INSTRUCTION BOOK FOR SCIENTRIX

100 INTERESTING EXPERIMENTS

Handbook

: of :

SCIENTRIX EXPERIMENTS

First Edition.

TRIX Ltd.,
4, GOLDEN LANE, LONDON, E.C.1.

Dear TRIX Friends!

How long is a second? How is a cannon fired? What is Electro-magnetism? How is Electricity produced?

Apparently a few simple questions, yet soon you will understand how they carry you deeply into the realms of physics with all its mystery and wonder. To give you the opportunity to experiment and find out for yourselves the hidden powers of Nature, we have produced

SCIENTRIX

This is a set for experiments, which follows in the TRIX path, i.e., outstanding value for money and above all things practical and straight to the point. Each part can be used any number of times. This set will lead you into the heart of Physics and Electricity. You learn easily from a hundred experiments the elementary principal rules of Science. Naturally these hundred experiments do not exhaust the possibilities of SCIENTRIX. Wonder after wonder has been revealed by those who spend their lives experimenting. They are the pioneers who through their industry provide the great things of life for us.

TRIX INFORMATION BUREAU,

4, Golden Lane, LONDON, E.C.1.

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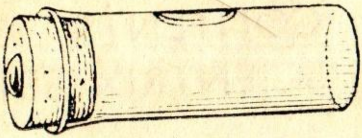
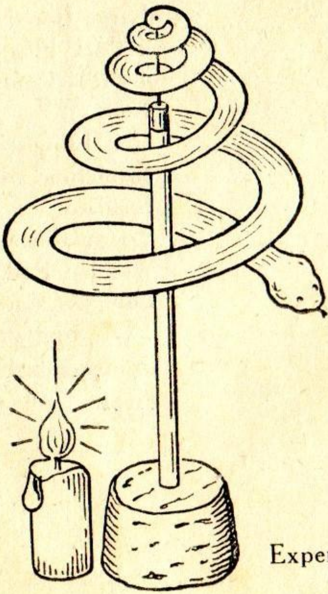




Experiment 2

A LEVEL.

Experiment 1

We almost fill the glass beaker with water, cork it and seal the hole with wax or plasticine. The small quantity of air which has been shut in the beaker rises and forms a bubble. If we place the beaker on an inclined surface the bubble rises to the highest point. This type of level is used by workmen to make sure their work is exactly horizontal, just as a plumb line gives the perpendicular.

Materials :

Glass Beaker, Cork, Wax or Plasticine.

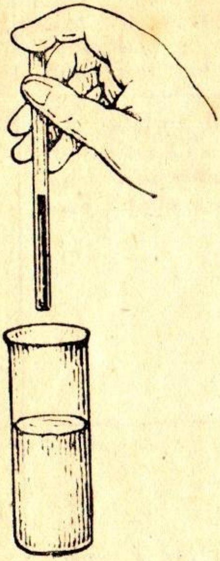
WARM AIR RISES.

Experiment 2

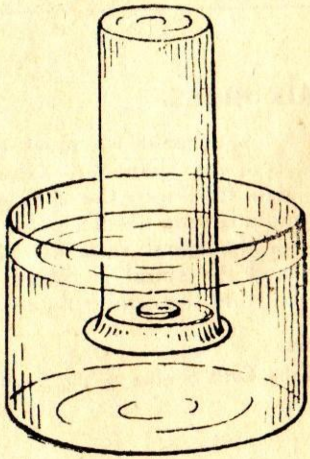
For this experiment we must cut out a paper spiral of $2\frac{3}{4}$-ins. diameter. Now push one end of the glass tube into the cork and fix into the other end a sewing needle, point upwards. The centre of the spiral rests on the point of the needle and the spiral is rotated by the heated air rising from the candle flame placed beneath.

Materials :

Glass Tube, Cork, Sewing Needle, Candle, Paper Spiral.



Experiment 3



Experiment 4

A WATER CONTAINER WITHOUT A BOTTOM.

Experiment 3

Is this magic? No, it is quite a natural occurrence. We hold our glass tube vertically and dip it into some water. The water rises in the glass tube somewhat higher than the outside surface of the water (*see* Experiment 25). Now we put our finger over the top of the tube and lift it out of the water. Not a single drop of water is spilt. How does this happen? You have, no doubt, heard of atmospheric pressure; air exerts pressure on all sides. It presses the column of water from underneath but it cannot press it down from above as our finger blocks the way. If we lift our finger, then air exerts pressure from above and the water falls out by its own weight.

Materials:

Glass Tube, Vessel of Water.

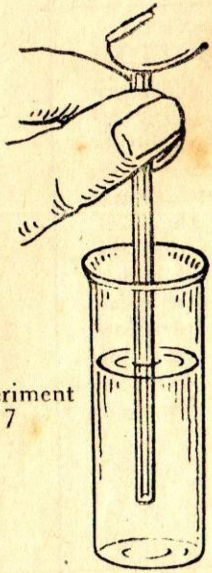
AIR OCCUPIES SPACE.

Experiment 4

We can prove the truth of our statement by the following experiment. We dip the glass beaker upside down in some water. The water does not enter the beaker. So that we can see this more clearly we put one of the cork floats in the water and place the glass beaker over it. If the water had risen in the beaker it would have raised the cork with it.

Materials:

Glass Beaker, Cork Float, Vessel of Water.



Experiment
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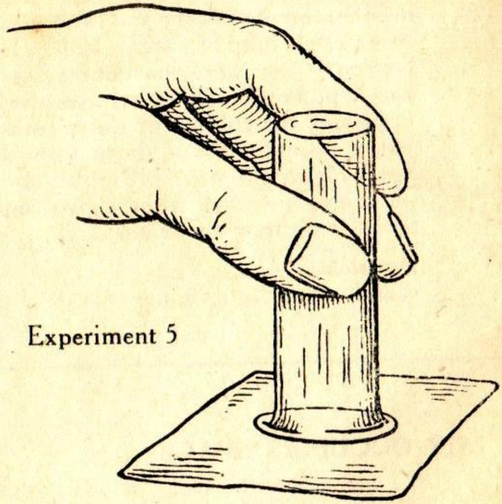
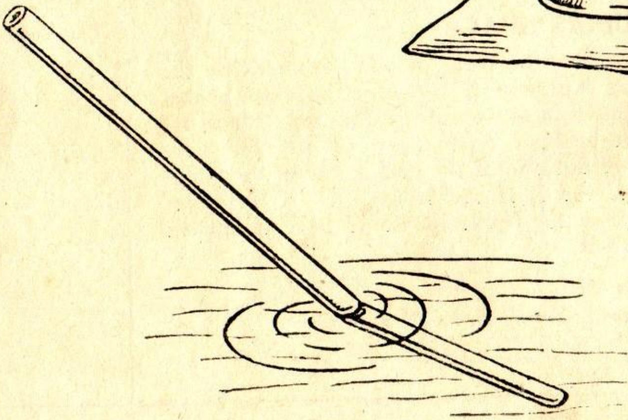


Experiment 5



Experiment
6

WHY DOESN'T THE PAPER FALL OFF ?

Experiment 5

It is certainly heavier than air! How does it resist the pressure of water in the beaker? Perhaps you think it is fastened to the glass by glue. Just try for yourself. Fill the glass beaker **to the brim** with water and lay a piece of paper over it. Now carefully turn the beaker over. Not a drop of water runs out. The paper forms an absolute seal. When you think again of Experiment 3 you will find the explanation. The upward pressure of air has given the paper power to hold up the water, and even if you prick the paper with a needle, the water will not flow out.

Materials : Glass Beaker with Water, Needle, Paper.

THE BENT GLASS TUBE.

Experiment 6

When rays of light from air to water enter or emerge, they are refracted or bent, so that if we hold the glass tube in water, the part under water appears to us to be raised and the glass tube bent. The point where the tube appears to be bent is at the spot where it dips into the water.

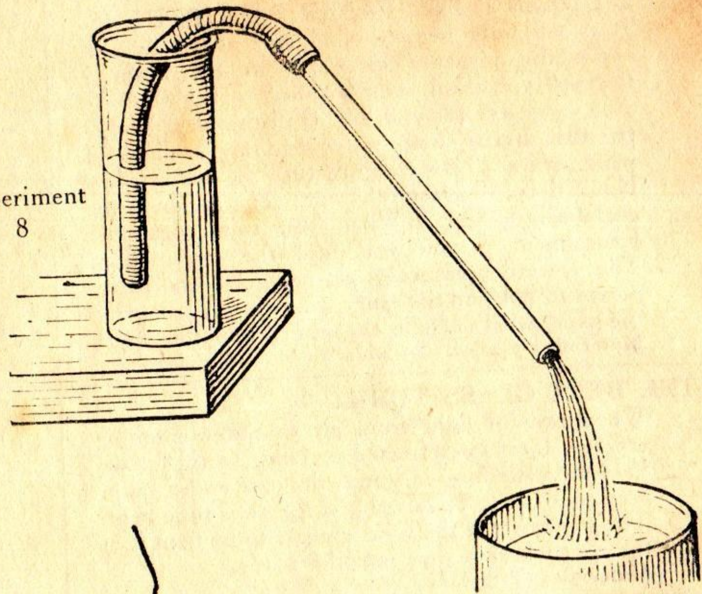
Materials : Glass Tube, Vessel of Water.

IS AIR NOTHING ?

Experiment 7

Air is a substance just as iron or water. The space a piece of iron occupies, nothing else can take up. That is obvious. In just the same way, no other substance can be where air is. Perhaps this sounds more complicated—but you can prove it if you take a glass tube and put your finger over one end and dip the other end into water. Practically no water at all rises up the tube. Where there is air there cannot be water as well. Now lift up your finger. What happens? The water rises up the tube to the outside level of the water, for now it is able to displace the air in the tube and take its place.

Materials : Glass Tube, Glass Beaker with Water.



Experiment
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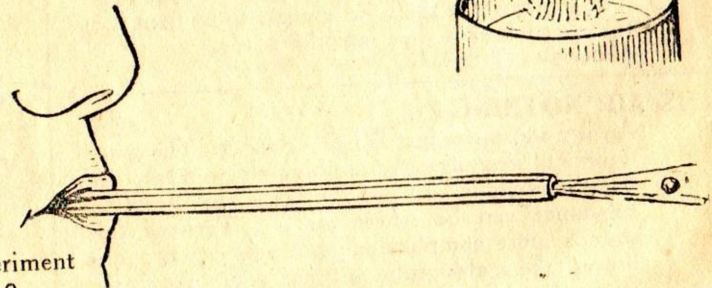

Experiment
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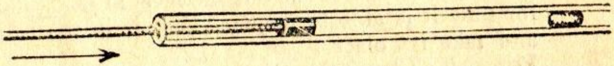


Experiment
10

A SIPHON.

Experiment 8

For this experiment we use the piece of rubber tubing, pushed over one end of the glass tube. We place the tubing nearly to the bottom of the glass beaker filled with water. The glass tube leads into an empty vessel so that the end lies at a lower level than the end of the tubing in the beaker. To start the siphon, we suck the glass tube until the water runs into the mouth. We then find it will continue running without assistance and will flow until the glass beaker is emptied to the level of the end of the tubing.

Materials :

Rubber Tubing, Glass Tube, Glass Beaker with Water, Vessel.

A PEA SHOOTER.

Experiment 9

We can use our glass tube for this. Small paper balls, small peas, etc., can be used as ammunition.

Materials :

Glass Tube, Small Paper Balls or Small Peas.

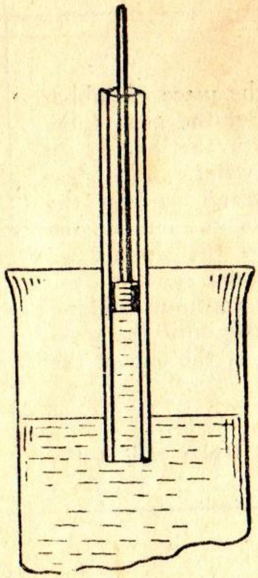
A PRESSURE AIR GUN.

Experiment 10

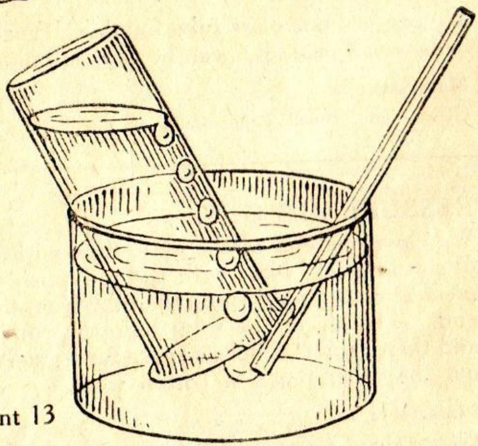
We close one end of the glass tube with a piece of cotton wool. Now with the rod push another piece of cotton wool along the tube from the open end. The air in the tube becomes compressed and there is not sufficient space for it, so it forces out the other piece of cotton wool.

Materials :

Glass Tube, 2 pieces of Cotton Wool, Wooden Rod.



Experiment 11



Experiment 13

THE SUCTION TUBE.

Experiment 11

To make a plunger for this experiment, we wind some tow or cotton wool around one end of the small wooden rod, so that it exactly fits the glass tube. Now we push the plunger nearly to the bottom of the glass tube and dip this into some water. Then, draw up the plunger. The water rises up the glass tube. The upward movement of the plunger causes a space beneath, the air is thinned and the greater outside air pressure pushes the water upwards in the tube.

Materials :
Wooden Rod, Cotton Wool, Glass Tube, Glass Beaker with Water.

ATMOSPHERIC PRESSURE SUPPORTS A COLUMN OF WATER.

Experiment 12

We fill the beaker with water and close it with paper as in Experiment 5. We plunge the beaker into a vessel of water, so that the paper and open end of the beaker are under the surface of the water. We now draw away the paper and yet we find the water will not run out of the beaker, for the reason that the outside atmospheric pushing down on the surface of the water supports it.

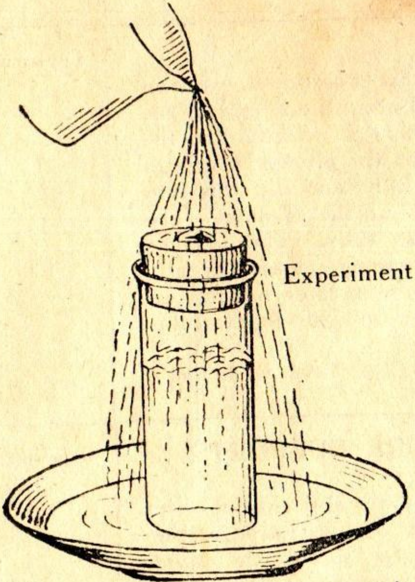
Materials : Glass Beaker, Vessel of Water, Paper.

AIR DISPLACES WATER.

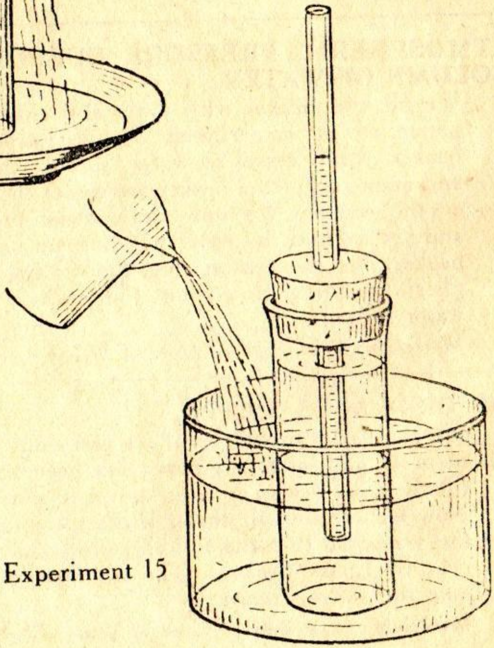
Experiment 13

We can easily prove this if we carry out Experiment 12 and, after the paper has been removed, tilt the glass beaker over as shown in illustration. Now let us blow air through the glass tube into the water, so that the bubbles produced rise up into the glass beaker. The air will gradually take the water's place.

Materials : Glass Beaker, Vessel of Water, Glass Tube.



Experiment 14



Experiment 15

BOILING WATER BY MAGIC.

Experiment 14

Oh, but boiling water is easy, you say. You just heat a vessel of water until it begins to boil! But by our magic we can make the water boil by merely shaking cold water over the vessel. Try it! Boil up some water in the glass beaker. Seal it up very quickly with the cork and plasticine. The water has by this time stopped boiling. When it is quite still, shake some cold water over the glass beaker, and all at once the water starts to boil again. It bubbles up full of life!

When the water boils for the first time the space above the liquid fills with steam. This steam is then sealed in with the cork and plasticine. The cold water condenses the steam and leaves an air-thinned space and a lower pressure above the liquid in the glass beaker. At a lower pressure, the water will boil at a lower temperature, and so begins to bubble again.

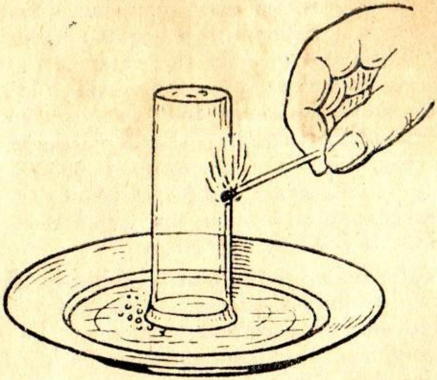
Materials :
Glass Beaker, Cork and Plasticine, Vessel for Water.

DOES HEAT INCREASE A FLUID'S VOLUME?

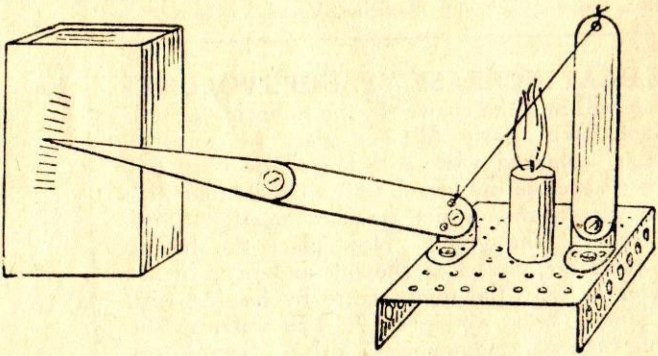
Experiment 15

You will find the answer in the following experiment. We nearly fill our glass beaker with water, coloured with a little red or blue ink. Then we close the vessel with a cork, fitted with the glass tube, which reaches nearly to the bottom of the vessel. Now place the beaker in the larger vessel as shown, and pour in hot water or raise the temperature by heating with a flame. What do we see? The water in the little tube soon commences to rise. So we have proved that a fluid's volume increases with heat.

Materials :
Glass Beaker, Cork, Glass Tube, Vessel of Water.



Experiment 16



Experiment 17

Experiment 16

AIR EXPANDS, TOO—

when it is heated. We place the glass beaker upside down in a plate filled with water and gently heat the sides of the beaker above the water level with a flame. Soon air bubbles rise out of the water. The heat is expanding the air in the beaker and the space is no longer sufficient, so part of the air escapes and bubbles through the water. Perhaps you know that a hard-pumped up bicycle tyre, if left standing for a long time in the hot sun, will finally burst with a loud bang. The air expands so much with the heat that the tube is no longer able to withstand the pressure.

Materials : Glass Beaker, Plate or Saucer with Water.

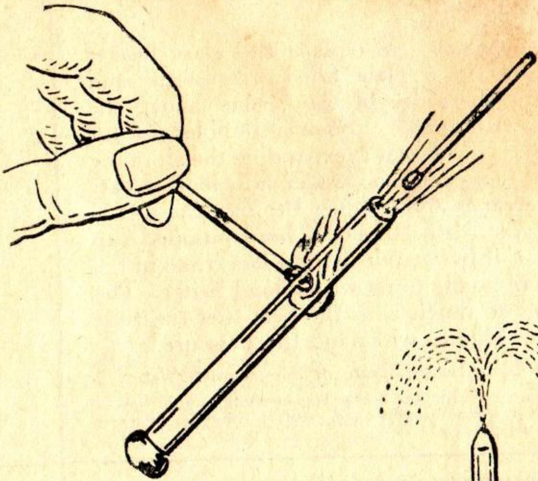
NOTE: Take care to warm the beaker very carefully with the lighted match, moving it around as gently and evenly as possible, otherwise you will crack the glass beaker.

Experiment 17

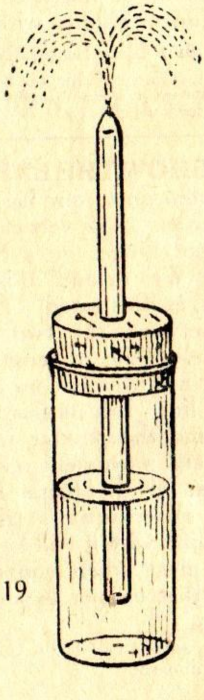
HOW TO SHOW THE EXPANSION of a METAL.

We fasten on to our base two F 9's by means of two angles. The vertical F 9 is tightly fixed, but the other hinges on a bolt and locknuts in the angle. We extend this F 9 by a cardboard pointer, as illustrated. Now fix an iron or copper wire between the two F 9's as shown. This wire should be of length sufficient to give the pointer a movement on a scale marked out on a box or lid. Let us heat this wire with a candle flame and the pointer will immediately make a downward movement on the scale, showing that the heat of the flame has expanded the wire. If this experiment is tried out with both iron and copper wire it will be noticed that the pointer moves most when copper wire is used. This proves that copper expands more than iron.

Materials :
Base, two angles, two F 9's, Copper and Iron Wire, Candle, Box, Cardboard.



Experiment 18



Experiment 19

A GLASS CANNON.

Experiment 18

Yes, there is such a thing, and every one of you can make one. The gun is our glass tube, closed at one end by sealing wax. The shot is a match and the charge is the match head. The gun is loaded with the match head downwards, and you will see from the illustration how the shot is fired. At the command "Fire away!" hold a flame under the tube and, in a few seconds, the shot flies out. What has happened? The heat of the flame goes right through the glass tube and ignites the match head. Gases are formed by the combustion of the materials in the match head. These require a greater amount of space and, as the glass tube is sealed at one end, the gases cannot escape there. So they must go forward. The match stick blocks the way, so out it has to go.

Materials :

Glass Tube, Match, Sealing Wax, Candle.

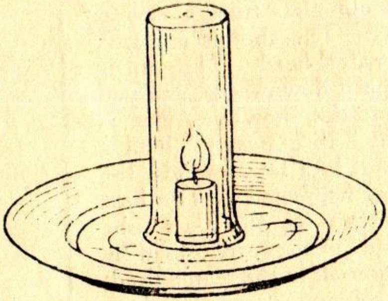
HERON'S FOUNTAIN.

Experiment 19

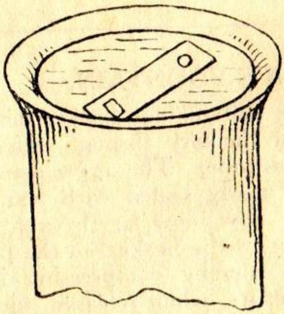
We half fill our beaker with water and close it with the cork, through which we have pushed the glass tube. The upper opening of the tube must be nearly sealed with wax leaving a pin hole. We now blow air through this pin hole and it rises in the beaker, to the place occupied by the air, thereby compressing it. The created air pressure, when released, blows the water out of the pin hole as a fountain. The Greek Heron was the first to make this discovery.

Materials :

Glass Beaker, Cork, Glass Tube, Wax, Needle.



Experiment 20



Experiment 21

WHY DOES THE CANDLE FLAME DIE ?

Experiment 20

Not because the candle is used up, but because its flame has burnt up the oxygen. Oxygen is one of the gases of which the air is composed. We cannot breathe without it, and it is also necessary to make a flame live. Put a lighted candle on a saucer with a little water and place the glass beaker upside down over it, so that the brim dips into the water and allows no more air to enter. The flame becomes weaker and dies out after a very short time. It has used up the oxygen of the air contained in the beaker and therefore could burn no longer. We can see that the oxygen has gone out of the air in the beaker as the water rises inside to take its place.

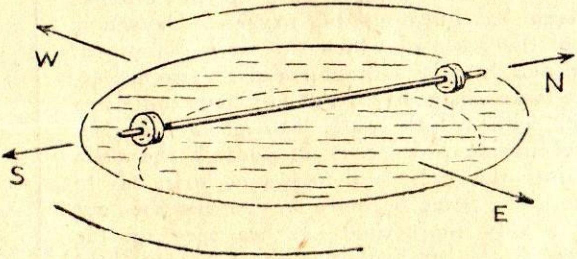
Materials :
Candle, Saucer with Water, Glass Beaker.

FLOATING METAL.

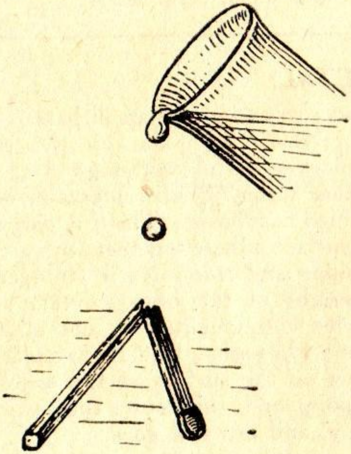
Experiment 21

If we dry and rub one of the small brass contact springs and carefully lay it flat on the surface of water it does not sink, although it is metal and heavier than water. This remarkable occurrence is explained as follows : The tiny particles of water at the surface adhere together with a certain force—adhesion—and this force is stronger than the lesser weight of the brass contact spring. These particles consequently do not allow the latter to push through. But if we place the contact spring on the surface of the water with the edge or point first, this causes the particles to separate easily, and down it goes.

Materials :
Brass Contact Spring, Glass Beaker with Water.



Experiment 22



Experiment 23

HOW CAN WE MAKE A KNITTING NEEDLE FLOAT ?

Experiment 22

Beginners in swimming can be supported on the top of the water by cork fastened around the waist. A knitting needle can float in this way, too. We place a cork float on each end of the needle and then lay it in the water. The lightness of the cork carries the heavy needle and prevents it sinking. If we magnetise the knitting needle beforehand, we have constructed a simple compass.

Materials :

Knitting Needle, Cork Floats, Vessel of Water.

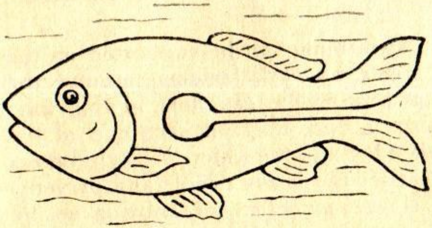
THE ANIMATED MATCH.

Experiment 23

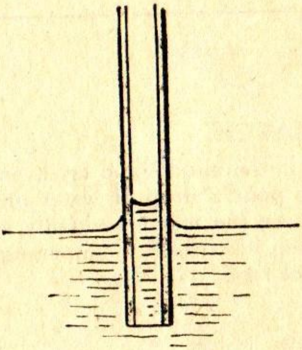
We bend a match in the middle and lay it on the table. Now if we pour a drop of water on the bent part, we can see the match suddenly come to life and straighten itself out. Dampening the wood is the cause of this.

Materials :

Glass Beaker with Water, Match.



Experiment 24



Experiment 25

THE MAGIC FISH.

Experiment 24

Out of a piece of cardboard we cut a little fish as illustrated, and float it on water. Now we drop some oil into the cut-out portion in the centre of the fish. This oil attempts to spread itself over the upper surface of the water and moves along the channel towards the back of the fish. In doing so it gives the fish an impulse to move in the opposite direction and so makes it swim forward in the water.

Materials :

Cardboard, Oil, Vessel of Water.

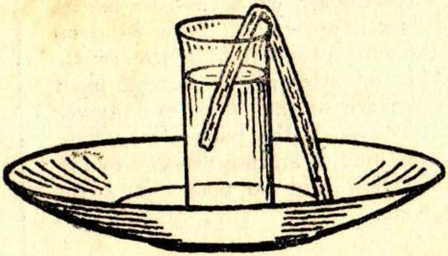
HOW DOES BLOTTING PAPER WORK ?

Experiment 25

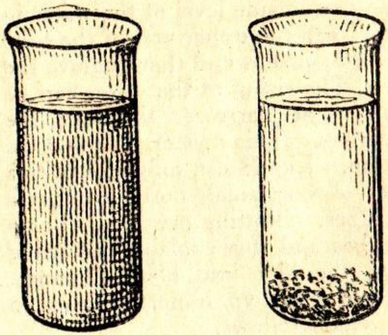
Let us try the following experiment to find the cause of this phenomenon. We place our glass tube in a vessel of water, coloured with ink. We notice that the water in the glass tube rises a little higher than the outside level of the water in the vessel. Now keep the upper end of the tube closed while you immerse it and then remove the finger suddenly. The rising of the water can be clearly observed. The narrower the tube the higher the water rises. This mystery is known as capillary attraction. Liquid can only rise in this manner in tubes of very small bore, which are called capillary tubes. Blotting paper is built up of many such tubes and this explains the rising of the ink from the blot into blotting paper. Capillary attraction plays an important part in the experiment which follows.

Materials :

Glass Tube, Glass Beaker with Water, Ink.



Experiment 26



Experiment 27

BLOTTING PAPER AS A CONVEYOR OF WATER.

Experiment 26

Stand the glass beaker filled with water in an empty saucer in front of you. With the help of a piece of blotting paper, you can conduct the water out of the glass beaker into the saucer. This is not difficult. Fold a piece of blotting paper into a strip and bend it so that it dips into the water and the other end hangs over into the saucer. We find the water slowly flows from the beaker to the saucer, and capillary attraction is the reason.

Flower pots absorbing water in a similar manner is a well known practical example of this.

Materials :

Glass Beaker with Water, Saucer, Blotting Paper.

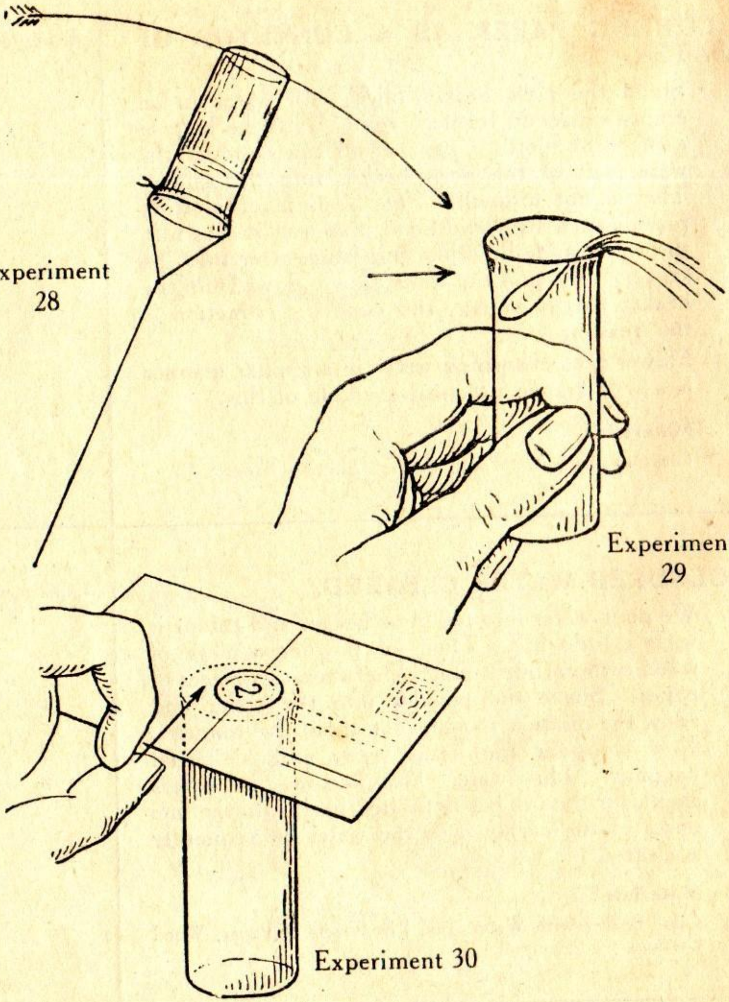
COLOURED WATER CLEARED.

Experiment 27

We pour water into the glass beaker and colour it with a little ink. Then we powder a piece of wood carbon (burnt match) between two pieces of paper. Shake the powder into the water and allow the mixture to stand for about five minutes. Now we pour the liquid away and see what happens. The water has become colourless again, for the ink has deposited itself into the fine pores of the carbon and the water consequently is cleared.

Materials :

Glass Beaker with Water, Ink, Two Sheets of Paper, Wood Carbon.



Experiment 28

Experiment 29

Experiment 30

CENTRIFUGAL FORCE.

Experiment 28

We fasten the glass beaker firmly to a piece of string, as shown in the illustration, and pour some water into it. Then we swing the beaker quickly in a circle. You might think that the water would fall out, but this is not the case. How is it explained? All bodies which move at speed around a middle point endeavour to force themselves away from this centre point. The force with which they strive to move away is called centrifugal force.

In the position the beaker is shown in the illustration, centrifugal force is effective upwards. It is stronger than the downward pressing weight of the water, and therefore not a drop of water escapes.

Materials : Glass Beaker with Water, String.

WHEN THE TRAIN STOPS SUDDENLY—

Experiment 29

then we fall forward in our compartment. Our body was in motion and maintained this when the train stopped. This is exactly what happens with the water in the glass beaker, and we can prove it if we do the following experiment. Move the beaker containing the water slowly to the right, gradually move it quicker and quicker—then stop with a sudden jerk. The water, by the force of inertia, overflows in a forward direction while attempting to continue its previous movement.

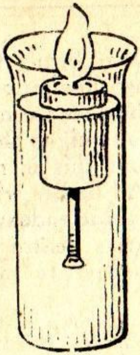
Materials : Glass Beaker with Water.

THE OBSTINATE COIN.

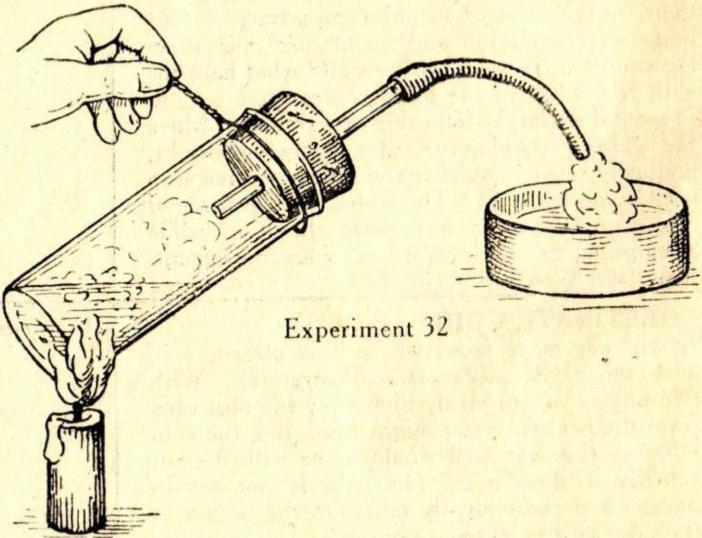
Experiment 30

It will not move from where it is placed, viz., over the glass beaker (see illustration). With two fingers, we suddenly flick away the post card from the beaker. You might think that the coin lying on the post card would move with it—but actually it does not. The coin is not set in motion and consequently falls into the beaker as the post card is jerked away.

Materials : Glass Beaker, Coin, Post Card.



Experiment 31



Experiment 32

HOW LONG WILL THE CANDLE BURN?

Experiment 31

With our candle we can try the following very interesting experiment. Push a nail into the bottom of the short piece of candle, so that its weight holds the candle in a floating position in a beaker of water, as illustrated. Now light the candle. In a short time you will naturally expect to see the candle extinguished, but this will not happen. As a matter of fact, the candle will burn itself right away, for the more the candle burns down and the lower the flame sinks, so much lighter becomes the weight of the candle and consequently it continually keeps itself afloat.

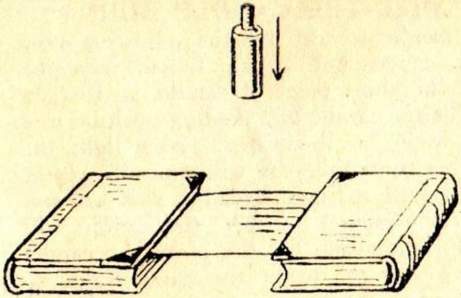
Materials: Candle, Nail, Glass Beaker with Water.

HOW CAN WATER FLOW UPWARDS?

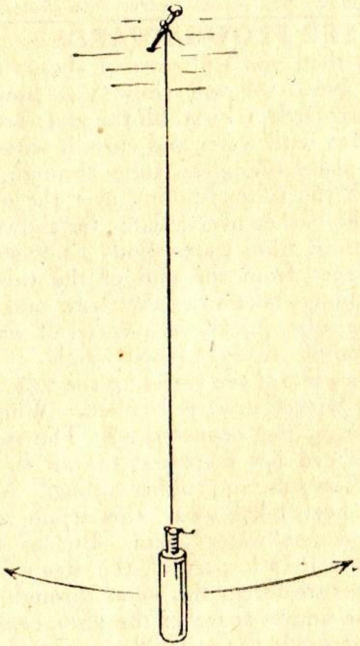
Experiment 32

It never does that, you will say; it always runs downwards. Now we will show you how to make it flow upwards. First, fill the glass beaker to about a 1/5th with water and close it with the cork. Now place the glass tube through the cork and push the rubber tubing over the other end. Hold the beaker over a flame (as shown in illustration) until the water boils and steam produced escapes from the end of the tubing. While it is boiling, take away the flame and dip the end of the tube quickly in a vessel of water, which is standing ready. Now watch . . . the water rushes out of the vessel up the tube and into the glass beaker until it is filled. What is the explanation of this occurrence? The steam which is produced has displaced the air in the glass beaker, glass tube and rubber tubing. After the flame has been taken away, this steam cools down and becomes water again. But as this occupies only 1/1675th part of the steam, the outside air pressure forces the water through the tubing into the empty space in the glass beaker, and so we have made the water flow upwards.

Materials: Glass Beaker with Water, Cork, Glass Tube, Rubber Tubing, Vessel of Water.



Experiment 33



Experiment 34

THE IMPACT OF A FALL.

Experiment 33

We stretch a sheet of thin paper between two books. Now we allow the soft iron core to drop from a short distance above. The paper is not torn. If, however, we increase the height gradually the paper will finally be broken through by the core. The further the core falls so much easier and smoother it breaks through the paper. The force of the fall increases with the height of the fall.

Materials :
Paper, Two Books, Soft Iron Core.

HOW LONG IS A SECOND ?

Experiment 34

Perhaps you will say : "You can tell by the clock ! " Yes, but only if there is a seconds hand. If we haven't this hand, we can make a seconds pendulum by hanging up the iron core on a thread and letting it swing. If we make this pendulum exactly 99.4 cms. long, no matter what the distance it swings, it takes just one second per swing.

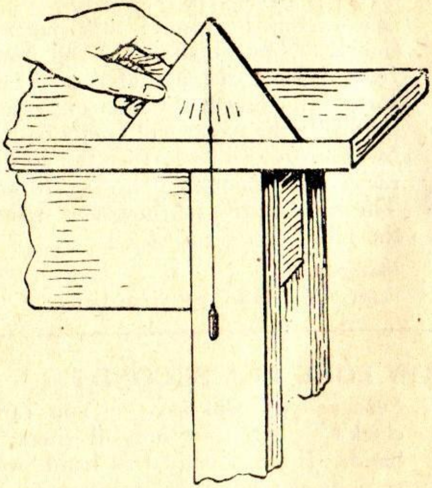
Materials :
Soft Iron Core, Thread.

A PENDULUM TEST.

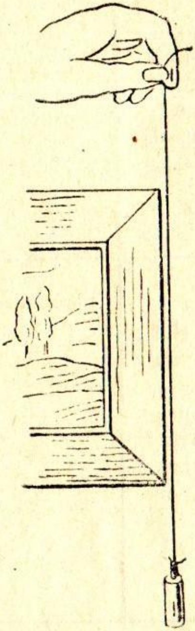
Experiment 35

We swing several pendulums of various lengths, but of the same weight. What is the result ? The longer the pendulum the longer the time of the swing, and the shorter the pendulum the shorter the swing.

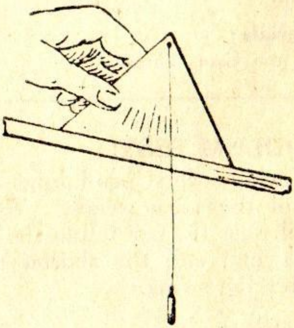
Materials :
Soft Iron Core, Thread.



Experiment 38a



Experiment 37



Experiment 38b

ANOTHER PENDULUM TEST.

Experiment 36

We make two pendulums of the same length. On one thread we attach the soft iron core and on the other a piece of wood, about the same size. The result is that both pendulums swing at the same pace. The difference in weight has no influence on the time of the swing.

Materials: Soft Iron Core, Piece of Wood, Thread.

HOW CAN WE HANG A PICTURE LEVEL?

Experiment 37

Our eyes very often deceive us so we make certain with a plumb-line. Suspend the soft iron core on a long thread and move it to a position near the edge of the picture, as shown in illustration. The iron core is pulled by gravity and always hangs in a perpendicular position, pointing towards the centre of the earth. So we can set the picture to the line of the thread which is always vertical.

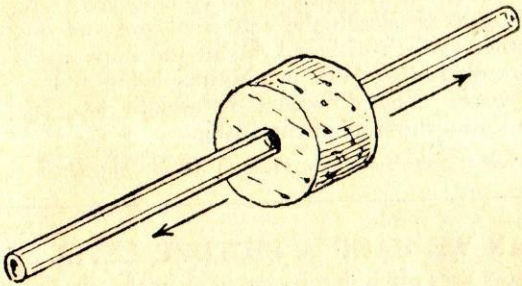
Materials: Soft Iron Core, Thread.

IS OUR TABLE LEVEL?

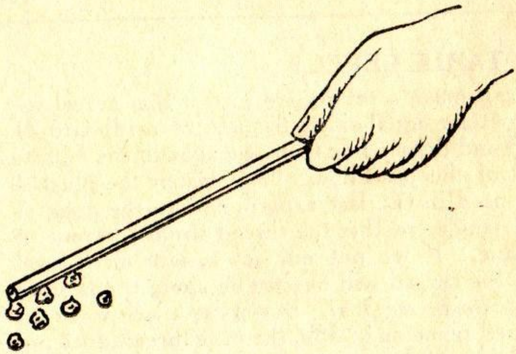
Experiment 38

We can make a set square to test this ourselves. We cut an equal-sided triangle of cardboard or wood and draw a line from the apex to the middle point of the base line. Now fasten the plumb-line, used in the last experiment, to the apex of the triangle, so that the thread hangs in front of the line. If we put our set square on a level table the thread will exactly lie along the line we have drawn, *see* 38a. But if we place it on an inclined plane as in 38b, then the thread does not coincide with the line.

Materials: Cardboard or Wood, Plumb-line.



Experiment 39



Experiment 40

FRICTION PRODUCES HEAT.

Experiment 39

Just rub your hands together once or twice. This will prove to you the truth of the above statement. Another way is to push the glass tube through the opening of our large cork and move the latter quickly up and down. The glass tube will soon become very hot.

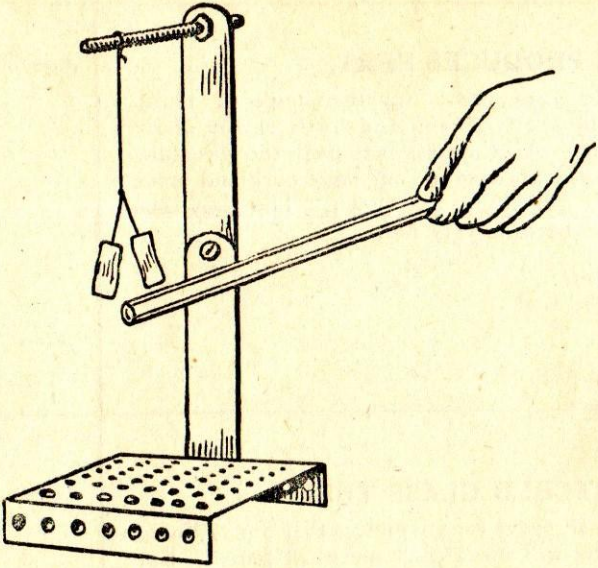
Materials :
Glass Tube, Cork.

THE BEWITCHED GLASS TUBE.

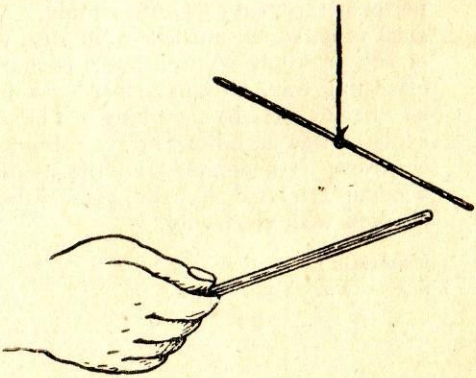
Experiment 40

You can all prove for yourselves that our ordinary glass tube will not attract pieces of paper. But if we bewitch it, then it easily attracts pieces of paper as a magnet does iron filings. How do we perform this feat? Quite simply. We rub the glass tube, which must be quite dry, with a piece of silk or wool. A well-dried post card, a stick of sealing wax, a fountain pen (ebonite) can also be bewitched by rubbing. The wise man explains this as follows:—By rubbing, frictional electricity is generated and the pieces of paper become attracted by the glass tube which is charged with electricity.

Materials :
Silk or Wool, Glass Tube.



Experiment 41



Experiment 42

Experiment 41

THE GLASS TUBE AND PIECES OF PAPER.

On the metal base we build a stand with two flat strips and a spindle. On this we hang small pieces of paper on silk threads, as shown in the illustration. Now we rub the glass tube and bring it near to the pieces of paper. It attracts these. However, if we bring the glass tube and pieces of paper in contact for a short time, the papers will repel each other. The electricity is transmitted from the glass tube to the pieces of paper by the contact, and thereby they become charged with the same polarity. Electrically charged bodies of like polarity repel each other.

Materials :

2 Flat Strips F 9, Nuts and Bolts, Metal Base, Spindle, Glass Tube, Paper, Silk Thread.

Experiment 42

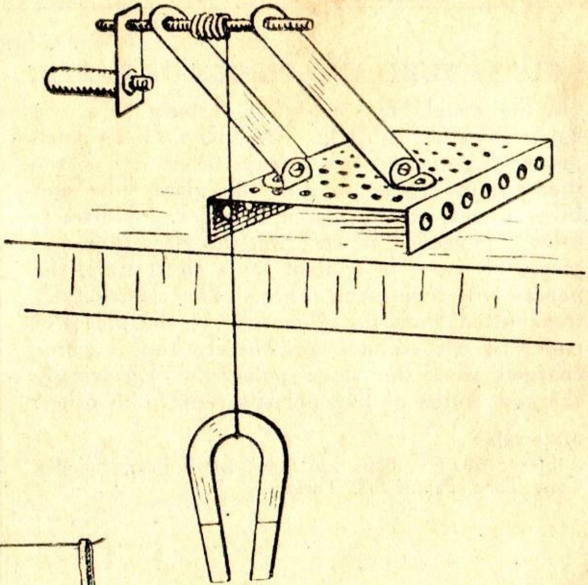
OUR GLASS TUBE ALSO ATTRACTS WOOD.

To prove this we hang our wooden rod on the stand so that it swings horizontally. Now, if we bring the electrified glass tube near to one of the ends of the wooden rod this will be attracted.

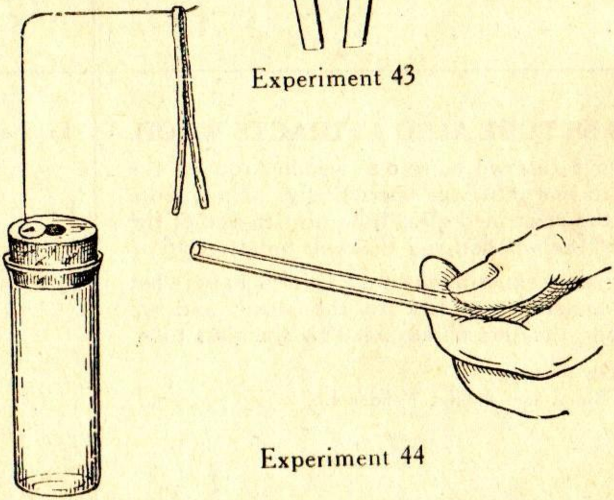
For further experiments we can also hang what other materials we like on the stand, and we shall find they are all attracted by the glass tube.

Materials :

As for Experiment 41 and Wooden Rod.



Experiment 43



Experiment 44

Experiment 43

MAGNETIC CRANE.

Attach the horseshoe magnet by string to the winding spindle of the crane erection shown in the illustration. Now if we bring pieces of iron towards the magnet these will be attracted, and by turning the hand crank we lift the magnet together with the pieces of iron.

Materials :
Magnet, String, Spindle, Angles, Insulator, Nuts and Bolts, Metal Base, Flat Strips F 9's.

Experiment 44

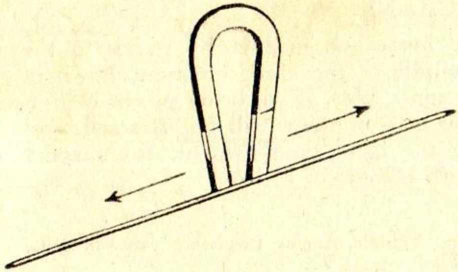
WE MAKE AN ELECTROSCOPE.

We fasten a small piece of our copper wire by a drawing pin to the cork, which is pushed into the glass beaker (see illustration).

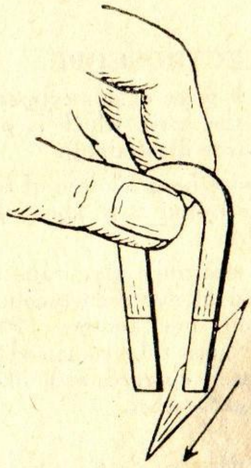
On the copper wire hang a piece of tinsel about 4-ins. long (or a tinfoil strip about $\frac{1}{8}$-in. wide) bent in the middle.

If we bring the electrified glass tube to the two ends of the metal of our electroscope they will spread away from one another. Part of the electricity of the glass tube is passed into them and they have been charged with like polarity. Like poles repel each other.

Materials :
Glass Beaker, Cork, Wire, Drawing Pin, Glass Tube, Tinsel or Tinfoil.



Experiment 45



Experiment 46

HOW TO MAGNETISE A KNITTING OR SEWING NEEDLE.

Experiment 45

We place the permanent horseshoe magnet on the middle of the needle. This we stroke with both poles to one end of the needle and from there back again over the whole length of the needle without lifting the magnet up. Repeat this 40 to 50 times. We then lift the magnet away, when it is once again in the centre of the needle.

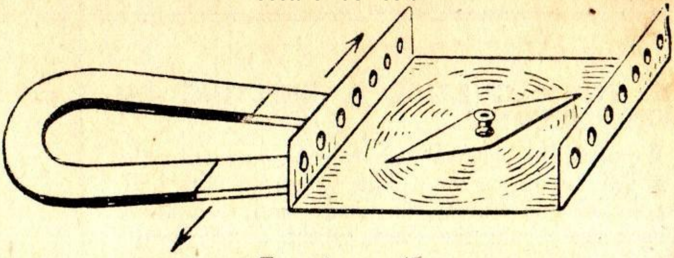
Materials :
Magnet, Needle.

WE MAGNETISE OUR COMPASS NEEDLE.

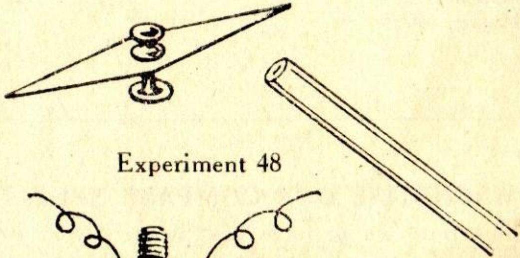
Experiment 46

This time we perform our magnetisation in a different way. We place one pole of the horseshoe magnet on the middle of the compass needle and stroke as far as one end. Then we take away the magnet pole and carry it through the air to the centre and repeat the same procedure (about 40 times). Now we stroke the other half of the compass needle with the other pole of the magnet beginning from the centre as before. The needle is now magnetised, and its north pole is at the end where the south pole of the magnet ended.

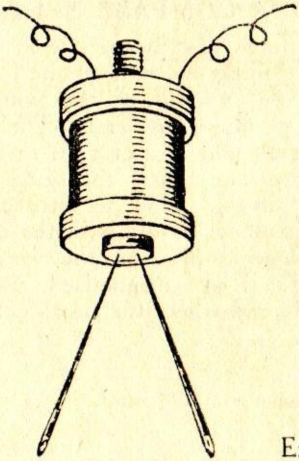
Materials :
Magnet, Compass Needle.



Experiment 47



Experiment 48



Experiment 49

THE REVOLVING COMPASS NEEDLE.

Experiment 47

If we bring the north pole of a magnet to the north pole of our compass needle, both poles will repel each other and the compass needle will be set in motion thereby.

Materials :
Magnet, Compass Needle, Pivot, Metal Base.

WE CAN CONTROL OUR COMPASS NEEDLE. . .

Experiment 48

by bringing near to it the glass tube, electrified as in Experiment 40.

We place our magnetised compass needle on the point of the pivot. Now our electrified glass tube will attract each of the two poles of the magnet.

This proves the law . . . . The Magnetism of one body (the needle) cannot overcome the attractive force of the glass tube electrically charged by friction.

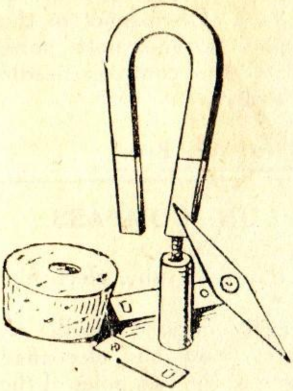
Materials : Compass Needle, Pivot, Glass Tube.

NEEDLE ENEMIES.

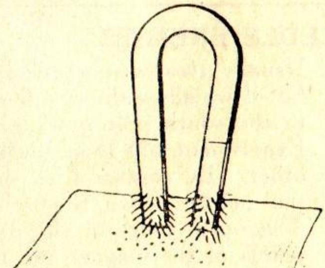
Experiment 49

Usually two sewing needles are not unfriendly, but if we allow the points of both to be attracted to the south pole of the horseshoe magnet (*see* Experiment 63) then the other ends repel each other. By contact with the pole of the magnet the needles have themselves become magnets. The north poles of the needles are the contact points of the magnet and the other ends are the south poles. We know that like poles repel, so the needles fly apart. A similar result is obtained with the Electro Magnet, as illustrated.

Materials :
Two Sewing Needles, Magnet (Electro or permanent).



Experiment 51



Experiment 52

SEVERAL MAGNETS CAN BE MADE OUT OF ONE MAGNET.

Experiment 50

We take a magnetised knitting needle (*see* Experiment 45) and break it in the middle. Each of the two broken pieces is now a new complete magnet with North and South Poles. The two magnets obtained in this way can be broken again with the same result and we have then four magnets. You can prove for yourself that these pieces are really magnets by setting up the compass needle as in Experiment 47.

Materials : Knitting Needle.

WHAT DOES THE MAGNET ATTRACT ?

Experiment 51

Try for yourself. Paper, Wood and Glass are not attracted. And there is no attraction with very many metals (brass contact springs for instance). The truth is a magnet only attracts iron, steel and nickel.

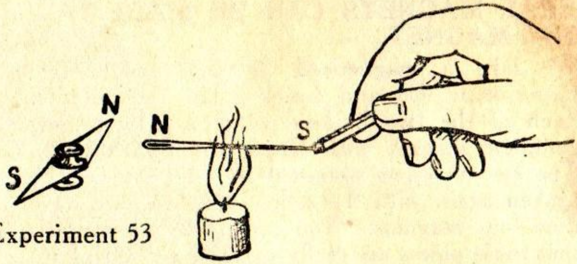
Materials :
Magnet, Paper, Wood, Glass, Brass, Copper, Iron, Nickel.

THE SELECTIVE MAGNET.

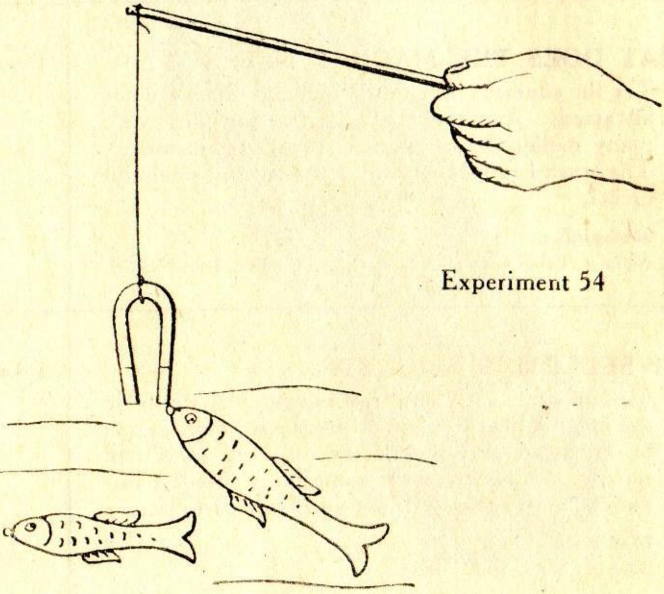
Experiment 52

Mix up some sand and iron filings. If we bring the magnet near to the mixture the iron filings will be attracted and picked up, but the sand will remain. Magnets are sometimes used commercially to separate brass and iron particles.

Materials :
Magnet, Sand, Iron Filings.



Experiment 53



Experiment 54

MAGNETISM CAN DISAPPEAR.

Experiment 53

This interesting experiment leads again to one of the mysteries of Magnetism. Here, as you see, we have a darning needle which has been magnetised as in Experiment 45. Its north pole is seen repelling the north pole of our compass needle. The point of the darning needle is stuck into one end of a match, so that we do not burn our fingers and the lighted piece of candle is placed underneath. As the needle gets heated so it loses its magnetism and its north pole begins to attract the north pole of the compass needle and also the south pole. It has completely lost its polarity.

The mystery of this is that it has lost some peculiar property which even to-day our scientists cannot explain.

Materials :

Compass Needle, Pivot, Darning Needle, Candle, Match.

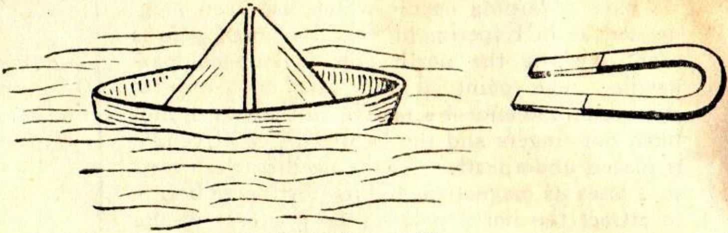
FISHING WITHOUT WATER.

Experiment 54

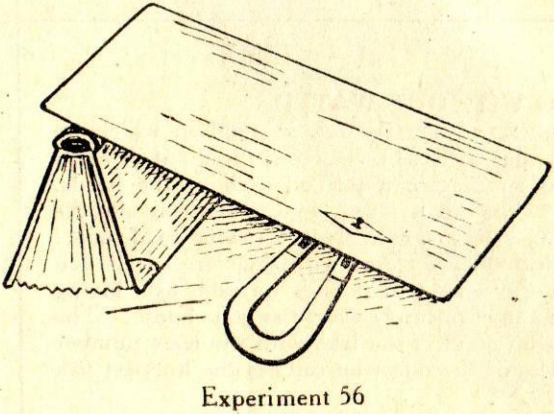
A box represents the sea or pond in which we throw our little fish. We cut these out of cardboard and fasten a pin on each of the heads. Our fishing kit is a rod, a piece of string and the bait, i.e., the magnet. Now for some good sport! You can play a game with your friends if you write the weight in pounds on each fish, giving them a light or heavy weight as you choose. The one who empties the lake with the least number of casts or the one who catches the heaviest fish wins.

Materials :

Magnet, Box, Cardboard, Wooden Rod, String, Pins.



Experiment 55



Experiment 56

A WONDER SHIP.

Experiment 55

We make a little paper ship and lay our compass needle in it. Now let the little ship float in a vessel of water. From the edge of the water (the bank) the boat can be steered by moving a horseshoe magnet or electro magnet.

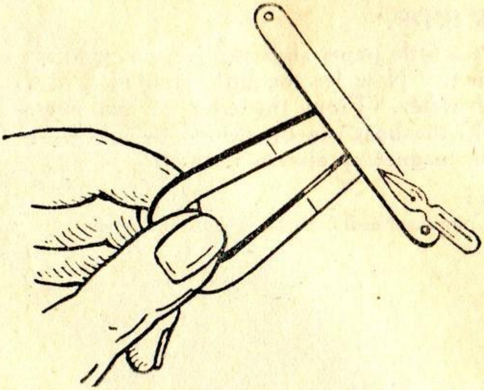
Materials :
Magnet, Compass Needle, Paper, Vessel of Water.

OUR COMPASS NEEDLE CLIMBS A HILL.

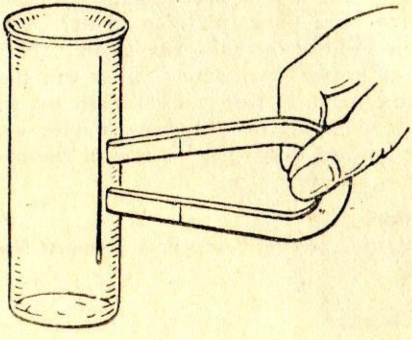
Experiment 56

The hill is a sheet of paper supported on one side by a book (inclined plane). At the foot of the hill lies the compass needle. Now if we hold our horseshoe magnet under the sheet of paper and move it from underneath up the hill, then the compass needle above moves with it. Like a faithful dog with his master the needle follows the magnet.

Materials :
Magnet, Sheet of Paper, Book, Compass Needle.



Experiment 57



Experiment 58

THE SAME EXPERIMENT IS UNSUCCESSFUL.

Experiment 57

If we use sheet iron for our inclined plane. (Flat strip F 9). The magnetism will not penetrate through this as the iron itself remains magnetised as long as it is in contact with the magnet. If, however, we remove the magnet from the iron it again loses its magnetism.

Materials :

Magnet, Flat Strip F 9, Needle or Pen Nib.

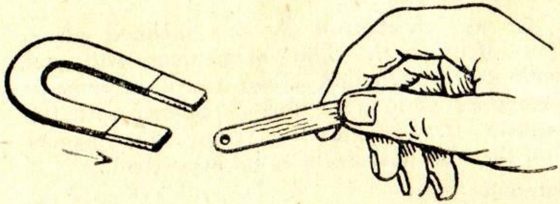
CLIMBING THE BEAKER.

Experiment 58

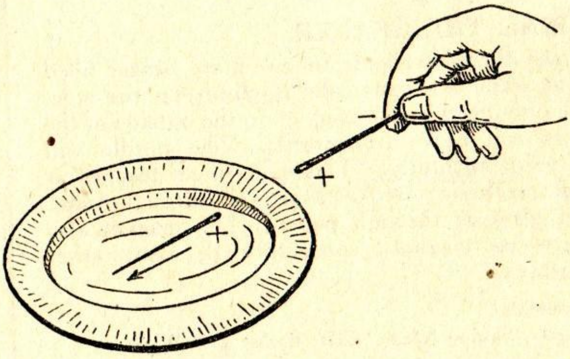
If we throw a needle in our glass beaker filled with water we can make it climb up the side. We only need hold a magnet on the outside of the glass and move it upwards. The needle will follow it faithfully. This experiment teaches us that magnetic force acts as well through water and glass as through paper. The magnet also exerts its magnetic force through many other substances.

Materials :

Magnet, Sewing Needle, Glass Beaker with Water.



Experiment 59



Experiment 60

DOES THE MAGNET ATTRACT THE IRON, OR THE IRON THE MAGNET?

Experiment 59

If we bring a piece of unmagnetised iron towards our horseshoe magnet the former will be attracted by the magnet. But if we hold the piece of iron and move the magnet towards it the magnet will be attracted by the unmagnetised iron. It is consequently incorrect to say "The magnet attracts iron or nickel." It is better to say "Between the magnet and the unmagnetised iron or nickel an attractive force operates, viz., Magnetism."

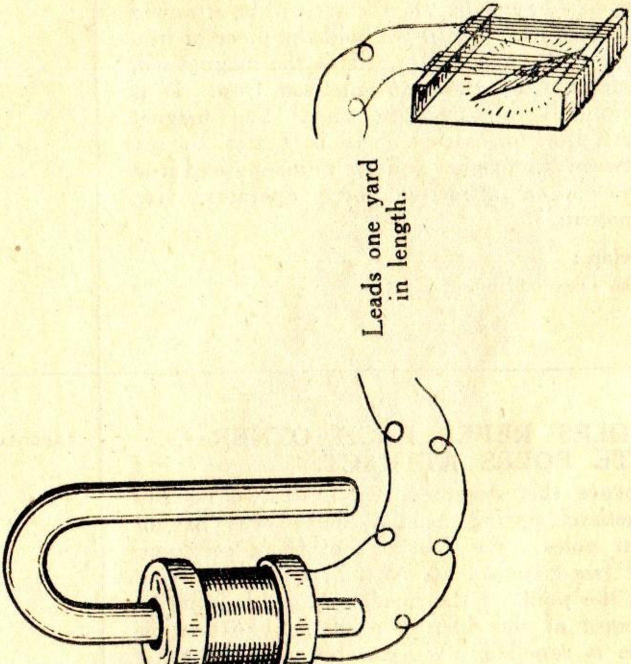
Materials :
Magnet, Piece of Iron.

LIKE POLES REPEL EACH OTHER—OPPOSITE POLES ATTRACT.

Experiment 60

To prove this statement we need two equally magnetised sewing needles, both eyes having similar poles. We float one of these on some water (*see* Experiments Nos. 21 and 64). Now bring the point of the needle we are holding to the point of the floating needle. The floating needle is repelled. We can produce the same effect with the eyes. On the contrary, if we bring the point and the eye together they will attract each other as they have unlike poles.

Materials :
2 Sewing Needles, Vessel of Water.



Experiment 62

HOW TO PROVE IF IRON OR STEEL IS A REAL MAGNET.

Experiment 61

This is not so simple as you may think; it is magnetic when it attracts another piece of iron or steel. But how do we know if the other piece of iron or steel is a real magnet or not? The proof is as follows:—

We bring one end of one of the pieces which is to be tested first towards one pole and then towards the other of a compass needle. (Experiment 47). If both poles are attracted then the piece is not a magnet. If however one pole is attracted and the other repelled the piece is a magnet.

Materials :

Compass Needle, Iron or Steel, Pivot.

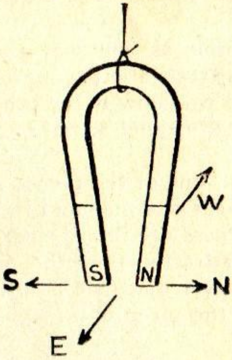
WHAT IS ALTERNATING CURRENT?

Experiment 62

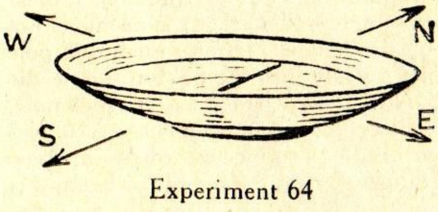
We take our Galvanometer as Experiment 90 and connect up to it the bobbin coil. The distance between the bobbin and the Galvanometer must not be less than one yard so that the needle is not influenced by the magnet. If we push one pole of our magnet quickly into the bobbin the needle will move. Now if we change the magnet pole, the needle will reverse its movement. A movement of this needle also occurs when we draw the magnet quickly out of the bobbin. From this we may conclude by quick approach or withdrawal of a magnetic field near a closed circuit, there is induced each time in the latter a current flowing in opposite directions.

Materials :

Magnet, Bobbin Coil, Galvanometer, Copper Wire.



Experiment 63



Experiment 64

THE HORSESHOE MAGNET AS A COMPASS.

Experiment 63

Suspend the horseshoe magnet on a thread. When it has come to rest one pole points north (north pole) and the other south (south pole). If we turn the magnet round it will soon revert to its former position. In later experiments we shall distinguish between the poles as follows: North pole is N, South pole is S. A small piece of soft iron laid across the poles is called the "keeper." It retains the power of the magnet and hence prevents it weakening.

Materials :
Magnet, Thread.

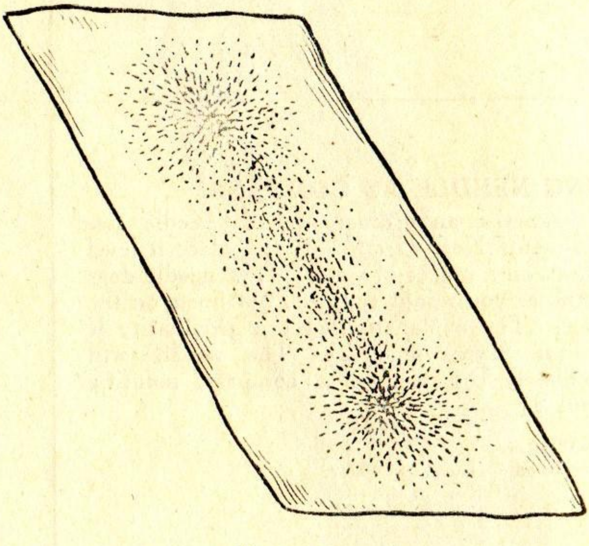
A SEWING NEEDLE AS COMPASS.

Experiment 64

We magnetise an ordinary sewing needle (*see* Experiments Nos. 45 and 46) and place it level carefully on a saucer of water. The needle does not sink as you might suppose, but floats on the surface. The explanation of this peculiarity is found in Experiment 21. The needle will immediately set itself as a compass, pointing N. and S.

Materials :
Sewing Needle, Saucer of Water.

Experiment 65



Experiment 66

THE MAGNET AND IRON FILINGS.

Experiment 65

If we lay our horseshoe magnet in iron filings they will be picked up, but not to the same degree on all parts of the magnet. The biggest clusters of filings are at the poles of the magnet; on the contrary the middle (a neutral zone) is completely free from filings. We can find out the strength of the different parts of the magnet if we draw along it a piece of iron. At the poles our movement will meet with the greatest opposition, and towards the middle it diminishes considerably.

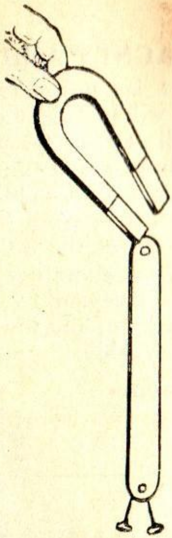
Materials :
Magnet, Iron Filings.

MAGNETIC LINES OF FORCE.

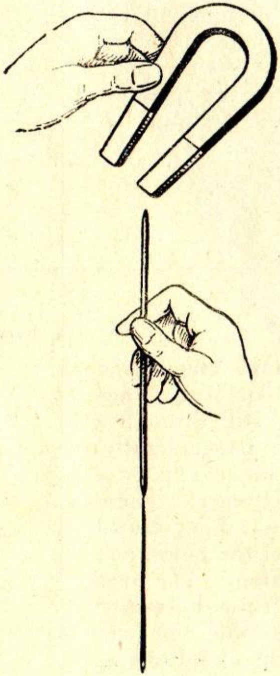
Experiment 66

We lay a sheet of paper over a strongly magnetised knitting needle. Then we sprinkle iron filings on the paper by hand, or better still through a pepper pot, whilst we tap the paper lightly. The filings arrange themselves in orderly lines stretching from one pole to the other. These are called magnetic lines of force. They crowd together thickest in the vicinity of the poles, i.e., where there is the greatest attraction. The lines of force can also be shown with a horseshoe magnet. Place the latter on the table and over it a sheet of drawing paper. Then continue as with the above experiment.

Materials :
Magnet, Iron Filings, Paper.



Experiment 67



Experiment 68

MAGNETIC INFLUENCE THROUGH IRON.

Experiment 67

If we bring the south pole of our strong horseshoe magnet to the end of a piece of iron (F 9) and move small tacks towards the iron they will be attracted by the end of the strip but not by the middle. The strip has itself become a magnet, and further, the end towards the magnet is the north pole and the opposite end the south pole. This occurrence is called magnetic influence. If we take away the magnet from the iron strip the nails will drop off. The strip has lost its magnetism.

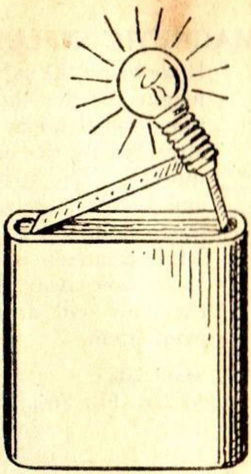
Materials :
Magnet, Flat Strip F 9, Small Tacks.

MAGNETIC INFLUENCE THROUGH STEEL.

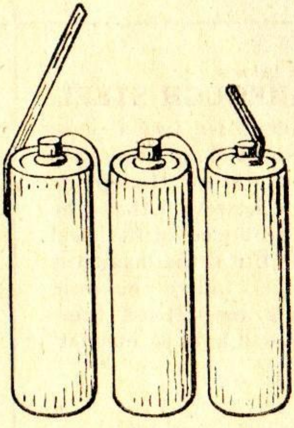
Experiment 68

If in the foregoing experiment we use a piece of steel (knitting needle) instead of the iron strip we can produce the same results (magnetic influence). We shall find however that the strength of the magnetism produced in the steel is less than that in the iron. But if the magnet is again removed from the steel, unlike the iron, the knitting needle remains magnetised (permanent magnet). Hard steel will hold its magnetism longer than soft steel.

Materials :
Magnet, Knitting Needle, Small Tacks or Needle.



Experiment 69



Experiment 70

Experiment 69

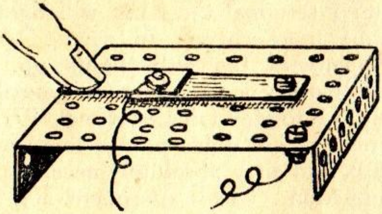
HOW LIGHT is produced from a Pocket Lamp. How is the current of a battery transformed into light? If we bring into contact the cap of the lamp with one terminal of our battery and the metal contact in the middle of the bottom of the cap with the other terminal the lamp will light up. It would be more correct to say: "A little metal filament in the bulb lights up." The current of the battery flows through this metal filament and causes it to glow (*see* Experiment 97). The metal filament cannot burn out as there is no air in the bulb, and air is absolutely necessary to support combustion. (*See* Experiment 20).

Materials: Pocket Lamp Bulb, Battery.

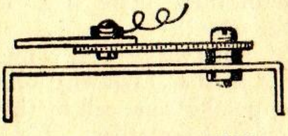
Experiment 70

INFORMATION about Pocket Lamp Batteries. Have you ever given a thought as to how the electric current is produced which supplies pocket lamp batteries? Have you seen such a battery without its cover—and taken a peep into the inside? If not, then take a used battery and place it in boiling water. The black pitch and the paper covering will be loosened by the hot water. You will notice three small zinc cylinders. In each of these there is a carbon rod surrounded by a quantity of sawdust which is soaked in an acid. The cylinders are connected together by wires and further, each wire joins the carbon rod (positive pole) of one cell to the zinc covering (negative pole) of the other. The combination of metal (zinc), carbon and an acid is called a galvanic cell. Such a cell produces electrical current when the metal and the carbon are connected by leads. The current flows from the carbon to the zinc, i.e., from positive to negative pole. (*See* Experiment 100).

Materials: Battery, Boiling Water.



Experiment 71a



Experiment 71b

MORSE CODE KEY.

Experiment 71

We fasten a brass contact spring on our base as shown in the illustrations. We then connect one of the terminals from the source of current to the brass contact spring and the other to the base. As soon as we press down the key the circuit is completed. As the contact spring leaves the base the circuit is broken ; no current flows.

Materials :

Metal Base, Insulator, Brass Contact Spring, Battery, Nuts and Bolts.

MORSE SIGNAL.

Experiment 72

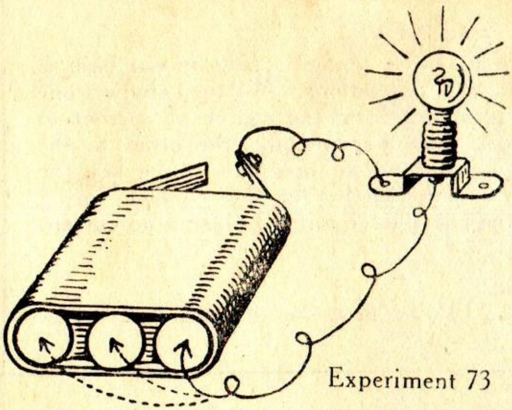
When we have made the Morse Code Key we can continue by breaking the circuit at some point and putting in our lamp and holder. By using the switch, we can send out light signals by long and short taps, according to the following Morse alphabet.

· —	**A**	— — —	**O**	· — — — —	**1**
— · · ·	**B**	· — — ·	**P**	· · — — —	**2**
— · — ·	**C**	— — · —	**Q**	· · · — —	**3**
— · ·	**D**	· — ·	**R**	· · · · —	**4**
·	**E**	· · ·	**S**	· · · · ·	**5**
· · — ·	**F**	—	**T**	— · · · ·	**6**
— — ·	**G**	· · —	**U**	— — · · ·	**7**
· · · ·	**H**	· · · —	**V**	— — — · ·	**8**
· ·	**I**	· — —	**W**	— — — — ·	**9**
· — — —	**J**	— · · —	**X**	— — — — —	**0**
— · —	**K**	— · — —	**Y**		
· — · ·	**L**	— — · ·	**Z**		
— —	**M**				
— ·	**N**				

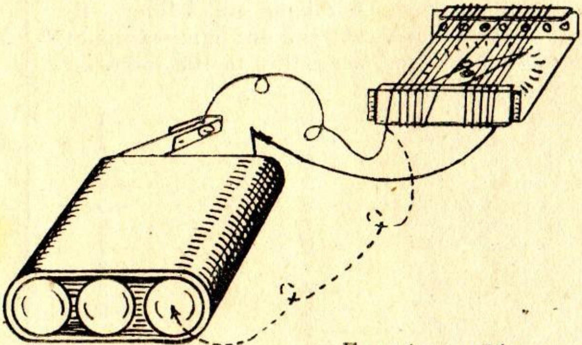
— — — — Space

Materials :

Metal Base, Insulator, Brass Contact Spring, Battery, Lamp, Lamp Holder, Bolts and Nuts.



Experiment 73



Experiment 74

A CELL AND A BATTERY.

Experiment 73

When we examined a pocket lamp battery we learned what both these are. Several cells connected together by wire are called a battery. Why do we join these together? The following experiment will show you. Take off the bottom of a pocket lamp battery so that the three cylinders are in view. Now we put in circuit a small flash lamp bulb with the short terminal and the first metal cell; the lamp only glows. If we connect it up instead with the second cell the lamp burns brighter. And again, if we connect the lamp with the third zinc cell, then the lamp burns brightest. The battery enables you to obtain a higher voltage than one cell and therefore causes the wire in the bulb to burn more brightly.

Materials:

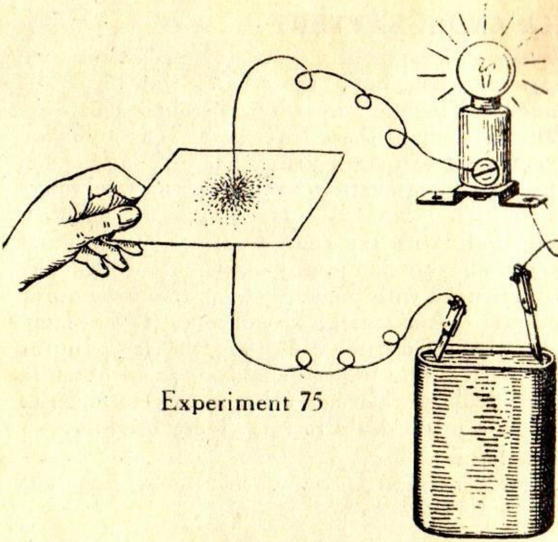
Copper Wire, Brass Contact Springs, Battery, Lamp with Holder, Nuts and Bolts.

A CELL AND A BATTERY AGAIN.

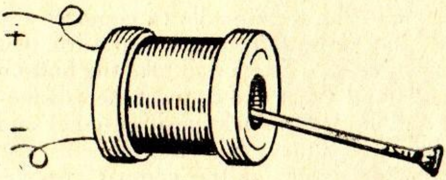
Experiment 74

With the help of our home-made galvanometer (*see* Experiment 91), we are able to compare the strength of the current from one cell with that of a battery of cells. First of all take the bottom off a pocket lamp battery and connect the galvanometer to the short terminal (positive pole) and the first zinc cylinder (*see* Experiment 73). Read off the deflection of the compass needle. Then change the lead from the cylinder to the long terminal (negative pole). The deflection of the compass needle will now be greater showing the greater strength of the current.

Materials: Galvanometer, Battery.



Experiment 75



Experiment 76

WHERE IS THE MAGNET?

Experiment 75

We set a wire vertically through a sheet of paper. The wire is connected to the terminals of a battery with a lamp in the circuit as shown. If we sprinkle iron filings on the paper and tap it lightly the iron filings arrange themselves in circles around the wire. Magnetic lines of force are shown. But where is the magnet? The wire through which the current flows is taking the place of a magnet. Around every wire through which current flows magnetic lines of force are present.

Materials :

Paper, Wire, Lamp and Holder, Battery, Iron Filings.

THE MAGNETISED BOBBIN COIL.

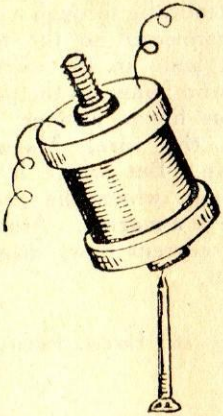
Experiment 76

We have already found out that around every wire through which current flows magnetic lines of force exist. The lines of force are particularly numerous if the wire is wound round a bobbin. With the increase in the number of lines of force, the magnetic force (force of attraction) also increases in the centre of the bobbin and influences iron objects (nails, needles). It will draw these into the bobbin. In the centre of the bobbin the lines of force are greatest, and consequently this is the centre of the strongest magnetic attraction.

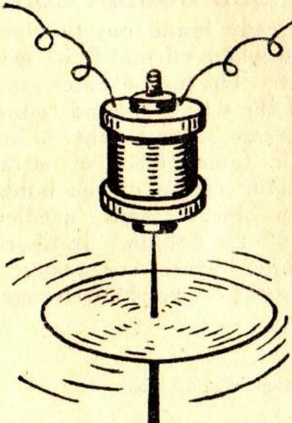
Materials :

Wire, Bobbin Coil, Battery, Nail.

Experiment 77



Experiment 78



THE ELECTRO MAGNET.

Experiment 77

Push the soft iron core into the bobbin and connect the bobbin to a pocket lamp battery again. The number of lines of force and the magnetic attraction of the spool now increases. At both ends of the core magnetic poles are formed. This combination—the bobbin through which current flows and iron core—is called an electro-magnet. Its action is the same as that of a horseshoe magnet. Just try this out and see its strength.

Materials :

Wire, Bobbin Coil, Soft Iron Core, Battery.

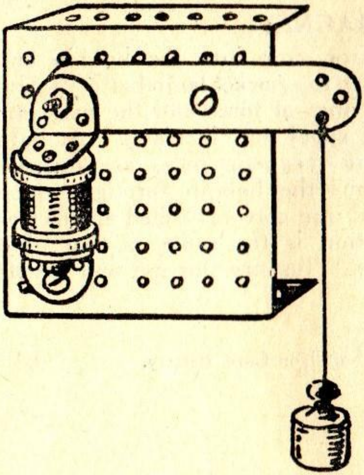
A FINE SPINNING TOP.

Experiment 78

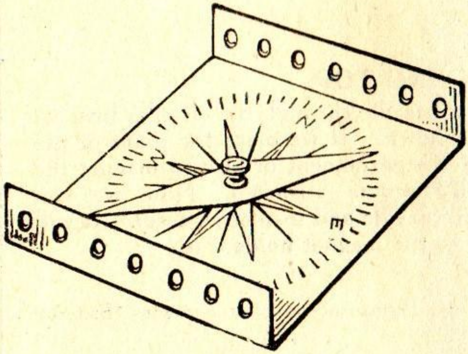
We push our needle through the circular insulating disc as shown. If we place the point of the needle under a permanent or electro-magnet the needle will become attracted. Now we can spin our top (needle and insulating disc). It will not fall off as the magnet holds it up.

Materials :

Insulating Disc, Permanent or Electro-magnet (Battery), Needle.



Experiment 79



Experiment 80

A TEST OF STRENGTH.

Experiment 79

It is not **your** strength we wish to test but that of our electro-magnet. To do this we fix it on the metal base by an angle. Then we fasten a flat strip F 9 to an angle and let it swing on a bolt attached to the base. If we bring the angle near to the magnet and complete the circuit with the battery it will be attracted. At the other end of the F 9 hang a weight on a piece of string. Now there are two forces pulling on the F 9; on one end the force of the magnet and on the other end the weight, i.e., gravity. By hanging on various weights we can test the strength of the magnet.

Materials :

Metal Base, Bobbin Coil, Soft Iron Core, Angles, Flat Strip F 9, Nuts and Bolts, String, Weights.

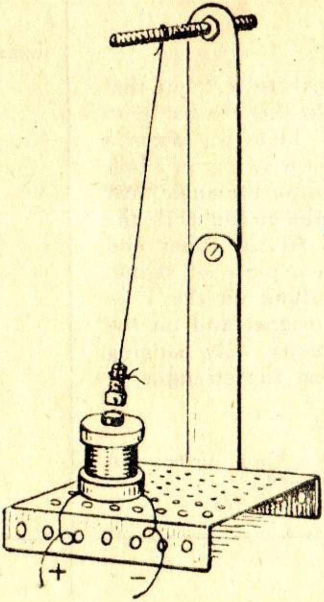
LET US MAKE A COMPASS.

Experiment 80

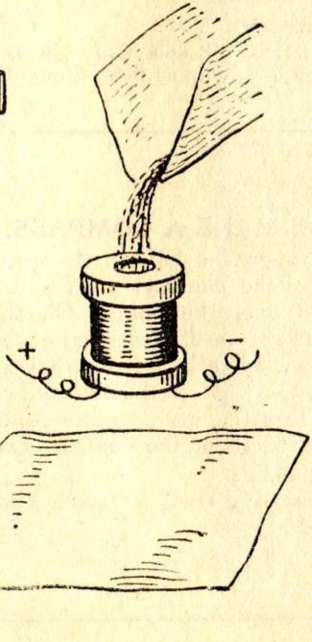
Through the hole in the centre of the base we place the compass pivot and push the compass card over the point. On the pivot place the compass needle (magnetised beforehand) so that it swings freely. It soon takes up a North-South position. Turn the base and compass card round so that the needle corresponds with the North and South of the compass card.

Materials :

Metal Base, Compass Needle, Compass Card, Compass Pivot.



Experiment 81



Experiment 82

ELECTRO MAGNET AND PENDULUM.

Experiment 81

We make up a stand for the pendulum as illustrated. The pendulum itself is a piece of cotton with a bolt tied to the end. If we complete the circuit through the bobbin, then the bolt will be attracted and the pendulum set in motion. When the bolt swings over the magnet we break the circuit and thereby take away the attractive force. The pendulum swings back and by the Law of Inertia swings over the centre again. When it moves towards the magnet we complete the circuit, so increasing the movement of the pendulum. By repeating this procedure we keep the pendulum swinging.

Materials :

Bobbin Coil, Flat Strips F 9, Pendulum, Soft Iron Core, Metal Base, Spindle, Nuts and Bolts, Battery.

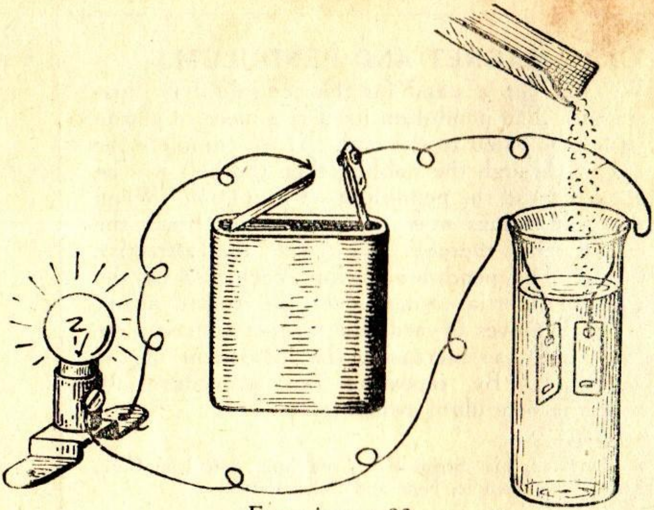
THE BOBBIN AND THE IRON FILINGS.

Experiment 82

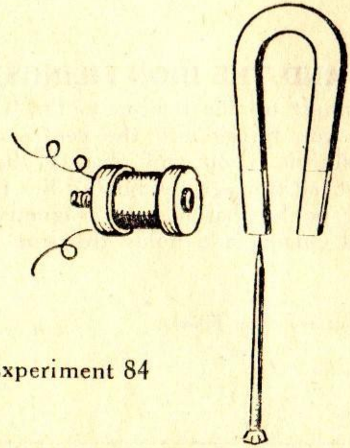
First we connect up the bobbin to the battery. Now shake iron filings into the centre of the bobbin as shown. You will observe that the filings do not fall through the bobbin but remain inside. The bobbin has become magnetised by the electrical current and holds the iron filings fast.

Materials :

Bobbin Coil, Battery, Iron Filings.



Experiment 83



Experiment 84

IS WATER A CONDUCTOR OF ELECTRICITY?

Experiment 83

Certainly, but it is made a better conductor if acid (vinegar) or salt is added to it.

We set up our experiment as shown in the illustration and will find that the lamp will not light until salt or vinegar is added. As we add either of these the lamp commences to glow and the more we add the brighter it lights.

Materials:

Glass Beaker with water, Brass Contact Springs, Copper Wire, Lamp and Holder, Battery, Salt or Vinegar.

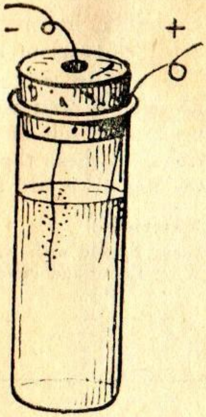
WHEN TWO QUARREL . . .

Experiment 84

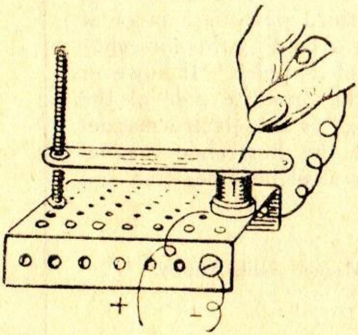
In this case the two are the horseshoe magnet and the electro-magnet. A third party is a piece of iron or steel. The latter is held by the horseshoe magnet, clinging to one of its poles. If however we bring near to this the opposite pole of the electro-magnet, the power of the electro-magnet overcomes the force of the horseshoe magnet and the piece of iron or steel becomes free and falls to the floor.

Materials:

Horseshoe Magnet, Electro-Magnet, Nail, Battery.



Experiment 85



Experiment 86

HOW TO FIND THE NEGATIVE POLE.

Experiment 85

We partly fill the glass beaker with water and add a small quantity of salt or vinegar to make it a better conductor of electricity. Then we connect a piece of wire to one terminal of the source of current and push the other end through the cork into the liquid. In the same way we dip the end of another wire from the battery into the liquid. We shall soon see bubbles accumulating around one of the wires. This wire is the negative pole. Acid accumulators usually have the negative terminal painted blue and the positive red, so you can remember "blue negative bubbles."

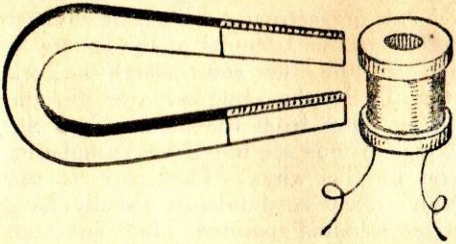
Materials :
Glass Beaker, Cork, Salt or Vinegar, Wire, Battery.

THE ELECTRIC BUZZER.

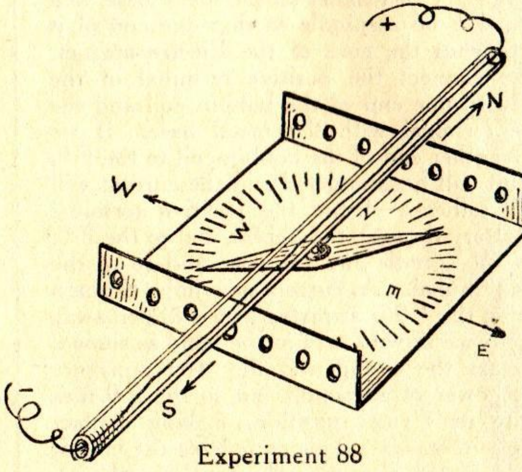
Experiment 86

Mount the electro-magnet on the metal base, and fasten an F 9 on a spindle so that one end of it nearly touches the core of the Electro-magnet. Now we connect the positive terminal of the battery with one end of the bobbin coil and the negative terminal with the metal base. If we touch the other end of the bobbin coil to the F 9, the circuit will be completed and the current will flow as follows:—from the positive terminal of the battery through the bobbin coil to the F 9, through the spindle and the base and so to the negative terminal. As current now flows through the bobbin the F 9 is attracted and is drawn away from the piece of wire held in the hand as shown. This breaks the circuit and the electro-magnet loses its power of attraction and so the F 9 flies back into its former position, making contact with the wire again. This completes the circuit again and so the buzzer works continuously.

Materials : Metal Base, Flat Strip F 9, Electro-Magnet, Spindle, Nuts and Bolt, Battery, Copper Wire.



Experiment 87



Experiment 88

A MAGNETIC FIELD.

Experiment 87

If we bring the horseshoe magnet towards our bobbin coil, in such a way that the magnet poles are opposite to the wooden ends of the bobbin, the bobbin coil, which is connected to a battery, will be attracted by the magnet, or repelled. But what is it the magnet attracts here, as there is no iron core in the bobbin? Is it the wood or the copper wire?

No, it is the magnetic field which is created inside and outside the bobbin. For around every wire through which current is flowing a magnetic field is made. (See Experiment 75).

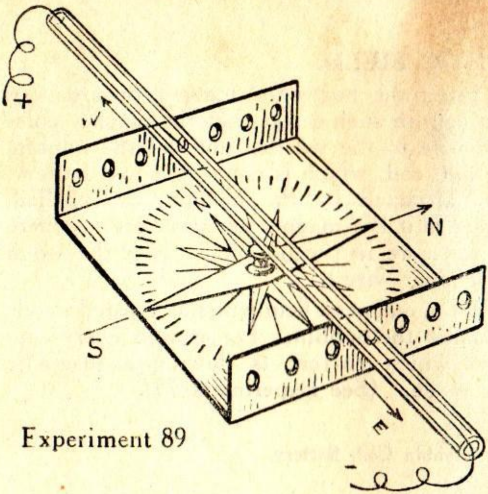
Materials:
Magnet, Bobbin Coil, Battery.

ELECTRIC CURRENT DEFLECTS THE COMPASS NEEDLE.

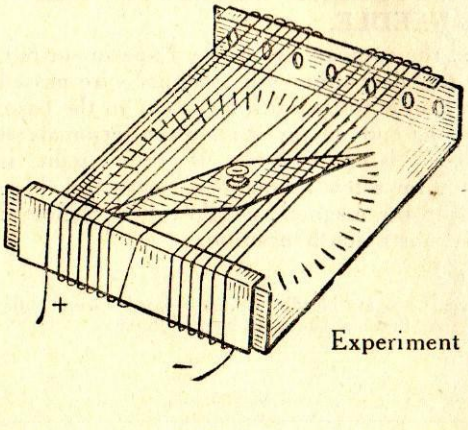
Experiment 88

We need the compass again (see Experiment 80), and lay the glass tube with a copper wire passed through it in a north-south direction on the base. Connect the ends of the wire to the terminals of the pocket lamp battery. If the circuit is completed for a few moments a magnetic field is formed and the magnetic needle will be deflected from the north-south position.

Materials:
Metal Base, Compass Needle, Compass Card, Glass Tube, Copper Wire, Battery, Compass Needle Pivot.



Experiment 89



Experiment 91

THE COMPASS NEEDLE IS NOT DEFLECTED . . .

Experiment 89

although we lead a wire, charged with electric current, over the compass. But this time we place the glass tube and with it the wire in an east-west direction, also directly above the axis of the compass needle. The explanation of this is that the lines of force encircle the wire vertically and exert no turning movement on the needle.

Materials : As for Experiment 88.

ELECTRICAL MEASURING INSTRUMENT.

Experiment 90

We bolt an angle to the metal base and then the electro-magnet so that it lies on its side. Now place the compass needle on its pivot in the centre (as in Experiment 48) and turn the base round until the compass needle points towards the electro-magnet. Now if we connect up the bobbin to the battery the point of the needle pointing to the magnet core will be repelled. If this is not the case, change over the connections on the battery. The amount the needle is deflected shows the strength of the current.

Materials :

Metal Base, Electro-Magnet, Compass Needle, Angle, Bolts, Nuts, Battery, Compass Card, Compass Needle Pivot.

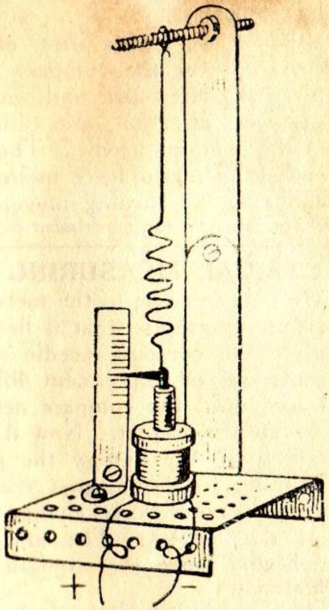
AN INSTRUMENT FOR MEASURING CURRENT (GALVANOMETER) IS MADE.

Experiment 91

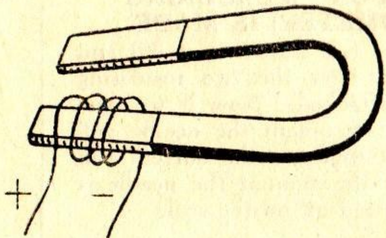
We take our compass (*see* Experiment 80) and wind wire around it, after the two insulating channels have been attached. Now if we pass current through the instrument the needle will be deflected. The strength of the current can now be measured by the amount the needle is deflected and can be read off on the scale.

Materials :

Copper Wire, Battery, Metal Base, Compass Needle, Compass Card, Two Insulating Channels, Compass Needle Pivot.



Experiment 92



Experiment 93

HOW WE MEASURE THE STRENGTH OF CURRENT.

Experiment 92

We fasten the bobbin coil to the metal base and hang the core up on a thin spiral spring or piece of elastic over the opening of the bobbin. Attach a pointed indicator in a horizontal position to it. If we allow the current from a battery to flow through the bobbin coil it becomes magnetised and the iron core is drawn into the bobbin. The stronger the current the more it will be drawn in. The amount of this attractive force can be read off on a vertical paper scale, in front of which the pointer moves.

Materials :

Metal Base, Spiral Spring or Piece of Elastic, Paper Scale, Battery, Flat Strips F 9, Spindle, Nuts, Bolts, Angle, Magnet Core.

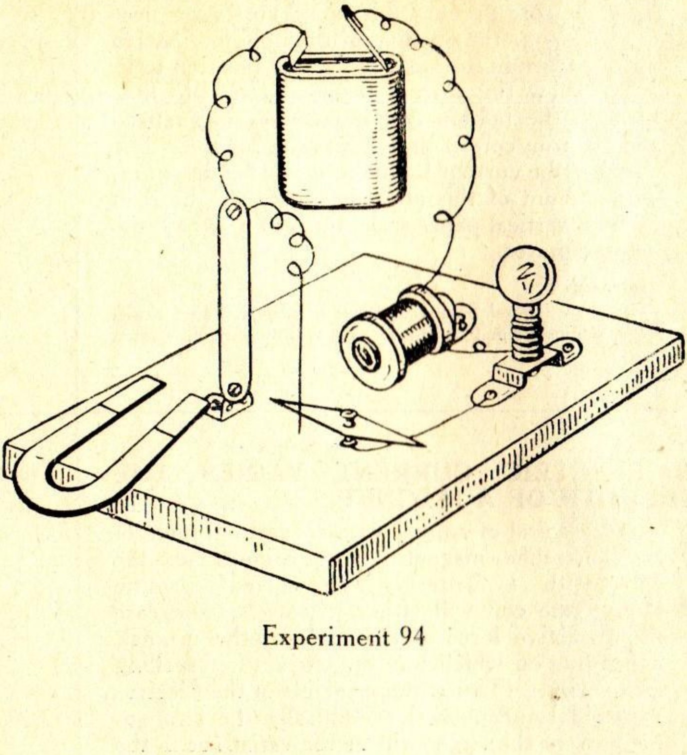
AN ELECTRIC CURRENT VARIES THE STRENGTH OF A MAGNET.

Experiment 93

Wind a spiral of copper wire around one pole of the horseshoe magnet. Now connect up the wire with a battery. The current passing around the coil will either increase or decrease the attractive force of that pole of the magnet, depending on which way the current is travelling in the wire. (This is the principle of the Electro-dynamic Loudspeaker). Naturally the stronger the current the larger will be the variations in the magnetic force.

Materials :

Copper Wire, Magnet, Battery.



Experiment 94

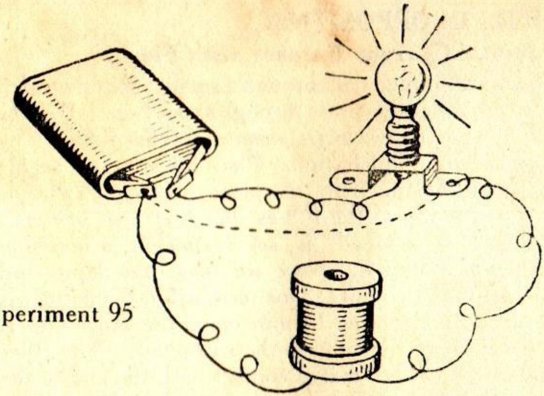
BROTHERS IN OPPOSITION !

An Automatic Current Breaker with Flasher.

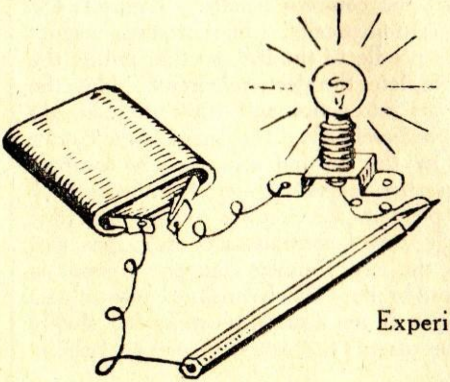
Knock a sharp pointed nail through a small piece of wooden board so that the point comes through about ⅜-in. We now fasten to the board our electro-magnet and flat strip F 9 by angles as shown in illustration. Place the compass needle on the point of the nail. A piece of copper wire is attached to the top of the F 9 as shown so that one end, which has been scraped, is set vertically to one side of the compass needle. Now we place the lamp and lamp holder in the circuit. One terminal of the battery is joined to one end of the bobbin coil; the other end is connected through the lamp to the nail pivot. The other terminal of the battery makes contact with the end of the copper wire from the F 9. The circuit is complete and the Electro-magnet, on account of the current flowing through it, attracts the compass needle and draws it away to one side for a moment. Now we lay the horseshoe magnet with one of its poles on the angle holding the F 9; this magnet will likewise attract the compass needle. This sets the apparatus in motion automatically. The horseshoe magnet draws the compass needle to the F 9, so that it hits the copper wire and completes the electrical circuit. Now the electro-magnet comes into action and draws the compass needle to it but immediately lets it free again as the circuit has been broken by the turning away of the compass needle. The horseshoe magnet attracts the needle back again to its former position, the circuit is re-made and thus the compass needle moves continuously backwards and forwards between the two magnets and the current is alternately closed and broken. Each time the current flows the bulb lights up. If the apparatus works too slowly bring the horseshoe magnet nearer to the compass needle.

Materials :

Wooden Board, Small Nail, Electro-Magnet, Flat Strip F 9, Angles, Wood Screws, Copper Wire, Lamp and Holder, Battery, Horseshoe Magnet, Nuts, Bolts, Compass Needle.



Experiment 95



Experiment 96

THE CURRENT MAKES A BIG JOURNEY.

Experiment 95

What we actually do is to send it through the bobbin coil. We do not know how much wire is used to make the coil, but the current must travel through the whole length of it. A tiring journey! It is not surprising that it comes out of the bobbin weaker than when it went in. How can we prove this? First of all we connect in the usual way a small pocket lamp bulb to the battery; the lamp burns brightly. Now we make a new circuit and pass the current through the bobbin as well as the lamp (see illustration). This time the lamp burns less brightly for the current has become weaker through the resistance set up by the long thin wire of the bobbin coil.

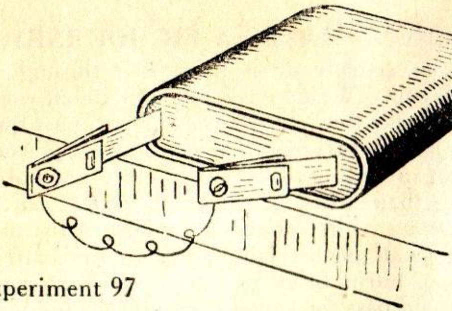
Materials: Bobbin Coil, Lamp and Lamp Holder, Battery, Contact Springs, Nuts, Bolts.

A PENCIL RESISTANCE.

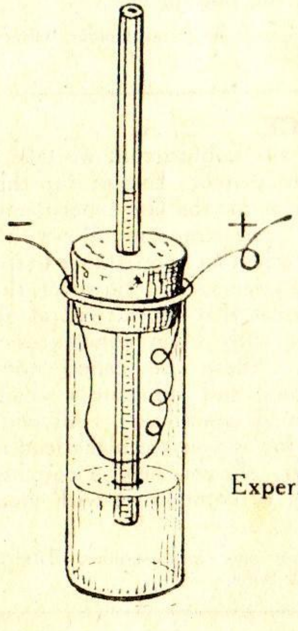
Experiment 96

This time, instead of the bobbin coil, we take a black lead or graphite pencil. Except for this everything is the same as for the last experiment. Now what happens? The lamp only glows this time. The black lead offers more resistance to the electric current and so weakens it. However, the resistance is not so great that no current at all can flow through, as with some substances—rubber for instance. These are called non-conductors or insulators, and substances which carry current are named conductors. All conductors are not alike, for as you see black lead is not so good as copper. If you have a copying pencil it is interesting to compare it with your ordinary black-lead.

Materials: Pencil, Lamp and Lamp-holder, Battery, Contact Springs, Nuts and Bolts.



Experiment 97



Experiment 98

AN ELECTRIC CURRENT MAKES A WIRE RED HOT.

Experiment 97

The current supplied by our pocket lamp battery is passed through a very thin iron wire or filament. After a short time the wire becomes red hot. This is explained as follows :—

The electric current has not enough space in the fine wire. Consequently it must force itself through. This causes friction in the wire and produces heat. In a thicker wire the current has more space and the friction is not so great ; therefore there is less heat produced. There are also metals of varying degrees of conductivity. Iron and nickel do not conduct current so well as copper and platinum ; they offer greater resistance.

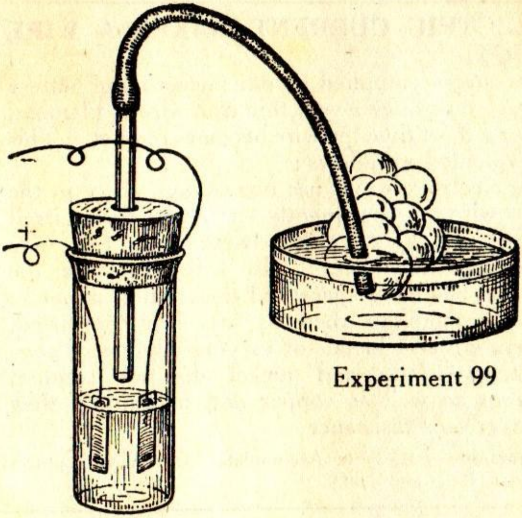
Materials : Battery or Accumulator, Iron Wire, Contact Springs, Bolts and Nuts.

PROOF THAT WIRES BECOME HEATED.

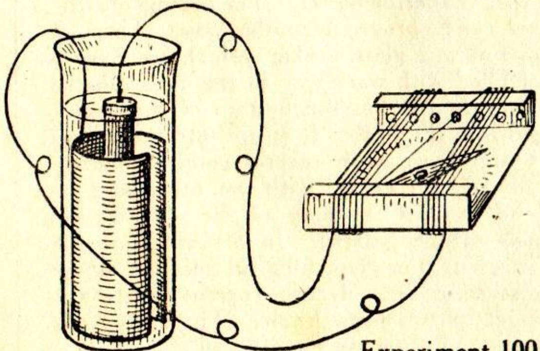
Experiment 98

We have seen that the electric current will heat a thin wire (Experiment 97). The heating of wire, however, can be proved in another way. Through the cork of our glass beaker (which we have a quarter filled with water) we fit the glass tube so that it nearly touches the bottom of the vessel. We lead into the beaker (but not into the water) a very thin wire with several coils as shown. Carefully seal the beaker with wax to make it air tight and connect the ends of the wire to the terminals of the battery. In a short time the water rises up the glass tube on account of the air pressure. The electric current heats the wire which in turn heats the air. The air expands and forces the water up the glass tube.

Materials : Glass Beaker, Cork, Wax, Glass Tube, Iron Wire, Battery or Accumulator, Water.



Experiment 99



Experiment 100

Experiment 99

ELECTRIC CURRENT CHANGES WATER INTO GAS.

We set up the apparatus for this experiment as in Experiment 83, and in addition close the glass beaker with a cork, through which we push the glass tube. The glass tube must not dip into the water. If we connect up the rubber tubing and pass one end into a second vessel, containing soapy water, we can see bubbles gradually rise and burst. The gas formed is a mixture of two parts hydrogen and one part oxygen, and is called oxy-hydrogen gas. This is an explosive mixture.

Warning ! Do not apply a light to this mixture as it will explode and form water again.

Materials :
As Experiment 83, Cork, Glass Tube, Rubber Tubing, Vessel of Soapy Water.

Experiment 100

A CHEAP WAY OF MAKING ELECTRICITY FOR OURSELVES.

We take the carbon and the zinc cylinder from an old battery. Remove the bottom of the cylinder and cut the covering length-ways. When we have attached wire leads from our galvanometer to the zinc and carbon our preparations are complete. Fill a glass beaker with salt water and insert the carbon and zinc. Now our home-made cell will produce electricity. The pointer of the galvanometer will prove this to you.

Materials :
Glass Beaker with Salt Water, Battery, Galvanometer.

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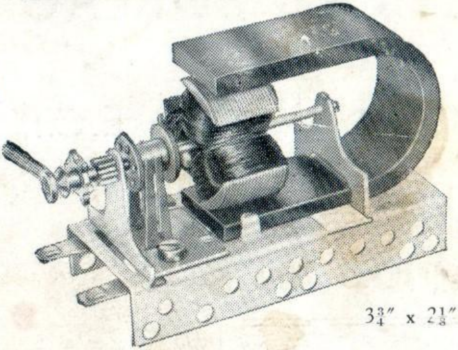
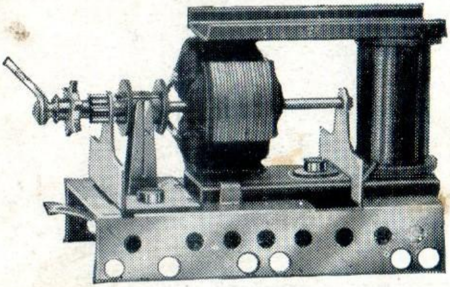


TRIX ELECTRIC MOTOR

No. 2051.

$3\frac{3}{4}'' \times 2\frac{1}{8}''$

Permanent Magnet Type with three pole armature, self starting. The armature shaft is fitted with gear and pulley wheels for driving models; also special driver for boat propeller shafts. The base is perforated in such a way that the motor can be built into practically any metal constructional model. Operated by one or two pocket batteries, or by 4 to 8 volt accumulator.



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New **Field Magnet** TRIX Motor, with solid brass base and cowl.

Suitable for 6 to 8 volt—D.C., or for 8 to 12 volt—A.C. $3\frac{3}{4}'' \times 2\frac{1}{8}''$.

Fills a long-felt-want for an **A.C. small voltage Motor** at a reasonable price.

This Motor can be operated from the Light or Power Mains, Alternating Current only, through a suitable Transformer.