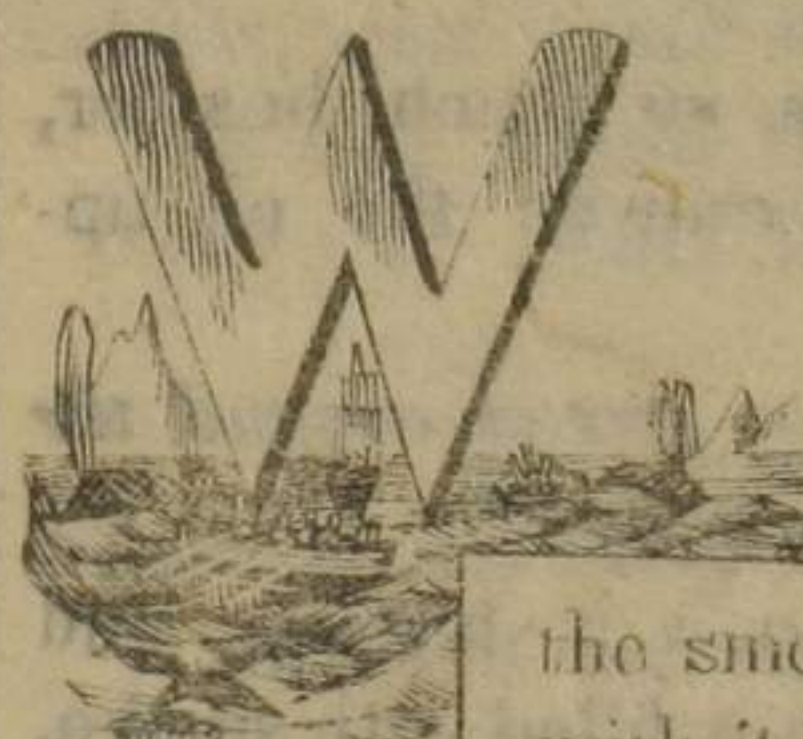




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### Lesson Sixteenth.



*Why does smoke rise from the fire and go up through the chimney?*

Because the air in the fire-place, when heated, rises up and carries the smoke, which is also light, with it.

*When the smoke goes out of the chimney, why does it not fall to the ground?*

Because the warm air, which brought the smoke from the chimney continues to rise and carry up the smoke with it.

*What is this like?*

It is somewhat like oil upon water.

*Why does not the oil sink below the water?*

Because the water is heavier than the oil.



65- 1290

SPECIFIC GRAVITY.

*If you should put the oil in the basin first, and then pour water upon it, would the oil remain at the bottom?*

It would not; but would rise through the water, and lie upon the top of it.

*Why would it?*

Because the water is so much heavier, that it sinks down, and crowds the oil upward.

*Why will not the smoke spread around the chimney, instead of rising higher?*

Because the air above it is heavier, and crowds the light air, which is filled with smoke, upward, as the water did the oil.

*How high will the smoke ascend?*

Till the warm and light air that carries it comes to other air that is no heavier than itself.

*How long will it remain there?*

Till the air that carries it becomes as cool as the air around it; and then the smoke will slowly fall to the ground.

BALLOONS.

*What makes soap water bubbles rise in the air?*

The light air that is in them.

*If you could fill a thin bag with very light air, and throw it into the air, as you do soap-bubbles, what would it do?*

The bag would rise.

*How high would it rise?*

Till it came to air of its own weight.

*If you should fasten a bit of wood to it, would the bag carry up the wood with it?*

It would, if the wood did not make the bag as heavy or heavier than the air around it.

*How are balloons made?*

A light bag of thin silk, somewhat like a very large bubble, is filled with a kind of air lighter than the common air.

*How is this air kept from coming out of the bag?*

The bag is lined with a varnish, made of India rubber and spirits of turpentine, so that it is *air tight*.

## ALLOONS.

*How can a person go up in such balloons?*

A little *car* is fastened to the bag, which can carry one or two persons in it.

*How can a balloon carry a loaded car up into the air?*

The air in the bag or balloon is so very light that it will go up; and, when the car, with one or two people in it, is fastened to the balloon, the whole together are so much lighter than the air around them, that they can no more stay down to the earth than the hot air from the chimney can.

*Do accidents ever happen to those who ascend in balloons?*

Very often.

*How?*

When the balloon comes down, it sometimes falls into the sea, and the people in it are injured or drowned; and sometimes it strikes a tree suddenly, or is dragged violently along the ground, and the persons in it get hurt.

*How can a balloon descend?*

## PARACHUTES.

By letting out some of the light air from the bag.

*How will this make the bag descend?*

There will be less light air in the bag, to keep up the car; and so the balloon will be heavy, and descend.

*What is a parachute?*

It looks like a very large umbrella, open.



*Of what use is a parachute?*

If a balloon-bag bursts, or a car upsets, and the man in it has a parachute, he can hold upon the handle of it, and keep himself from falling quickly to the ground or sea.

*How will the parachute hold him up?*

PARACHUTES.

While it is spread out, the air that it covers will support it so much that it comes down gently.

*How can you make a little parachute?*

By fastening strings to the four corners of a sheet of paper, then bring the four strings together in the middle, and fasten a light piece of wood to them.

*Then what must you do?*

Carry it to a high place, and let it fall.

*How will it fall?*

Very slowly indeed.

*If you should have an open umbrella in your hand while falling or jumping from a high place, would you fall heavily to the ground?*

I should not.

*Why?*

The air beneath the umbrella would support it, and so keep me from falling heavily.

*How do birds keep from falling, when they are up in the sky?*

They spread out their wings, and the air

PARACHUTES.

supports them.

*Is this the only reason why the air supports them?*

No; their bodies contain a great deal of air.

*How can they remain in the same place in the air, without descending at all?*

They strike the air beneath them with their wings a very little, and then the air reacts or strikes back again a very little, and as long as they do this they keep their places.

*How do they rise in the air?*

They strike harder against the air, and the air reacts just as much, and sends them up higher.

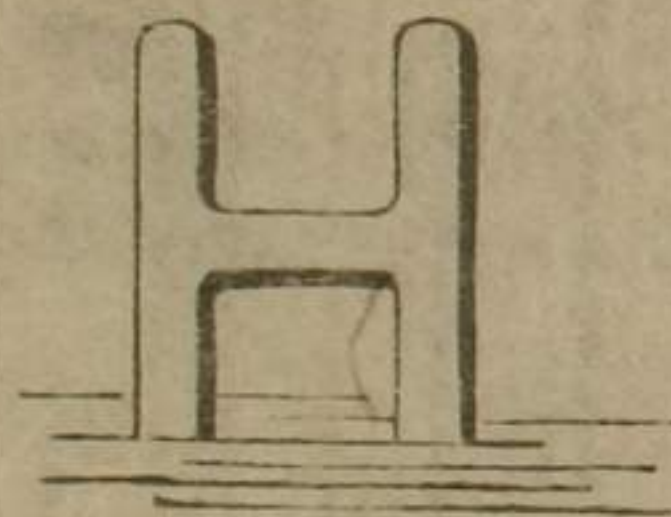
*How do they descend?*

By partly shutting their wings, and letting themselves descend by their own weight.

*How do they know exactly what to do when they wish to rise, or descend, or stand still?*

God, who made them, has taught them, and they never make a mistake, or forget how to do it.

## Lesson Seventeenth



How are fishes able to keep themselves from sinking in water?

They have fins, that spread out like the wings of a bird, and the water

under them supports them, as the air supports the wings of a bird.

But you said that the body of a bird had a great deal of air in it, is it so with fish?

Fishes have bladders of air in their bodies, that make them lighter.

How can they sink down into the water, when they wish?

God has given them the power of letting out the air from the bladder.

## SPECIFIC GRAVITY.

How can they rise again?

God has given them the power of filling these bladders with air again, whenever they choose.

How do the fins of fishes differ from the wings of birds?

Their fins are not so large for them as the wings of birds are for them.

Why are they not made as large?

Because water is heavier than air, and supports fish better; so that fishes need no larger fins than God has given them.

How do people imitate fishes, when they wish to go into the water?

They take bladders, filled with air, and fasten them around their bodies, under their arms, and the air keeps them from sinking.

Do they ever use any other light body instead of blown bladders?

Cork is so light that it will not sink in water, and people use it in the same way as they do bladders.

SPECIFIC GRAVITY.

*What are* SWIMMING-GIRDLES, AIR-JACKETS, and LIFE-PRESERVING BELTS?

They are India rubber bags, filled with air, and tied around the body, instead of cork or bladders.

*What is the danger of using these bags?*

If they should slip down to the hips, the heaviest part of the body would be above them, and the body would instantly turn, so that the head would be down and the feet up, and the person would soon drown.

*What are life-boats?*

Boats that contain tight cells along their sides, full of air.

*Why are they called life-boats?*

Because they take people from a sinking ship, and thus save them from a watery grave.

*If you should fall into the water, what must you do first, to keep from drowning?*

I must turn upon my back, and stretch my body out as straight as I can.

*What must you do with your hands?*

SPECIFIC GRAVITY.

I must extend them under the water, with my hands open.

*How must you place your feet?*

I must keep them as near the top of the water as possible.

*How must you place your head?*

I must let it drop back, so as to have the top of it nearly covered.

*Then what parts of your body will be above the water?*

Only the face and a part of the chest.

*What must you do then?*

I must try to breathe, so as to take more air into my body.

*When you throw out the air as you breathe, will not your body sink?*

It will, a little, for an instant.

*What effort may you make to keep from sinking?*

If I can float so I must not make any effort, except to keep my face out, so that I can breathe.

SPECIFIC GRAVITY.

*If you find your feet sinking, what must you do?*

I must draw them up, and throw them out with a jerk.

*What might happen if you did not try to keep your feet near the top of the water?*

They might sink, so as to make my body stand in the water, and that would bring my mouth under it, and I should drown.

*What must you be careful NOT to do?*

Not to scream or struggle.

*When may you call for help?*

When I am a little over my fright.

*Who are the least likely to sink, fleshy people, or those who are not fleshy?*

Those who are fleshy.

*Why?*

Because the fat part of their bodies is so much lighter than water.

*What amusing account can you give of Marco Paulo?*

Marco Paulo lived in the city of Naples,

SPECIFIC GRAVITY.

many years ago. His bones were very small, and he was very fat. His body, also, would contain a great quantity of air. These things made him so light, that he would swim on the sea like a duck. When he stood up in deep water, the water would not rise higher than his stomach. It is said that, when two men dived into the sea to drag him down with them, the moment they let him go, his body instantly rose to the surface.

*How can heavy bodies, like blocks of marble, be raised, when they have fallen into a harbor or river?*

By fastening casks of air to them with ropes, when the water is low.

*Why should the water be low?*

Because the distance between the marble at the bottom, and the casks at the top of the water, would then be the shortest.

*How could it be raised then?*

When the water rises it will bear up the casks with it, and they will carry up the mar-



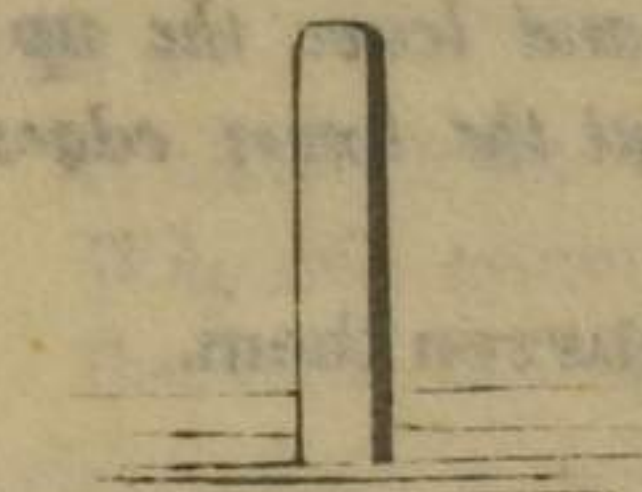
SPECIFIC GRAVITY.

ble, so that it can be taken into a boat.

*Why would not the boat sink, after the heavy stone was placed in it?*

One reason is, because the wood of boats is so light, and they spread out over a large space on the water.

Lesson Eighteenth.



*If you should take a small glass tube, open at both ends, and put one end into water, what change would you see in the tube?*

I should see the water rise up into the tube.

*What makes it rise?*

The sides of the tube draw up the water in it.

*What kind of attraction is this called?*

Capillary attraction.

*What is the meaning of CAPILLARY?*

Hair like.

*Why is this attraction called capillary attraction?*

CAPILLARY ATTRACTION.

Because the pore or hole through the tube is about the size of a hair.

*In what tubes will water rise highest?*

In those that have the smallest pore or hole through them.

*If you take two pieces of flat glass, and put the two lower edges together, and leave the upper ones a little apart, and put the lower edges in water, what will happen?*

The water will rise up between them.

*What attracts the water?*

The inner sides of the glass.

*What kind of attraction is this?*

Capillary attraction.

*If you dip one end of a piece of sponge into water, why will the water rise above that part that was dipped in?*

Capillary attraction makes it rise.

*What are the capillary tubes of sponge?*

The little holes that we see in it. Sponge is full of large and small capillary tubes.

*What makes sponge so useful?*

CAPILLARY ATTRACTION.

It will hold a quantity of water, and will drink up water that is spilled.

*When such a substance as sponge drinks up a liquid, what do we say it does?*

We say it absorbs the liquid.

*Then what does sponge do to water, when put into it?*

It absorbs the water.

*Why will cotton and linen cloth absorb water?*

Because the cotton and linen threads, of which cloth is made, are full of pores, or very fine capillary tubes, which attract the water.

*If you take a bowl of water, and lay one end of a towel in it, what will happen?*

After some time, the towel will be perfectly wet, and the bowl will be empty.

*Where will the water be that was in the bowl?*

It will all have run out, through the towel.

*How can it go from the bowl to the towel?*

The tubes in the linen draw the water out of the bowl.

*Of what use are wicks in lamps?*

CAPILLARY ATTRACTION.

They are a great number of capillary tubes, which draw up the oil from the lamp.

*Why must not the wick be smaller than the lamp tube?*

Because there would not then be tubes enough to bring up the oil.

*Why must not the wick be so large as to be crowded tight in the tube?*

If the wick was crowded very tightly, the capillary tubes in it would be closed, so that the oil could not rise through them.

*What happens when you dip one end of a lump of sugar into water or tea?*

The liquid will rise and fill the whole lump.

*What makes it rise?*

The capillary tubes in the sugar.

*How are large rocks sometimes split, in Germany?*

Holes are bored in a straight line, at certain distances from each other, and wooden wedges driven into them.

*What is done after this?*

CAPILLARY ATTRACTION.

Water is poured upon these wedges, and the pores or capillary tubes in them fill with water.

*What follows?*

The wedges begin to swell, and as they pour water upon them, they swell larger and larger, till they burst the rock. It is in this way that grindstones are broken off.

*Is capillary attraction useful in any other ways than those you have mentioned?*

It causes the moisture, that is low down in the ground, to rise up through the loose earth, to the roots of plants and trees.

*Of what other use is it to them?*

It causes the sap to ascend in trees, and to form beautiful leaves, and flowers, and fruit.

*Of what use is capillary attraction to our bodies?*

It assists in the circulation of the blood in our bodies.

*When sugar, or salt, is dissolved in a liquid, what becomes of it?*

SOLUBLE BODIES.

It is divided into such very small particles that we can not see them.

*How do you know that the sugar is in the water, if you can not see it?*

Because the water is sweet after the sugar is put in, and it was not sweet before.

*Does the water rise higher in the tumbler after the sugar is dissolved than it did before?*

It does not.

*What does this prove?*

That there are exceedingly small spaces between the particles of water; and the particles of sugar fill up these spaces, so that the water does not rise to make room for the sugar.

*What will happen when these spaces are full, if you put in more sugar?*

The sugar will sink, and the water will rise in the tumbler.

*When water has dissolved as much sugar as it can, what do we say of it?*

We say the water is saturated with sugar. *If you should fill a tumbler full of marbles,*

SOLUBLE BODIES.

*could you pour sand in it without taking out the marbles?*

I could.

*Where would the sand go?*

Into the spaces between the marbles.

*What is supposed to be the shape of the particles of water?*

Round.

*Then, when you put sugar into water, what is it like?*

It is like pouring sand into a tumbler full of marbles.

*How large are the particles of water?*

Very small indeed.

*When chalk powder is put into water, will it dissolve?*

It will not, but will only mix with it.

*How do you know it is not dissolved?*

I can see it in the water, and the water, instead of looking clear, is thick and white.

*What is the difference between MIXING a solid in water and DISSOLVING it?*

SOLUBLE BODIES.

When a solid is dissolved it can not be seen, neither does the water rise in the tumbler.

*How is it when mixed?*

It colors the water like itself, and makes the water rise in the tumbler.

*What are those bodies called which can be dissolved?*

Soluble bodies, or bodies that can be dissolved.

*What are those called which can not be dissolved?*

Insoluble bodies.

Lesson Nineteenth.



*WHAT instrument shows the effect of water pressure?*

A hydrostatic bellows.

*If you wish to make a hydrostatic bellows, what would be the first thing you would do?*

I should get two round pieces of board, and fasten them together with leather, so that they would rise and fall together like common bellows.

*What would you do next?*

I would take a long tube, and fasten it to one side of the bellows, so that the lower end of the tube would open into the bellows.

*How would you make the tube stand erect, after it was fixed to the bellows?*

HYDROSTATIC BELLOWS.



By bending it up from the bottom.

*What shape must the top of the tube be?*

Like a tunnel.

*If a man should stand upon the bellows and pour water into the tube, what would follow?*

The upper side of the bellows would begin to rise, to make room for the water, and raise the man standing on it, higher and higher, till the bellows was full.

*What supports the man?*

The water in the bellows.

*How can water run into the bellows, while a heavy man is standing upon it?*

The water in the tube presses the water

HYDROSTATIC BELLOWS

at the bottom of it into the bellows, because its own downward pressure is greater than that of the man.

*Then what kind of pressure does the downward pressure of water make?*

Sidewise, or lateral pressure.

*What is the meaning of LATERAL?*

Sidewise.

*Then when the downward pressure of the water in the tube presses that in the bottom sidewise into the bellows, what other pressure follows?*

Upward pressure.

*What causes the upward pressure of the water?*

The lateral, or sidewise pressure.

*How does it?*

When there is no more room in the bellows for the water to move sidewise, it must press upward, if the water is continually running in, because it can go no other way.

#### HYDROSTATIC BELLOWS

*How could you let the water out of your bellows?*

By making a hole at the bottom of the tube.

*How can you show the pressure of AIR with the same instrument or bellows?*

Two men may stand on it, and one of them may blow hard into the tube, instead of pouring in water, and they will both be lifted up.

*How can they keep the air in the tube and bellows from coming out?*

By putting the finger tightly down upon the top of the tube.

*If you fill a vial almost full of water and cork it, and then turn it up and down, what will you see moving up and down along the side of the vial?*

A bubble of air.

*If you lay it on an inclined plane, where will the bubble be?*

Near the upper end of the vial.

*Where will it be if you lay it on a level table?*

Exactly in the middle of the vial.

#### SPIRIT-LEVEL.

*How can you tell whether a table is level, or inclined?*

By laying the vial on it, and looking at the bubble, to see if it is in the middle or near one end.

*What useful instrument is made somewhat in this way?*

A spirit-level.

*What is a spirit-level?*

It is a glass tube, nearly full of colored spirit, and is fitted into a brass case, in such a way that the bubble of air can be seen.

*If you wish to find whether the floor is level or inclined, how must you use this instrument?*

I must place it on the floor, and see whether the bubble of air is in the middle of the tube.

*For what purpose is the spirit-level often used?*

It is used in making roads and canals.

*What are canals?*

They are large, long ditches, filled with water, that go from one town to another.

CANAIS. AQUEDUCTS.

*Why are canals made?*

Because there are no rivers in just the places where men want them, and so they make rivers for themselves, for boats to sail upon.

*Where do they get the water to fill their canals?*

From the rivers near them.

*What is done when a canal must go across a river?*

They make tight bridges, which carry the water in the canal safely over the river.

*What are such bridges called?*

Aqueduct bridges.

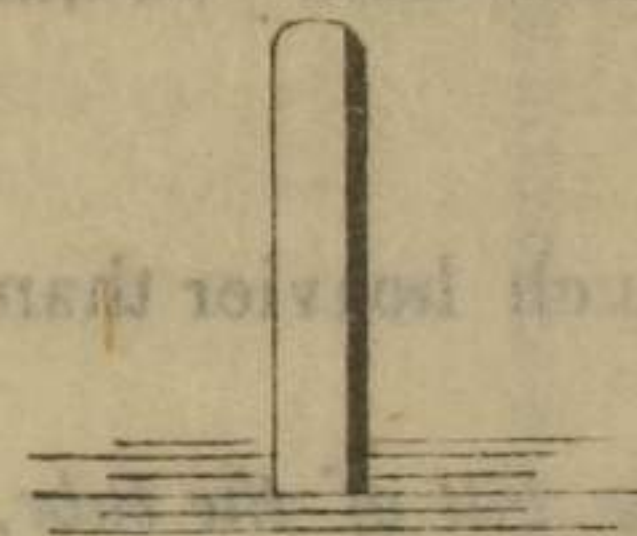
*What is the meaning of AQUEDUCT?*

Aqua means water, and duct means leader.

*Then what do you mean by AQUEDUCT?*

A water-leader.

Lesson Twentieth.



*If I should take a glass tube, open at both ends, and put it into a bowl of water, and then press down all the water around the tube, what*

*would it do?*

The water would rise up into the tube.

*What would make it rise into the tube?*

Your hands would press down the water around the tube, and the water could not help rising in the tube.

*What is mercury?*

It is a liquid metal, that looks like melted silver.

*What is mercury sometimes called*



QUICKSILVER. BAROMETER

Quicksilver, or liquid silver.

*If I should put quicksilver or mercury into the bowl, instead of the water, and then press it down, would it rise in the tube?*

It would; but not as high as the water rose, unless you pressed upon it more than you did upon the water.

*Why would it not?*

Because mercury is so much heavier than water.

*If I could take all the air out of the tube, and stop the upper end, and put the other end into the water, would the water rise in the tube, if I did not touch it?*

It would.

*What would make it rise?*

The air around the tube.

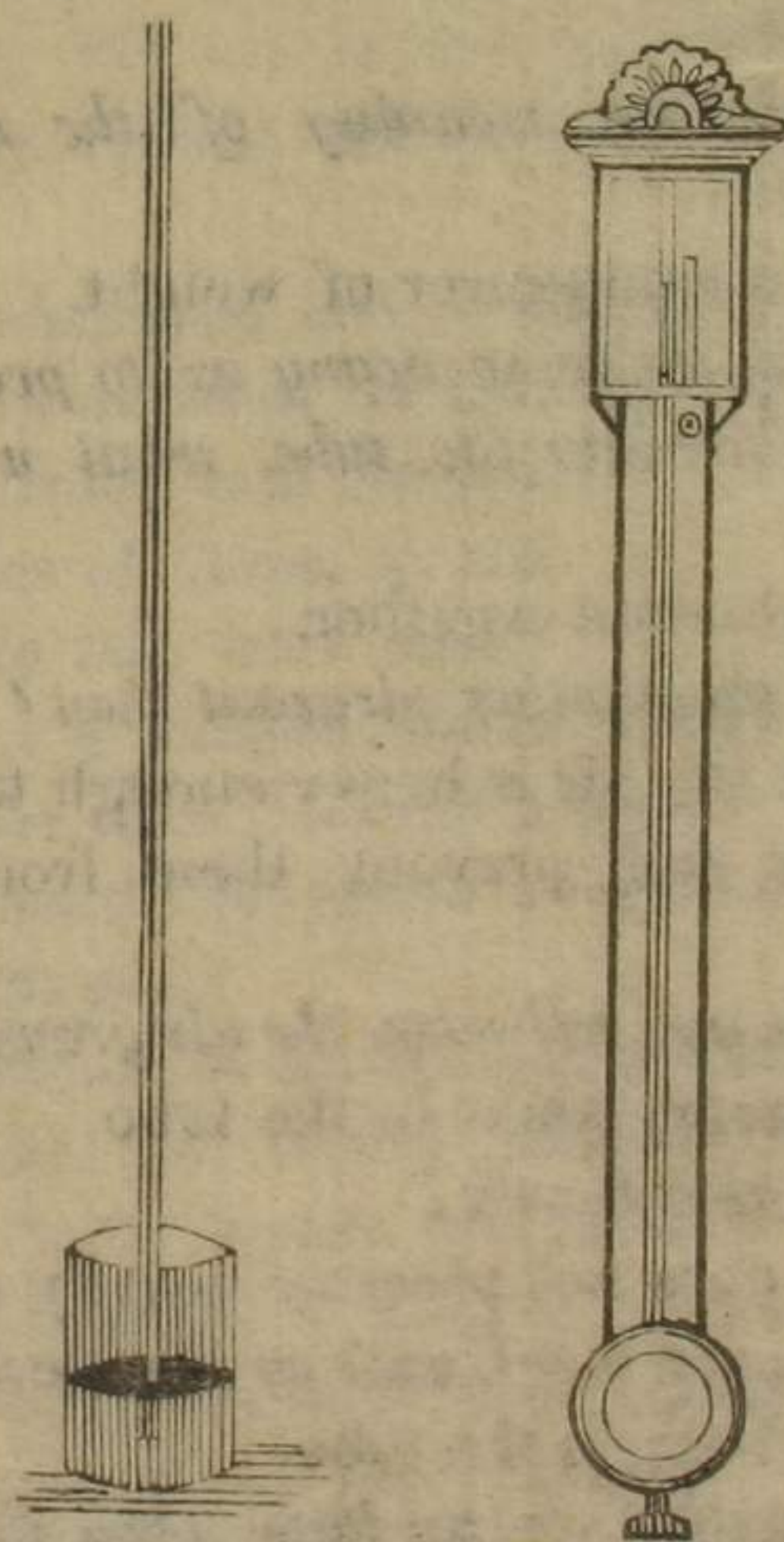
*How could the air make the water rise in the tube?*

By pressing down upon the water in the bowl.

*What does this prove?*

BAROMETER.

It proves that the air has weight.



BAROMETER.

*What is the name of the instrument, made of such a tube and bowl of mercury?*

Barometer.

*What is the meaning of the word BAROMETER?*

It means a measurer of weight.

*When the air is so heavy as to press up the mercury high into the tube, what weather do we have?*

Clear, pleasant weather.

*Why is the weather pleasant then?*

Because the air is heavy enough to hold up the clouds, and prevent them from falling down.

*How can you tell when the air grows lighter?*

The mercury sinks in the tube.

*What makes it sink?*

The air does not press so heavily upon the mercury in the bowl, and so the mercury can not rise as high in the tube.

*What weather do we have when the mercury sinks in the tube?*

BAROMETER—GOOD EFFECTS.

**Stormy weather.**

*Why do we have stormy weather?*

Because the air is not heavy enough to hold up the clouds, and so they fall down in rain.

*Then what good does a barometer do us?*

It shows us what weather to expect.

*Who always need barometers?*

Captains of ships, at sea.

*Why do they need them?*

Because a sudden storm would destroy a ship sooner than it would a house.

*How would a barometer prevent a ship from being destroyed?*

The captain could see the mercury sinking in the tube, and would immediately prepare the ship for the storm, and thus save it.

*Can you relate a story of a captain's saving his ship, because he had a barometer?*

Dr. Arnot gives the account. He was in the ship at the time. He says they were in the southern hemisphere. The sun had just

BAROMETER. GOOD EFFECTS.

mildly set, closing a beautiful afternoon. The evening amusements were going on as usual, when suddenly the captain's orders came to prepare with all haste for a storm. The mercury in the barometer had begun to fall with awful rapidity. As yet, the oldest sailors could see nothing like a storm in the sky, and were surprised at the greatness and hurry of the preparations. But before every thing was quite ready, a hurricane came on them, more dreadful than the oldest of the sailors had ever known. Nothing could resist its power. The sails were torn to tatters, the masts injured, and, at one time, the whole rigging was near being destroyed. So loudly, for a few hours, did the hurricane roar above, the waves around, and the dreadful thunder peal, that no human voice could be heard; even the speaking-trumpet sounded in vain.

On that awful night, if it had not been for the little tube of mercury which gave the warning, neither the strength of the noble

BAROMETER. GOOD EFFECTS.

ship, nor the skill and activity of her commander, could have saved one man to tell the tale.

Lesson Twenty-First.



How high above the earth  
does the air extend?

Forty-five miles.

Then how many miles  
of air press down upon  
the mercury in the bowl?

Forty-five miles of air.

If the tube was as large as a  
pump, and the bowl as large as a cistern, would  
water rise in the tube?

It would.

What would make it rise?

The weight of the air pressing upon the  
water around it.

What is necessary to the making of a pump?

A large tube, with the upper end closed.

PUMPS.

If there was AIR in the pump, would the  
water rise in it?

It would not.

Why would it not?

Because the air and water could not be in  
the same place at the same time.

If the top of the pump was taken off, would  
the water rise in it then?

It would not.

Why would it not?

Because the air above the tube could then  
press down through the tube, and keep the  
water from rising.

How could the air be taken out of the  
pump.

By making a stopper just as large as the  
hole through the pump, that can slide up and  
down in it.

What is the stopper in a pump called?

It is called the piston. It has a hole  
through it.

PUMPS.

*What is there on the top of this stopper or piston?*

Just over the hole in the piston, there is a little leather cover, fastened so as to open and shut like a little door on a hinge.

*What is this COVER called?*

It is called a *valve*, or little door.

*Where is there also another valve?*

In the lower part of the pump.

*You said the air could be taken out of the pump by such a piston as you have described; how could this be done?*

When I press the piston down toward the water, the air underneath lifts up the cover or valve in it, and escapes through the hole.

*What will then be below the piston?*

Nothing but water.

*If you now raise the piston, what will the water do?*

It will open the lower valve and rise as fast as the piston rises.

*What will make the water rise?*

PUMPS.

**The air pressing upon the water in the cistern, outside of the pump.**

*When the piston is pressed down the second time, what will take place?*

As it is pressed down, the water under it closes the lower valve, and forces up the little valve of the piston, and when it is open, the piston can sink down through the water.

*What will take place when the piston is drawn up again?*

The water above the piston will press upon the little valve and close it, so that the water can not pass back through the piston again.

*What becomes of the water above the piston then?*

As the piston rises, it lifts up this water, and throws it from the pump.

*How could you raise as much water as you wish?*

By moving the piston down and up several times.

*How could you press down the piston?*

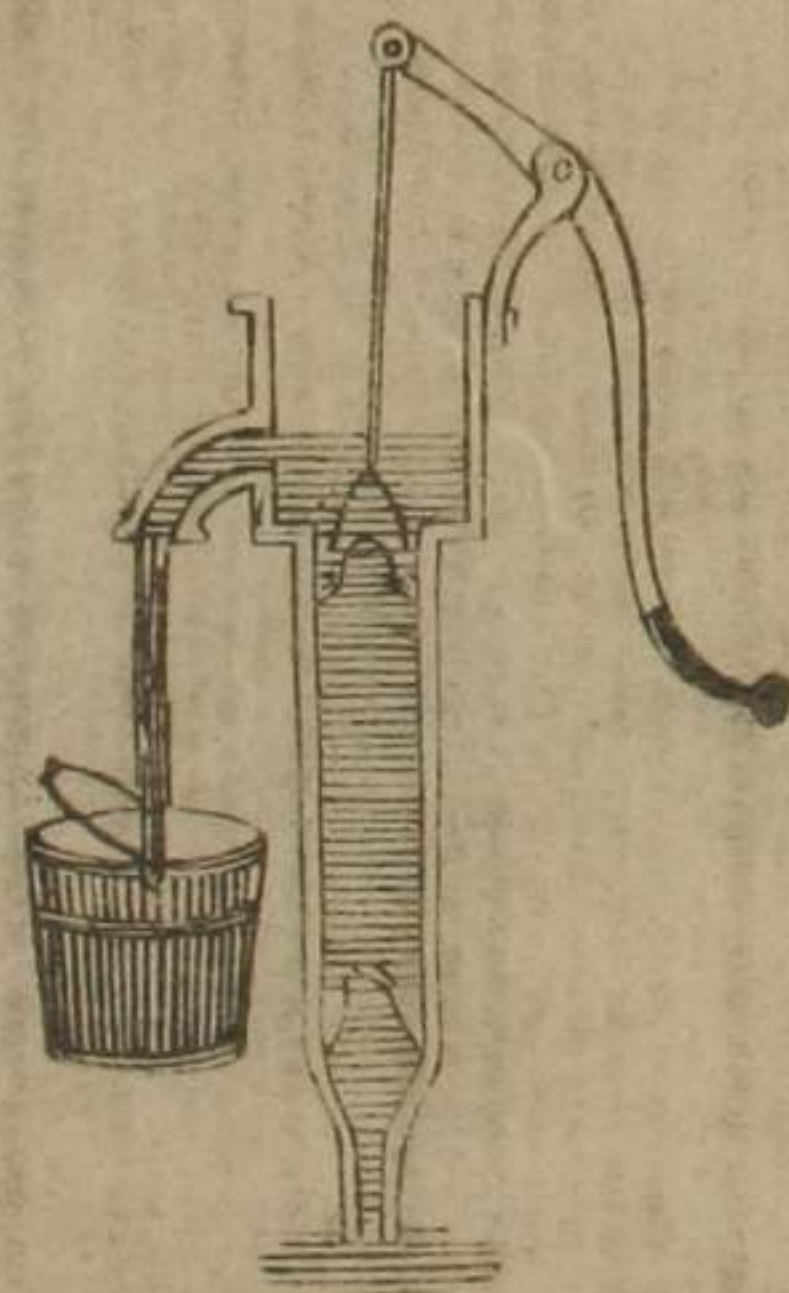
PUMPS.

By having a long pole fastened to it, with a handle at the top of it.

*What is the long pole called?*

The pump-handle.

Here is a picture of a pump.



*How high will water rise in a pump, where there is no air?*

Thirty-four feet.

PUMPS.

*Why will it rise no higher?*

Because the air does not press heavily enough upon the water in the cistern, to raise the water any higher in the pump.

*What does this prove?*

It proves that thirty-four feet of water weighs just as much as forty-five miles of air does.

*Then which is the heaviest, air or water?*

Water.

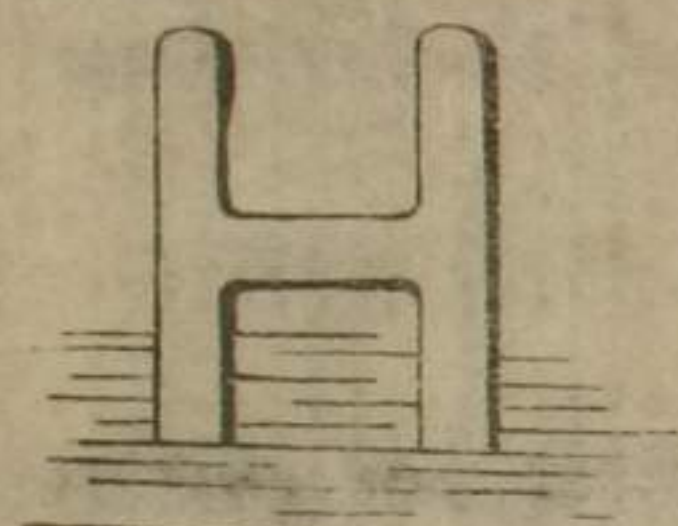
*Would the mercury rise thirty-four feet in a tube?*

It would not.

*What does that prove?*

That mercury is heavier than water.

## Lesson Twenty-Second.



How do boys make the play-  
things which they call  
SUCKERS?

They take a round  
piece of wet leather, and  
fasten a string in the  
center of it.

*How do they use it?*

They press the leather very closely to the  
stone which they wish to lift, and then, when  
they lift up the leather with the string, the  
stone comes up with it.

*What makes the stone rise too?*

When the string pulls up the leather, it  
stretches the leather, because it is wet, so that  
nothing but its edges touch the stone.

## SUCTION.

*Then what is between the leather and the  
stone?*

Nothing, not even air.

*How do you know there is no air under the  
leather?*

Because the edges of the leather are fixed  
so tightly to the stone, that no air could get  
under it.



*Then what keeps the stone and leather so  
tightly together?*

The pressure of the air

*What does this prove?*

That air has weight.

SUCTION.

*What if the edge should be lifted up on one side?*

The air would get between the leather and the stone

*Could you lift the stone with the sucker then?*

I could not.

*Why could you not?*

Because the air under the sucker would press it up, while the air above was pressing down.

*Then when you wish to raise any thing with a sucker, may you have any air between the sucker and the weight?*

I must not.

*How can a fly walk upon a window glass?*

Its feet are much like suckers, and are kept upon the glass by the pressure of the air.

*How can they take them up from the glass, so as to walk as fast as they do?*

God has given them the power of letting the air under their feet very quickly, whenever they wish to step.

SLIES. LIZZARD. WALRUS.

*Are there any other animals that walk over smooth surfaces by means of such feet?*

The lizzard, that lives in the island of Java, walks up a smooth wall in the same way, to catch flies; and the large walrus walks upon ice easily, because his hind feet are shaped like a sucker

*Have any kinds of fishes this contrivance?*

One kind of fish has a set of suckers upon its head, that enables it to fasten itself to rocks, or to any thing it chooses.

*If you should cork an empty bottle, and let it down deep into the sea, what would happen to the bottle?*

It would be crushed.

*What would crush it?*

The water pressing all around it would crush it in.

*What does this prove?*

It proves that the pressure of water is greater than the pressure of the air.

*If you fill the bottle with water, and cork it,*



SUCTION.

*and then let it down into the sea, will it be crushed?*

It will not.

*Why will it not?*

Because the water in the bottle presses outward so strongly as to prevent the pressure of the water around the bottle crushing it.

*If you should take a tight barrel, filled with water, and make a hole on the under side for the water to run out, would it flow?*

It would not.

*Why would it not?*

Because there would be nothing to press it down.

*How could you make the water run?*

By making another hole in the upper side of the barrel.

*What good would that do?*

It would make a place for the air above the barrel to press down upon the water in the barrel.

*Then when you wish to have the fluid in the*

DIVING-BELLS.

*barrel run out at one end, what must you always do?*

I must take out the *bung* or stopper at the top, to let the air come into the barrel.



*What contrivance have people for going safely to the bottom of the sea?*

They can go in *Diving-Bells*.

*What are they?*

They are shaped like a bell, and are large enough for one or two persons to sit in them.

*How is the water kept out of them?*

DIVING-BELLS.

They are let down into the water in such a way that the air in them can not escape; and thus the air prevents the water from rising into them.

*How can you explain this?*

If I put a tumbler into water, with the upper side down, I can not fill it, because the air in it will not allow the water to come up into it too.

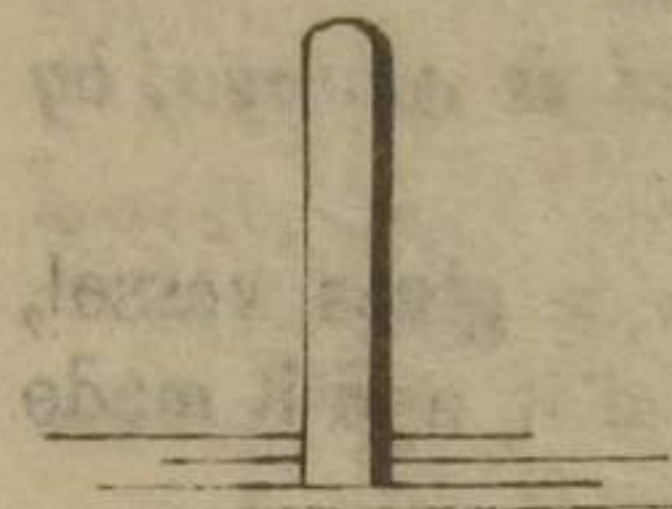
*How can the persons in the diving-bell breathe?*

A long, flexible tube goes from the inside of the bell up through the water, and the air is passed down to the men through it.

*What other contrivance has been made, for the same purpose?*

Instead of a bell, a tight cover has been made for the head, which has an air-tube fixed to it. A man can fasten this cover upon his head, and put on a water-proof dress, and then go safely down to find pearls, or wrecks of ships, at the bottom of the sea.

Lesson Twenty-Third.



*If you throw a stone into the water, what will the water do?*

It will move in little waves, shaped like circles, and these circles

will grow larger and larger.

*When the steeple o'clock strikes, what does it cause the air to do?*

It makes the air around it move in circular waves, just as the water does when a stone is thrown into it.

*When one of the circles reaches your ear, what do you say?*

I say that I hear the clock striking.

*Then what is sound?*

Sound is the effect of air coming against the ear.

SOUND.

*What are these circular motions, or waves of the air, called?*

They are called *vibrations* of the air.

*What is necessary then to make a sound?*

Something that will vibrate.

*How is it known that sound is conveyed by means of air?*

A bell has been rung in a glass vessel, when the air was taken out of it, and it made no sound.

*If a cannon should be fired several miles off, would you hear it the moment it was fired?*

I should not.

*Why would you not?*

Because it takes some time for the waves made by the cannon to reach my ears.

*What brings the sound of the cannon to your ears?*

The air.

*Then what may we call the air?*

A conductor of sound.

SOUND: AIR. BELL.

*Why do we hear a bell ring more distinctly, when the wind blows toward us from the bell?*

Because it brings more waves of air to our ears, than would reach us, if the wind did not blow that way.

*When the wind blows in a different direction, how does the bell sound?*

Very faint, and sometimes we can not hear it at all.

*Why is the sound so faint?*

Because the wind blows almost all the waves of air away from our ears.

*If you strike two stones together in water, can you hear the sound as plainly as you can in the air?*

I can, if my head is under the water.

*What does this prove?*

It proves that water is a good conductor of sound.

*Which is the best conductor of sound, water or air?*

Water.

SOUND.

*How can this be proved?*

If a bell should be rung in water by one person, and another person at a distance should put his head under the water, it would sound much louder than if the bell and the person were out of the water.

*If you lay your ear upon one end of the table, and I scratch the other end of the table with a pin, will you hear it?*

Yes; and it will sound very loud.

*What does this prove?*

It proves that wood is a good conductor of sound.

*Why do animals seem to know an earthquake is going to take place sooner than men do?*

Their heads are so near the ground that they hear the rumbling sound first.

*What does this prove?*

It proves that the earth is a good conductor of sound.

*Can you repeat a story that shows what good*

SOUND. EARTH.

*it has done to know that the earth is a good conductor of sound?*

Many years ago, there was a war in Greece. The Greeks fought against the Turks, because the Turks had got their lands away from them, and treated them very cruelly. In one of the Greek cities, there was a strong tower. The name of the city was Missolonghi. A great many Greeks had fled to this tower, to get away from the Turks. The Turks came, and tried to destroy the tower. It had a great quantity of powder in the cellar, for the Greek soldiers to use. After trying a good while to destroy it, the Turks went away, as if they were not going to try any more. They began to dig a hole at some distance from the tower. The Greeks did not know what it was for; but soon one Greek began to think that the Turks were digging a hole under ground, to reach the cellar of the tower. He thought that they would lay tow all along, (from the powder in the cellar to

the beginning of the hole,) and then set fire to the tow. This would burn till the fire got to the powder in the collar, and then that would take fire and blow up the tower, and all the people in it.

*What did the Greek do?*

He piled up some stones in the middle of the cellar, or magazine, as a cellar of powder is called, and put four smaller stones very loosely upon the top. Then he watched those four stones till he saw them shake. As soon as they began to shake, he put his ear down to the earth, and could hear which way the sound came from. As soon as he found out which way the sound came from, he began to dig down, and soon came to the tow that was laid there, all ready to be set on fire. This he destroyed. When the Turks had set the further end on fire, they waited at a distance to see the tower blow up. When they found that it did not blow up, they began to dig somewhere else.

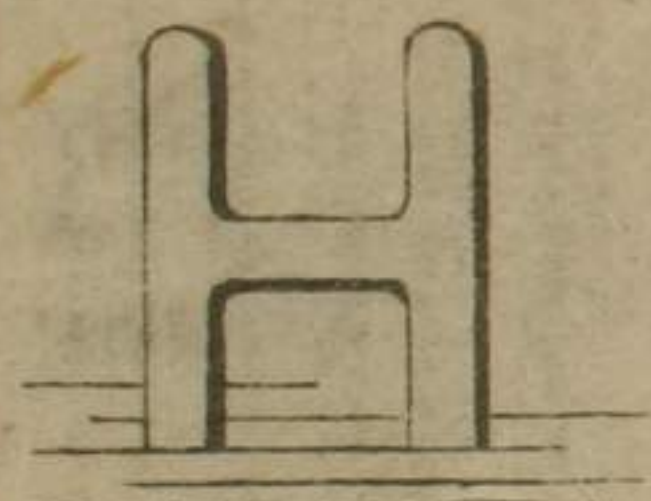
*What did the Greek do then?*

He kept watching the stones, and soon saw them shake again. Then he put his ear down and heard the noise, and dug again till he came to another train of tow, and destroyed that.

*Did the Turks try again?*

They did, several times; but at last they began to think that the Greeks knew what they were doing, and so they gave over trying to blow up the tower.

### Lesson Twenty-Third.



How fast does sound pass through the air?

One mile in about five seconds of time.

Then, if you should see the flash of a cannon, and could count thirty seconds before you hear the first sound, how far off should you say the cannon was?

It would be six miles off.

How could you tell?

If it goes one mile in five seconds, it would go six miles in thirty seconds, because there are six times five in thirty.

If it should lighten, and you should not hear it thunder till you had counted fifteen seconds,

### REFLECTION OF SOUND.

How far off should you say the thunder cloud was?

Three miles off.

How would you find out that?

There are three times five seconds in fifteen seconds, and if five seconds would bring the sound one mile, fifteen seconds would bring the sound three times as far, which would make three miles.

If you speak very loud, what will the air around you do?

It will begin to move or vibrate in circles, that will spread further and further.

If these circles spread till they strike against a high rock, what will happen to them?

The rock will reflect or send them back, just as it would a ball, if you threw one against it.

If the circles made by the reflection of the rock should come back to the ear, what would you say?

I should say I heard the echo of my voice.

ECHOES.

*Then what is an ECHO?*

An echo is sound sent back again.

*What besides rocks will echo?*

Hills, buildings, and walls of rooms, if they are near enough and not too near.

*How near must they be, in order to make an echo, when you speak very loud?*

So near that the circles made by my voice can reach them, and that they can send the circles back to me.

*If the rock should also send its circles to another rock, that would send them back to your ear, what would you hear?*

I should hear *two* echoes

*How would it be, if several rocks or surfaces sent back the sound at different instants?*

I should hear several echoes.

*Are there any places where several echoes can be heard?*

There are many in the world.

*Can you mention one in the United States?*

At Lake George there is a place where a

ECHOES.

person can stand, and call out very loudly, and he will hear several echoes.

*What curious echo is there in England?*

At Woodstock, there is an echo that will repeat seventeen syllables, and, on the north side of the church at Sussex the echo will repeat twenty-one syllables

*What one still more wonderful can you mention?*

In Italy, near the city of Milan, there are two walls of a building that face each other, and a person, standing at a window between them, can hear the echo repeat one word more than *forty* times.

*How is it when a pistol is fired there?*

The echo repeats the sound *sixty* times.

*What can you say of the Whispering Gallery of St. Paul's Church, in London?*

If a person whispers very softly close to the wall on one side of the gallery, it will be echoed so that, if another person puts his ear close to the wall on the other side of

EOLIAN HARP. GIANT'S HARP.

the gallery, he can hear every word distinctly.

*What is an Eolian Harp?*

A musical instrument made with strings

*Can you describe it?*

Strings or wires are stretched very tightly from one fastening to another, and placed where the wind can blow directly upon them.

*What does the wind do to the strings?*

It makes them strike against the air, and, when the circles made by them reach your ears, you hear very sweet sounds.

*What very large one was made in Milan, many years ago?*

Gattoni stretched seven strong iron wires from the top of a tower fifty feet high to the house of Signor Mascati.

*What was it called?*

The Giant's Harp.

*Why was it called the Giant's Harp?*

Because, when the wind blew, it sent forth

GIANT'S HARP.

such lengthened peals of music: now it was a loud chorus, and then it died away in soft murmurings. In a storm it was heard several miles.



## Lesson Twenty-Fifth.

W

HEN children carry fruit along the streets in cities, to sell, why do they turn toward the houses they pass, and put their hand up to one side of their mouths, when they scream out--  
"Strawberries?"

So as to make the sound of their voices go into the windows, instead of spreading out and being lost in the noise of the streets.

When a boy is calling to another, who is at a distance, what does he often do?

He puts both hands around his mouth, like a tube, and then calls.

Why does he put his hand around his

## SPEAKING-TRUMPETS.

mouth?

They keep the sound from spreading out, and thus make it go straighter to the other boy's ear.

If the other boy hears the sound, and turns around to know what is wanted, what will he do?

He will probably put one hand to his ear, to listen.

Why will he do so?

So to catch more of the sound of his friend's voice.

What do firemen and sea-captains use, instead of their hands, to make their orders heard in a great noise?

They use speaking-trumpets.



EAR TRUMPETS.

*What contrivance have people for hearing, instead of putting the hand to the ear?*

They have ear-trumpets, or tubes.

*How can deaf people hear the conversation of their friends?*

They have a long, flexible tube of India-rubber, with a small ivory opening at one end, to go into the ear, and at the other end is a larger opening made of ivory.

*How is it used?*

If I wish to speak to the deaf person, he puts the small end to his ear, and I take the other end of the tube, and speak into it.

*Why will this help him to hear you?*

The sound goes directly from my lips, through the tube, into his ear.

*How is it when you have no tube?*

The sound goes every way when it leaves my mouth, and so but little could go into his ear.

*What contrivance is made in houses, by which people in the upper part can easily talk with those in the rooms below?*

SPEAKING-TUBES.

Tubes are put into the walls, with openings from them into the rooms, upstairs and below.

*How are they used?*

If a person in the upper room speaks into the tube opening there, the other in the room below hears, and goes to the opening in his own room, and puts his ear to it to listen, and then speaks back through the tube.

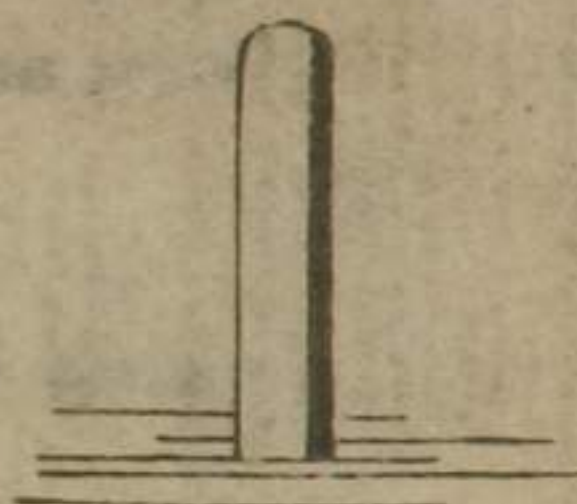
*Must they talk very loud?*

They need only speak as if they were in the same room.

*Why?*

Because the sound is kept in the tube till it gets to the other opening.

## Lesson Twenty-Sixth.



INTO how many colors may light be separated?

Light may be separated into seven colors.

What are the names of these colors?

Violet, indigo, blue, green, yellow, orange, red.

When light shines upon a sheet of paper, how can you see the paper?

By the light which the paper reflects or throws back to my eyes.

Would the paper reflect ALL the light that shines upon it?

If it was white paper, it would.

How do you know that WHITE paper reflects ALL the light that falls upon it?

## COLORS.

Because it takes all the seven colors to make white light and the paper looks white, which it could not do if it did not reflect all the seven colors.

How do you know that it takes all the seven colors to make white?

Because, if you separate a ray of white light by a prism, it will be changed into just seven colors, and no more; and if you bring all these seven colors together again, they will form a ray of white light.

Do all bodies reflect all these colors?

They do not; some reflect one color, and some another.

What becomes of those colors which the body does not reflect?

That body absorbs them.

What do you mean by a body's ABSORBING colors

It seems to take them into itself, so that we can not see them.

If a body should absorb all the col-

COLORS.

*ors, and reflect none, what color would it have?*

It would not have any color.

*Then what should we call it?*

We should call it a *black* body.

*Then is black a real color?*

It is not.

*Then, when we say a body is black, what do we mean?*

We mean that the body has *no* color.

*And, when we say a body is white, what do we mean?*

That it has *all* the seven colors.

*If it absorbs all the colors but the red, and reflects the RED, of what color will the body be?*

It will be a *red* body.

*What color shall we call it, if it reflects the green, and absorbs all the rest?*

We shall call it a *green* body.

*How can you tell which color a body reflects, and which it absorbs?*

It will be of the color it reflects, and

COLORS.

we shall know it absorbs all the colors but that.

*Then how do we see any object?*

By the color it reflects to our eye.

*What is the reflection of light like?*

Like the reflection of sound

*Can you explain it?*

The sun shines upon a green leaf, and the leaf reflects the green color to my eyes. just as a person stands out of my sight and calls, and the rock on which the sound of his voice falls reflects it to my ear.

*Why do not all bodies reflect THE SAME color and absorb the others?*

Because the particles of bodies are put together differently; so that one body can reflect one color, another all of them, and another none.

*Which would reflect ALL?*

A *white* body.

*Which would reflect NONE?*

A *black* body.

COLORS. REFRACTED LIGHT.

*If you should go into a perfectly dark room, and let in a ray of light, through a small hole in the shutter of the window, and put a PRISM over this hole, what would the prism do to the light that came through it?*

It would separate it into the seven colors.

*Would all these colors be mixed together?*

They would not.

*How would they be?*

They would lie one beneath the other, very distinctly, like the colors in the rainbow.

*Then do they all go through the prism in a straight line together?*

They do not; they are broken, and turned out of the straight line.

*When a ray of light is broken, and turned out of a straight line, in passing through a body, what do we say of it?*

We say the light is refracted.

*What is the meaning of REFRACT?*

To break.

*When is light REFRACTED?*

REFLECTION OF LIGHT.

*When it is broken.*

*If you should put a piece of white paper into the BLUE ray that has passed through your prism, of what color would the paper be?*

It would be blue.

*Why would it be blue?*

Because it could reflect only the blue color.

*Why would it not be white?*

Because it must reflect the seven colors to make white, and there is but one for it to reflect when the blue alone falls upon it.

*If you should put the paper into the yellow ray, of what color would it be?*

It would be yellow.

*What does this prove?*

It proves that bodies are of the color which they reflect.

*Then, if no light should fall on a body, would it have any color?*

It would not.

*Why would it not?*

REFLECTION OF LIGHT.

Because there would be no color for it to reflect.

*When a body does not reflect any color, what do we call it?*

A black body.

*If a room is so dark that no light can enter it, of what color will the objects in the room be?*

They will be of no color; because there is no color to be reflected.

*Then what must we call them as long as they are in the dark?*

We must call them black bodies.

*Can we ever see them, when they are made black in this way?*

We can not, because we can see nothing when it is perfectly dark.

*Why can we see a tree upon the top of a hill at a distance, plainer than we can see one on a plain, or in a valley, at the same distance?*

Because the sky behind the tree on the hill is so much lighter than the tree, that we can see the shape of the tree very distinctly.

REFLECTION OF LIGHT.

*Why is not the tree in the valley as distinct as the one on the hill?*

Because the green color of the grass behind the tree seems to mingle with the green of the tree, and we can not distinguish the one from the other.

*Why can we see a white house at a distance, plainer than we can see a tree at the same distance?*

Because there is so great a difference between the white object and the dark ground around it.

*If you wish to make a room very light, what should you do besides having many windows in it?*

I would have the walls white, or papered with very light-colored paper.

*Why would light paint and paper make a room lighter than dark paint and paper, if there were the same number of windows in it?*

Because white walls throw all the light that falls upon them back into the room, and dark

REFLECTION OF HEAT.

walls absorb some of the light, and reflect only a part into the room.

*Why do people, who have weak eyes, wear a shade over them in the day time when reading?*

To keep the light that is reflected from the walls of the room from coming into their eyes.

*Why do they wear a shade when reading by candle or gas light?*

To prevent the rays of light that come from the candle or gas from entering their eyes.

*Is HEAT reflected in the same manner that light is?*

It is.

*Then why is a white dress so cool in summer?*

Because it reflects the heat of the sun.

*Why is a black dress so warm?*

Because it absorbs the heat.

*How can you prove that white reflects heat, and black absorbs it?*

If I place a piece of white and a piece of

REFLECTION OF HEAT.

black cloth upon snow, after sometime, I shall find the snow melted beneath the black, but not beneath the white cloth.

*When the heat of the sun falls upon the side of a mountain, what becomes of a part of this heat?*

It is reflected in various directions.

*If a valley is surrounded by such mountain, will it be warm or cold?*

It will be warm.

*Are there any such valleys?*

There are valleys in Switzerland, surrounded by such mountains, that receive so much reflected heat from every side, that they are always green, though they are in the midst of perpetual snow.

## Lesson Twenty-Seven.



**W**HAT wonderful thing can be done by means of the light of the sun?

Pictures of people can be made by it.

What are such pictures called.

When they are made upon little plates of metal, they are called *daguerreotypes*.

Why do they have that name?

Because Mr. Daguerre first found out how to make such pictures.

When they are made upon PAPER, what are they called?

Photographs.

Why are they called photographs?

## PHOTOGRAPHS. AMBROTYPES.

Because *photos* means *light*, and *graph* means written or drawn.

Then what does *photo-graph* mean?

It means *drawn by light*.

But are not *daguerreotypes* drawn by light too?

They are; but the names are different, to show the difference of the pictures.

Can the pictures be drawn on glass?

They can; and then they are called *ambrotypes*.

Can the colors of the picture be made too by light?

A Mr. Hill has found out a way to make the colors on the pictures too, and his pictures are called *Hillotypes*.

Why do they have that name?

To show that it was a Mr. Hill who found out the way to make them.

If you were going to have a picture of yourself taken, what would you do?

I should sit or stand before a small box



DAGUERREOTYPES.

that had a glass in the side toward me, and I should look at that glass as I would into a looking-glass.

*What is in the box, behind that glass?*

The metal or paper on which the picture is to be made.

*While you are looking at the glass what happens?*

A picture of myself is made, just as if by looking into a looking glass I should leave a picture of my face upon the looking-glass.

*But is your picture made upon the GLASS in the side of the box?*

No; it passes through it, and is made upon the metal behind it.

*Is the picture as large as yourself?*

It is very small.

*What makes it small?*

The glass I look at is so formed as to make things look a great deal smaller than they are, and this makes the picture small.

*How long do you have to keep perfectly still*

DAGUERREOTYPES.

*and look into the glass?*

Only a few seconds.

*Can the picture be made upon ANY piece of metal or paper?*

No; something is put upon it first to prepare it, to keep the picture from passing away.

*What has to be done after the picture is taken out of the box?*

When it is taken out, the artist, in some peculiar way, fastens the picture to the paper, before he puts it into its frame.

*Do we know whether any better way to make such pictures could be found out?*

We do not; because people are always trying to find out better ways of doing things.

*When any better way is found, what is it called?*

It is called an *improvement*.

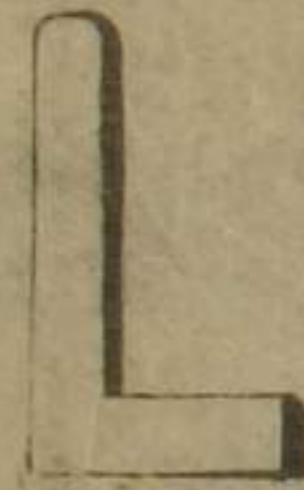
*Could our EYES be made any better?*

They could not.

*Why?*

Because God made them—it is only what man makes that can be made better.

## Lesson Twenty-Eighth.



LOOK into my eye, and tell me what you see?

I see a white ball, with a ring of some color on the middle of it, and in the ring a round

black spot.

Look into that black spot, do you see any thing there?

I see a little picture of my own face, as if I were looking in a very small looking-glass.

Now, if I turn my eye toward a bright light, what will you see in it?

I see the colored ring seem to draw up around the black spot, like drawing up a bag

## THE EYE.

with a string, and the black spot looks much smaller.

If I now turn away from the light, what will you see?

The ring seems to spread out, and the black spot looks larger again.

Then do you see what the ring does to the black spot?

I do; it makes the spot larger or smaller, like opening and shutting a bag with a string.

Which part of your eye do you see with?

The black spot.

What is the name of the black spot?

It is called the pupil of the eye.

What is the name of the colored ring?

It is called the iris.

What is the color of the PUPIL?

It is always black.

What is the color of the ring, or iris?

It is sometimes blue, sometimes gray, and sometimes dark brown, or, as it is called, black.

*Then, when we say any one has blue or black eyes, what do we mean?*

We mean that the *iris* of the eye is blue or black.

*What is the use of the iris?*

When the light is very bright, the iris keeps too much of it from coming into the pupil.

*Is it of use when there is very little light?*

It is; for it opens the pupil very wide, so that light enough may come into the eye for us to see easily.

*How can it?*

God has given it the power of opening wide in the dark, to let in all the light it can, and then of almost shutting or drawing up, when the light is too great.

*Why does it hurt our eyes to look at lightning at night, or at any sudden light?*

Because the iris has not time to draw up so suddenly, and so too much light comes into the pupils.

*What has God made to protect our eyes?*

*The eyelids.*

*How does he give the eyes rest?*

By sending the darkness of night, to keep off all light from them.

*Then is it well to sleep with a light in your room at night?*

It is not; because our eyes need the rest that darkness brings, to keep them well and strong.

*Is it well to have the bright sun shining in your room when you first open your eyes in the morning?*

It is not; because the iris can not draw up around the pupil quick enough to keep too much light from coming into it.

*Then how is the best way to have your bed placed in the room?*

So that the windows shall be behind me when I wake in the morning.

*Why can tigers, cats, and owls see in the dark?*

Because God has given them power to make

### THE EYE.

the pupils of their eyes larger than ours, and thus more light can come into them than can come into ours at night.

*Why do tigers and many other wild animals need to see better in the dark than we do?*

Because they seek their food by night, while we sleep.

*When you go from a light room into one almost dark, why can you not see objects at first as plainly as you can afterward?*

Because it takes a little time for the iris of my eyes to open wide enough to let in what light there is in the dark room.

### Lesson Twenty-Ninth.

W

*What can you tell me about the use of glass for seeing objects?*

It is used for windows, for mirrors or looking-glasses, for spectacles, for microscopes, and for telescopes.

*What kind of glass is made for windows?*

Glass perfectly plain and even on both sides.

*What for looking-glasses?*

The same kind of glass, with one side covered with quicksilver.

*What is the use of the quicksilver?*

It reflects whatever is in front of the glass.

GLASSES.

*What kind of glass is used for spectacles?*

For the eyes of old people, the glasses in spectacles must be made thicker in the middle than at the edges.

*How must it be for short-sighted or near-sighted people?*

Their glasses must be thickest at the edge, and thinnest in the center.

*Of what use are the glasses in telescopes?*

They seem to bring the moon and stars nearer to us, because they make them look so much larger, and show us many we never saw before.

*What are those glasses that make objects look larger called?*

They are called *magnifying-glasses*.

*What does MAGNIFY mean?*

Making large or great.

*There are other glasses that make very small objects look immensely large, what are they called?*

Microscopes.

TELESCOPES.

*What is the meaning of MICROSCOPE?*

*Micro* means *little*, and *scop* means *I see*.

*What does telescope mean?*



*Tele* means *distant*, and *scop* means *I see*.

*Tell me something about the MICROSCOPE?*

If you were to look at the down of the butterfly's wing with a microscope, it would look like beautiful feathers.

*How would a drop of rain water look?*

As if it were full of large and strange looking animals or insects.

*How would very small insects look?*

Large and sometimes very beautiful.

SPY-GLASSES.

*What do we learn by using a microscope?*

We learn that God has made these little creatures, and little flowers, even those that are too small to be seen without a microscope, just as perfect and as beautiful as those that are very large and splendid.

*What kind of a glass do sea-captains use?*

They use a *spy-glass*.

*What is a spy-glass?*

A glass that makes distant objects seem near.

*Then what is its use?*

The captain is able to see any distant ship, or land, before he is near enough to them to see them with his eye alone.

*What other glass is the spy-glass like?*

It is just like the telescope, only smaller.

*What is a PRISM?*

A three-sided piece of glass.

*For what is it used?*

To separate the light that passes through it into its seven colors, like a rainbow.

Lesson Thirtieth.

Y

*You have told about light and heat, can we see light?*

We can.

*Can we see heat?*

We can not.

*Has God made any thing besides heat that we can not see?*

Yes; he has made a wonderful fluid that can not be seen, and yet it seems to be every where.

*What is the name of this wonderful fluid?*

It is called *electricity*.

*If it can not be seen, how do we know there is any such fluid?*

We see what it *does*, just as we see what heat *does*.

ELECTRICITY.

*What does electricity do?*

it causes the lightning.

*What is lightning?*

It is caused by electricity passing from the cloud to the earth, or from one cloud to another.

*How many kinds of electricity are there?*

Two; and these always attract each other.

*What are they called?*

Vitreous and resinous; they are also often called positive and negative electricities.

*Why does electricity pass from one cloud to another, or to the ground?*

Because they are in different states of electricity, and so they attract each other.

*If the cloud is over a tall tree, or church-spire, what way does the electricity take to pass from the cloud to the ground?*

It often goes down the tree or spire.

*Then what do we say has happened to the tree?*

We say it has been struck by lightning.

ELECTRICITY.

*Then the tree would LEAD or CONDUCT the lightning, would it not?*

It would; and we should call it the conductor of the lightning.

*Is it safe to stand under a tree in a thunder-storm?*

It is not.

*Why are lightning rods fixed to houses?*

To keep the lightning from striking the house.

*How can they keep off lightning?*

Iron draws or attracts electricity, and thus the iron lightning rod conducts the lightning away from the house to itself.

*What becomes of the lightning then?*

The rod leads or conducts it down into the ground, and prevents it from doing any harm.

*Is there any thing that electricity will not pass through?*

It will not pass through glass, ivory silk, gutta percha, and several other substances.

*Then how should a lightning-rod be fastened*

FRICION.

*to the house to keep it from going off the rod, and injuring the house?*

It should be fastened by something that does not conduct electricity.

*In what other way can you see the EFFECT of electricity, or what electricity does?*

If I take a cat into a dry, dark room, and rub the fur on her back with a piece of silk, I shall see sparks of light, and hear them crackle.

*Why do you use silk?*

Because silk keeps the electricity, caused by rubbing, from going off to my hand.

*Then rubbing or FRICION can produce electricity, can it not?*

Yes; all bodies may be made to produce electricity by friction.

*If you take a dry and warm glass rod and rub it with silk, why will it attract bits of paper and feathers to itself?*

Because the friction or rubbing has excited a different electricity in the glass from what

MAGNETISM.

is in the paper or feathers.

*Why do they instantly drop off?*

Because, when they touch, they are brought into the same state of electricity, and the attraction ceases.

*What remarkable stone can you mention?*

There is one which attracts iron and steel, called *lodestone*, and also *magnet*, from *Magnesia*, where it was found.

*What happens if you rub this lodestone upon iron or steel?*

It gives magnetism to them, and they will also attract needles or little pieces of steel to themselves.

*Does the earth seem to have more magnetism in one part than in another?*

It does.

*What part has the greatest magnetism?*

That near the north pole.

*Of what use is that magnetic attraction to us?*

If a needle be magnetized, or rubbed with



MAGNETISM.

a lodestone, and placed where it can turn easily, one end will point toward the north.

*Why will it?*

Because the magnetism of the earth, near the north pole, is so great that it draws that end of the needle.

*Then how is it useful to us?*

It shows us which way is north, when we are traveling or sailing.

*What little INSTRUMENT or MACHINE do sea-captains have to tell them the way to sail their ships?*

They have such a needle fixed loosely in a little box, with a glass cover to it, and by looking at this needle they can see which way they are sailing.

*What is the name of this useful little instrument?*

It is called the *mariner's compass*.

*What toys are made for children, to show magnetism?*

Sometimes little tin boats are made, with a

MAGNETISM.

steel wire at one end, and the boat will float in a basin of water.

*How can the boat be made to move?*

I can take the little wire magnet that comes with such boats, and, if I point it toward the steel wire at the end of the boat, it will move toward my magnet, and so I can draw it all around the basin.

*Are there any other such toys?*

Sometimes little glass ducks and fishes are made with a bit of steel in their mouths, and they will be drawn to the magnet in my hand in the same way.

### Lesson Thirty-First.

Y

ow told me that all bodies may be made to produce electricity by friction; can electricity be produced in any other way?

It can, by means of metals and a peculiar liquid called an acid.

Can you explain how it is done?

When certain different kinds of metals are put into an acid, and then these metals are connected by a wire, a peculiar kind of electricity will be made to pass along the wire, from one metal to the other.

How long will this electricity continue to pass?

### ELECTRICITY.

As long as the metals remain in the acid and are connected by the wire.

How long may the wire be which connects the metals and carries the electricity?

As long as we choose to make it.

Which way would the electricity move?

It could go either way, though not at the same instant.

How could the electricity be kept from passing off from the wire?

By covering the wire with gutta percha, or something that does not conduct electricity.

How could it be stopped in passing along the wire?

By putting to it another wire, or any thing that conducts electricity, or by cutting the wire.

Where do we see such wires?

The telegraph wires that we see fastened to tall posts are such wires.

Where are the ends of these wires?

One end of the wire is generally in a house

ELECTRICITY.

in some large city, like New York, and the other in another city, like Washington or Boston.

*How fast does the electricity go from one end of the wire to the other?*

It seems to take no time; but the instant it starts it seems to be at the other end.

*What wonderful instrument is fixed at each end of the telegraph wire?*

Mr. Morse has contrived an instrument to make marks by means of the electricity.

*What is the use of these marks?*

Each mark stands for some letter of the alphabet.

*What is done with these marks?*

Some one writes out the letters they stand for on a piece of paper, thus:—

T e l l J o h n .

*Of what use is all this?*

A person at the instrument, in New York,

ELECTRICITY.

can make the electricity pass along the wire to the Washington instrument, and scratch the letter-marks on the paper there.

*Then what will be done in Washington?*

The person at the instrument there will read the words, and then send back electricity along the wire, which will write his answer in the office in New York.

*What more wonderful instrument has Mr. House made?*

He has made an instrument that prints the letters themselves.

*What does it look like?*

It looks a little like a piano, with a small machine on the top of it

*How is it used?*

A gentleman sits before it, as if he were playing the piano. As he touches the ivory keys, the electricity passes along the wire to Washington, and the instrument there begins to print the letters that each key makes.

*What are these letters printed upon?*

They are printed upon a narrow strip of paper, that rolls off a little wheel as fast as it is wanted.

*What is done with this strip of paper?*

It is cut off, and sent wherever it is directed; and then the instrument is ready for another message.

*Why is this way of writing letters to people very convenient?*

Because people can talk together about their business, without losing any time, just as if they were in the same room.

*Are there many telegraph wires?*

Yes; all the large cities have them.

*What was the most wonderful telegraph wire ever made?*

The one that stretched across the Atlantic ocean.

*Are there telegraph wires in other countries?*

There are; and the time may come when people in every part of the world can talk together, by means of them.

### Lesson Thirty-Second.



*How high from the earth does the atmosphere extend?*

More than forty-five miles.

*From what does all our light come?*

It comes from the sun.

*When the rays of light, in coming from the sun, enter the atmosphere, what happens to them?*

They are refracted or broken, and turned out of their course.

*What refracts them?*

The atmosphere.

*Does it also separate the light into different colors, like the prism?*

It does not; it only breaks them.

REFRACTED LIGHT.

*If the atmosphere becomes more DENSE or THICK, how would the light be refracted?*

It would be refracted more and more, the more dense the atmosphere becomes.

*When light passes through a prism, which colored ray is refracted the most, or turned the furthest out of its course?*

The violet.

*Which is refracted the least?*

The red.

*What is it that refracts the light?*

The glass, of which the prism is made.

*If light passes through water, is it refracted more or less than when it passes through the atmosphere?*

It is refracted more.

*Why does water refract light more than the atmosphere?*

Because it is more dense than air.

*Then what bodies refract light most?*

The densest bodies through which light can pass refract it most.

REFLECTED LIGHT.

*Why does the sky or atmosphere look blue?*

The rays of light come from the sun, pass through the atmosphere to the earth, and are reflected back through the atmosphere, and the blue rays are stopped on their way, and reflected again to our eyes.

*What becomes of the other colors?*

They pass on through, without being reflected.

*Why are the blue rays stopped?*

Because they do not seem to have momentum enough to carry them through.

*What did you say was the meaning of MOMENTUM?*

Moving power; or weight and speed put together.

*Then what do you mean by the momentum of a blue ray?*

Its power to carry itself through the atmosphere.

*Which color has the greatest momentum?*

The red.

OPAQUE BODIES.

*If the atmosphere should become very thick or dense, what would be the effect upon the light that passes through it?*

*None of the rays but the red would have momentum enough to pass through the atmosphere.*

*When does the sun look red?*

*When it is seen through a fog or vapor.*

*If the atmosphere did not reflect any of the sun's rays, how would the sky appear?*

*Perfectly black.*

*When bodies do not allow any light to pass through them, what do we call such bodies?*

*Opaque bodies.*

*Can you mention an opaque body?*

*A piece of wood, or marble, or iron, is opaque.*

*How can you tell?*

*By holding them up, to see whether the light will pass through them.*

*When a body permits light to pass through it, what kind of a body is it called?*

TRANSPARENT BODIES.

*A transparent body.*

*Will you mention some transparent body?*

*Glass is transparent.*

*Why is it transparent?*

*Because light can pass through it.*

*Is water transparent?*

*It is.*

*Then why is it more difficult to see bodies distinctly through a fog than when the air is clear?*

*The fog refracts these rays of light that bodies reflect through it so much more than air does, that we can not distinguish the size and shape of those bodies very well; they seem much larger than they really are.*

*Can you relate a story about a singular mistake caused by a dense fog or mist?*

*A shepherd upon one of the Cumberland mountains, in Europe, was suddenly surrounded with a thick fog. Every thing seemed so very large that he lost his way. He tried to find some object that he knew,*

SPECTER OF THE BROCKEN.

and by which he could find where he was, and where he ought to go. He soon came to what seemed to be a very large mansion, which he did not remember of having seen before. He went into it to inquire the way home, and there found his own family. It was his own cottage. The fog had deceived him so much that it was some time before he could believe the fact.

*Do clouds ever reflect shadows of objects that are before them?*

They do.

*Will you mention one instance?*

Many years ago, a Mr. Hane went up the Hartz mountains, in Germany, at a place called the Brocken. As he looked toward the south-west, he saw, at a very great distance, the figure of a man as large as a giant. Just then a gust of wind almost blew off his hat, and he raised his hand to his head to keep on his hat. The figure did the same. He then bent his body, as if to salute it. The

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SPECTER OF THE BROOK

figure returned it at the same instant. He then went back, and took another man with him. They then saw two such giant figures; and all that these men did, the figures imitated.

*What was the cause of this appearance?*

When the sun is rising or setting, and throws his rays over the Brocken, upon the fine, light clouds floating around, if a man comes between the rays of light and the cloud, the shadow of the man will be seen on the clouds opposite him, and all his motions will be represented by his shadow.

*How large will his shadow be?*

It may extend five or six hundred feet.

*How far from the man will it be?*

Two miles off.

*What name have the people in that country given to this immense shadow?*

They call it the *Specter of the Brocken*.

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LETTER ON

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78





