other cards write the same names, with this restriction, that the first name on every card must be taken from the first of the other cards, whose last name begins with I; the second name must be taken from that whose last name begins with N; and so of the rest. Then let any person choose a card out of the first ten, and after he has fixed on a name give it to you again, when you carefully note the last name, by which you know the number of that card. You then take the other ten cards, and, after shuffling them, shew them to the person, and ask if he sees the name he chose, and when he answers in the affirmative, you look to that name which is the same in number from the top with the number of the card he took from the other parcel, and that will be the name he fixed on.

Instead of ten cards there may be twenty to each parcel, by adding duplicates to each card, which will make it appear more mysterious, and will not at all embarrass it, as you have only to remember the last name on each card. Instead of names you may write questions on one of the parcels, and answers on the other.

Several different Cards being fixed on by different Persons, to name that on which each Person fixed.

THERE must be as many different cards shewn to *each person*, as there are cards to choose; so that, if there are three persons, you must shew three cards to each person,

telling the first to retain *one* in his memory. You then lay those three cards down, and shew three others to the second person, and three others to the third. Next take up the first person's cards, and lay them down separately, one by one, with their faces upwards; place the second person's cards over the first, and the third over the second's, so that there will be one card in each parcel belonging to each person. You then ask each of them in which parcel his card is, and by the answer, you immediately know which card it is; for the first person's will always be the first, the second person's the second, and the third person's the third, in that parcel where each says his card is.

This amusement may be performed with a single person, by letting him fix on three, four, or more cards. In this case you must shew him as many parcels as he is to choose cards, and every parcel must consist of that number, out of which he is to fix on one, and you then proceed as before, he telling you the parcel that contains each of his cards.

To name the Rank of a Card that a Person has drawn from a Piquet Pack.

THE rank of the card means whether it be an ace, king, queen, &c. You therefore first fix a certain number to each card; thus you call the king four, the queen three, the knave two, the ace one, and the others according to the number of their pips.

You then shuffle the cards, and let a person draw any one of them; then turning up the remaining cards, you add the number of the first to that of the second, the second to the third, and so on, till it amount to ten; which you then reject, and begin again; or if it be more, reject the ten, and carry the remainder to the next card, and so on to the last; and to the last amount add four, and subtract that sum from ten, if it be less, or from twenty, if it be more than ten, and the remainder will be the number of the card that was drawn; as for example, if the remainder be two, the card drawn was a knave, if three a queen, and so on.

To tell the Amount of the Numbers of any Two Cards drawn from a common Pack.

EACH court card in this amusement counts for ten, and the other cards according to the number of their pips. Let the person who draws the cards add as many more cards to each of those he has drawn as will make each of their numbers twenty-five. Then take the remaining cards in your hand, and, seeming to search for some card among them, tell them over to yourself, and their number will be the amount of the two cards drawn.

For example:—Suppose the person has drawn a ten and a seven, then he must add fifteen cards to the first, to make the number twenty-five, and eighteen to the last for the same reason; now fifteen and eighteen make thirty-three, and the two cards themselves make thirty-five, which deducted from fifty-two, leaves seventeen, which must be the number of the remaining cards, and also of the two cards drawn.

You may perform this amusement without touching the cards, thus:

Let the person who has drawn the two cards deduct the number of each of them from twenty-six, which is half the number of the pack, and after adding the remainders together, let him tell you the amount, which you privately deduct from fifty-two, the total number of all the cards, and the remainder will be the amount of the two cards.

Example:—Suppose the two cards to be as before, ten and seven; then the person deducting ten from twenty-six, there remain sixteen, and deducting seven from twenty-six, there remain nineteen; these two remainders added together make thirty-five, which you subtract from fifty-two, and there must remain seventeen for the amount of the two cards, as before.

To tell the Amount of the Numbers of any Three Cards that a Person shall draw from the Pack.

AFTER the person has drawn his three cards, draw one yourself, and lay it aside, for it is necessary that the

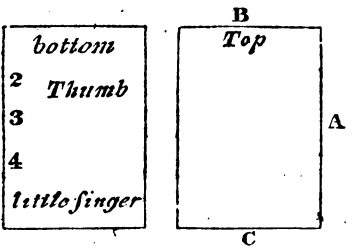
number of the remaining cards be divisible by three, which they will not be in a pack of fifty-two cards, if only three be drawn. The card you draw, you may call the confederate, and pretend it is by the aid of that card you discover the amount of the others. Then tell the party to add as many more to each of his cards, as will make its number sixteen, which is the third part of the remaining forty-eight cards; therefore, suppose he has drawn a ten, a seven, and a six; then, to the first he must add six cards,—to the second, nine,—and to the third, ten, which together make twenty-five, and the four cards drawn being added to them, make twenty-nine. You then take the remaining cards, and telling *them* over, as in the last amusement, you find their number to be twenty-three, the amount of the three cards the person drew.

This amusement may also be performed without touching the cards, thus:—When the party has drawn his three cards, and you have drawn one, let him deduct the number of each of the cards he has drawn from seventeen, which is one-third of the pack after you have drawn your card; and let him tell you the amount of the several remainders, to which you privately add one to the card you drew, and deducting that amount from fifty-two, (the whole number of the cards) the remainder will be the amount of the three cards drawn.

Example.—Suppose the three cards to be ten, seven, and six, as before; then, each of those numbers, subtracted from seventeen, the remainders will be, respectively, seven, ten, and eleven, which, added together, make twenty-eight, to which the single card you drew being reckoned as one, and added, makes twenty-nine; and that number deducted from fifty-two, leaves twenty-three, which is the amount of the three cards the party drew.

THE following amusements principally depend on dexterity of hand; and, as what is termed *making the pass*, will be necessary to be acquired, to enable the operator to perform many of them, we subjoin the following explanation of this term:

How to make the Pass.—Hold the pack of cards in your right-hand, so that the palm of your hand may be under the cards: place the thumb of that hand on one side of the pack; the first, second, and third fingers on the other side, and your little finger between those cards that are to be brought to the top, and the rest of the pack. Then place your left hand over the cards in such a manner that the thumb may be at C, the fore-finger at A, and the other fingers at B, as in the following figure:



The hands and the two parts of the cards being thus disposed, you draw off the lower cards, confined by the little finger and the other parts of the right hand, and place them, with an imperceptible motion, on the top of the pack.

But before you attempt any of the tricks that depend on *making the pass*, you must have great practice, and be able to perform it so dexterously and expeditiously, that the eye cannot detect the movement of the hand; or you may, instead of deceiving others, expose yourself.

The Long Card.—Another stratagem, connected with the performance of many of the following tricks, is what is termed the *long card*; that is, a card, either a trifle longer or wider than the other cards, not perceptible to the eye of the spectator, but easily to be distinguished by the touch of the operator.

The Divining Card.

PROVIDE a pack in which there is a long card; open it at that part where the long card is, and present the

pack to a person in such a manner that he will naturally draw that card. You then tell him to put into any part of the pack, and shuffle the cards. You take the pack, and offer the same card in like manner to a second or third person, taking care that they do not stand near enough to see the card each other draws.

You then draw several cards yourself, among which is the long card, and ask each of the parties if his card be among those cards, and he will naturally say *yes*, as they have all drawn the same card. You then shuffle all the cards together, and cutting them at the long card, you hold it before the first person, so that the others may not see it, and tell him that is his card. You then put *it in* the pack, shuffle it, cut it again at the same card, and hold it to the second person, and so of the rest.

You can perform this recreation without the long card, in the following manner:

Let a person draw any card, and replace it in the pack. You then *make the pass*, (see p. 101.) and bring that card to the top of the pack, and shuffle them, without losing sight of that card. You then offer that card to a second person that he may draw it, and put it in the middle of the pack. You *make the pass*, and shuffle the cards a second time in the same manner, and offer the card to a third person, and so again to a fourth or fifth.

The Four Confederate Cards.

A PERSON draws four cards from the pack, and you tell him to remember one of them. He then returns them to the pack, and you dexterously place two under and two on the top of the pack. Under the bottom ones you place four cards of any sort, and then taking eight or ten from the bottom cards, you spread them on the table, and ask the person if the card he fixed on be among them. If he say *no*, you are sure it is one of the two cards on the top. You then pass those two cards to the bottom; and drawing off the lowest of them, you ask if that is not his card. If he again say *no*, you take up that card, and bid him draw his card from the bottom of the pack. —If, on the contrary, he say his cards *are* among those

you *first* drew from the bottom, you must dexterously take up the four cards you put under them, and placing those on the top, let the other two be the bottom cards of the pack, which you are to draw in the manner before described.

The Numerical Card.

LET the long card be the sixteenth in a pack of picquet cards. Take ten or twelve cards from the top of the pack, and, spreading them on the table, desire a person to think on any one of them, and to observe the number it is from the first card. Make the pass at the long card, which will then be at the bottom. Then ask the party the number his card was at, and counting to yourself from that number to sixteen, turn the cards up, one by one, from the bottom. Then stop at the seventeenth card, and ask the person if he has seen his card, when he will say *no*. You then ask him how many more cards you shall draw before his card appears; and when he has named the number, you draw the card aside with your finger, turn up the number of cards he proposed, and throw down the card he fixed on.

The Card found out by the Point of a Sword.

WHEN a card has been drawn you place it under the long card, and by shuffling them dexterously, you bring it to the top of the pack. Then lay, or throw the pack on the ground, observing where the top card lays. A handkerchief is then bound round your eyes, which ought to be done by a confederate, in such a way that you can see the ground. A sword is put into your hand, with which you touch several of the cards, as if in doubt, but never losing sight of the top card, in which at last you fix the point of the sword, and present to the party who drew it.

The Card hit upon by Guess.

SPREAD part of a pack before a person, in such a way, that only one court card is visible; and so arrange it,

that it shall appear the most prominent and striking card. You desire him to think on one; and observe if he fix his eye on the court card. When he tells you he has determined on one, shuffle the card, and turning them up one by one, when you come to the court card, tell him that is the one.

If he does not seem to fix his eye on the court card, you should not hazard the experiment; but frame an excuse for performing some other amusement; neither should it be attempted with those who are conversant with these sort of deceptions.

The Card changed by Word of Command.

You must have two cards of the same sort in the pack, say the king of spades. Place one next the bottom card (say seven of hearts), and the other at top. Shuffle the cards without displacing those three, and shew a person that the bottom card is the seven of hearts. This card you dexterously slip aside with your finger, which you have previously wetted, and taking the king of spades from the bottom, which the person supposes to be the seven of hearts, lay it on the table, telling him to cover it with his hand.

Shuffle the cards again, without displacing the first and last card, and shifting the other king of spades from the top to the bottom, shew it to another person. You then draw that privately away, and taking the bottom card, which will then be the seven of hearts, you lay that on the table, and tell the second person (who believes it to be the king of spades) to cover it with his hand.

You then command the cards to change places; and when the two parties take off their hands, and turn up the cards, they will see, to their great astonishment, that your commands are obeyed.

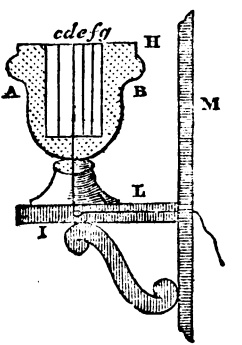
The Three Magical Parties.

Offer the long card to a person, that he may draw it, and replace it in any part of the pack he pleases. *Make the*

pass, and bring that card to the top. Next divide the pack in three parcels, putting the long card in the middle heap. You then ask the person which of the three heaps his card shall be in. He will, probably, say the middle; in which case you immediately shew it to him. But if he say either of the others, you take all the cards in your hand, placing the parcel he has named over the other two, and observing to put your little finger between that and the middle heap, at the top of which is the card he drew. You then ask at what number in that heap he will have his card appear. If, for example, he say the sixth, you tell down five cards from the top of the pack, and then dexterously making the pass, you bring the long card to the top, and tell it down as the sixth.

The Magic Vase.

CONSTRUCT a vase of wood, or pasteboard. (See Figure)



On the inside let there be five divisions; two of them, *c*, *d*, to be large enough to admit a pack of cards each; and the other three, *e f g*, only large enough to contain a single card. Place this vase on a bracket, L, which is fastened to the partition M. Fix a silken thread at H. the other end of which passes down the division *d*, and

over the pulley I, runs along the bracket L, and goes out behind the partition M.

Take three cards from a picquet pack, and place one of them in each of the divisions, *e f g*, making the silk thread or line go under each of them. In the division *c* put the remainder of the pack.

You then get another pack of cards, at the top of which are to be three cards, the same as those in the three small divisions; and, making the pass, bring them to the middle of the pack. Let them be drawn by three persons; let them shuffle all the cards; after which place the pack in the division *d*, and tell the parties that the cards they drew will rise at their command, *separately*, from the vase.

A confederate behind the partition then gently drawing the line, the three cards will gradually appear from the vase; then taking the cards from *c*, you shew that those three are gone from the pack.

The vase must be placed so high that the company cannot see the inside.

The Divining Perspective Glass.

PROCURE a small perspective glass, wide enough, where the object-glass is placed, to hold the following table:

1,131	10,132	19,133
2,231	11,232	20,233
3,331	12,332	21,333
4,121	13,122	22,123
5,221	14,222	23,223
6,321	15,322	24,323
7,111	16,112	25,113
8,211	17,212	26,213
9,311	18,312	27,313

Take a pack of twenty-seven cards; give them to a person, bid him fix on one, shuffle them, and return them to you. Arrange the twenty-seven cards in three parcels, by laying one down, alternately, on each parcel; but before you lay each card down, shew it to the person, without seeing it yourself. When you have completed the three parcels, ask him at what number, from one to twenty-seven, he will have his card appear, and in which heap it then is. You then look at the heap through your glass; and if the first of the three numbers, which stands against the number it is to appear at, be one, put that heap at top; if the number be two, put it in the middle; and if it be three, put it at bottom. Next divide the cards into three heaps in the same manner, a second and third time, and his card will be at the number he chose.

Example.—Suppose the person wishes his card to be the twentieth from the top; and the first time of making the heaps, he says it is in the third heap; you then look at the table in the perspective, and you see that the first figure is two; you, therefore, put that heap in the middle of the pack. The second and third times, you in like manner put the heap in which he says it is, at bottom; the number each time being three. Then looking at the pack with your glass, as if to discover which the card was, you lay the cards down, one by one, and the twentieth will be the card fixed on.

The Card in the Ring.

GET a ring made of any metal, in which is set a large transparent stone or piece of glass, to the bottom of which is fastened a small piece of black silk; under the silk is to be the figure of a small card; and the silk must be so constructed, that it may be either drawn aside or spread, by turning the stone round.

You then cause a person to draw the same sort of card as that at the bottom of the ring; and tell him to burn it in the candle. Now the ring being so constructed, that the silk conceals the card underneath it, you first shew him the ring, that he may see it is not there, and

tell him you will make it appear; then rubbing the ashes of the card on the ring, you manage to turn the stone or glass dexterously round, and exhibit to him the small card at the bottom.

The Card in the Mirror.

PROVIDE a mirror, either round or oval, the frame of which must be at least as wide as a card, and the glass must be wider than the distance between the frame, by at least the width of a card. The glass in the middle must be made to move in two grooves, and so much of the quicksilver must be scraped off, as is equal to the size of a common card. You then paste over the part where the quicksilver is rubbed off, a piece of pasteboard, on which is a card, that must exactly fit the space, which must at first be placed behind the frame.

Fix this mirror against a partition, through which two strings are to go, by which an assistant in an adjoining room can easily move the glass in the grooves, and make the card appear or disappear at pleasure. Or it may be done without an assistant, if a table be placed against the partition, and a string from the glass be made to pass through a leg of it, and communicate with a small trigger, which you may easily push down with your foot, and at the same time wiping the glass with your handkerchief, under the pretence that the card may appear more conspicuous, which will also serve most effectually to disguise the operation.

Having every thing thus arranged, you contrive to make a person draw the same sort of card as that fixed to the mirror; if you do not succeed in this with a stranger, make some pretence for shuffling the cards again, and present the pack to a confederate, who, of course, will draw the card you wish, and who is to shew it to two or three persons next to him, under the pretence that it might slip his memory. This card you place in the middle of the pack, then *make the pass*, and bring it to the bottom. Direct the person to look for his card in the mirror, when the confederate behind the partition is to draw it slowly forward; or if you perform the opera-

tion yourself, press the trigger with your foot, and the card will appear as if placed between the glass and the quicksilver. While the glass is drawing forward, you slide off the card from the bottom of the pack, and convey it away.

The Card in the Opera Glass.

PROCURE an opera glass, two inches and a half long; the tube to be made of ivory, so thin that it may appear transparent. Place in it a magnifying glass, of such a power, and at such a distance, that a card, three quarters of an inch long, may appear like a common-sized card. At the bottom of the tube lay a circle of black pasteboard, to which fasten a small card, with the pips, or figures, on both sides, and in such a manner that by turning the tube either side of the glass may be visible.

You then offer two cards to two persons similar to the double card in the glass. You put them in the pack again, or convey them in your pocket; and after a few flourishing motions, you tell the persons you have conveyed their cards into the glass; then you shew each person his card in the glass, by turning it in the proper position.

You may easily induce the parties to draw the two cards you wish, by placing them first on the top of the pack, and then, by making the pass, bringing them to the middle. When you can make the pass in a dexterous manner, it is preferable to the long card, which obliges the operator to change the pack frequently, as, if the same card is always drawn, it may excite suspicion.

To separate the Two Colours of a Pack of Cards by One Cut.

To perform this amusement all the cards of one colour must be cut something narrower at one end than the other. You show the cards, and give them to any one that he may shuffle them, then holding them between your hands, one hand being at each extremity, with one motion you separate the hearts and diamonds from the spades and clubs.

The Metamorphosed Cards.

In the middle of a pack place a card that is something wider than the rest, which we will suppose to be the knave of spades, under which place the seven of diamonds, and under that the ten of clubs. On the top of the pack put cards similar to these, and others on which are painted different objects, *viz.*

First card....A bird
Second .....A seven of diamonds
Third .....A flower
Fourth .....Another seven of diamonds
Fifth .....A bird
Sixth.....A ten of clubs
Seventh.....A flower
Eighth .....Another ten of clubs.

Then seven or eight indifferent cards, the knave of spades, which is the wide card, the seven of diamonds, the ten of clubs, and the rest any indifferent cards.

Two persons are to draw the two cards that are under the wide card, which are the seven of diamonds and the ten of clubs. You then take the pack in your left hand, and open it at the wide card, as you open a book, and tell the person who drew the seven of diamonds to place it in that opening. You then blow on the cards, and, without closing them, instantly bring the card which is at top, and on which a bird is painted, over that seven of diamonds. To do this dexterously you must wet the middle finger of your left hand, with which you are to bring the card to the middle of the pack. You then bid the person look at his card, and when he has remarked the change, to place it where it was before. Then blow on the cards a second time, and bringing the seven of diamonds, which is at the top of the pack, to the opening, you bid him look at his card again, when he will see it is that he drew. You may do the same with all the other painted cards, either with the same person, or with him who drew the ten of clubs.

The whole artifice consists in bringing the card at the top of the pack to the opening in the middle, by the wet finger, which requires no great practice. Observe, not to let the pack go out of your hands.

To discover the Card that is drawn by the Throw of a Die.

PREPARE a pack of cards, in which there are only six sorts of cards. Dispose these cards in such manner that each of the six different cards shall follow each other, and let the last of each suite be a long card. The cards being thus disposed, it follows, that if you divide them into six parcels, by cutting at each of the long cards, those parcels will all consist of similar cards.

Let a person draw a card from the pack, and let him replace it in the parcel from whence it was drawn, by dexterously offering that part. Cut the cards several times, so that a long card be always at bottom. Divide the cards in this manner into six heaps, and giving a die to the person who drew the card, tell him that the point he throws shall indicate the parcel in which is the card he drew; then take up that parcel and show him the card.

To tell the Number of the Cards by their Weight.

TAKE a parcel of cards, suppose forty, among which insert two long cards; let the first be, for example, the fifteenth, and the other the twenty-sixth from the top. Seem to shuffle the cards, and then cutting them at the first long card, poise those you have cut off in your left hand, and say, "there should be here fifteen cards." Cut them again at the second long card, and say, "there are here only eleven cards." Then poising the remainder, you say, "here are fourteen cards."

The Four inseparable Kings.

TAKE the four kings, and behind the last of them place two other cards, so that they may not be seen. Then spread open the four kings to the company, and put the six cards at the bottom of the pack. Draw one of the kings, and put it at the top of the pack. Draw one of the two cards at the bottom and put it towards the middle. Draw the other, and put it at some distance

from the last, and then shew that there remains a king at bottom. Then let any one cut the cards, and as there remained three kings at bottom, they will then be altogether in the middle of the pack.

To change the Cards that several Persons have drawn from the Pack.

On the top of the pack put any card you please, suppose the queen of clubs; make the pass, and bring that card to the middle of the pack, and offer it to a person to draw. Then, by cutting the cards, bring the queen again to the middle of the pack. Make the pass a second time, and bring it to the top, and shuffle the cards without displacing those on the top. Make the pass a third time, and bring it to the middle of the pack, and offer it to a second person to draw, who must be at a proper distance from the first person, that he may not perceive it is the same card. After the like manner let five persons draw the same card.

Shuffle the pack without losing sight of the queen of clubs, and laying down four other cards with the queen, ask each person if he sees his card there; they will all reply "yes," as they all drew the queen of clubs. Place four of those cards to the pack, and drawing the queen privately away, you approach the first person, and shewing him that card, so that the others cannot see it, ask if that be his card; then putting it on the top of the pack, blow on it, or give it a stroke with your hand, and shew it in the same manner to the second person, and so of the rest.

The Card discovered under the Handkerchief.

Let a person draw any card from the rest, and put it in the middle of the pack; you make the pass at that place, and the card will consequently be at top; then placing the pack on the table, cover it with a handkerchief, and putting your hand under it, take off the top card, and after seeming to search among the cards for some time, draw it out.

This amusement may be performed by putting the cards in another person's pocket, after the pass is made. Several cards may also be drawn and placed together in the middle of the pack, and the pass then made.

The Convertible Aces.

On the ace of spades fix, with soap, a heart, and on the ace of hearts a spade, in such manner that they will easily slip off.

Show these two aces to the company; then, taking the ace of spades, you desire a person to put his foot upon it, and as you place it on the ground, draw away the spade. In like manner you place the seeming ace of hearts under the foot of another person. You then command the two cards to change their places; and that they obey your command, the two persons, on taking up their cards will have ocular demonstration.

A deception similar to this is sometimes practised with one card, suppose the ace of spades, over which a heart is pasted slightly. After shewing a person the card, you let him hold one end of it, and you hold the other, and while you amuse him with discourse, you slide off the heart. Then laying the card on the table, you bid him cover it with his hand; yon then knock under the table, and command the heart to turn into the ace of spades.

To tell the Card that a Person has touched with his Finger.

This amusement is to be performed by confederacy. You previously agree with your confederate on certain signs, by which he is to denote the suite, and the particular card of each suite; as thus: if he touch the first button of his coat, it signifies an ace; if the second, a king, &c. and then again, if he take out his handkerchief, it denotes the suite to be hearts; if he take snuff,—diamonds, &c. These preliminaries being settled, you give the pack to a person who is near your confederate, and tell him to

separate any one card from the rest, while you are absent, and draw his finger once over it. He is then to return you the pack, and while you are shuffling the cards, you carefully note the signals made by your confederate; then turning the cards over one by one, you directly fix on the card he touched.

The Card in the Pocket Book.

A CONFEDERATE is previously to know the card you have taken from the pack and put into your pocket book. You then present the pack to him, and desire him to fix on a card, (which we will suppose to be the queen of diamonds,) and place the pack on the table. You then ask him the name of the card, and when he says the queen of diamonds, you ask him if he is not mistaken, and if he be sure that the card is in the pack: when he replies in the affirmative, you say, "It might be there when you looked over the cards, but I believe it is now in my pocket:" then desire a third person to put his hand in your pocket, and take out your book, and when it is opened, the card will appear.

The Card in the Egg.

TAKE a card, the same as your long card, and rolling it up very close, put it in an egg, by making a hole as small as possible, and which you are to fill up carefully with white wax. You then offer the long card to be drawn, and when it is replaced in the pack you shuffle the cards several times, giving the egg to the person who drew the card, and while he is breaking it, you privately withdraw the long card, that it may appear upon examining the cards, to have gone from the pack into the egg. This may be rendered more surprising by having several eggs, in each of which is placed a card of the same sort, and then giving the person the liberty to choose which egg he thinks fit.

This deception may be still further diversified, by having, as most public performers have, a confederate, who is previously to know the egg in which the card is

placed; for you may then break the other eggs, and shew that the only one that contains a card is that in which you directed it to be.

The Card discovered by the Touch or Smell.

YOU offer the long card, or any other that you know, and as the person who has drawn it holds it in his hand, you pretend to feel the pips or figure on the under side, by your fore finger; or you sagaciously smell to it, and then pronounce what card it is.

If it be the long card, you may give the pack to the person who drew it, and leave him at liberty either to replace it or not. Then taking the pack, you feel immediately whether it be there or not, and shuffling the cards in a careless manner, without looking at them, you pronounce accordingly.

The Inverted Cards.

PREPARE a pack of cards, by cutting one end of them about one-tenth of an inch narrower than the other: then offer the pack to any one, that he may draw a card; place the pack on the table, and observe carefully if he turn the card while he is looking at it: if he does not, when you take the pack from the table, you offer the other end of it for him to insert that card; but if he turn the card, you then offer him the same end of the pack. You afterwards offer the cards to a second or third person, for them to draw and replace a card in the same manner. You then let any one shuffle the cards, and taking them again into your own hand, as you turn them up one by one, you easily perceive by the touch which those cards are that have been inverted, and laying the first of them down on the table, you ask the person if that card be his, if he say *no*, you ask the same of the second person, and if he say *no*, you tell the third person it is his card; and so of the second and third cards. You should lay the pack on the table after each person has drawn his card, and turn it dexterously in taking it up, when it is to be turned, that the experi-

ment may not appear to depend on the cards being inverted.

The Transmutable Cards.

In a common pack of cards let the ace of hearts and nine of spades be something larger than the rest. With the juice of lemon draw over the ace of hearts a spade, large enough to cover it entirely, and on each side draw four other spades.

Present the pack to two persons, so adroitly, that one of them shall draw the ace of hearts, and the other the nine of spades, and tell him who draws the latter, to burn it on a chafing-dish. You then take the ashes of that card, and put them into a small metal box, and give it to him that has the ace of hearts, that he may himself put that card into the box and fasten. Then put the box for a short time on the chafing-dish, and let the person who put the card in it, take it off, and take out the card, which he will see is turned into the nine of spades.

The Convertible Cards.

To perform this amusement you must observe, that there are several letters which may be changed into others, without any appearance of the alteration, as the *a* into *d*, the *c* into *a*, *e*, *d*, *g*, *o*, or *q*; the *i* into *b*, *d*, or *l*; the *l* into *t*; the *o* into *a*, *d*, *g*, or *q*; the *v* into *y*, &c.

Take a parcel of cards, suppose twenty, and on one of them write with the juice of lemon or onion, or vitriol and water, the word *law*, (these letters should not be joined;) and on the other, with the same ink, the words *old woman*; then holding them to the fire they both become visible. Now you will observe, that by altering the *a* in the word *law* into *d*, and adding *o* before the *l*, and *oman* after the *w*, it becomes *old woman*. Therefore you make those alterations with the invisible ink, and let it remain so. On the rest of the cards you write any words you think fit.

Present the cards in such manner to two persons, that one of them shall draw the word *law*, and the other the words *old woman*. You then tell the person who drew the word *law*, that it shall disappear, and the words on the other card shall be wrote in its place; and that you may not change the cards, desire each of the parties to write his name on his card. Then putting the cards together, and holding them before the fire, as if to draw the names just wrote, the word *law* will presently change into *old woman*.

To observe an Eclipse of the Sun, without Injury to the Eye.

TAKE a burning glass, or a spectacle glass, that magnifies very much; hold it before a book or pasteboard, twice the distance of its focus, and you will see the round body of the sun, and the manner in which the moon passes between the glass and the sun, during the whole eclipse.

The Burnt Writing restored.

COVER the outside of a small memorandum book with black paper, and in one of its inside covers make a flap, to open secretly, and observe there must be nothing over the flap but the black paper that covers the book.

Mix soot with black or brown soap, with which rub the side of the black paper next the flap; then wipe it clean, so that a white paper pressed against it will not receive any mark.

Provide a black lead pencil that will not mark without pressing hard on the paper. Have likewise a small box, about the size of a memorandum book, and that opens on both sides, but on one of them by a private method. Give a person the pencil and a slip of thin paper, on which he is to write what he thinks proper; you present him the memorandum book at the same time, that he may not write on the bare board. You tell him to keep what he writes to himself, and direct him to burn it on an iron plate laid on a chafing-dish of coals, and give you

the ashes. You then go into another room to fetch your magic box, before described, and take with you the memorandum book.

Having previously placed a paper under the flap in the cover of the book, when he presses hard with the pencil, to write on his paper, every stroke, by means of the stuff rubbed on the black paper, will appear on that under the flap. You therefore take it out, and put it into one side of the box.

You then return to the other room, and taking a slip of blank paper, you put it into the other side of the box, strewing the ashes of the burnt paper over it. Then shaking the box for a few moments, and at the same time turning it dexterously over, you open the other side, and shew the person the paper you first put in, the writing on which he will readily acknowledge to be his.

If there be a press or cupboard that communicates with the next room, you need only put the book in the press, and your assistant will open it, and put the paper in the box, which you presently after take out, and perform the rest of the amusement as before.

There may likewise be a flap on the other cover of the book, and you may rub the paper against that with red lead. In this case you give the person the choice of writing either with a black or a red pencil; and present him the proper side of the book accordingly.

The opaque Box made transparent.

MAKE a box of three or four inches long, and two or three wide, and have a sort of perspective glass, the bottom of which is of the same size with the box, and slides out, that you may privately place a paper on it. The sides of this perspective are to be of glass, covered n the inside with fine paper.

Let a person write on a slip of paper, putting your memorandum book under it as in the last amusement; then give him the little box, and let him put what he has wrote into it. In the mean time you put the memorandum book into the press, where the perspective is already placed. Your assistant then takes the paper

out of the book, and puts it at the bottom of the perspective; which you presently take out of the press, and direct the person to put the little box that contains his paper under it. You then look in at the top of the perspective, and feigning to see through the top of the box, you read what is wrote on the paper at the bottom of the perspective.

With this perspective box you may perform another amusement, which is, by having in a bag twelve or more ivory counters, numbered, which you shew to the company, that they may see all the numbers are different. You tell a person to draw any one of them, and keep it close in his hand. You then put the bag in the press, when your assistant examines the counters, and sees which is wanting, and puts another of the same number at the bottom of the perspective, which you then take out, and placing the person's hand close to it, look in at the top, and pretending to see through his hand, you name the number on the counter in it.

The Transposable Pieces.

TAKE two guineas and two shillings, and grind part of them away, one one side only, so that they may be but half the common thickness; and observe, that they must be quite thin at the edge; then rivet a guinea and a shilling together. Lay one of these double pieces, with the shilling upwards, on the palm of your hand, at the bottom of your three first fingers, and lay the other piece with the guinea upwards in like manner, in the other hand. Let the company take notice in which hand is the guinea, and in which the shilling. Then as you shut your hands, you naturally turn the pieces over, and when you open them again, the shilling and the guinea will appear to have changed their places.

The Penetrative Guinea.

PROVIDE a round tin box, of the size of a large snuff box, and in this, place eight other boxes, which will go

easily into each other, and let the least of them be of a size to hold a guinea. Each of these boxes should shut with a hinge, and to the least of them there must be a small lock, that is fastened with a spring, but cannot be opened without a key;—observe that all these boxes must shut so freely, that they may be all closed at once. Place these boxes in each other, with their tops open, in the drawer of the table on which you make your experiments; or, if you please, in your pocket, in such manner that they cannot be displaced.

Then ask a person to lend you a new guinea, and desire him to mark it that it may not be changed. You take this piece in one hand, and in the other you have another of the same appearance, and putting your hand into the drawer, you slip the piece that is marked into the least box, and shutting them all at once, you take them out; then shewing the piece you have in your hand, and which the company suppose to be the same that was marked, you pretend to make it pass through the box, and dexterously convey it away.

You then present the box, for the spectators do not yet know there are more than one, to any person in company, who, when he opens it, finds another, and another, till he comes to the last, but that he cannot open without the key, which you then give him, and retiring to a distant part of the room, you tell him to take out the guinea himself, and see if it be that he marked.

This amusement may be made more surprising, by putting the key into the snuff box of one of the company, which you may do by asking him for a pinch of his snuff, and at the same time conceal the key, which must be very small, among the snuff; and when the person, who is to open the box, asks for the key, you tell him that one of the company has it in his snuff box. This part of the amusement may likewise be performed by means of a confederate.

To make Pictures of Birds with their natural Feathers.

FIRST take thin board or pannel, of deal or wainscot, well seasoned that it may not shrink; then paste white paper smoothly on it, and let it dry; if the colour of the wood shew through, paste a second paper over it. When the paper is dry, get ready any bird that you would represent, and draw the outline as exact as you can on the papered pannel. You then paint the ground work, stump of a tree, the bill and legs, their proper colour, with water colours, leaving the body to be covered with its own natural feathers. In the space you have left for the body, you lay on very thick gum water, letting each coat dry before you lay on another, and so continuing till the gum is as thick as a shilling. Then take the feathers off the bird; and, as you proceed, draw a camels'-hair pencil, dipped in gum-water, over the coat of gum that you have laid on the paper, that it may more readily adhere. As you strip the bird, you must fix the feathers in their proper places on the board, and you shave the shafts or stems of the larger feathers, that they may lay flat. The most ready way to perform the operation, is to provide yourself with a pair of steel pliars to take up and lay on the feathers with. You should prepare some small leaden weights to lay on the feathers, that they may more readily adhere to, and lay flat on, the gum. The part where the eye is, must be supplied by a small piece of paper, coloured and shaped like one, or you may, probably, be able to get a glass bead that will answer the purpose better. In order that the feathers may lay smooth and regular, when the whole is perfectly dry, lay a book, or a flat board, with a weight on it.

The Art of Bronzing.

BRONZING is that process by which figures of plaster-of-paris, wood, &c. are made to have the appearance of copper or brass The method is as follows:

Dissolve copper filings in aqua-fortis. When the copper has impregnated the acid, pour off the solution, and put

into it some pieces of iron, or iron filings. The effect of this will be to sink the powder to the bottom of the acid. Pour off the liquid, and wash the powder in successive quantities of fresh water. When the powder is dry, it is to be rubbed on the figure with a soft cloth, or piece of leather; but observe, that previous to the application of the bronze powder, a dark blackish sort of green is first to be laid on the figure; and if you wish the powder to adhere stronger, mix it with gum water, lay it on like paint with a camels'-hair brush, or previously trace the parts to be bronzed with gold size, and when nearly dry, rub the powder over it.

Method of taking the Impression of Butterflies on Paper.

CLIP the wings off the butterfly, lay them on clean, in the form of a butterfly when flying. Spread some thick clean gum-water on another piece of paper, press it on the wings, and it will take them up; lay a piece of white paper over it, and rub it gently with your finger, or the smooth handle of a knife. The bodies are to be drawn in the space which you leave between the wings.

To cast Figures in Imitation of Ivory.

MAKE isinglass and strong brandy into a paste, with powder of egg-shells, very finely ground. You may give it what colour you please; but cast it warm into your mould, which you previously oil over. Leave the figure in the mould till dry, and you will find, on taking it out, that it bears a very strong resemblance to ivory.

To soften Horn.

To one pound of wood ashes, add two pounds of quick lime; put them into a quart of water. Let the whole boil till reduced to one-third. Then dip a feather in, and if, on drawing it out, the plume should come off, it is a proof that it is boiled enough; if not, let it boil a little

longer. When it is settled, filter it off, and in the liquor thus strained, put in shavings of horn. Let them soak for three days; and, first anointing your hands with oil, work the horn into a mass, and print or mould it into any shape you please.

To make Moulds of Horn.

If you wish to take the impression of any coin, medal, &c. previously anoint it with oil; then lay the horn shavings over it in its softened state. When dry, the impression will be sunk into the horn; and this will serve as a mould to re-produce, either by plaister-of-paris, putty and glue, or isinglass and ground egg-shells, the exact resemblance of the coin or medal.

To extract the Silver out of a Ring, that is thick gilded, so that the Gold may remain entire.

Take a silver ring that is thick gilded. Make a little hole through the gold into the silver; then put the ring into aqua-fortis, in a warm place: it will dissolve the silver, and the gold will remain whole.

To soften Iron or Steel.

Either of the following simple methods will make iron or steel as soft as lead:

1. Anoint it all over with tallow; temper it in a gentle charcoal fire, and let it cool of itself.
2. Take a little clay, cover your iron with it, temper it in a charcoal fire.
3. When the iron or steel is red hot, strew hellebore on it.
8. Quench the iron or steel in the juice or water of common beans.

To take a Plaster-of-Paris Cast from a Person's Face.

THE person must lie on his back, and his hair be tied behind. Into each nostril put a conical piece of paper, open at each end to allow of breathing. The face is to be lightly oiled over, and the plaster being properly prepared, is to be poured over the face, taking care that the eyes are shut, till it is covered a quarter of an inch thick. In a few minutes, the plaster may be removed. In this a mould is to be formed, from which a second cast is to be taken, that will furnish casts exactly like the original.

THE ART OF MAKING FIREWORKS.

To make Touch-paper.

DISSOLVE in some spirits of wine or vinegar, a little saltpetre; then take some purple or blue paper, wet it with the above liquor, and when dry it will be fit for use. When you paste this paper on any of your works, take care that the paste does not touch that part which is to burn. The method of using this paper is, by cutting it into slips, long enough to go once round the mouth of the serpent, cracker, &c. When you paste on these slips, leave a little above the mouth of the case not pasted; then prime the case with meal powder, (see p. 128) and twist the paper to a point.

To make Crackers.

CUT some stout cartridge paper into pieces three inches and a half broad, and one foot long; one edge of each of these pieces fold down lengthwise about three quarters of an inch broad; then fold the double edge down a quarter of an inch, and turn the single edge back half over the double fold; open it, and lay all along the channel,

which is formed by the foldings of the paper, some meal powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this being done, bend it backwards and forwards, two inches and a half, or thereabouts, at a time, as often as the paper will allow; hold all these folds flat and close, and with a small pinching cord, give one turn round the middle of the cracker, and pinch it close; bind it with packthread, as tight as you can; then in the place where it was pinched, prime one end, and cap it with touch paper. When these crackers are fired, they will give a report at every turn of the paper; if you would have a great number of bounces, you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it straight while it is pinching.

To make Squibs and Serpents.

First make the cases, of about six inches in length, by rolling slips of stout cartridge paper three times round a roller, and pasting the last fold; tying it near the bottom as tight as possible, and making it air-tight at the end by sealing-wax.—Then take of gunpowder half a pound, charcoal one ounce, brimstone one ounce, and steel-filings half an ounce, (or in like proportion), grind them with a mullar, or pound them in a mortar. Your cases being dry and ready, first put a thimble-full of your powder, and ram it hard down with a ruler; then fill the case to the top with the aforesaid mixture, ramming it hard down in the course of filling two or three times; when this is done, point it with touch-paper, which should be pasted on that part which touches the case, otherwise it is liable to drop off.

Of Saltpetre.

SALTPETRE being the principal ingredient in fireworks, and a volatile body, by reason of its aqueous and aërial parts, is easily rarified by fire; but not so soon when foul and gross, as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of fireworks is intended to be made, it would be necessary first to examine the saltpetre; for if it be not well cleansed from all impurities, and of a good sort, your works will not have their proper effect.

To pulverize Saltpetre.

TAKE a copper kettle the bottom being spherical, and put into it fourteen pounds of refined saltpetre, with two quarts or five pints of clean water; then put the kettle on a slow fire, and when the saltpetre is dissolved, if any impurities arise, skim them off, and keep constantly stirring it with two large spatulas, till all the water exhales; and when done enough, it will appear like white sand, and as fine as flour; but if it should boil too fast, take the kettle off the fire, and set it on some wet sand, which will prevent the nitre from sticking to the kettle. When you have pulverized a quantity of saltpetre, be careful to keep it in a dry place.

Of Sulphur, or Brimstone.

SULPHUR is by nature the food of fire, and one of the principal ingredients in gunpowder, and almost in all compositions of fireworks; therefore, great care ought to be taken of its being good, and brought to the highest perfection. Now, to know when the sulphur is good, you are to observe that it be of a high yellow, and if, when held in one's hand, it crackles and bounces, it is a sign that it is fresh and good; but as the method of reducing brimstone to a powder is very troublesome to do, it is better to buy the flour ready-made, which is done in large quantities, and in great perfection; but when a great

quantity of fireworks is to be made, it is best to use the lump brimstone ground in the same manner as gunpowder.

To prepare Charcoal for Fireworks.

CHARCOAL is a preservative, by which the saltpetre and brimstone are made into gunpowder, by preventing the sulphur from suffocating the strong and windy exhalation of the nitre. There are several sorts of wood made use of for this purpose; some prefer hazel, others willow, and others alder. The method of burning the wood is this: cut it in pieces about one or two feet long, then slit each piece in four parts; scale off the bark and hard knots, and dry them in the sun, or in an oven; then make in the earth a square hole, and line it with bricks, in which lay the wood crossing one another, and set it on fire; when thoroughly lighted, and in a flame, cover the hole with boards, and fling earth over them close, to prevent the air from getting in, yet so as not to fall among the charcoal; and when it has lain thus for twenty-four hours, take out the coals and lay them in a dry place for use. It is to be observed that charcoal for fireworks must always be soft and well burnt, which may be bought ready done.

Of Gunpowder, &c.

GUNPOWDER being a principal ingredient in fireworks, it will not be improper to give a short definition of its strange explosive force, and cause of action, which, according to Dr. Shaw's opinion of the chemical cause of the explosive force of gunpowder, is as follows: "Each grain of gunpowder consisting of a certain proportion of sulphur, nitre, and coal, the coal presently takes fire, upon contact of the smallest spark; at which time both the sulphur and the nitre immediately melt, and by means of the coal interposed between them, bursts into flame; which spreading from grain to grain, propagates the same effect almost instantaneously, whence the whole mass of powder comes to be fired; and as nitre contains a large

proportion both of air and water, which are now violently rarified by the heat, a kind of fiery explosive blast is thus produced, wherein the nitre seems, by its aqueous and aërial parts, to act as bellows to the other inflammable bodies, (sulphur and coal) to blow them into a flame, and carry off their whole substance in smoke and vapour."

How to meal Gunpowder, Brimstone, and Charcoal.

THERE have been many methods used to grind these ingredients to a powder for fireworks, such as large mortars and pestles made of ebony, and other hard woods; but none of these methods have proved so effectual and speedy as the last invention, that of the mealing table. This table is made of elm, with a rim round its edge, four or five inches high; and at the narrow end is a slider, which runs in a groove and forms part of the rim; so that when you have taken out of the table as much powder as you conveniently can, with a copper shovel, you may sweep all clean out at the slider. When you are going to meal a quantity of powder, observe not to put too much on the table at once; but when you have put in a good proportion, take a muller and rub it therewith till all the grains are broke; then searce it in a lawn sieve, that has a receiver and top to it; and that which does not pass through the sieve, return again to the table and grind it more, till you have brought it all fine enough to go through the sieve. Brimstone and charcoal are ground in the same manner as gunpowder, only the muller must be made of ebony, for these ingredients being harder than powder, would stick in the grain of the elm, and be very difficult to grind; and as the brimstone is apt to stick and clog to the table, it would be best to keep one for that purpose only, by which means you will always have your brimstone clean and well ground.

Of such Ingredients as show themselves in Sparks when rammed into choaked Cases.

THE set colours of fire produced by sparks are divided into four sorts, viz. the black, white, grey, and red; the black charges are composed of two ingredients, which are meal powder and charcoal; the white of three, viz. saltpetre, sulphur, and charcoal; the grey of four, viz. meal powder, saltpetre, brimstone, and charcoal; and the red of three, viz. meal powder, charcoal, and saw-dust.

There are, besides these four regular or set charges, two others, which are distinguished by the names of compound and brilliant charges; the compound charge being made of many ingredients, such as meal powder, saltpetre, brimstone, charcoal, saw-dust, sea-coal, antimony, glass-dust, brass-dust, steel-filings, cast-iron, tanners' dust, &c. or any thing that will yield sparks; all which must be managed with discretion. The brilliant fires are composed of meal powder, saltpetre, brimstone, and steel-dust; or with meal powder and steel-filings only.

Of the Method of mixing Compositions.

THE performance of the principal part of fireworks depends much on the compositions being well mixed; therefore great care ought to be taken in this part of the work, particularly in the composition for sky-rockets. When you have four or five pounds of ingredients to mix, which is a sufficient quantity at a time (for a larger proportion will not do so well,) first put the different ingredients together, then work them about with your hands, till you think they are pretty well incorporated; after which put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any should remain that will not pass through the sieve, grind it again till fine enough; and if it be twice sifted it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredients must be very fine, and great care taken in mixing

them well together: and observe, that, in all compositions wherein are steel or iron filings, the hands must not touch; nor will any works, which have iron or steel in their charge, keep long in damp weather, without being properly prepared, according to the directions given in the following article:

It may sometimes happen, that fireworks may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust, the natural consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and drossy sparks; and besides, the charge will be so much weakened, that if this should happen to wheels, the fire will not be strong enough to force them round; but to prevent such accidents, prepare your filings after the following manner:—Melt in a glazed earthen pan some brimstone over a slow fire, and when melted, throw in some filings, which keep stirring about till they are covered with brimstone; this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broke it as fine as corn powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep two or three months in winter; this may be done by rubbing them between the strongest sort of brown paper, which has been previously moistened with linseed oil.

N. B. If the brimstone should take fire, you may put it out, by covering the pan close at top. It is not of much signification what quantity of brimstone you use, provided there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about one foot diameter, will do for five or six pounds of filings. Cast-iron for gerbes will be preserved by the above method.

Of Water Rockets.

WATER rockets may be made from four ounces to two pounds; but if larger they are too heavy, so that it will be difficult to make them keep above water without a cork-float, which must be tied to the neck of the case, but the rockets will not dive so well with as without floats.

Cases for water rockets are made in the same manner and proportion as sky rockets, only a little thicker of paper; when you fill these rockets, which are drove solid, put in first, one ladle-full of slow fire, then two of the proper charge, and on that one or two ladles of sinking charge; then the proper charge, with the sinking charge again, and so on till you have filled the case within three diameters; now drive on the composition one ladle-full of clay, through which make a small hole to the charge; fill the case within half a diameter, with corn powder, on which turn down two or three rounds of the case in the inside; pinch and tie the end very tight. Having filled your rockets according to the above directions, dip their ends in melted resin or sealing-wax, or else secure them well with grease. When you fire these rockets, throw in six or eight at a time; but if you would have them all sink or swim at the same time, you must drive them with an equal quantity of composition, and fire them altogether.

Of Water Squibs.

WATER squibs are generally made of one-ounce serpent cases, seven or eight inches long, filled two-thirds with charge, and the remainder bounced; the common method of firing them is thus:—Take a water-wheel, with a tin mortar in its centre, which load with squibs after the usual method, but the powder in the mortar must be no more than will just throw the squibs out easily into the water; you may place the cases on the wheel, either obliquely or horizontally; and on the top of the wheel round the mortar, fix six cases of brilliant fire, perpendicular to the wheel; these cases must be

fired at the beginning of the last case of the wheel, and the mortar at the conclusion of the same.

Of Maroons.

FORMERS for maroons, are from three-quarters of an inch to one and a half in diameter; cut the paper for the cases twice the diameter of the former broad, and long enough to go three times round; when you have rolled a case, paste down the edge, and tie one end close; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the case with corn-powder one diameter and a quarter high, and fold down the rest of the case tight on the powder. The maroon being thus made, wax some strong packthread with shoemakers' wax, this thread wind up in a ball; unwind two or three yards of it, and that part which is near the ball, make fast to a hook; then take a maroon, and stand as far from the hook as the packthread will reach, and wind it lengthwise round the marron, as close as you can, till it will hold no more that way; turn it, and wind the packthread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the packthread, and beat down both ends of the maroon, to bring it into shape. The method of firing maroons is, by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of strong paper, in which wrap up the maroon, with two leaders, which must be put down to the vent, and the paper tied tight round them with small twine; these leaders are bent on each side, and their loose ends tied to other maroons, and are nailed in the middle to the rail of the stand. The use of winding the packthread in a ball is, that you may let it out as you want it, according to the quantity the maroon may require; and that it may not be tied in knots, which would spoil the maroon.

Of Sky Rockets.

As the performance of rockets depends much on their moulds or cases, it is necessary to give a definition of

them. They are generally made about six inches long, and one in diameter. The mould should be of the stoutest cartridge paper, or pasteboard, six times round, and glued together well. The composition for filling them is, mealed powder one pound four ounces, saltpetre four ounces, and charcoal two ounces. The composition should be drove in as tight as possible with a rammer and mallet, the mould being fixed in a frame of iron or brass, made on purpose.

Of Table Rockets.

TABLE rockets are designed merely to shew the truth of driving, and the judgment of a fireworker; they have no other effect, when fired, than spinning round in the same place, where they begin, till they are burnt out, and show nothing more than an horizontal circle of fire.

The method of making these sort of rockets is as follows:—Have a cone turned out of hard wood, two inches and a half in diameter, and as much in height; round the base of it draw a line; on this line fix four spokes, two inches in length each, so as to stand one opposite the other; then fill four nine inch one pound cases, with any strong composition, within two inches of the top, rammed with the greatest exactness.

Your rockets being filled, fix their open ends on the short spokes; then in the side of each case bore a hole near the clay; all these holes or vents must be made in such a manner, that the fire of each case may act the same way; from these vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets, set them on a smooth table, and light the leaders in the middle; all the cases will fire together, and spin on the point of the cone.

Note: all the vents in the under side of the cases must be lighted at once, and the sharp point of the cone cut off, at which place make it spherical.

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To make Wheels and other Works incombustible.

It will be necessary, when your works are new, to paint them of some dark colour; therefore, if instead of which, you make use of the following composition, it will give them a good colour, and in a great measure prevent their taking fire so soon as if painted. Take brick-dust, coal ashes, and iron filings, of each an equal quantity, and mix them together with double size made hot. With this wash over your works, and when dry, wash them over again; this will preserve the wood greatly against fire. Let the brick-dust and ashes be beat to a fine powder.

Of Single Vertical Wheels.

There are different sorts of vertical wheels, some having their fells of a circular form, others of a hexagon, octagon, or decagon form, or any number of sides, according to the length of the cases you design for the wheel. Your spokes being fixed in the nave, nail slips of tin, with their edges turned up, so as to form grooves for the cases to lie in, from the end of one spoke to another; then tie your cases in the grooves, head to tail, in the same manner as those on the horizontal water wheel, so that the cases successively taking fire from each other, will keep the wheel in an equal rotation. Two of these wheels are very often fired together, one on each side of a building, and both lighted at the same time, and all the cases filled alike, to make them keep time together, which they will do if made by the following directions:—In all the cases of both wheels, except the first, on each wheel, drive two or three ladles full of slow fire in any part of the cases, but be careful to ram the same quantity in each case; and in the end of the cases on each wheel, you may ram one ladle full of dead-fire composition, which must be very lightly drove; you may also make many changes of fire by this method.

Let the hole in the nave of the wheel be lined with brass, and made to turn on a smooth iron spindle. On the end of this spindle let there be a nut, to screw off and on; when you have put the wheel on the spindle,

screw on the nut, which will keep the wheel from flying off. Let the mouth of the first case be a little raised. Vertical wheels are made from ten inches to three feet diameter, and the size of the cases must differ accordingly; four-ounce cases will do for wheels of fourteen or sixteen inches diameter, which is the proportion generally used. The best wood for wheels of all sorts, is a light and dry beech.

Of Horizontal Wheels.

HORIZONTAL wheels are best when their fells are made circular; in the middle of the top of the nave must be a pintle, turned out of the same piece as the nave, two inches long, and equal in diameter to the bore of one of the cases of the wheel; there must be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made, nail at the end of each spoke (of which there should be six or eight) a piece of wood, with a groove cut to receive the case. Fix these pieces in such a manner that half the case may incline upwards, and half downwards; and that, when they are tied on, their head and tails may come very near together. From the tail of one case to the mouth of the other, carry a leader, which secure with pasted paper. Besides these pipes, it will be necessary to put a little meal powder inside the pasted paper, in order to blow off the pipe, that there may be no obstruction to the fire from the cases. By means of the pipes the bases will successively take, one burning upwards, the other downwards. On the pintle fix a case of the same sort as those on the wheel; this case must be fired by a leader from the mouth of the last case on the wheel, which case must play downwards. Instead of a common case in the middle, you may put a case of Chinese fire (see p. 137) large enough to burn as long as two or three of the cases on the wheel.

Horizontal wheels are often fired two at a time, and made to keep time like vertical wheels, only they are made without any slow or dead fire. Ten or twelve inches will be enough for the diameter of wheels with six spokes.

Of the vertical Scrole Wheel.

THIS wheel may be be made of any diameter, but must be constructed thus:—Have a block of a moderate size, into which fix four flat spokes, and on them fix a flat circular fell of wood. Round the front of this fell place port-fires; then, on the front of the spokes form a scrole, either with a hoop or strong iron wire; on this scrole tie cases of brilliant fire, in proportion to the wheel, head to tail. When you fire this wheel, light the first case near the fell; then, as the cases fire successively, you will see the circle of fire gradually diminish; but whether the illuminations on the fell begin with the scrole or not, is immaterial.

A slow Fire for Wheels

MUST be composed of saltpetre, four ounces; brimstone, two ounces; and meal powder, one ounce and a half.

A dead Fire for Wheels.

SALTPETRE, one ounce and a quarter; brimstone, a quarter of an ounce; lapis-calaminaris, a quarter of an ounce; and antimony, two drachms.

A brilliant Fire.

MEAL powder, six pounds; saltpetre, half a pound; brimstone, two ounces; and steel-dust, twelve ounces.

For a Blue Flame.

MEAL powder, saltpetre, and sulphur vivum; the sulphur must be the chief part. Or, meal powder, saltpetre, brimstone, spirit of wine, and oil of spike; but let the powder be the principal part.

Of Port or Wild Fires.

SALTPETRE, one pound two ounces; meal powder, one pound and a half; and brimstone, ten ounces. This composition must be moistened with one gill of linseed oil.

Chinese Method of embellishing Fireworks with Flowers, &c.

THE only ingredient necessary to produce these flowers is cast-iron reduced to sand, which is done by heating small pieces of old cast-iron in a forge, and then throwing them into water, where they are left to cool. Thus calcined, the rust falls off in scales, and they are easily reduced into sand. The anvil and hammer used for this purpose must also be of cast-iron, because steel flats the grains of sand. It is necessary that the angles of those grains should be sharp, as the angles form the flowers; and according as this sand has passed through sieves more or less fine, the flowers are either larger or smaller.

If the plant which is intended to be represented, has a greater or less quantity of flowers, the sand is in proportion increased or diminished; and the quality of more or less coarse is used in respect of the size of the natural flowers. A yellow, red, or white colour is given to the fire of those flowers, in imitation of the colour of the flowers of the plant which they represent; and great variety may be introduced by varying the doses of the composition, and changing the quantity and quality of the sand.

The cartouches of these sort of squibs ought to be proportioned to the sand. If the cartouch is of too great or too small a diameter, either the sand will not melt, or it will melt before it goes out of the cartouch. Find sand requires only a moderate fire; but coarse, one that is violent. A cartouch with an opening of two or three lines diameter, is sufficient for the finest sand; for the sand of the second order, four or five lines; for that of the third order, six or seven lines; for that of the fourth order, nine or ten lines; for that of the fifth order one

inch; and lastly for the coarsest sand, one inch and a half.

The cartouches of the Chinese squibs, except those of the crackers, are made of a thin paste-board, composed only of two leaves of coarse paper. The paste-board for the cartouches of the rockets that are fired off before the emperor, is composed of three leaves of paper made of hemp. To prevent accidents of fire, and to keep the cartouches from bursting; in diluting the paste for them, to one pound of flour they throw in a good handful of sea salt; and before laying on the fire the flour diluted with salt, they steep some clay to the consistence of thin mud. When the paste is made and taken off the fire, they mix it with nearly as much steeped clay as there is paste, which consequently must make the paste very thin. The whole is well mixed together, being stirred with a stick; the clay keeps the pasteboard from catching fire easily, and is therefore less subject to burst; the salt causes the fire that may have caught the pasteboard to be soon extinguished.

The saltpetre, which is an ingredient in the composition of the flowers, ought to be well purified. All the materials, except the iron sand, must be sifted through a fine silk searce; and they are mixed up with only as much of the strongest brandy as may be thought sufficient to make them granulate. If there be too much brandy, it will cause the flowers to fail. The sand is first moistened, and afterwards mixed with the sulphur; then the saltpetre is added, the charcoal, and the other materials that are sometimes ingredients for diversifying the colours of the fire.

The cartouches are charged as those of rockets. The match is placed half out of the cartouch; and this half, for greater security against fire, is wrapt up in a bit of paper that reaches beyond it, but is twisted only about the match where it enters the squib.

To contain those squibs when they are fired off, it is sufficient to put them between two bricks laid flat It would be advisable to raise them a little, especially when the composition has not much force, that the flowers may all appear before the sand falls to the ground.

The materials for forming raisins, or bunches of grapes, in the Chinese fireworks, is nothing else than sulphur reduced to an impalpable powder, of which a paste of a pretty hard consistence is made with that of flour. With this paste they garnish letters made of strong iron wire, that the matter may the more easily hold, which will remain on fire as long as one pleases, in proportion to the quantity of matter employed therein. That all may take fire at the same time, a match is applied about the figures; and besides the matches, the whole is wrapped up in paper, which, on catching fire, communicates it in an instant everywhere.

The Manner of preparing burning Letters and Names for Illuminations.

ORDER a joiner to cut capital letters of what length and breadth you please, about two feet long, and three or four inches wide, and an inch and a half thick. Hollow out of the body of the letters a groove, a quarter of an inch deep, reserving for the edges of the letters a quarter or half an inch of wood. If you design to have the letters burn with a blue fire, make wicks of cotton or flax, according to the bigness and depth of the grooves in the letters; draw them leisurely through melted brimstone, and place them in the grooves; brush them over with brandy; strew them with meal powder, and again with brandy, and thin dissolved gum tragacanth; and on that strew meal powder again: when dry, drive small tacks all round the edges of the grooves, and twist small wire to those tacks, that it may cross the letters, and keep the cotton or flax close therein; then lay over it brandy paste; strew over that meal powder, and at last glue a single paper over it.

If you would have the letters burn white, dissolve six pounds of saltpetre, and add to it a little corn powder: in that dip your wicks of cotton or flax.

There is another method for burning letters without groves, which is done by boring small holes in the letters, of about an inch distance one from the other; the dia-

meter of these holes must not be above the eighth of an inch; and into them put glue cases, rammed with burning charges. These letters do not burn so long as the others, except the charges are very long.

Another method is used, by getting the letters formed by a smith, of coarse wire, about a quarter of an inch thick. This done, get some cotton spun into match thread, but not much twisted. To two yards of this, take one pound of brimstone, six ounces of saltpetre, and two ounces of antimony. Melt these ingredients in a kettle, first, the brimstone by itself, and then the rest altogether. When melted, put in the match thread, and stir it about, till it has drawn in all the matter. Then take it out and strew it over with meal powder; let it dry, and wind it about the wire letters; fasten these upon a board that has been well laid over with a preservative to keep it from firing. When you have lighted one letter, the rest of the letters will immediately take fire.

To make Water boil by Cold, and cease to boil by Heat.

HALF fill a Florence flask with water, place it over a lamp furnace*, and let it boil briskly for a few minutes; then cork the mouth of the flask as expeditiously as possible, and tie a slip of moist bladder over the cork, to exclude the air. The water, on being now removed from the lamp, will keep boiling, and when the ebullition ceases, the boiling may be renewed, by wrapping round the empty, or upper part of the flask, a cloth wetted with cold water, or by gradually pouring cold water upon the flask; but if hot water be applied to the flask, the boiling instantly ceases. In this manner the ebullition may be renewed, and again made to cease, alternately, by the mere application of hot and cold water.

* The lamp-furnace, and every other requisite for performing chemical experiments on a small scale, may be had of Mr. Accum, Operative Chemist, Compton-Street, Soho, from whose interesting work many of the following experiments are extracted.

To cause Bubbles of Gas to issue from Water, which take fire with a brilliant Flame.

PUT a piece of phosphuret of lime, of the size of a pea, into a wine glass, half-filled with water: the phosphuret will fall to pieces, and bubbles of gas rise up to the surface of the water, which take fire with a brilliant flame and snapping noise, when they come into contact with the air; each bubble of gas, as it explodes, if the air be calm, is succeded by a horizontal ring of dense white smoke, which mounts up to the ceiling with an undulatory motion, and gradually enlarges in diameter as it ascends.

The residue of the phosphuret of lime, when taken out of the water, and suffered to dry, inflames, by pouring on it a little muriatic acid.

The bottle containing the phosphuret of lime, should never be left open, for the contact of air soon renders it unfit for use.

Two Liquids, which united together, melt Gold, but neither possessing this quality in a separate state.

POUR half an ounce (about a tea-spoonful) of common nitric acid into a wine-glass, and double that quantity of muriatic acid into another glass, and then put a gold leaf into each of the glasses. The gold leaf will remain unaltered; but if the contents of the two glasses be mixed, a chemical action instantly ensues, the mixed acid gradually acquires an orange colour, a multitude of very minute air bubbles is speedily disengaged, and the gold leaves become dissolved.

Precipitation of Metallic Gold upon Charcoal.

PREPARE a solution of muriate of gold, as described in the preceding experiment, by adding gold leaves to nitro-muriatic acid, till the acid refuses to dissolve any more. Then dilute the solution with five or six times its

bulk of water, and having put into it a long slip of fresh burnt charcoal, expose the whole to the direct light of the sun, or to a very gentle heat. The gold will be revived, and appear upon the charcoal in a brilliant metallic state, exhibiting beautiful spangles of metallic gold.

To set a combustible Body on Fire, by the Contact of Water.

FILL a saucer with water, and let fall into it a piece of potassium, of the size of a pepper-corn, which is about two grains. The potassium will instantly burst into a flame, with a slight explosion, and burn vividly on the surface of the water, darting at the same time from one side of the vessel to the other, with great violence, in the form of a beautiful red-hot fire ball.

If a piece of potassium be placed on ice, it instantly takes fire with a bright flame, and melts a deep hole into the ice.

To freeze Water in the midst of Summer, without the application of Ice.

TAKE eleven drachms of muriate of ammonia, ten of nitrate of potash, and sixteen of sulphate of soda: reduce each of these salts, separately, to a fine powder, and mix them gradually in a glass, with five ounces of water, (the capacity of the vessel should be just large enough to hold the materials,) the result will be, that as the salts dissolve, cold will be produced, and a thermometer immersed in the mixture will sink, at, or below freezing. A little water, about half an ounce, in a test-tube, when immersed in the mixture during its solution, becomes frozen in about ten minutes.

The salts employed in this experiment, may be recovered from the solution, if the sulphate of soda be omitted, by evaporating the water, to serve again any number of times. Five parts of muriate of ammonia, five of nitre, and eight of sulphate of soda, mixed with

sixteen of water, at the usual temperature, sink the thermometer, from 50 deg. to about 10 deg.

The salts, to produce the fullest freezing effect, should be recently chrystallized in fine powder, and contain as much water of chrystallization as possible, but they should not be damp.

Heat and Cold produced by the same Body, at the same Time, and at the same Temperature.

ARRANGE three basons, and put into the first, water of a temperature of about 33 deg. Fahrenheit; fill the second bason with water heated to about 50 deg. Fahrenheit; and the third with water heated to about 100 deg. Fahrenheit. Immerse the right hand into the water of the temperature of 100 deg. Fahrenheit, and the left into the water of the temperature of 33 deg. Fahrenheit; let them remain for a minute, and then suddenly plunge both hands into the water of the intermediate temperature of 50 deg. Fahrenheit; the right hand will feel cold, and the left hand warm; and thus different sensations are produced by the same body, at the same time, and at the same temperature.

To distinguish Iron from Steel.

To distinguish iron from steel by a chemical process, take nitric acid, dilute it with so much water, that it will only feebly act upon the blade of a common table knife. If a drop of this acid thus much diluted, be put upon steel, and allowed to remain on it for a few minutes, and then washed off with water, it leaves a black spot. But if a drop of the same acid be put upon iron, the spot will not be black, but of a whitish grey colour.

To detect Alkalies.

THE best test for this purpose is paper stained a pale yellow with tincture of turmeric. First dip a piece of this paper into common water, its yellow colour will

remain unaltered, then add a grain of potash, or soda, either in a pure state, or in the state of a carbonate, to a wine-glass half full of common water, and immerse into the solution the same piece of paper, it will instantly acquire a brown colour. Or hold a piece of turmeric paper, slightly wetted with water, over the open mouth of a bottle containing liquid ammonia. The yellow colour of the paper will become changed to brown; remove the paper, and hold it near the fire, the brown colour will vanish, and its original yellow will re-appear, because the ammonia becomes volatilized.

To detect Acids.

THE most convenient test for detecting minute portions of acids, is litmus paper, which becomes changed to red, its colour being blue. Immerse a slip of this paper into any sort of wine, cider, ale, porter, or any other fermented liquor, its natural blue colour will become changed to red, because all vinous fluids, even the mildest, contain a free acid, some more, others less. The redness occasioned by vinous liquors on litmus paper, is owing to the presence of tartaric, malic, or acetic acid.

Paper stained with the juice of the violet flower, or the scrapings of purple radishes, answers the same purpose.

The colour of litmus paper ought to be a pale, not a dark violet blue. This paper, when long kept exposed to the contact of air and light, loses its colour, and then becomes unfit for use. It should therefore be preserved in opaque stopped bottles, or placed between the leaves of a book.

To detect Copper.

THE best test for detecting minute portions of copper, is liquid ammonia; its effect will become obvious from the following experiment.

Add a grain or two of sulphate of copper to half a

wine-glass full of water, no change will take place; but if a little liquid ammonia be added, the mixture assumes a fine sapphire blue colour, and thus indicates the presence of copper.

The presence of copper when contained in pickles, to which a beautiful green colour has been given, according to the directions of the most popular *homocidial* cookery books, by boiling them with half-pence, or allowing them to stand for twenty four hours in copper or brass pans, may thus be detected: It is only necessary to mince the suspected pickles, and to pour liquid ammonia, diluted with an equal bulk of water over them, in a stopped phial; if the pickles contain the minutest quantity of copper, the ammonia will assume a blue colour.

To detect Iron.

THE principal test for detecting minute portions of iron, is tincture of galls. It produces with this metal, a violet, or black precipitate, whether the iron be held in solution by carbonic acid, or by any other acid. If the iron be dissolved in carbonic acid, as is often the case in mineral waters, the solution after having been concentrated by boiling, is no longer tinged of a violet, or black colour; but if it be held in solution by any fixed acid, the test still continues to produce a black precipitate. When the quantity of iron is exceedingly small, as is in general the case in chalybeate waters, tincture of galls does not actually produce a sensible precipitate, but only a slight purple tinge. A neat way of applying this test in cases where the quantity of iron is very small, consists in suspending a slice of the gall nut, by a silken string in the water to be examined. The following experiments will shew these facts.

1. Impregnate a quantity of distilled water with carbonic acid gas, shake it up for a few minutes with a small quantity of iron filings, let the mixture stand for about twenty-four hours, and then decant and filter it. Take a wine-glass half full of this chalybeate water, and add to it a few drops of tincture of galls. The mixture

will assume a violet colour, and a black precipitate will become deposited, composed of gallic acid, tan, and oxide of iron.

2. Take another portion of the same chalybeate water, concentrate it by boiling to about one half of its bulk, and when it is become cold, filter it; a brown precipitate (carbonate of iron) will fall down. The remaining clear fluid will no longer be altered by tincture of galls, which shews that the iron was combined with an excess of carbonic acid, which held it dissolved in the water.

3. Add to two or three ounces of distilled water, five or six drops of sulphuric acid, together with a small quantity of iron filings, shake the mixture for a few minutes, and let it stand till it is become perfectly clear, or it may be filtered after having stood eight or ten hours.

4. To one half of this clear solution of iron, add a few drops of tincture of galls, a violet colour, which speedily darkens, will immediately appear. Boil the other half of the fluid till it is concentrated to about one half of its original bulk; a brown powder will separate from the solution during the process. When this fluid is cold, filter it, and examine it again by adding to it a few drops of tincture of galls, which will still occasion a violet or black colour, because the iron is combined with a mineral acid. A minute quantity of sulphate of iron, dissolved in distilled water, will give the same results.

Prussiate of potash is also an useful test for detecting iron; it produces with this metal a blue precipitate, provided the iron exists in a state of high oxidisement. The following experiments will shew the effect of this test.

1. To three or four ounces of distilled water impregnated with carbonic acid gas, or common Seltzer water, add a few iron filings, or iron wire, and let it stand in a corked phial for three or four days, occasionally shaking the mixture, and then filter the solution, which will be an artificial chalybeate aërated water. To one half of it add a grain or two of prussiate of potash; the liquid will become blue, and some time after a blue precipitate will be deposited.

2. Evaporate the other half of the chalybeate aërated water, obtained as above stated, to one half of its bulk, a brown powder, or sub-carbonate of iron will fall down. When the water has become cold, filter it, and assay it again with prussiate of potash, which will now produce no effect; because the excess of carbonic acid, which held the iron in solution, is volatilized, and the iron thus reduced to a sub-carbonate of iron, is no longer soluble in the water.

3. Shake two or three ounces of distilled water, with thirty or forty grains of iron filings, and five or six drops of sulphuric acid, for a few minutes; let the mixture stand for a day or two, and decant or filter it, (or dissolve a few grains of sulphate of iron in half a wine-glass full of distilled water:) to one half of this clear solution, add a few drops of a solution of prussiate of potash, and a blue precipitate will be formed.

4. If the other half of the fluid be evaporated a little, and the same test be added to it, a blue precipitate will nevertheless be produced; because the iron is held in solution by mineral or fixed acid, which cannot be volatilized by heat.

5. Put into one wine-glass half filled with distilled water, a few grains of prussiate of potash, and into another glass, containing a like quantity of distilled water, dissolve a grain of green sulphate of iron; pour the solutions together when the salts are dissolved, and an olive-green precipitate will be produced, which will speedily acquire a blue colour.

To detect Lead.

SULPHATE of soda, or sulphate of potash, may be employed for detecting the presence of lead, by virtue of one of the constituent parts of this salt, namely, the sulphuric acid, combining with the oxide of lead, and forming with a white precipitate, (sulphate of lead) which is insoluble in water, and in liquid ammonia, but soluble in dilute nitric acid, when assisted by heat; and which becomes blackened by water impregnated with sulphuretted hydrogen gas. These characters are suffi-

cient to distinguish it at once, from other precipitates, obtained by means of this test, and with which it might be confounded. Dr. T. Thomson considers this test "as the most unequivocal re-agent of lead which we possess;" for, by means of it, he was enabled to detect in in water the one-millionth part of its weight of lead.

Let fall into a wine-glass half full of distilled water, a drop of super-acetate of lead, and add to the mixture a few drops of a solution of pure sulphate of soda, or sulphate of potash, a dense white precipitate will fall down, which is sulphate of lead. Decant the super-natant fluid, pour upon the precipitate dilute nitric acid, and apply a gentle heat. The precipitate will again become re-dissolved. If water impregnated with sulphuretted hydrogen be added to it, it will become instantly blackened.

To detect Arsenic.

THE presence of arsenic may be detected by sub-nitrate of silver. We are indebted for this test to Mr. Hume. The following experiment will illustrate its effect.

Put two or three grains of arsenious acid, (white arsenic) and eight ounces of distilled water, into a Florence flask; heat the mixture over a lamp till the solution boils, and then add to it a grain or two of sub-carbonate of potash or of soda. Pour a few table spoons full of the solution into a wine glass, and present to the mere surface of the liquid a stick of dry sub-nitrate of silver, or lunar caustic. A yellow precipitate will instantly appear, which will proceed from the point of contact of the sub-nitrate with the fluid, and settle towards the bottom of the glass as a flocculent and copious precipitate. Dr. Marcet has lately pointed out the following modification of this test.

Let the fluid suspected to contain arsenic be filtered, and suffer the end of a glass rod, wetted with liquid ammonia, to be brought into contact with it, and let the end of a glass rod be also wetted with the solution of nitrate of silver, be immersed in the mixture, a yellow

precipitate will appear at the point of contact, and will gradually fall down to the bottom. As this precipitate is soluble in ammonia, the greatest care is necessary not to add an excess of that alkali.

The objection arising from the action of muriatic acid upon this test, is easily obviated; for if a little muriatic acid be dropped into the fluid suspected to contain arsenic, and the nitrate of silver be very cautiously added, till the precipitate ceases, the muriatic acid will be removed, and the arsenic remain in solution, and the addition of liquid ammonia will produce the yellow precipitate in its characteristic form.

Vivid Combustion of Three Metals, when brought in contact with each other.

MIX a grain or two of potassium, with the like quantity of sodium, by rubbing them together with the point of a knife. The mixture will take place quietly; but if the alloy of these two bodies be brought into contact with a globule of quicksilver, the compound, when agitated, instantly bursts into a flame, and burns vividly.

The Bulk of two Liquids, when mixed, is less than the Sum of the two Bulks taken separately before their Mixture.

PUT into a glass globe, of the size of an orange, furnished with a long narrow neck, (a bolt-head,) as much water as will half fill it; and pour upon the water highly rectified alcohol, nearly up to the top of the neck of the globe. It is essential that the alcohol be poured very carefully upon the water, without shaking the globe. When this has been done, the stratum of the alcohol will be seen floating upon the water unmixed. (The water may be coloured with a little red ink, to render it more distinct.) Then mark on the neck or tube of the instrument, the exact height to which the alcohol reaches; and having closed the open end of the

tube with the finger, shake the instrument for a few minutes, to cause the two fluids to mix. The globe will become sensibly warm to the hand during the union of the two liquids; and when it has again acquired its original temperature, the level to which the liquor rises will now be found much lower than before the mixture.

To freeze Quicksilver.

If merely the congelation of mercury is wanted to be exhibited in a miniature process, the readiest way is to throw a little of the metal loose into a rather large mass of a freezing mixture, composed of snow and muriate of lime, where it will congeal in a few minutes; but where this experiment is performed in a room, with a number of persons standing round, the natural temperature will always be so much raised, that the operator can hardly depend on success, without previously cooling, separately, the muriate of lime and snow, by a separate mixture of the same materials. It is also of great importance, that the snow should remain without doors till the moment that it is wanted, and the whole of the muriate should be kept cold, by immersing in snow or iced water the vessel that contains it, or better in a freezing mixture.

Great caution should be used in touching frozen mercury. It gives an immediate sensation like a wound from a rough-edged instrument, or as if the finger was squeezed in a vice, and the mere sensation can hardly be distinguished from the burn of a red-hot iron. The part in contact immediately becomes quite white and numb, and there is no doubt, that if it were to remain a very little time in contact with the frozen metal, a gangrene would come on. It is removed by rubbing the part a little time with snow.

The Well of Fire.

Add gradually one ounce, by measure, of sulphuric acid, to five or six ounces of water, contained in an earthenware bason; and add to it also, gradually, about

three-quarters of an ounce of granulated zinc. A rapid production of hydrogen gas will instantly take place. Then add, from time to time, a few pieces of phosphorus of the size of a pea, A multitude of gas bubbles will be produced, which take fire on the surface of the effervescent liquid; the whole surface of the liquid will become luminous, and fire-balls, with jets of fire, will dart from the bottom through the fluid with great rapidity, and a hissing noise.

Violet-coloured Gas.

PUT three or four grains of iodine into a small test-tube, and seal the other extremity of the tube hermetically. If the tube be gently warmed by holding it over a candle, the iodine becomes converted into a beautiful violet-coloured gas, or vapour, which condenses again into minute brilliant metallic chrystals of a bluish black colour when the tube is suffered to grow cold; and this experiment may be repeated with the same tube for any number of times.

To produce a Carmine-red Flame.

The flame of spirit of wine may be coloured by the addition of various bodies which the spirit holds in solution, or which are mixed with it. And although the real causes which modify the colours of burning bodies are not yet sufficiently known, the phenomena are in themselves sufficiently striking to deserve to be stated. The flame of alcohol is tinged red in the following manner: Put into a small iron ladle one part of muriate of strontia, and pour over it three or four of alcohol, then set it on fire with a candle, or a piece of burning paper, it will burn with a bright carmine-red flame, especially if the mixture be heated by holding the ladle over the flame of a candle or lamp, to cause the alcohol to boil rapidly.

The muriate of strontia left behind as residue, after being again thoroughly dried, may be used for the same

purpose repeatedly. This is acquired by dissolving native carbonate of strontia in muriatic acid, evaporating the solution, and suffering it to crystallize.

To produce an Orange-coloured Flame.

PUT muriate of lime, deprived of its water of crystallization, into an iron ladle, cover it with spirit of wine, and cause it to burn in the manner stated. Muriate of lime is made by dissolving common marble in muriatic acid, and evaporating the solution to perfect dryness.

To produce an Emerald-Green Flame.

CAUSE alcohol to burn in a ladle upon nitrate of copper, which is prepared by dissolving copper clippings or filings in a sufficient quantity of nitric acid, of a moderate strength; when no further effervescence ensues, boil the acid gently upon the copper, until a pellicle appears; decant the solution, evaporate it slowly, and when a very strong pellicle is formed, suffer it to crystallize. The salt is of a fine blue colour.

To produce a Yellow Flame.

THIS may be effected by most of the muriates, as common salt, or by nitre. When these salts are added in the proportion of three parts of common salt, or nitre, to one of alcohol, the flame produced is a dun-yellow.

To change a Blue Colour, Red, Green, Crimson, or Purple.

PUT two or three table-spoonfuls of tincture of cabbage, which is of a dark blue colour, into one tall ale-glass, and pour half the mixture into another glass. If a drop of sulphuric acid be added to one of the glasses, the blue will become changed to a lively crimson, and

by adding to the other glass a drop of liquid ammonia, or a solution of potash, soda, barytes, or strontia, the blue will be changed to a bright green; and if you carefully let fall, down the inner sides of the glass, into the green fluid, a single drop of sulphuric acid, crimson will appear in the bottom of the glass, purple in the middle, and green at the top; and by adding a few drops of liquid ammonia, or any other alkali, to the crimson fluid, the colours will present themselves in an inverted order.

N. B.—Tincture of cabbage is obtained by cutting fresh leaves of the red cabbage into small pieces, and pouring over it boiling-hot distilled water. Let it soak a few hours; decant the clear fluid, mix it with one-eighth of its bulk of spirit of wine, and it is fit for use.

To change a Blue Fluid Red, by the Air respired from the Lungs.

ADD to two tea-spoonfuls of water (in a wine-glass), a sufficient quantity of tincture of cabbage to tinge it very slightly blue, and blow through the coloured water the breath from the lungs, by means of a quill or tobacco-pipe dipped into the fluid. The bubbles of the air, expired whilst passing through the water, will speedily produce the reddening effect, because the air respired from the lungs contains carbonic acid.

To render a Green Fluid Blue, by the Air respired from the Lungs.

LET a few tea spoonfuls of tincture of cabbage be rendered very slightly green, by adding to it a very minute portion of liquid ammonia, or any other alkali, and blow through it the air respired from the lungs, as directed in the preceding experiment. The green tincture will be rendered blue again, because the carbonic acid gas, expired with the breath, neutralizes the effect of the alkali. And if you continue to pass air from the lungs, to act upon the blue tincture, it becomes reddened by

virtue of the excess, or uncombined carbonic acid, which it then contains.

Two transparent Liquids, when mixed, form an opaque and almost solid Mass.

INTO a wine-glass pour a few tea-spoonfuls of a concentrated solution of silicited potash, and add to it gradually, and drop by drop, sulphuric acid. If these two liquids be stirred together with a glass rod, they become converted into an opaque, white, and almost solid mass.

Silicited potash is made as follows:—Procure common gun-flints, expose them in a crucible to a red heat, and then plunge them into cold water; by this treatment they become brittle, and easily reducible to powder. Mix them, when pulverized, with three times their weight of sub-carbonate of potash, and let the mixture be fused in a dull red heat, in a common crucible, which must be only half filled. As soon as the matter enters into fusion, it puffs up considerably, and continues to swell till the alkali has dissolved the silex. The crucible must be kept uncovered as long as the effervescence lasts; but when it is over, cover the crucible, and augment the heat till the whole fuses quietly; then pour the contents out on a dry iron plate or stone; the matter, as it cools, becomes hard, and assumes the appearance of glass. This substance, when pulverized and dissolved, by pouring water over it, becomes silicited potash.

To cause an Invisible Writing to appear in Silver Characters.

WRITE on paper with a dilute solution of super-acetate of lead of commerce, the writing will be perfectly invisible. To make the characters legible, hold the paper, whilst the letters are still wet, over a saucer, containing water impregnated with sulphuretted hydrogen gas; the characters then assume a brilliant metallic and iridescent colour.

Fire produced without Air.

TAKE three parts, by weight, of flowers of sulphur, and eight parts of copper filings; mix them intimately together, and put the mixture into a large test tube, or small glass matrass. If the tube be now held over the flame of the lamp furnace, the mass begins to swell, and a small ignited spark becomes visible at the bottom, which rapidly increases in size; and lastly, the whole mass glows and exhibits a brilliant combustion.

To shew that Water is contained in the Air of the Atmosphere during the driest Weather.

TAKE a tea-spoonful of dry muriate of lime, or acetate of potash, or sub-carbonate of potash, spread it in a saucer or other vessel, and suffer it to be exposed to the open air for a few days. The dry salt will thus be rendered completely liquid, by the watery vapour which always exists in the atmosphere.

Chemical Effect of the Air respired from the Lungs.

HALF fill a wine-glass with fresh-prepared lime-water, or barytic water, and breathe air from the lungs into the fluid for a few minutes, by means of a tobacco-pipe, or glass tube. The lime-water will speedily become turbid, and a white precipitate fall to the bottom of the glass.

Singular Combustion of Tin-foil by Chemical Action.

ON a piece of tin-foil, of twice or three times the size of this leaf of paper, previously spread out smoothly, place a tea-spoonful, or quarter of an ounce, of nitrate of copper; moisten the nitrate by sprinkling over it so much water, and no more, as will just make it into a liquid paste, and then cover it with a few filaments of tow, (this, however, is not absolutely necessary). Then fold up the foil as quickly as possible round the moist-

ened nitrate of copper, and press down the edges and corners of the parcel to exclude the air. In a few minutes it becomes heated, a portion of the dissolved nitrate begins to ooze through, and a copious stream of nitrous gas forces its way out at different openings, attended with sparks of ignited tin, and small jets of fire. The success of the experiment is much assisted by sprinkling the mass with a little water, if the action be feeble at the moment the gas appears to rush out.

Easy Method of Gilding Steel.

THIS method of covering steel with gold, depends on the fact, that the sulphuric ether be mingled with a solution of muriate of gold, the ether reduces the gold to the metallic state, and keeps it for some time in solution, whilst the muriatic acid is separated, forming a distinct fluid almost wholly deprived of its gold. If into the ether, thus charged with gold, a piece of highly polished steel be immersed, the ether speedily evaporates, and leaves a coat of gold upon the steel. By applying a fine brush, or pen, all kinds of figures may be dilineated on highly polished steel instruments, such as on the best kinds of razors, scissars, pen-knives, &c. It is of advantage to wash or immerse the steel, the moment it has been gilt, into water. The adhesion of the gold is considerably improved by the application of the burnisher.

To silver Copper or Brass.

FIRST clean the article intended to be silvered by means of a little dilute nitric acid, or by scouring it with a mixture of common salt and alum. When is is perfectly bright, moisten a little of the powder, known in commerce by the name of silvering powder, with water, and rub it for some time on the perfectly clean surface of copper or brass, which will become covered with a coat of metallic silver. It may afterwards be polished with soft leather.

Fulminating Quicksilver.

THIS powder, which is less dangerous than any of the before-named fulminating compounds, is remarkable for the extreme force of detonation which it possesses when exploded by various methods. When struck on an anvil with a hammer, it explodes with a stunning, disagreeable report; and with such force, as to indent both the hammer and the anvil. Four or six grains are as much as ought to be used for such experiment. It may be purchased ofthe chemists.

Metallic Crystalization.

MELT a ladle-full of bismuth, and allow it to cool slowly and quietly, till a thin crust has formed on the surface; and, then, by means of a pointed iron, make two small opposite apertures through the crust, and quickly pour out by one the fluid portion, as carefully, and with as little motion of the mass as possible, whilst the air enters by the other aperture; there will appear, on removing the upper crust by means of a chisel, when the vessel has become cold, a cup-shaped concavity, studded with very brilliant crystals, and more or less regular, according to the magnitude of the quantity of mass employed, the tranquillity and slowness with which it has cooled, and the dexterity with which the fluid portion, at the moment before it commenced to solidity, was decanted from the crystalized part. The same effect will be produced by fusing the substance in a crucible which has a hole in its bottom, lightly closed by an iron rod or stopper, which is to be drawn out when the mass begins to congeal; by this means, the superior portion, which is fluid, is made to run off, and a cake studded over with crystal is obtained.

Easy Method of breaking Glass in any required Direction.

DIP a piece of worsted thread into spirit of turpentine; wrap it round the glass in the direction that you

require it to be broken, and then set fire to the thread; or, apply a red hot wire, a quarter of an inch thick, round the glass, and if it does not immediately crack, throw cold water on it, whilst the wire remains hot.

By these means, glass that is broken may often be fashioned and rendered useful for a variety of chemical purposes.

To make Gold Powder for gilding Silver, without Heat.

DIP linen rags into a concentrated solution of muriate of gold; suffer the rags to dry, and then set them on fire. The gold with which they were impregnated, becomes thus reduced to the metallic state, and mixes with the charcoal of the rags. To use this powder, (which therefore consists of finely divided metallic gold and charcoal), take a soft sound cork, moisten it with a little water, and dip it into the powder, to cause part of it to adhere to the cork, and then rub it forcibly, by means of the cork, on the surface of the silver, which should be perfectly clean and polished. The silver will become covered with an extremely thin coating of metallic gold, the colour and brilliancy of which may be heightened by burnishing.

To boil Water over the Surface of Ice.

INTO a cylindrical glass tube, eight or ten inches long, and half an inch in diameter, pour water sufficient to occupy half an inch of it, or more: freeze the water into a solid mass of ice, by surrounding it with a freezing mixture. Then fill the tube with cold water, within one inch of the top, and surround the lower part, which contains the ice, with flannel redoubled around it This being done, hold the tube, inclined at an angle of about 45 deg. over the flame of a spirit-lamp*; so that the portion of the water, in the upper part of the tube only,

* See Note, p. 140.

may be heated, taking care to hold the tube in the hand by that part of it which is wrapped in flannel. When the surface of the water boils, the heat may gradually be applied, nearer and nearer, towards the lower part of the tube; and thus the water may be made to boil violently within half an inch of the surface of the ice, without melting any notable portion of it.

If we reverse the experiment, by applying heat to the bottom part of the tube filled with water, having a piece of ice floating on its surface, the water will speedily become heated, and the ice melt in a very short time.

Metallic Chamelion.

PUT into a wine-glass a few grains of alkalized oxide of manganese, and put a like quantity into another glass. If cold water is now poured into the one glass, a green solution will be obtained, which very rapidly changes to purple, and gradually becomes red; and if the other glass be filled with warm water, a violet-coloured solution is produced, which quickly changes to crimson. The intensity of the changes of colour is influenced by the quantity of oxide added to the water. When about ten grains of it are put into half a pint of cold water, the solution is of a beautiful green colour, and changes in a few seconds to a deep purple, which lastly becomes red; and if, upon a like quantity of it, four ounces of water be poured, the solution is of a deep green colour; and on adding to it more water, it acquires a rose-red colour; and in a few hours it again becomes colourless, suffering a yellowish precipitate to subside. A few drops of nitric acid, added either to the green or to the purple solution, changes it instantly to a vivid red.

To engrave on Glass.

TAKE a piece of plate or common window-glass, clean it well from grease, and cover one side of it all over either with hard engravers' varnish, called etching ground, or with bees'-wax. When the coating is dry,

trace out upon it, by means of a needle, or other sharp-pointed tool, as in common etching, the design intended to be engraven, taking care that every stroke or line be carried clean and smooth through the coat of varnish to the surface of the glass, so that the light may be seen wherever the varnish is cut through.

Having done this, take one part of powdered flour spar, put it into a leaden basin, add to it two parts of sulphuric acid, and lay the glass with the engraved side downwards, on the basin, and place the vessel on the lamp furnace, (see p. 140), for a few minutes, or so long only, till white fumes are disengaged abundantly from the mixture; then withdraw the basin, and suffer the glass to be corroded by the action of the white fumes or fluoric acid gas, which will be accomplished in eight or ten minutes. The varnish or wax may be removed by a little oil of turpentine.

To render the Surface of Water luminous.

WET a lump of fine loaf sugar with phosphorized ether, and throw it into a basin of water; the surface of the water will become luminous in the dark, and, by gently blowing upon it, phosphorescent undulations will be formed, which illuminate the air above the fluid to a considerable distance.

In winter it will be necessary to render the water blood-warm. If the phosphorized ether be applied to the hand, or other warm objects (which may be done with safety), it renders them phosphorescent in the dark.

N. B.—Phosphorized ether is prepared by suffering sulphuric ether to stand, for some weeks, over a considerable quantity of phosphorus in a well-stopped phial.

Influence of Colour in absorbing and reflecting Heat.

ON a winter's day, when the ground is covered with snow, take four pieces of woollen cloth, of equal dimensions, but of different colours, *viz.* black, blue, brown, and

white; and lay them, at the same time, on the surface of the snow, in the immediate neighbourhood of each other, where the sun's rays can fall upon them: in a few hours they will be found to have sunk into the snow to various depths.

To cause Drops of Water to roll over Paper without breaking.

RUB over the surface of a sheet of writing paper a small quantity of the dust of lycopodium, or puff-ball, and then let water fall on it in small quantities. The water will instantly form itself into distinct drops, which touch the lycopodium in a few points only, and roll over the paper with uncommon rapidity, without breaking. That the drops do touch the lycopodium merely in a few points is obvious, from the copious reflection of white light from their under surface.

To cause Drops of one Fluid to roll over the Surface of another without breaking.

TAKE a glass tube, about half an inch or more in the bore, and three or four inches long, furnished with a ball of about one inch in diameter, and drawn out at one extremity into a fine capillary point; suck up into it, by means of the mouth, a quantity of spirit of wine, a little warmed, so as to fill the ball, and then suffer the spirit to fall in a fine stream from the capillary opening of the tube, at a height of ten or twelve inches, upon spirit of wine, likewise warmed, and contained in a saucer, or other shallow vessel. The drops which fall from the tube will roll over the surface of the spirit in the saucer in all directions, for several seconds.

Mutual Approach and Recession of Glass Bubbles floating in Water.

UPON the greater or less strength of cohesion, which the particles of a fluid have among themselves, in oppo-

sition to their cohesion with any solid body, depends the concave or convex surface of the fluid in a vessel, its flowing or not flowing down the side of it, on being poured out, when quite filled, and its brim not turned downwards; and that of glass bubbles, or cork balls, swimming upon a fluid, and being seemingly either repelled from or drawn towards the edge of the vessel. Hence, if we merely fill a goblet, or basin, with water, the surface of the water will be seen below the brim, and represents a curve; but if the vessel be filled up to the brim, the water then is parallel to the horizon, and may be heaped near the edge above the brim, if it be dry, and not turned downwards; and it is then convex from the brim to the centre. In the first case, if a hollow glass bubble, or cork ball, be suffered to float upon the water, it will move towards the brim, unless placed exactly in the centre. And in the second case, a glass bubble, or a cork ball, will move away from the brim, and float towards the centre. And, in both cases, if two glass bubbles be placed near the middle of the water, they will move towards each other, and at last rush together; the water becoming concave or convex, and the bubbles moving in all these cases to the sides on which the attraction of the water is greatest.

Twisting of Ropes and raising of heavy Burdens by capillary Attraction.

If we suspend perpendicularly a rope ten or twelve feet long, and affix to its lower extremity a heavy weight, to stretch it as much as possible, the rope, when wetted, will be shortened, and if its length be such only as to allow the weight to touch the ground, the weight will be raised from the ground when the rope is wetted with water.

To illustrate this, we quote the following anecdote, respecting the famous obelisk erected by Pope Sixtus V. before St. Peter's, at Rome:—The chevalier Fontana, who had undertaken to raise this monument, was, it is said, on the point of failing in his operation, just when

the column was about to be placed on its pedestal. It was suspended in the open air; and, as the ropes had stretched a little, the base of the obelisk could not reach the summit of the pedestal, a man cried out, "Wet the ropes." This advice was followed, and the column, as if of itself, gradually rose to the required height, to be placed upright on the pedestal prepared for it.

To cause Needles to float upon Water.

PLACE carefully a fine, clean, and perfectly dry sewing needle, horizontally upon water, it will swim, although the specific gravity of the needle is considerably greater than that of water.

Silver Tree upon Glass or Slate.

SPREAD on a plate of glass, or smooth slate, a few drops of nitrate of silver, previously diluted with double its quantity of soft water; place at the bottom of it, flat upon the glass, and in contact with the fluid, a copper or zinc wire, bent to any figure, and let the whole remain undisturbed in an horizontal position. In a few hours a brilliant crystallization of metallic silver will make its appearance round the wire upon the glass, and this arrangement of crystals will extend gradually till the whole quantity of fluid has been acted on by the wire.

Two highly volatile and odorous Bodies become destitute of Smell by Mixture.

POUR into a wine-glass a tea-spoonful of liquid ammonia, which possesses a highly pungent smell, and add to it gradually muriatic acid, which is also very odorous; these two bodies instantly lose their odour, and form a fluid void of smell, *viz.* muriate of ammonia.

Crystallization effected by Sublimation.

PUT a tea-spoonful or two of benzoic acid into a Florence flask, and apply a gentle heat to the bottom of it, by means of the lamp-furnace. The benzoic acid will be volatilized in the form of white vapours, which again condense within the upper part of the flask in a crystalline form.

Two invisible Fluids, when brought near each other, produce a dense White Cloud.

WET the inner surface of one large rummer-glass, or wide-mouth receiver, with muriatic acid; and prepare, by means of a feather, in a like manner, a second vessel, with liquid ammonia. If both these glasses be kept at a distance from each other, they will appear empty, though in reality they contain, the one muriatic acid vapour, and the other ammonia. But if they be placed close to each other, or if the mouth of the one be placed invertedly upon the other, they will both become filled with dense white vapours, which roll over each other for some time, like a cloud, and at last become condensed into a slight crystalline crust on the inner side of the glasses.

To set Oil of Turpentine on Fire by a cold Fluid.

POUR into a tea-cup two or three tea-spoons full of oil of turpentine, and add to it, not gradually, but at once, double that quantity of fuming nitrous acid, previously mingled with about one-fourth part of sulphuric acid: the moment the acid comes in contact with the oil of turpentine, a hissing noise takes place, and an instantaneous inflammation follows, attended with a prodigious volume of black smoke.

In performing this experiment, the phial, containing the nitrous acid, should be fastened at the end of a long stick, that the operator may be at the distance of two or three feet when the oil takes fire, for part of the mixture may spirt out of the vessel.

Two cold Liquids, when mixed, become boiling-hot.

PUT into a thin phial two parts, (by measure), of sulphuric acid, and add to it one part of water: on agitating or stirring them together, the mixture instantly becomes hot, and acquires a temperature above that of boiling water.

Instantaneous Crystalization.

MAKE a concentrated solution of sulphate of soda, or Glauber's salt, by adding portions of it gradually to water kept boiling, till this fluid dissolves no more, (an ounce and a half of boiling water will dissolve about two ounces of salt): having done this, pour the solution, whilst boiling-hot, into common medicine phials, previously warmed, and immediately cork them, or tie slips of wetted bladder over the orifice of the phials, to exclude the access of air from the solution. This being done, set the phials by in a quiet place, without shaking. The solution will cool to the temperature of the air, and remain perfectly fluid; but the moment the cork has been drawn, and atmospheric air becomes admitted, it will begin to crystalize on its upper surface in fine satin-like crystals, which shoot downwards in a few seconds, like a dense white cloud, and so much heat becomes evolved, as to make the phial very sensibly warm to the hands. When the crystalization is accomplished, the whole mass is usually so completely solidified, that, on inverting the vessel, not a drop of it falls out.

Pyrophorus.

THE name of pyrophorus is given to a powder which takes fire spontaneously on exposure to the air. If a little of this preparation be poured out on any flat surface, it presently diffuses an odour of sulphuretted hydrogen gas, and in a few seconds it becomes red-hot, and burns with a lambent bluish flame, leaving a small quantity of white ashes.

Preparation of Pyrophorus.—Take equal parts of powdered alum and coarse brown sugar, mix them together, and heat the mass over a common fire, in an iron ladle or shovel. By the first impression of the heat, both the alum and sugar melt, and mix intimately with each other; after a little time, when most of the water is evaporated, the residue begins to foam and swell considerably, and to give out a pungent empyreumatic acid: it must now be stirred constantly with an iron spatula, taking care to detach it from the ladle in proportion as it dries, and to heat every part as uniformly as possible: when the last remains of clamminess are destroyed, and the spungy black matter that is left is quite friable, it must be transferred, while hot, into a mortar, and hastily reduced to a somewhat coarse powder. As soon as it is pulverized, let the mixture be introduced into a green glass phial of the capacity of about six ounces, (previously luted on the inside by rinsing it out with a weak solution of borax, thickened with pipe-clay to the consistence of cream), and then set it up to the neck in a crucible filled with sand, its mouth being loosely stopped with a piece of charcoal; or a glass tube luted into the neck. Then place the crucible in a furnace, or in an open fire, and raise the heat gradually to a moderate redness. At first a dense white vapour will issue from the phial, for nearly a quarter of an hour, and will then be succeeded by inflammable gas, burning with a light blue flame: as soon as this makes its appearance, keep up the heat at an uniform temperature for about twenty minutes longer: then remove the crucible from the fire, and let the mouth of the phial be closed with a plug of clay, till the phial can be safely handled: the pyrophorus must be hastily poured into a warm and perfectly dry ground-stoppered phial in which it may be kept without injury for any length of time, provided the access of air be carefully avoided.

Another excellent method of preparing pyrophorus is the following: Mix together three parts of alum and one of flour, and heat the mixture to dryness in an iron pot, as described in the preceding paragraph: the black calcined mass thus produced, is to be put into ounce

phials of green glass, coated without and within with clay. The phials thus charged are to be lightly stopped with balls of tempered clay, and then set up to their necks in sand in an iron pot; charcoal powder is next to be strewed on to the depth of half an inch, over which is to be placed an earthen cover, luted to the pot. The whole apparatus is now to be placed in a furnace, and kept at a red heat for about an hour and a half: at the expiration of this period, being taken out of the furnace, and cooled quickly, it is to be unpacked, and the phials containing the pyrophorus are to be placed with their mouths inverted in mercury, in which situation the pyrophorus may be kept for many years without injury.

Sometimes, either from a defect in the preparation, or from the air not having been entirely excluded from the phial in which it is contained, the pyrophorus, when poured out, undergoes no sensible change; when this happens, however, the combustion may often be brought about by breathing on the powder, and thus supplying it with the moisture which seems to be the primary agent in this phenomenon. Pyrophorus, when made according to the last-mentioned manner, is so very inflammable, as to take fire as it is falling from the mouth of the phial.

A Powder which takes Fire when rubbed in a Mortar.

To six grains of chlorate of potash, (hyperoxymuriate of potash), reduced to a fine powder, add three of finely pulverized charcoal; mingle them together, by the gentlest possible friction, on a piece of paper. If to this mixture two grains of sulphur be added, the whole, when forcibly rubbed with a pestle in a mortar, inflames with a rapid flash, like fired gunpowder.

The hand should be covered with a glove or handkerchief in performing this experiment.

To kindle Spirits of Wine without Fire.

POUR five or six drachms of spirit of wine into a tea-cup, and add to it ten or fifteen grains of chlorate of potash. If to this mixture about six drachms, by measure, of sulphuric acid be added, it begins to boil, a multitude of small fire-balls, of a vivid blue colour, dart out of the fluid, and the whole bursts into flame.

A Powder, which produces successive Reports by Friction.

TAKE three grains of chlorate of potash, rub them to an impalpable powder, in a perfectly dry mortar, and mingle them intimately, and with as little friction as possible, with two grains of sulphur. Having done this, collect the mixture into one place in the mortar, and press the pestle down upon it forcibly, directing the pressure from the upright sides of the mortar towards the middle of it, to crush the powder suddenly. If this be dexterously done, a loud detonation will ensue, with a vivid flash. If the pressure of the pestle be diminished, so as to produce a mere forcibly rotatory friction, several successive explosions take place, like the loud cracks of a whip, attended with purple flashes of fire.

If the mixture, after having been wrapped in a piece of tin-foil, be struck with a heavy hammer on an anvil, it inflames with an explosion like the report of a pistol; and if the quantity of sulphur be diminished to one grain, the successive reports, by friction, are more easily produced.

In performing this experiment, the above-stated quantity of materials is all that can be operated on with safety, or at least without risk of splitting the mortar; and it is more prudent to divide even that quantity of mixture, when made, into two or three parts, to be operated on separately. Nor is it altogether safe to keep the mixture in any quantity ready-made, as a spontaneous explosion of it has happened by slight agitation.

Detonation of Phosphorus.

TAKE two grains of chlorate of potash, reduce it to powder, and bring it together to one place, at the bottom of the mortar; if a piece of phosphorus, of double the size of a large pin's head, (or two grains), be placed upon it, and the phosphorus be rubbed with the pestle strongly on the salt, a violent explosion instantly may be produced, with a flash of fire. A similar detonation takes place with the same substances, by wrapping the materials in tin-foil, and giving it a smart blow with a heavy hammer on an anvil.

This experiment requires caution; the explosion of the phosphorus is so extremely violent and instantaneous, as to prevent the experiment from being made, at least with safety, with more than a few grains of the articles; for small particles of burning phosphorus are frequently projected with violence to a distance, which renders the experiment always hazardous. It is best to wrap up the phosphorus and chlorate of potash in a piece of tin-foil, and to cause the explosion to be effected by percussion, as stated, taking care to guard the hands with gloves, and the face with a mask.

Two solid metallic Alloys, which melt, when rubbed together.

MAKE an amalgam of bismuth, and an amalgam of lead, rub them together in a mortar, they will form a compound which is nearly as liquid as mercury.

A Metal which melts in boiling Water.

MELT four parts, by weight, of bismuth, two and a half of lead, and one and a half of tin, together, in an iron ladle, over the fire to form one mass. If a piece of this metal be put into water, it melts when the water begins to boil, and remains melted as long as the water is kept boiling. A spoon, formed of this alloy, when used for

stirring water while briskly boiling, melts in the hand of the operator.

A Powder that bursts into a Flame when touched with an Acid.

TAKE five grains of chlorate of potash, reduce it to powder, and mingle it, by triture, in a mortar, with seven grains of lump sugar. If on this mixture a drop or two of sulphuric acid be suffered to fall, or if it be merely touched with the end of a glass rod, moistened with the acid, it takes fire, and burns rapidly.

Sudden Transition of a Liquid into Gas.

PUT into a glass globe, with a long slender neck, three or four tea-spoonfuls of sulphuric ether, and fill up the empty part of the vessel with cold water; then close the orifice of the slender neck of the globe with the finger, and invert it perpendicularly, or with the closed end downwards, into a basin of water, and withdraw the finger. The ether will thus be made to rise through the water into the globe, and swim on the surface. If hot water be now poured gradually upon the globe, the ether will become converted into an invisible aeriform-like fluid, the expansive force of which expels the water out of the globe, and occupies its place; and if a little cold water be poured on it, a sudden condensation of the etherised gas or vapour takes place, and the water rushes rapidly into the vessel, and completely fills it, as at first.

This alternate conversion of ether into a gas-like substance, and its subsequent condensation, may be effected at pleasure, with the same contents of the globe, provided care be taken that the ether is not driven out of the vessel, which may easily be guarded against by not suffering the whole of the water to be expelled.

To produce Streams of vivid Green Fire under Water.

PUT into an ale-glass two ounces of water, and add first a piece or two of phosphorus, about the size of a pea, and then thirty or forty grains of chlorate of potash. This being done, pour upon the mass, by means of a tube or funnel, with a long neck, reaching to the bottom of the glass, five or six drachms, by measure, of sulphuric acid. As soon as the acid comes into contact with the materials, flashes of fire begin to dart from under the surface of the fluid. When this takes place, drop into the mixture a few lumps (not powder) of phosphuret of lime, equal, in size, to a large pea. This will instantly illuminate the bottom of the vessel, and cause a stream of fire of an emerald-green colour, to pass through the fluid. By a fresh addition of the same materials, the action may be kept up when it begins to subside.

Precipitation of Copper in a crystalline and metallic Form.

SUFFER a piece of phosphorus to remain immersed for about twelve hours in a solution of sulphate of copper, which will cause it to become enveloped in a coat of extremely brilliant and crystalline metallic copper, impervious to air.

Precipitation of Silver in a crystalline and metallic Form.

THIS may be effected by suffering phosphurus to be immersed for a few days in a solution of nitrate of silver. The whole of the metal will be precipitated on the phosphorus in fine denticulated crystal.

Phosphoric Tapers.

TAKE a glass tube, about four inches long, and one or two lines in the bore, closed at one end: introduce into

it a few grains of phosphorus, previously dried on blotting-paper. When this has been done, put a small taper, the one extremity of which has been deprived of wax, into the tube, taking care that the end of the taper freed from the wax touches the phosphorus. Then seal the open end of the tube hermetically, and plunge the other extremity into hot water, which will cause the phosphorus to melt, and affix itself to the cotton of the wax taper. A line may then be drawn, by means of a diamond or file, at one end of the tube. To use these tapers, the tube must be broken at the marked line; and when the taper is then quickly drawn out, it takes fire and burns rapidly.

To imitate the luminous Appearance of the Lunar Disk.

INTRODUCE a few pieces of phosphorus, of the size of a pea, into a hollow glass ball, of three or four inches in diameter; and having heated it to cause the phosphorus to catch fire, keep turning the ball round, till half the inner surface is covered with phosphorus. When the inflammation has ceased, there will be left a whitish crust or lining, which, in a dark place, shines for some considerable time. Broad spaces will assume by degrees an obscure aspect, while circular spots, frequently interspersed, will yet glow with a vivid lustre.

Rotary Motion of Camphor upon Water.

FILL a saucer or broad basin with water, and let fall upon it camphor, reduced to the form of coarse sand. The floating particles will instantly begin to move, and acquire a progressive rotary motion, which continues for some minutes, and then gradually subsides.

If the water be touched by any substance which is in the slightest degree greasy, all the floating particles briskly dart back, and are, as if by a stroke of magic, instantly deprived of their motion and vivacity.

Easy Method of silvering Ivory.

TAKE a slip of polished ivory, immerse it in a dilute solution of sub-nitrate of silver, and suffer it to be immersed till the ivory has acquired a bright yellow colour; then take it out of the solution, and immerse it in a tumbler of distilled water, and expose it, in the water, to the direct rays of the sun. After the ivory has been thus exposed for about two or three days to the action of the sun's light, it appears black; but on rubbing it a little, the black surface will be changed into a bright metallic one, resembling a slip of silver.

Although this coating of revived metal is extremely thin, yet if the ivory be well impregnated with the sub-nitrate of silver, the solution penetrates to a considerable depth; and as fast as the silver wears off from the surface of the ivory, the oxide below it, becoming uncovered and exposed to the sun's rays, a new coating of revived metal will be formed to replace it, and the surface of the ivory will not lose its metallic appearance.

A metallic Wire, heated below Redness, becomes instantly red-hot, by the mere Contact of a Vapour.

TAKE platina wire, of about one-sixtieth or one-seventieth of an inch in diameter; coil it up at one end, and having made the coil of the wire red-hot in a candle, plunge it, when it has ceased to be red-hot, into the vapour of sulphuric ether; which may easily be done by pouring about twenty drops of sulphuric ether into a wine-glass, and then holding the coil of the wire a little above the ether in the glass.

The coil of wire, when made to approach the surface of the ether, will instantly begin to glow again, and continue to be ignited for some time; and by agitating the glass, to cause the ether to become diffused over the inner surface of the wine-glass, the ignition of the wire will be assisted when it begins to slacken. Instead of platina wire, a thin slip of platina foil may be used.

When this experiment is made in the dark, a pale

phosphorescent light is perceived near the wire, which is most distinct when the wire ceases to be ignited, and a peculiar acrid volatile and acid vapour becomes evolved, which may be rendered more obvious by bringing near it a glass rod, moistened with muriatic acid. The vapour acts strongly on the eyes, and excites tears. The above experiment may be pleasingly varied, by entwining a coil of platina wire, with a wire of gold. When the combined wires are heated, and brought into the vapour, or near the surface of the ether, in the wine-glass, the platina wire continues to glow red-hot; whilst the gold wire will be seen dark, among the threads of platina.

If two coils of platina and steel wires, in contact, both previously made hot, be plunged, when the ignition has ceased, into the vapours of ether, the steel wire will begin to glow, while the platina wire is not luminous. On the moment, however, the reverse takes place, and the platina becomes luminous, whilst the steel wire instantly ceases to be ignited; nor does the latter exhibit a phosphorescence when the platina wire glows.

Instead of sulphuric ether, other highly inflammable and volatile liquids may be employed; thus the vapour of phosphorized ether, sulphuret of carbon, a solution of camphor in alcohol, and oil of wine produce the same effect.

Electric Precipitation of metallic Gold upon Platina.

POUR into a wine-glass a small quantity of a solution of the muriate of gold, and immerse into it a slip of platina: no change will take place; but if a slip of zinc be added, and made to touch the platina, the zinc will precipitate the gold in the form of a black powder, and the platina becomes also covered with metallic gold; but if the zinc does not touch the platina, the latter will remain unaltered.

Great Increase of Density by chemical Combination.

CAST two bullets of copper, melt them in a crucible with two bullets of tin of the same size, and cast out the melted mass again into the same mould. It will now form only about three bullets, the united weight of which will be equal to the weight of the four bullets before their union.

Phosphoresoence produced by Heat.

TAKE coarsely pulverized fluor spar, sprinkle it, in darkness, on the surface of a fire-shovel, heated below redness: it will shine with a beautiful phosphorescent light, and the shovel will appear, for a few seconds, as if sprinkled over with gems. To exhibit the luminous property of fluor spar in the greatest perfection, let some oil be heated in a Florence flask till it nearly boils, and drop into it, gradually, pulverized fluor spar; the moment the latter touches the hot oil, a bright flash of light is emitted, which may be renewed by a fresh admixture of fluor spar, and by shaking the vessel. The variety of fluor spar, which is of a purple blue colour, and which, when scraped or struck, emits a fœtid bituminous odour, is more phosphorescent by heat than any other variety of this mineral.

Gas Lights in Miniature.

To imitate in miniature the production of gas lights, put common coal into the bowl of a tobacco-pipe; cover the coal closely with clay, made into a stiff lute or paste with water; and when the clay is dry, put the bowl of the pipe into the fire, and heat it gradually. In a few minutes a stream of carburetted hydrogen gas will issue from the end of the tobacco-pipe, accompanied with an aqueous fluid, and a tenacious oil or tar. The gas may be set fire to with a candle, and will burn with a bright flame. When no more gas is disengaged, there will be found, in the bowl of the pipe, the coke or coal deprived of its bituminous matter.

Indelible Ink for marking Linen.

DISSOLVE two drachms of fused sub-nitrate of silver, in six drachms of distilled water, and add to the solution two drachms, by measure, of thick mucilage of gum arabic. This forms the writing liquor, or marking ink. To use the ink, it is necessary that the linen be impregnated with a mordant, which is prepared in the following manner:

Dissolve half an ounce of sub-carbonate of soda of commerce in four ounces of water, and add to the solution half an ounce, by measure, of thick mucilage of gum arabic. This forms the mordant, or preparatory liquor.

To use the ink, wet thoroughly the part intended to be marked with the mordant, dry it near a fire, and when perfectly dry, write thereon with the marking ink, by means of a clean pen, and let it dry. The letters are pale at first, but soon become black by exposure to light, and more speedily if exposed to the direct rays of the sun. The writing will then be permanently fixed on the cloth, and resist the action of washing or bleaching.

To form a distinct writing upon cloth, it is necessary to carry all the strokes of the pen downwards, and the pen should have a short and stiff nib.

Curious Method of obtaining large and beautiful artificial Crystals.

DISSOLVE the salt to be crystallized in water, for example, alum; concentrate the solution slowly by evaporation, to such a degree that it shall crystalize on cooling, which may be known by suffering a drop of it to cool on a plate of glass or other substance. This being done, put the solution aside, and when perfectly cold, pour off the liquid portion from the mass of crystals at the bottom, and put it into a flat-bottomed vessel. After having stood for some days, solitary crystals of alum will be formed. This being done, crystals will

begin to form at some distance from each other, which gradually increase in size; select the most regular of these, and place them in a flat-bottomed vessel, at some distance from each other, and pour over them a quantity of the concentrated liquid obtained by evaporating a solution of the alum, till it crystalizes on cooling. Alter the position of every crystal once, at least, every day, with a glass rod, that all the faces may be alternately exposed to the action of the liquid: for the side on which the crystal rests, or is in contact with the vessel, never receives any increment. The crystals will thus gradually grow, or increase in size. When they have grown to such a size, that their form can easily be distinguished, let the most perfect ones be selected, or those having the exact shape which you wish to obtain; and put them separately in a vessel filled with a portion of the same liquid, and let them be turned in the manner directed several times a day. By this means they may be obtained of almost any size we wish. When the crystal has continued in the liquid for a certain time, the quantity of alum, held in solution, becomes so much diminished, that the liquid begins to act upon the crystal, and re-dissolve it. This action is first perceptible on the angles and edges of the crystal; they become blunted, and gradually lose their shape altogether. Whenever this begins to be perceived, pour off the liquid, and pour a portion of new liquid in its place; otherwise the crystal is infallibly destroyed. They will grow in length if they be made to lay upon their sides, and in breadth when they are placed upon their bases.

To make Gold and Silver Powder for Painting.

TAKE gold leaves, rub them together with a little clear honey, into a stiff mass, by means of a slab and muller, and triturate the mixture, till the gold is reduced to the greatest possible fineness. When this has been effected, put the mass into a bason or glass vessel, and dilute it with a large quantity of water, in order to suffer the divided gold to subside. Pour off the clear water

when the gold has subsided, and repeat the washing for several times successively, and then put the gold powder into a tea-cup or glass vessel, and pour over it a small quantity of pure muriatic acid, and digest the mixture with a gentle heat for a few minutes; having done this, clear the powder from the adhering acid, by repeated ablutions of rain water, or better with distilled water, and when the wet powder no longer changes the colour of litmus-paper, when laid on it, let it be dried, and preserve it for use. Although this process is very tedious, and requires much time and labour, the writer of this, from a vast number of experiments made by the desire of an artist, is authorised to state, that by the above process, which has been long known, a product is obtained far superior in colour and fineness, to what can be produced by other operations, usually stated in books. *Pale gold powder* may be prepared in a similar manner from gold alloyed with silver; *silver powder*, from treating in a similar manner, silver leaf.

To show the Effect of Galvanism, or Voltaic Electricity, upon the Bodies of living Animals.

THE following experiments, which are not attended with any circumstances that can wound the feelings of humanity, may be easily made to show the action of Voltaic electricity, upon the bodies of living animals.

1. Place a living frog upon a plate of zinc, wetted with water, and paste a slip of tin foil, or a shilling, also wetted with water, upon the back of the frog. If a communication be formed between the zinc and the tin-foil, by means of a wire, or other piece of metal, the frog will be violently convulsed, and jump off the plate.

2. Take a live flounder, and put it on a pewter plate, or upon a large piece of zinc, wetted with water, and place a silver coin, also wetted with water, upon its back; or place the fish upon its back, and apply the coin to its cheek or breast, then touch the plate or zinc with a wire, and apply the other extremity of the wire to the piece of silver, violent contractions will be immediately

excited in the fish, which may be renewed at pleasure, by forming a connexion between the two metals. The animal, therefore, lies quiet, until a communication be made between the silver and the zinc, by means of a third metal to the edges of the others. The Galvanic agency then takes place, because a Galvanic circle is formed.

3. Besides these effects produced by the voltaic influence on the muscles, the sensations which it excites in some of the organs of sense, are easily evinced in the following manner:

Place a thin plate of zinc upon the upper surface of the tongue, and a half-crown, or a shilling, or silver tea-spoon, on the under surface. The metals ought to be allowed to remain for a little time in contact with the tongue before they are made to touch each other, that the taste of the metals themselves may not be confounded with the sensation produced by their contact. When the edges which project beyond the tongue are then made to touch, a sensation is produced, which it is difficult accurately to describe. It takes place suddenly, like a slight electrical shock, and a sub-acid taste, somewhat resembling dilute nitric acid, is perceived, confounded with an evident metallic taste.

4. Or place a silver tea-spoon, as high as possible, between the gums and the upper lip, and a bar of zinc between the under lip; on bringing the extremities of them into contact, a very vivid sensation, resembling a flash of light, will be perceived. It is singular, that this light is equally vivid in the dark with the strongest light, and whether the eyes be shut or open.

5. Place a cup of silver, filled with water, on a plate of zinc, standing upon a table, and touch the water with the tip of the tongue, it will be tasteless, as long as the zinc plate is not touched, for the body does not then form a voltaic circle with the metals. Moisten well the hands, and lay hold of the plate of zinc, whilst the tongue is brought to touch the water, a peculiar sensation, and an acid taste, will be immediately experienced.

If a piece of zinc be immersed under water, which is freely exposed to the atmosphere, it oxidates very slowly;

but when placed in the same situation, in contact with a piece of silver, its oxidation is rapid. This fact explains why, in the sheathing of ships, it is necessary to use bolts of the same metal which form the plates, for if two different metals be employed, they both oxidate, and are corroded very speedily, in consequence of their forming, with the water of the ocean, a Galvanic action.

To analyze the Air of the Atmosphere.

TAKE a Florence flask, put into it ten grains of phosphorus, cork it perfectly air-tight, and heat it gradually, over a lamp. As soon as the phosphorus has been heated to a certain degree, it takes fire, and burns with a flame and a dense white smoke: when it ceases to burn, heat the vessel again, after it has cooled, to try if any further combustion will take place: lastly, let the flask cool.

If the flask was perfectly dry, the inside of it will now be lined with a white coating, (phosphorus acid); but if it was moist this coating will be dissolved into a fluid. Then plunge the flask, with its mouth downwards, into water, and draw out the cork; the water will ascend into it: hence a portion of air has disappeared. The water which has risen shews the quantity of air that has been lost during the combustion of the phosphorus, if its cubic contents be compared with that of the whole vessel. The portion of air thus vanished will amount to about one-fifth of the whole.

If the flask, after the phosphorus was enclosed in it, be accurately weighed, and again weighed when the combustion has taken place, no difference of weight will be found. The remaining air is unfit for burning phosphorus or other bodies; animals are likewise suffocated in it.

The following method of analyzing atmospheric air is also very easy and more correct.

Take a glass tube, about half an inch or three-quarters of an inch in diameter, and ten or twelve inches long, closed at the upper extremity, and graduated into equal parts. Fill part of it with the air to be examined, and

introduce into the tube a long stick of phosphorus supported upon a glass rod, while the tube stands inverted in the water. The phosphorus should be nearly as long as the part of the tube which contains the air. Immediately after the introduction of the phosphorus, white vapours will be formed, which fill the tube; these gradually descend and become absorbed by the water. When no more vapours appear, the process is at an end, for the oxygen gas, which was present in the confined quantity of air, has united with the phosphorus; the residuum is the quantity of nitrogen of the air submitted to examination.

To procure Oxygen Gas from the Leaves of Plants.

Fill a large bell glass, or glass globe, with water, and introduce into it a handful of fresh leaves of mint, or other fresh gathered green shoots or leaves from any tree or plant; invert the glass, with its mouth downwards, into a vessel likewise containing water, and expose the whole to the direct rays of the sun. Bubbles of gas will soon begin to form on the leaves, and will increase in size, till at last they rise to the top of the glass vessel. This process may be carried on as long as the vegetable continues healthy; and the gas, when examined, will prove to be oxygen gas.

Detonating Oil.

From the action of chlorine, or oxymuriatic acid gas, on ammonia, under peculiar circumstances, a very singular product, exceeding all others in detonating quality, is obtained. This compound was discovered by Dulong, a French chemist; and an extensive series of experiments has been made upon it by Messrs. Porret, Wilson, and Kirk. To obtain it, fill a small jar with chlorine, or oxymuriatic acid gas, and transfer it into a basin containing a solution of nitrate, or muriate of ammonia, a little warmed; the gas will slowly become condensed, and the liquor rise up in the jar; an oily-like film will

form on its surface, which increases and collects into globules, which at length fall through the liquor: this is the explosive compound. It explodes violently at 212 deg. F.; the most violent explosions, however, are produced from it when it is touched cold with inflammable bodies: a portion of it, for example, the size of a pin-head, being brought in contact with olive oil, the vessel is broken into fragments by the violence of the explosion; its effects are indeed so violent, as to have given rise to severe accidents; hence the propriety of the precaution of wearing a mask and gloves, and of taking care that the vessel in which it is formed, or the instrument by which it is removed, shall be perfectly clean and free from combustible matter, It is singular, that a number of inflammable substances do not cause this curious substance to explode, such as charcoal, alcohol, or ether; and among the inflammable bodies, which either do, or do not cause it to explode, it does not appear that any analogy can be traced.

Curious Experiment with a Glass of Water.

SATURATE a certain quantity of water in a moderate heat, with three ounces of sugar; and when it will no longer receive that, there is still room in it for two ounces of salt of tartar, and after that for an ounce and a drachm of green vitriol, nearly six drachms of nitre, the same of sal-ammoniac, two drachms and a scruple of alum, and a drachm and a half of borax.

To make artificial Coruscations.

THERE is a method of producing artificial coruscations, or sparkling fiery meteors, which will be visible, not only in the dark, but at noon day, and that from two liquors actually cold. The method is this:—Fifteen grains of solid phosphorus are to be melted in about a drachm of water; when this is cold, pour upon it two ounces of oil of vitriol: let these be shaken together, and they will at first heat, and afterwards will throw up fiery balls in great number, which will adhere like so many stars to the sides of the glass, and continue burning

a considerable time; after this, if a small quantity of oil of turpentine is poured in, without shaking the phial, the mixture will of itself take fire, and burn very furiously. The vessel should be large, and open at the top.

Another Method.

ARTIFICIAL coruscations may also be produced by means of oil of vitriol and iron, in the following manner:—Take a glass body capable of holding three quarts; put into this three ounces of oil of vitriol, and twelve ounces of water; then warming the mixture a little, throw in at several times, two ounces, or more, of clear iron filings; upon this an ebullition, and white vapours, will arise; then present a lighted candle to the mouth of the vessel, and the vapour will take fire, and afford a bright fulmination or flash, like lightning. Applying the candle in this manner several times, the effect will always be the same; and sometimes the fire will fill the whole body of the glass, and even circulate to the bottom of the liquor; at others, it will only reach a little way down its neck. The great caution to be used in making this experiment, is the making the vapour of a proper heat; for if made too cold, few vapours will arise; and, if made too hot, they will arise too fast, and will only take fire in the neck of the glass, without any remarkable coruscation.

To produce Fire from Cane.

THE Chinese rattan, which is used, when split, for the making of cane chairs, will, when dry, if struck against each other, give fire; and are used accordingly in some places, in lieu of flint and steel.

Weight of the National Debt of England, in £10 Bank Notes.

ONE hundred men could not carry the national debt of England in ten pound notes, 512 of which weigh a pound; so that 242 millions of pounds sterling (which was the

amount of the national debt in 1770, when this calculation was made) would weigh 47,650 pounds, which, for a hundred men, would be 437 pounds each.

To enter a Room on Fire with Safety.

CRAWL, or stoop low: the atmosphere near the floor will be so clear, that you can penetrate without inconvenience. Persons entering into the smoke, should also take the precaution of wetting their gloves and sleeves, which will prevent their being so easily burnt, or wrap a wet blanket round them.

To make an Eolian Harp.

THIS instrument may be made by almost any carpenter: it consists of a long narrow box of very thin deal, about five or six inches deep, with a circle in the middle of the upper side, of an inch and a half in diameter, in which is to be drilled small holes. On this side, seven, ten, or more strings, of very fine gut, are stretched over bridges at each end, like the bridge of a fiddle, and screwed up, or relaxed with screw pins. The strings must be all tuned to one and the same note, and the instrument be placed in some current of air, where the wind can pass over its strings with freedom. A window, of which the width is exactly equal to the length of the harp, with the sash just raised to give the air admission, is a proper situation. When the air blows upon these strings, with different degrees of force, it will excite different tones of sound; sometimes the blast brings out all the tones in full concert, and sometimes it sinks them to the softest murmurs.

To shew the Pressure of the Atmosphere.

INVERT a tall glass jar in a dish of water, and place a lighted taper under it: as the taper consumes the air in the jar, its pressure becomes less on the water immediately under the jar; while the pressure of the at-

mosphere on the water *without* the circle of the jar remaining the same, part of the water in the dish will be forced up into the jar, to supply the place of the air which the taper has consumed. Nothing but the pressure of the atmosphere could thus cause part of the water to rise within the jar, above its own level.

Subaqueous Exhalations.

POUR a little clear water into a small glass tumbler, and put one or two small pieces of phosphoret of lime into it. In a short time, flashes of fire will dart from the surface of the water, and terminate in ringlets of smoke, which will ascend in regular succession.

Biblical Curiosities.

THE twenty-first verse of the seventh chapter of Ezra, has all the letters of the alphabet in it. The nineteenth chapter of the second book of Kings, and the thirty-seventh chapter of Isaiah, are alike. And in the book of Esther, which has ten chapters, neither the word Lord nor God is mentioned.

Remarkable Properties in certain Plants.

PLANTS, when forced from their natural position, are endowed with a power to restore themselves. A hop plant, twisting round a stick, directs its course from south to west, as the sun does. Untwist it, and tie it in the opposite direction; it dies. Leave it loose in the wrong direction; it recovers its natural direction in a single night. Twist a branch of a tree so as to invert its leaves, and fix it in that position; if left in any degree loose, it untwists itself gradually, till the leaves be restored to their natural position. What better can an animal do for its welfare? A root of a tree meeting with a ditch in its progress, is laid open to the air; what follows? It alters its course like a rational being, dips into the ground, surrounds the ditch, rises on the opposite side to its

wonted distance from the surface, and then proceeds in its original direction. Lay a wet sponge near a root laid open to the air; the root will direct its course to the sponge; change the place of the sponge; the root varies its direction. Thrust a pole into the ground at a moderate distance from a scandent plant; the plant directs its course to the pole, lays hold of it, and rises on to its natural height. A honeysuckle proceeds in its course, till it be too long for supporting its weight, and then strengthens itself by shooting into a spiral. If it meet with another plant of the same kind, they coalesce for mutual support; the one screwing to the right, the other to the left. If a honeysuckle twig meets with a dead branch, it screws from the right to the left. The claspers of briony shoot into a spiral, and lay hold of whatever comes in their way, for support. If, after completing a spiral of three rounds, they meet with nothing, they try again by altering their course.

Flowers curiously affected by the Sun and the Weather.

THE petals of many flowers expand in the sun, but contract all night, or on the approach of rain. After the seeds are fecundated, the petals no longer contract. All the trefoils may serve as a barometer to the husbandman; they always contract their leaves on an impending storm.

Easy Method of obtaining Flowers of different Colours from the same Stem.

SCOOP out the pith from a small twig of elder, and having split it lengthwise, fill each of the parts with small seeds that produce flowers of different colours, but that blossom nearly at the same time. Surround them with earth; and then tying together the two bits of wood, plant the whole in a pot filled with earth, properly prepared.

A luminous Bottle, which will shew the Hour on a Watch in the Dark.

THROW a bit of phosphorus, of the size of a pea, into a long glass phial, and pour boiling oil carefully over it, till the phial is one-third filled. The phial must be carefully corked, and when used should be unstopped, to admit the external air, and closed again. The empty space of the phial will then appear luminous, and give as much light as a dull ordinary lamp. Each time that the light disappears, on removing the stopper it will instantly re-appear. In cold weather the bottle should be warmed in the hands before the stopper is removed. A phial thus prepared may be used every night for six months.

To make luminous Writing in the Dark.

FIX a small piece of solid phosphorus in a quill, and write with it upon paper; if the paper be then carried into a dark room, the writing will appear beautifully luminous.

The Sublimated Tree.

INTO a large glass jar inverted upon a flat brick tile, and containing near its top a branch of fresh rosemary, or any other such shrub, moistened with water, introduce a flat thick piece of heated iron, on which place some gum benzoin, in gross powder. The benzoin acid, in consequence of the heat, will be separated, and ascend in white fumes, which will at length condense, and form a most beautiful appearance upon the leaves of the vegetable.

Easy and curious Methods of foretelling Rainy or Fine Weather.

IF a line be made of good whipcord, that is well dried, and a plummet affixed to the end of it, and then hung against a wainscot, and a line drawn under it, exactly where the plummet reaches; in very moderate weather it will be found to rise above it before rain, and to sink

below when the weather is likely to become fair. But the best instrumnnt of all, is a good pair of scales, in one of which let there be a brass weight of a pound, and in the other a pound of salt, or of saltpetre, well dried; a stand being placed under the scale, so as to hinder its falling too low. When it is inclined to rain, the salt will swell, and sink the scale; when the weather is growing fair, the brass weight will regain its ascendancy.

Contrivance for a Watch Lamp, perfectly safe, which will shew the Hour of the Night, without any Trouble to a Person lying in Bed.

It consists of a stand, with three claws; the pillar of which is made hollow, for the purpose of receiving a water candlestick of an inch diameter. On the top of the pillar, by means of two hinges and a bolt, is fixed on a small proportionate table, a box of six sides, lined with brass, tin, or any shining metal, nine inches deep, and six inches in diameter. In the centre of one of these sides is fixed a lens, double convex, of at least three inches and a half diameter. The centre of the side directly opposite to the lens is perforated, so as to receive the dial-plate of the watch, the body of which is confined on the outside, by means of a hollow slide.—When the box is lighted by a common watch-light, the figures are magnified nearly to the size of those of an ordinary clock.

Curious Experiment with a Tulip.

The bulb of a tulip in every respect resembles buds, except in their being produced under ground, and include the leaves and flower in miniature, which are to be expanded in the ensuing spring. By cautiously cutting in the early spring, through the concentric coats of a tulip root, longitudinally from the top to the base, and taking them off successively, the whole flower of the next summer's tulip is beautifully seen by the naked eye, with its petals, pistil, and stamina.

The Travelling of Sound experimentally proved.

THERE is probably no substance which is not in some measure a conductor of sound; but sound is much enfeebled by passing from one medium to another. If a man, stopping one of his ears with his finger, stops the other also by pressing it against the end of a long stick, and a watch be applied to the opposite end of the stick, or a piece of timber, be it ever so long, the beating of the watch will be distinctly heard; whereas, in the usual way, it can scarcely be heard at the distance of fifteen or eighteen feet. The same effect will take place if he stops both his ears with his hands, and rests his teeth, his temple, or the cartilaginous part of one of his ears against the end of a stick. Instead of a watch, a gentle scratch may be made at one end of a pole or rod, and the person who keeps the ear in close contact with the other end of the pole, will hear it very plainly. Thus, persons who are dull of hearing, may, by applying their teeth to some part of an harpsichord, or other sounding body, hear the sound much better than otherwise.

If a person tie a poker, or any other piece of metal, on to the middle of a strip of flannel about a yard long, then press with his thumbs or fingers the ends of the flannel into his ears, while he swings the poker against any obstacle, as an iron or steel fender, he will hear a sound very like that of a large church bell.

To produce Metallic Lead from the Powder.

TAKE one ounce of red lead, and half a drachm of charcoal in powder, incorporate them well in a mortar, and then fill the bowl of a tobacco-pipe with the mixture. Submit it to an intense heat, in a common fire, and when melted, pour it out upon a slab, and the result will be metallic lead completely revived.

To diversify the Colours of Flowers.

FILL a vessel, of what size or shape you please, with good rich earth, which has been dried and sifted in the sun, then plant in the same, a slip or branch of a plant bearing a white flower, (for such only can be tinged) and use no other water to water it with, but such as is tinctured with red, if you desire red flowers. With blue, if blue, &c. With this coloured water, water the plant twice a day, morning and evening, and remove it into the house by night, so that it drink not of the morning or evening dew, for those weeks. You will then experience, that it will produce flowers, not altogether tinctured with that colour wherewith you watered it, but partly with that, and partly with the natural.

How far Sound travels in a Minute.

HOWEVER it may be with the regard to the theories of sound, experience has taught us, that it travels at about the rate of 1142 feet in a second, or near thirteen miles in a minute. The method of calculating its progress is easily made known. When a gun is discharged at a distance, we see the fire long before we hear the sound. If then we know the distance of the place, and know the time of the interval between our first seeing the fire, and then hearing the report, this will shew us exactly the time the sound has been travelling to us. For instance, if the gun is discharged a mile off, the moment the flash is seen, I take a watch and count the seconds till I hear the sound; the number of seconds is the time the sound has been travelling a mile.

Easy Method of making a Rain Gauge.

A VERY simple rain gauge, and one which answer all practical purposes, consists of a copper funnel, the area of whose opening is exactly ten square inches: this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 173,

which gives the depth in inches and parts of an inch. In fixing these gauges, care must be taken that the rain may have free access to them: hence the tops of buildings are usually the best places. When the quantities of rain collected in them at different places, are compared, the instruments ought to be fixed at the same heights above the ground at both places, because at different heights the quantities are always different, even at the same place.

To make beautiful transparent-coloured Water.

THE following liquors, which are coloured, being mixed, produce colours very different from their own. The yellow tincture of saffron, and the red tincture of roses, when mixed, produce a green. Blue tincture of violets, and brown spirit of sulphur, produce a crimson. Red tincture of roses, and brown spirits of hartshorn, make a blue. Blue tincture of violets, and blue solution of copper, give a violet colour. Blue tincture of cyanus, and blue spirit of sal-amoniac coloured, make green. Blue solution of Hungarian vitriol, and brown lie of potash, make yellow. Blue solution of Hungarian vitriol, and red tincture of roses, make black; and blue tincture of cyanus, and green solution of copper, produce red.

Curious Experiment on Rays of Light.

THAT the rays of light flow in all directions from different bodies, without interrupting one another, is plain, from the following experiment:—Make a little hole in a thin plate of metal, and set the plate upright on a table, facing a row of lighted candles standing near together; then place a sheet of paper or paseboard at a little distance from the other side of the plate, and the rays of all the candles, flowing through the hole, will form as many specks of light on the paper as there are candles before the plate; each speck as distinct and large as if there were only one candle to cast one speck; which shews that the rays do not obstruct each other in their motions, although they all cross in the same hole.

The Power of Water.

LET a strong small iron tube of twenty feet in height be inserted into the bung-hole of a cask, and the aperture round so strongly closed, that it shall be water-tight; pour water into the cask till it is full through the pipe; also continue filling the pipe till the cask bursts, which will be when the water is within a foot of the top of the tube. In this experiment the water, on bursting the vessel, will fly about with considerable violence.

The Pressure of Water.

THE pressure of water may be known to every one who will only take the trouble to look at the cock of a water-butt when turned; if the tub or cistern be full, the water runs with much greater velocity through the cock, and a vessel will be filled from it in a shorter time than when it is only half full, although the cock, in both cases, is equally replete with the fluid during the time the vessel is filling. From this also is understood, how a hole or leak, near the keel of a ship, admits the water much quicker, and with greater violence, than one of the same size near what the mariners call the water's edge.

Refraction of Light.

IN the middle of an empty bason put a piece of money, and then retire from it till the edge of the bason hides the piece from your sight; then keeping your head steady, let another person fill the bason gently with water: as the water rises in the bason the money will come in view; and when of a sufficient height in the basin, the whole of the piece will be in sight.

Wonderful Nature of Lightning.

IF two persons, standing in a room, looking different ways, and a loud clap of thunder, accompanied with zig-zag lightning, happens, they will both distinctly see the flash at the same time; not only the illumination,

but the very form of the lightning itself, and every angle it makes in its course, will be as distinctly perceptible, as though they had both looked directly at the cloud from whence it proceeded. If a person happened at that time to be looking on a book, or other object which he held in his hand, he would distinctly see the form of the lightning between him and the object at which he looked. This property seems peculiar to lightning, as it does not apply to any other kind of fire whatever.

To shew that the White of Eggs contains an Alkali.

ADD to a wine glass half full of tincture of red cabbage*, a small quantity of the white of an egg, either in a liquid state, or rendered concrete by boiling. The tincture will lose its blue colour and become changed to green, because the white of the egg contains soda.

Two inodorous Bodies, become very pungent and odorous by Mixture.

WHEN equal parts of muriate of ammonia and slaked lime, both substances destitute of odour, are intimately blended together in a mortar, a very pungent gas (ammonia) becomes evolved.

Interesting Experiment for the Microscope.

THE embryo grain of wheat, at the time of blossoming, being carefully taken out of the husk, will be found to have a small downy tuft at its extremity, which, when viewed in a microscope, greatly resembles the branches of thorn; spreading archwise, in opposite directions. By expanding a few of the grains, and selecting the most perfect, a very pretty microscopic object will be obtained for preservation.

* For the method of preparing this, see p. 153.

Astonishing Effect of compound Interest.

An English penny placed out at compound interest, at the rate of £5 per cent. at the birth of our Saviour, would, in the year 1786, have produced the enormous sum of £290,991,000000,000000,000000,000000,000000 sterling; which would make about 110 millions of our earth in solid gold. At simple interest, it would have produced only seven shillings and sixpence.

The Travelling of Light.

Light travels at the rate of an hundred and fifty thousand miles in a single second; and it is seven minutes in passing from the sun to the earth, which is nearly a distance of seventy millions of miles! Such is the rapidity with which these rays dart themselves forward, that a journey they perform thus in less than eight minutes, a ball from the mouth of a cannon would not complete in several weeks! But the minuteness of the particles of light are still several degrees beyond their velocity; and they are therefore harmless, because so very small. A ray of light is nothing more than a constant stream of minute parts, still flowing from the luminary, so inconceivably little, that a candle, in a single second of time, has been said to diffuse several hundreds of millions more particles of light, than there could be grains in the whole earth, if it were entirely one heap of sand. The sun furnishes them, and the stars also, without appearing in the least to consume, by granting us the supply: its light is diffused in a wide sphere, and seems inexhaustible.

Calculation of the Mass of Water contained in the Sea.

If we would have an idea of the enormous quantity of water which the sea contains, let us suppose a common and general depth to the ocean; by computing it at only 200 fathoms, or the tenth part of a mile, we shall see

hat there is sufficient water to cover the whole globe to the height of 503 feet of water; and if we were to reduce this water into one mass, we should find that it forms a globe of more than sixty miles diameter.

Different Degrees of Heat imbibed from the Sun's Rays by Cloths of different Colours.

WALK but a quarter of an hour in your garden when the sun shines, with a part of your dress white and a part black; then apply your hand to them alternately, and you will find a very great difference in their warmth. The black will be quite hot to the touch, and the white still cool.

Try to fire paper with a burning glass: if it be white you will not easily burn it; but if you bring the focus to a black spot, or upon letters, written or printed, the paper will immediately be on fire under the letters.

Thus, fullers and dyers find black cloths, of equal thickness with white ones, and hung out equally wet, dry in the sun much sooner than the white, being more readily heated by the sun's rays. It is the same before a fire; the heat of which sooner penetrates black stockings than white ones, and so is apt sooner to burn a man's shins. Also beer much sooner warms in a black mug set before the fire, than in a white one, or in a bright silver tankard. Take a number of little square pieces of cloth from a tailor's pattern card, of various colours; say black, deep blue, lighter blue, green, purple, red, yellow, white, and other colours, or shades of colours; lay them all out upon the snow in a bright sun-shiny morning; in a few hours, the black being warmed most by the sun, will be sunk so low as to be below the stroke of the sun's rays; the dark blue almost as low; the lighter blue not quite so much as the dark; the other colours less, as they are lighter; and the quite white remain on the surface of the snow, as it will not have entered it at all.

Alternate Illusion.

WITH a convex lens of about an inch focus, look attentively at a silver seal, on which a cypher is engraved. It will at first appear cut in, as to the naked eye; but if you continue to observe it some time, without changing your situation, it will seem to be in relief, and the lights and shades will appear the same as they did before. If you regard it with the same attention still longer, it will again appear to be engraved: and so on alternately.

If you look off the seal for a few moments, when you view it again, instead of seeing it, as at first, engraved, it will appear in relief.

If while you are turned toward the light, you suddenly incline the seal, while you continue to regard it, those parts that seemed to be engraved will immediately appear in relief: and if, when you are regarding these seeming prominent parts, you turn yourself so that the light may fall on the right hand, you will see the shadows on the same side from whence the light comes, which will appear not a little extraordinary. In like manner the shadows will appear on the left, if the light fall on that side. If instead of a seal you look at a piece of money, these alterations will not be visible, in whatever situation you place yourself.

Alarum.

AGAINST the wall of a room, near the ceiling, fix a wheel of twelve or eighteen inches diameter; on the rim of which place a number of bells in tune, and, if you please, of different sizes. To the axis of this wheel there should be fixed a fly to regulate its motion; and round the circumference there must be wound a rope, to the end of which is hung a weight.

Near to the wheel let a stand be fixed, on which is an upright piece that holds a balance or moveable lever, on one end of which rests the weight just mentioned, and to the other end must hang an inverted hollow cone, or funnel, the aperture of which is very small. This cone must be graduated on the inside, that the sand put in

may answer to the number of hours it is to run. Against the upright piece, on the side next the cone, there must be fixed a check, to prevent it from descending. This stand, together with the wheel, may be enclosed in a case, and so contrived as to be moved from one room to another with very little trouble.

It is evident from the construction of this machine, that when a certain quantity of the sand is run out, the weight will descend, and put the wheel in motion, which motion will continue till the weight comes to the ground. If the wheel be required to continue longer in motion, two or more pullies may be added, over which the rope may run.

Musical Cascade.

WHERE there is a natural cascade, near the lower stream, but not in it, let there be placed a large wheel, equal to the breadth of the cascade: the diameter of this wheel, for about a foot from each end, must be much less than that of the middle part; and all the water from the cascade must be made to fall on the ends The water that falls on the wheel may pass through pipes, so that part of it may be made occasionally to pass over or fall short of the wheel, as you would have the time of the music quicker or slower. The remaining part of the wheel which is to be kept free from the water, must consist of bars, on which are placed stops that strike against the bells: these stops must likewise be moveable. It is evident from the construction of this machine, that the water falling on the floats at the ends of the wheel, will make the stops, which are adapted to different tunes, strike the notes of those tunes on the respective bells. Two or three sets of bells may here be placed on the same line, when the cascade is sufficiently wide.

Where there is not a natural cascade, one may be artificially constructed, by raising part of the ground, wherever there is a descent of water; whether it be a stream that supplies a reservoir or fountain, or serves domestic uses; or if it be refuse water that has already served some other purpose.

Writing on Glass by the Rays of the Sun.

DISSOLVE chalk in aqua-fortis to the consistence of milk, and add to that a strong solution of silver. Keep this liquor in a glass decanter well stopped. Then cut out from a paper the letters you would have appear, and paste the paper on the decanter, which you are to place in the sun, in such a manner that its rays may pass through the spaces cut out of the paper, and fall on the surface of the liquor. The part of the glass through which the rays pass will turn black, and that under the paper will remain white. You must observe not to move the bottle during the time of the operation.

To produce the Appearance of a Flower from its Ashes.

MAKE a tin box, with a cover that takes off. Let this box be supported by a pedestal of the same metal, and on which there is a little door. In the front of this box is to be a glass.

In a groove, at a small distance from this glass, place a double glass, made in the same manner as described in p. 14, *(Magic Picture)*. Between the front and back glasses place a small upright tin tube, supported by a cross piece. Let there be also a small chafing-dish placed in the pedestal. The box is to be open behind. You privately place a flower in the tin tube, but not so near the front glass, as to be in the least degree visible, and presenting one that resembles it to any person, desire him to burn it on the coals in the chafing-dish.

You then strew some powder over the coals, which may be supposed to aid the ashes in producing the flower; and put the chafing-dish in the pedestal, under the box. As the heat by degrees melts the composition between the glasses, the flower will gradually appear, but when the chafing-dish is taken away, and the powder of the ashes is supposed to be removed, the flower soon disappears.

You may present several flowers, and let the person choose any one of them. In this case, while he is burn-

ing the flower, you fetch the box from another apartment, and at the same time put in a corresponding flower, which will make the experiment still more surprising.

Imitative Fireworks.

TAKE a paper that is blacked on both sides, or instead of black, the paper may be coloured on each side with a deep blue, which will be still better for such as are to be seen through transparent papers. It must be of a proper size for the figure you intend to exhibit. In this paper cut out with a penknife several spaces, and with a piercer make a great number of holes, rather long than round, and at no regular distance from each other.

To represent revolving pyramids and globes, the paper must be cut through with a penknife, and the space cut out between each spiral should be three or four times as wide as the spirals themselves. You must observe to cut them so that the pyramid or globe may appear to turn on its axis. The columns that are represented in pieces of architecture, or in jets of fire, must be cut in the same manner, if they are to be represented as turning on their axes.

In like manner may be exhibited a great variety of ornaments, cyphers, and medallions, which, when properly coloured, cannot fail of producing a most pleasing effect. There should not be a very great diversity of colours, as that would not produce the most agreeable appearance.

When these pieces are drawn on a large scale, the architecture or ornaments may be shaded; and to represent different shades, pieces of coloured paper must be pasted over each other, which will produce an effect that would not be expected from transparent paintings. Five or six pieces of paper pasted over each other will be sufficient to represent the strongest shades.

To give these pieces the different motions they require, you must first consider the nature of each piece: if, for example, you have cut out the figure of the sun, or of a star, you must construct a wire wheel of the same diameter with those pieces; over this wheel you paste a

very thin paper, on which is drawn, with black ink, the spiral figure. The wheel thus prepared, is to be placed behind the sun or star, in such manner that its axis may be exactly opposite the centre of either of those figures. This wheel may be turned by any method you think proper.

Now, the wheel being placed directly behind the sun, for example, and very near to it, is to be turned regularly round, and strongly illuminated by candles placed behind it. The lines that form the spiral will then appear, through the spaces cut out from the sun, to proceed from its centre to its circumference, and will resemble sparks of fire that incessantly succeed each other. The same effect will be produced by the star, or by any other figure where the fire is not to appear as proceeding from the circumference of the centre.

These two pieces, as well as those that follow, may be of any size, provided you observe the proportion between the parts of the figure and the spiral, which must be wider in larger figures than in small. If the sun, for example, have from six to twelve inches diameter, the width of the strokes that form the spiral, need not be more than one-twentieth part of an inch, and the spaces between them, that form the transparent parts, about two-tenths of an inch. If the sun be two feet diameter, the strokes should be one-eighth of an inch, and the space between, one quarter of an inch; and if the figure be six feet diameter, the strokes should be one quarter of an inch, and the spaces five-twelfths of an inch. These pieces have a pleasing effect when represented of a small size, but the deception is more striking when they are of large dimensions.

It will be proper to place these pieces, when of a small size, in a box quite close on every side, that none of the light may be diffused in the chamber: for which purpose it will be convenient to have a tin door behind the box, to which the candlesticks may be soldered, and the candles more easily lighted.

The several figures cut out should be placed in frames, that they may be put, alternately, in a groove in the fore part of the box; or there may be two grooves, that the

second piece may be put in before the first is taken out. The wheel must be carefully concealed from the eye of the spectator.

Where there is an opportunity of representing these artificial fires by a hole in the partition, they will doubtless have a much more striking effect, as the spectator cannot then conjecture by what means they are produced.

It is easy to conceive that by extending this method, wheels may be constructed with three or four spirals, to which may be given different directions. It is manifest also, that on the same principal, a great variety of transparent figures may be contrived, and which may be all placed before the same spiral lines.

To represent Cascades of Fire.

In cutting out cascades, you must take care to preserve a natural inequality in the parts cut out; for if to save time, you should make all the holes with the same pointed tool, the uniformity of the parts will not fail to produce a disagreeable effect. As these cascades are very pleasing when well executed, so they are highly disgustful when imperfect. These are the most difficult pieces to cut out.

To produce the apparent motion of these cascades, instead of drawing a spiral, you must have a slip of strong paper, of such length as you judge convenient. In this paper, there must be a great number of holes near each other, and made with pointed tools of different dimensions.

At each end of the paper, a part, of the same size with the cascade, must be left uncut; and towards those parts the holes must be made a greater distance from each other.

When the cascade that is cut out is placed before the scroll of paper just mentioned, and it is entirely wound upon the roller, the part of the paper that is then between, being quite opaque, no part of the cascade will be visible. But as the winch is turned gently and regularly round, the transparent part of the paper will give to the cascade the appearance of fire that descends in the same

direction; and the illusion will be so strong, that the spectators will think they see a cascade of fire; especially if the figure be judiciously cut out.

The oracular Mirror.

PROVIDE a round mirror of about three inches in diameter, and whose frame is an inch wide. Line the under part of the frame, in which holes are to be cut, with very thin glass; behind this glass let a mirror, of about two inches diameter be placed, which is to be moveable, so that by inclining the frame to either side, part of the mirror will be visible behind the glass on that side.

Then take Spanish chalk, or cypress vitriol, of which you make a pencil, and with this you may write on a glass, and rub it off with a cloth, and by breathing on the glass the writing will appear and disappear several times. With this pencil write on one side of the mirror, before it is put in the frame, the word *yes*, and on the other side *no*; and wipe them off with a cloth.

You propose to a person to ask any question of this mirror that can be answered by the word *yes*, or *no*. Then turning the glass to one side, and putting your mouth close to it, as if to repeat the question softly, you breathe on it, and the word *yes* or *no* will immediately appear. This mirror will serve for many other agreeable amusements.

The empty Bottle, which fills itself by invisible Means.

THE following curious experiment is inserted on the testimony of many captains and passengers on board the Brighton packets, who positively attest its authenticity.

Cork an empty glass bottle very tight; and seal it; then lower it (with a leaden weight attached) a very great depth into the sea, and draw it up quickly, it will become filled with water; the cork and seal both remaining uninjured. No satisfactory explanation has yet been given of this truly astonishing phenomenon.

The Palindrome.

A PALINDROME is the ingenious construction of a sentence, whereby it will read backwards and forwards the same; not merely verbally, but *literally*. The three following examples may give rise to others; the invention of which may be productive of much amusement:

1. *Lewd I did live, evil did I dwel.*
2. *Si nummis, immunis.*
3. *Ablata at alba.*

Observe, the merit of making a palindrome does not merely consist in its reading literally correct each way, but the sentence must have some meaning, and be accurate in its grammatical construction. The omission of a letter, as in the first example, *(dwel)* is not considered material.

The Hour of the Day or Night told by a suspended Shilling.

HOWEVER improbable the following experiment may appear, it has been proved by repeated trials:

Sling a shilling or sixpence at the end of a piece of thread by means of a loop. Then resting your elbow on a table, hold the other end of the thread betwixt your fore-finger and thumb; observing to let it pass across the ball of the thumb, and thus suspend the shilling into an empty goblet. Observe, your hand must be perfectly steady; and if you find it difficult to keep it in an immoveable posture, it is useless to attempt the experiment. Premising, however, that the shilling is properly suspended, you will observe, that when it has recovered its equilibrium, it will be for a moment stationary: it will then, of its own accord, and without the least agency from the person holding it, assume the action of a pendulum, vibrating from side to side of the glass; and after a few seconds, will strike the hour nearest to the time of day; for instance, if the time be twenty-five minutes past six, it will strike six; if thirty-five minutes past six, it will strike seven; and so of any other hour.

It is necessary to observe, that the thread should lay over the pulse of the thumb, and this may in some measure account for the *vibration* of the shilling; but to what cause its striking the precise hour is to be traced, remains unexplained; for it is no less astonishing than true, that when it has struck the proper number, its vibration ceases, it acquires a kind of rotary motion, and at last becomes stationary, as before.

Of Lightning, and the best Method of guarding against its mischievous Effects.

EXPERIMENTS made in electricity first gave philosophers a suspicion, that the matter of lightning was the same with the electric matter. Experiments afterwards made on lightning obtained from the clouds by pointed rods, received into bottles, and subjected to every trial, have since proved this suspicion to be perfectly well founded; and that whatever properties we find in electricity, are also the properties of lightning.

This matter of lightning, or of electricity, is an extreme subtile fluid, penetrating other bodies, and subsisting in them, equally diffused.

When, by any operation of art or nature, there happens to be a greater proportion of this fluid in one body than in another, the body which has most will communicate to that which has least, till the proportion becomes equal; provided the distance between them be not too great; or, if is too great, till there be proper conductors to convey it from one to the other.

If the communication be through the air without any conductor, a bright light is seen between the bodies, and a sound is heard. In small experiments, we call this light and sound the electric spark and snap; but in the great operations of nature, the light is what we call *lightning*, and the sound (produced at the same time, though generally arriving later at our ears than the light does to our eyes) is, with its echoes, called *thunder*.

If the communication of this fluid be by a conductor, it may be without either light or sound, the subtle fluid passing in the substance of the conductor.

If the conductor be good, and of sufficient bigness, the fluid passes through it without hurting it. If otherwise, it is damaged or destroyed.

All metals, and water, are good conductors.—Other bodies may become conductors by having some quantity of water in them, as wood, and other materials used in building, but not having much water in them, are not good conductors, and therefore are often damaged in the operation.

Glass, wax, silk, wool, hair, feathers, and even wood perfectly dry, are non-conductors: that is, they resist instead of facilitating the passage of this subtle fluid.

When this fluid has an opportunity of passing through two conductors, one good, and sufficient, as of metal, the other not so good, it passes in the best, and will follow in any direction.

The distance at which a body charged with this fluid will discharge itself suddenly, striking through the air into another body that is not charged, or not so highly charged, is different according to the quantity of the fluid, the dimensions and form of the bodies themselves, and the state of the air between them.—This distance, whatever it happens to be between any two bodies, is called their *striking distance*, as, till they come within that distance of each other, no stroke will be made.

The clouds have often more of this fluid in proportion than the earth; in which case, as soon as they come near enough, (that is, within the striking distance) or meet with a conductor, the fluid quits them and strikes into the earth. A cloud fully charged with this fluid, if so high as to be beyond the striking distance from the earth, passes quietly without making noise or giving light; unless it meets with other clouds that have less.

Tall trees, and lofty buildings, as the towers and spires of churches, become sometimes conductors between the clouds and the earth; but not being good ones, that is, not conveying the fluid freely, they are often damaged.

Buildings that have their roofs covered with lead, or other metal, and spouts of metal continued from the roof into the ground to carry off the water, are never

hurt by lightning, as, whenever it falls on such a building, it passes in the metals and not in the walls.

When other buildings happen to be within the striking distance from such clouds, the fluid passes in the walls, whether of wood, brick, or stone, quitting the walls only when it can find better conductors near them, or metal rods, bolts, and hinges of windows or doors, gilding on wainscots, or frames of pictures, the silvering on the backs of looking-glasses, the wires for bells, and the bodies of animals, as containing watery fluids. And in passing through the house it follows the direction of these conductors, taking as many in its way as can assist it in its passage, whether in a strait or crooked line, leaping from one to the other, if not far distant from each other, only rending the wall in the spaces where these partial good conductors are too distant from each other.

An iron rod being placed on the outside of a building, from the highest part continued down into the moist earth, in any direction, strait or crooked, following the form of the roof or other parts of the building, will receive the lightning at its upper end, attracting it so as to prevent its striking any other part; and, affording it a good conveyance into the earth, will prevent its damaging any part of the building.

A small quantity of metal is found able to conduct a great quantity of this fluid. A wire no bigger than a goose-quill has been known to conduct (with safety to the building as far as the wire was continued) a quantity of lightning that did prodigious damage both above and below it: and probably larger rods are not necessary, though it is common in America, to make them of half an inch, some of three quarters, or an inch diameter.

The rod may be fastened to the wall, chimney, &c. with staples of iron.—The lightning will not leave the rod (a good conductor) to pass into the wall (a bad conductor) through those staples.—It would rather, if any were in the wall, pass out of it into the rod, to get more readily by that conductor into the earth.

If the building be very large and extensive, two or more rods may be placed at different parts, for greater security.

Small ragged parts of clouds, suspended in the air between the great body of clouds and the earth, (like leaf gold in electrical experiments) often serve as partial conductors for the lightning, which proceeds from one of them to another, and by their help comes within the striking distance to the earth or a building. It therefore strikes through those conductors, a building that would otherwise be out of the striking distance.

Long sharp points communicating with the earth, and presented to such parts of clouds, drawing silently from them the fluid they are charged with, they are then attracted to the cloud, and may leave the distance so great as to be beyond the reach of striking.

It is therefore that we elevate the upper end of the rod six or eight feet above the highest part of the building, tapering it gradually to a fine sharp point, which is gilt to prevent its rusting.

Thus the pointed rod either prevents a stroke from the cloud, or if a stroke is made, conducts it to the earth with safety to the building.

The lower end of the rod should enter the earth so deep as to come at the moist part, perhaps two or three feet; and if bent when under the surface, so as to go in a horizontal line six or eight feet from the wall, and then bent again downwards three or four feet, it will prevent damage to any of the stones of the foundation.

A person apprehensive of danger from lightning, happening during the time of thunder to be in a house not so secured, will do well to avoid sitting near the chimney, near a looking-glass, or any gilt pictures or wainscot; the safest place is in the middle of the room, (so it be not under a metal lustre suspended by a chain) sitting in one chair and laying the feet up in another. It is still safer to bring two or three mattresses or beds into the middle of the room, and, folding them up double, place the chair upon them; for they not being so good conductors as the walls, the lightning will not chuse an interrupted course through the air of the room and the bedding, when it can go through a continued better conductor, the wall. But where it can be had, a hammock, or swinging bed, suspended by silk cords equally distant from the

walls on every side, and from the ceiling and floor above and below, affords the safest situation a person can have in any room whatever; and what indeed may be deemed quite free from danger of any stroke by lightning.

The Leech, a Prognosticator of the Weather.

CONFINE a leach in a large phial, three-parts filled with rain water, regularly changed thrice a week, and placed on a window frame, fronting the north. In fair and frosty weather it lies motionless, and rolled up in a spiral form, at the bottom of the glass; but prior to rain or snow, it creeps up to the top, where if the rain will be heavy and of some continuance, it remains a considerable time; if trifling, it quickly descends. Should the rain or snow be accompanied with wind, it darts about its habitation with amazing celerity, and seldom ceases until it begins to blow hard. If a storm of thunder or lightning be approaching, it is exceedingly agitated, and expresses its feelings in violent convulsive starts, at the top of the glass. It is remarkable, that however fine and serene the weather may be, and not the least indication to change, either from the sky, the barometer, or any other cause whatsoever, yet, if the animal ever shift its position, or move in a desultory manner, so certain will the coincident results occur, within thirty-six hours, frequently within twenty-four, and sometimes in twelve; though its motions chiefly depend on the fall and duration of the wet, and the strength of the wind.

The Awn of Barley, an Hydrometer.

THE awn of barley is furnished with stiff points, which, like the teeth of a saw, are all turned towards the point of it; as this long awn lies upon the ground, it extends itself in the moist air of night, and pushes forward the barley-corn, which it adheres to in the day; it shortens as it dries; and as these points prevent it from receding,

it draws up its pointed end; and thus, creeping like a worm, will travel many feet from the parent stem. That very ingenious mechanic philosopher, Mr. Edgeworth, once made on this principle a wooden automaton; its back consisted of soft fir-wood, about an inch square, and four feet long, made of pieces cut the cross-way in respect to the fibres of the wood, and glued together; it had two feet before, and two behind, which supported the back horizontally; but were placed with their extremities, which were armed with sharp points of iron, bending backwards. Hence, in moist weather, the back lengthened, and the two foremost feet were pushed forwards; in dry weather the hinder feet were drawn after, as the obliquity of the points of the feet prevented it from receding. Might not this machine be applied as an hydrometer to some meteorological purpose?

The Power of Water when reduced to Vapour by Heat.

WHATEVER force water may have while its parts remain together, is nothing, if compared to the almost incredible power with which its parts are endued, when they are reduced to vapour by heat. Those steams which we see rising from the surface of boiling water, and which to us appear feeble, yet, if properly conducted, acquire immense force. In the same manner as gunpowder has but small effect, if suffered to expand at large, so the steam issuing from water is impotent, where it is permitted to evaporate into the air; but where confined in a narrow compass, as, for instance, where it rises in an iron tube shut up on every side, it there exerts all the wonders of its strength. *Muschenbrook* has proved, by experiment, that the force of gunpowder is feeble when compared to that of rising steam. An hundred and forty pounds of gunpowder blew up a weight of thirty thousand pounds; but on the other hand, an hundred and forty pounds of water, converted by heat into steam, lifted a weight of seventy-seven thousand

pounds; and would still lift a much greater, if there were means of giving the steam greater heat with safety; for the hotter the steam, the greater is its force.

Artificial Memory.

In travelling along a road, the sight of the more remarkable scenes we meet with, frequently puts us in mind of the subjects we were thinking or talking of when we last saw them. Such facts, which are perfectly familiar, even to the vulgar, might very naturally suggest the possibility of assisting the memory, by establishing a connexion between the ideas we wish to remember, and certain sensible objects, which have been found from experience to make a permanent impression on the mind. It was said, that a person contrived a method of committing to memory the sermons which he was accustomed to hear, by fixing his attention, during the different heads of the discourse, on different compartments of the roof of the church, in such a manner, as that when he afterwards saw the roof, or recollected the order in which its compartments were disposed, he recollected the method which the preacher had observed in treating his subject. This contrivance was perfectly analagous to the topical memory of the ancients; an art which, whatever be the opinion we entertain of its use, is certainly entitled, in a high degree, to the praise of ingenuity.

Suppose you fix in your memory the different apartments in some very large building, and that you had accustomed yourself to think of these apartments always in the same invariable order. Suppose farther, that, in preparing yourself for a public discourse, in which you had occasion to treat of a great variety of particulars, you were anxious to fix in your memory the order you proposed to observe in the communication of your ideas. It is evident, that, by a proper division of your subject into heads, and by connecting each head with a particular apartment, (which you could easily do, by conceiving yourself to be sitting in the apartment while you were studying the part of your discourse you meant to connect with it), the habitual order in which these apartments

occurred to your thoughts, would present to you in their proper arrangement, and without any effort on your part, the ideas of which you were to treat. It is also obvious, that very little practice would enable you to avail yourself of this contrivance, without any embarrassment or distraction of your attention.

To procure Hydrogen Gas.

PROVIDE a phial with a cork stopper, through which is thrust a piece of tobacco-pipe. Into the phial put a few pieces of zinc, or small iron nails; on this pour a mixture, of equal parts, of sulphuric acid, (oil of vitriol), and water, previously mixed in a tea-cup, to prevent accidents. Replace the cork stopper, with the piece of tobacco-pipe in it; the hydrogen gas will then be liberated through the pipe into a small stream. Apply the flame of a candle or taper to this stream, and it will immediately take fire, and burn with a clear flame until all the hydrogen in the phial be exhausted. In this experiment the zinc or iron, by the action of the acid, becomes oxigenised, and is dissolved, thus taking the oxigen from the sulphuric acid and water; the hydrogen (the other constituent part of the water) is thereby liberated, and ascends.

Exploding Gas Bubbles.

ADAPT the end of a common tobacco-pipe to the bladder thus filled with hydrogen gas, and dip the bowl of the pipe into soap-suds, prepared as if for blowing up soap bubbles; squeeze out small portions of gas from the bladder into the soap-suds, and the bubbles will ascend into the air with very great rapidity, until they are out of sight. If a lighted taper or candle be applied to the bubbles as they ascend from the bowl of the pipe, they will explode with a loud noise.

Weather Table.

NEW AND FULL MOON.	SUMMER.	WINTER.
If the new or full moon enters into the first or last quarter of the hour of 12 at noon.	Very rainy	Snow and Rain
If between the hours of .... (P. M.) 2 and 4	Changeable	Fair and mild
4 and 6	Fair	Fair
6 and 8	Fair, if wind at N. W.	Fair and frosty, if wind at N. or N. E.
	Rainy, if wind at S. or S. W.	Rain or snow, if S. or S. W.
8 and 10	Ditto	Ditto
10	Fair	Fair and frosty
(A. M.) 2	Ditto	Hard frost, unless wind S. S. W.
2 and 4	Cold, with frequent showers	
4 and 6	Rain	Ditto, ditto
6 and 8	Wind and rain	Stormy weather
8 and 10	Changeable	Cold and rain, if wind N. snow if E.
10 and 12	Frequent Showers	Cold, with high wind

To fill a Bladder with Hydrogen Gas.

APPLY a bladder, previously wetted and compressed, in order to squeeze out all the common air, to the piece of tobacco-pipe inserted in the cork stopper of the phial, (as described in the experiment, p. 211). The bladder will thus be filled with hydrogen gas.

Another Method.

PUT a small quantity of phosphorus and some potash, dissolved in water, into a retort; apply the flame of a candle or lamp to the bottom of the retort, until the contents boil. The phosphuretted hydrogen gas will then rise, and may be collected in receivers. But if, instead of receiving the gas into a jar, let it simply ascend into water; the bubbles of gas will then explode in succession, as they reach the surface of the water, and a beautiful white smoke will be formed, which rises slowly and majestically to the ceiling If bits of phosphorus are kept some hours in hydrogen gas, phosphorized hydrogen gas is produced; and if bubbles of this gas are thrown up into the receiver of an air-pump, previously filled with oxygen gas, a brilliant bluish flame will immediately fill the jar.

The electric Kite.

MAKE a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross; and you have the body of the kite, which being properly accommodated with a tail, loop, and string, will rise in the air like those made of paper; but this being of silk, is more adapted to bear the wet and wind of a thunder gust, without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and

where the silk and twine join a key may be fastened. This kite is to be raised when a thunder-storm appears to be coming on; and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine do not touch the frame of the door or window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, while the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. When the rain has wetted the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key an electric phial may be charged; and from electric fire thus obtained, spirits may be kindled, and all the other electric experiments performed, which are usually done by the help of a rubbed glass or tube, and thereby the identity of the electric matter with that of lightning completely demonstrated.

Singular Impression on the visual Nerves by a luminous Object.

If, while sitting in a room, you look earnestly at the middle of a window a little while, when the day is bright, and then shut your eyes, the figure of the window will still remain in your eye, and so distinct that you may count the panes. A remarkable circumstance attending this experiment is, that the impression of forms is better retained than that of colours; for after the eyes are shut, when you first discern the image of the window, the panes appear dark, and the cross-bars of the sashes, with the window frames and walls, appear white and bright; but if you still add to the darkness of the eyes, by covering them with your hand, the reverse instantly takes place, the panes appear luminous, and the cross-bars dark; and by removing the hand, they are again reversed.

Remarkable Effect on the visual Nerves by looking through different coloured Glasses.

AFTER looking through green spectacles, the white paper of a book will, in first taking them off, appear to have a blush of red; and after looking through red glasses, a greenish cast. This seems to intimate a relation between green and red, not yet explained.

Curious Effects of Oil upon Water, and Water upon Oil.

FASTEN a piece of packthread round a tumbler, with strings of the same from each side, meeting above it in a knot at about a foot distance from the top of the tumbler. Then putting in as much water as will fill about one-third part of the tumbler, lift it up by the knot, and swing it to and fro in the air; and the water will keep its place as steadily in the water as if it were ice. But pour gently in upon the water about as much oil, and then again swing it in the air as before; the tranquillity before possessed by the water will be transferred to the surface of the oil, and the water under it will be violently agitated.

Another curious Experiment with Oil and Water.

DROP a small quantity of oil into water agitated by the wind; it will immediately spread itself with surprising swiftness upon the surface, and the oil, though scarcely more than a tea spoon full, will produce an instant calm over a space several yards square. It should be done on the windward side of the pond or river, and you will observe it extend to the size of nearly half an acre, making it appear as smooth as a looking-glass. One remarkable circumstance in this experiment is, the sudden wide, and forcible spreading of a drop of oil on the surface of the water; for if a drop of oil is put upon a highly polished marble table, or a looking-glass, laid

horizontally, the drop remains in its place, spreading very little, but when dropped on water it spreads instantly many feet round, becoming so thin as to produce the prismatic colours for a considerable space, and beyond them so much thinner as to be invisible, except in its effect of smoothing the waves at a much greater distance. It seems as if a repulsion of its particles took place as soon as it touched the water, and so strong as to act on other bodies swimming on the surface, as straw, leaves, chips, &c. forcing them to recede every way from the drop as from a centre, leaving a large clear space.

THE END.

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