Glaciers

People have been for years observing the motion of glaciers to find, if they could, a satisfactory explanation of it. If a line of wooden pegs be driven into the ice, it is found, the day after, that they have altered their relative positions, and that the pegs towards the middle have moved more rapidly down the valley than those towards the side. The motion is usually found to be very slow – not more than a few inches in the twenty-four hours; but the whole moves onward like a stream. The ice moves in a way that might rather be compared to treacle or any other viscous fluid than to an ordinary solid. As the glacier moves down the valley it widens and deepens, scraping the sides and bottom of the channel, and by means of the stones it carries with it, scratching the rocks that form the sides and bottom of its channel, and carrying with it a huge mass of earth and stones torn out of the solid hills. The glacier usually ends in an ice-cave from which issues a stream. The Rhine, and the Rhone, great rivers which begin in alpine glaciers, have their origin in such an ice-cave.

Give the meanings of the following words:

rapidly _____

motion _____

viscous _____

fluid _____

issues _____

alpine _____

Into which seas do the Rhine and the Rhone eventually flow?

Rhine _____

Rhone _____

Glaciers[1]:Experiments with Ice 1[2]

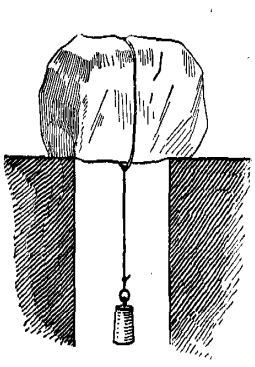
Objects needed

Teacher: Block of Ice[3]; Pieces of Ice[4]; Vessels with Water; Salt; Test-tubes[5], Bunsen Burner or other source of heat[6], Beakers; Hammer; Weight; Wire[7]; Pictures of Snow Crystals; Piece of Glass; Treacle or Golden Syrup.

Pupils: Test-tube with a little water.

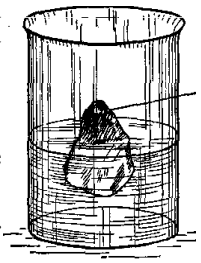
Experiments

I. Place ice in beaker over Bunsen and melt it.
II. Show that ice is brittle and not so heavy as water.
III. Question as to colour, and show that when pounded it is white.
IV. Stretch wire across supported block and attach heavy weight to wire, to show that it will pass through the ice without leaving a mark.
V. Put pieces of ice into children's test-tubes and let them observe what happens.
VI. Pound ice. Mix in a beaker the pounded ice with salt, to show hoar-frost forming on outside of vessel.
VII. Show pictures of snow crystals. Explain why the snow is white. Question as to form.



Explain to the class that you wish them, to learn a little about ice and snow because these play a very important part in the story of the world. Place the block of ice so that it will be supported, and pass a strong wire round it. Fix a heavy weight to the wire[8]. Direct the class to notice what you have done, and say that you will return to this by and by.

Experiment I. Get one of the children to put some pieces of ice into a heat proof beaker, and place the beaker over a Bunsen or other source of heat. Question the children as to what they expect will happen. They will probably all be able to answer that the ice will melt, and that soon there will be only water in the beaker. From this insist on the fact that ice is nothing but water in another form. Find what happens if you put a piece of ice in a beaker, weigh it, and then when it has melted re-weigh it. There is no loss of weight. Ice we sometimes call frozen water, that is, water that has been changed into the solid form by loss of heat. If you experiment with hot and cold water you will find that the hot water rises to the top, try now with ice and water to see how the ice behaves.



Ice in Water

Experiment II. Fill a beaker with water, and get one of the children to put a lump of ice in it. Question the class regarding it. See that they all observe water and that the ice floats on the top, that partly covered with the water; so ice, like hot water, is lighter

1 This basic information about how ice behaves will lead on to an understanding of glaciers in the next session. We found the experiments tremendous fun to do and very easy to adapt to the domestic kitchen!
2 From Frew, David, *Object Lessons in Geography and Science Part 2* (London, 1900)
3 Prepared in a large plastic lunch-box or food storage box in the freezer over night.
4 From the ice-cube tray in the freezer.
5 Any thin walled container such as a disposable plastic squash cup would do, you don't need to buy test tubes.
6 We used the kitchen cooker.
7 We used a piece of nylon sewing thread.
8 We put tea towels under the end of the ice to prevent it slipping off the supports (large kitchen containers). We used thin nylon thread and suspended some heavy metal nuts and washers from it.

than water at the ordinary temperature.[9]

Question the children as to where the ice, being the lighter, will form. It forms, of course, on the top. Tell the class that this ice-covering is really a kind of protection to the water below, preventing the cold of the air from freezing it.

Give one of the children a piece of ice. Let him strike it with a hammer and observe that it flies in pieces when so struck, that, like glass, it is a very brittle substance. Question them as to the name given to substances like ice and glass. If they do not know, tell them they are called crystalline substances, from a word meaning *glassy.* Get them to name other similar substances.

Experiment III. Question with regard to the colour of ice. Observe that a small bit of it is colourless, and, like glass, it is transparent.

Get a child to pound[10] a piece of ice and question the class about the colour of the pounded ice. They will notice that it is white. Question the class regarding the colour of water. They will observe that, like ice, it is colourless and transparent. Question them with regard to the colour of foam and of spray. These are, like pounded ice, white. Show a piece of glass. Like the ice and water it is transparent, but when pounded glass is transparent. Powder it, if possible in a mortar, or have some ready powdered, and show that the ground-glass, like the ground-ice, is white[11].

Experiment IV. Direct the attention of the children to the block of ice round which the wire was put at the beginning of the lesson. If the wire has not been dragged through the block it should be nearly so. Get one of the children to examine the block to see if he can find where the wire passed. Point out to the class that there is no mark, that the ice seems as solid as it did at first, and yet the wire must have cut down through it. Show the children some treacle. Get one of them to draw a knife through the treacle, and let the class notice that the part behind immediately closes up. Explain that just in the same way the part of the ice-block through which the wire passed closed up behind it, and that ice, solid as it looks and feels, is more like treacle or other slow-flowing liquid than it is like glass or an ordinary solid. [The wire passes through not due to pressure but to heat conducted from the air in the room which means the wire is warmer than the ice. The warm wire melts the ice under it and it passes gradually through the ice.]

Experiment V. Question the children with regard to the appearance of the inside of the windows on a very cold day in winter. In all likelihood they will have observed that the inside becomes dim, gets damp; and by and by that the damp gathers so thickly that it runs down and forms quite a little pool of water on the frame at the bottom of the glass. Make the children thoroughly dry the outside of their test tubes, and see that they are quite clear. Let them then fill the tubes with pounded ice and watch the result. They will very soon see that the outside of the tube begins to grow dim, and by and by, if they touch the tube with their finger they will feel that it is quite moist. Question them as to where the moisture comes from. It could not come from the inside of the tube, because the glass does not let water pass through. It must, therefore, have come from the air of the room. This is what took place. The ground ice in the test-tubes cooled the glass. The glass cooled the air that touched, and the air, being cooled, could not keep all its moisture, but deposited some of it on the test-tube. Explain that this is what takes place on bright clear nights in autumn. After the sun has set, the ground and plants give off their heat very rapidly. As they thus become colder than the air in contact with them they cool the air down, and as a consequence it gives up some of its moisture. This moisture is called dew; but it is formed in exactly the same way as the cloud forms on the outside of

9 The results from Experiment I show that the same weight of water results when ice is melted. We can see therefore from Experiment II that although the *weight* remains the same the *volume* must decrease.

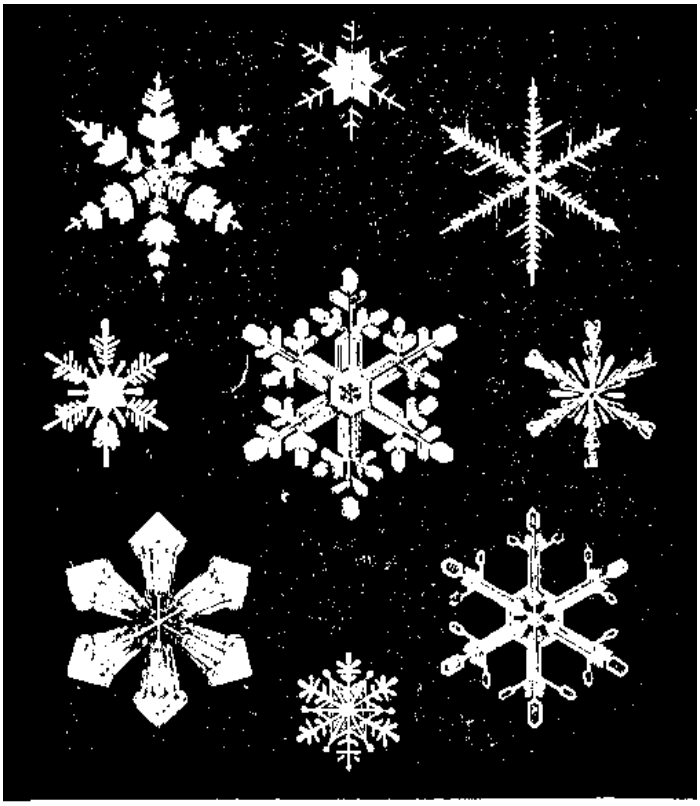
10 Best done in a strong plastic bag (such as a freezer bag) with a rolling pin.

11 We did not risk doing this! It is easy to make your own foam with detergent.

a glass of cold water brought into a hot room.

Experiment VI. Pound some ice and fill a large test-tube with the pounded ice mixed with common salt. Let the children fill their test-tubes with the pounded ice and salt, and then notice the result. The outside of the tube grows dim as before, but now if it be touched with the finger it will be found that the outside of the glass is colder by far than formerly, and that the glass is covered with crisp ice. Question the children as to the appearance of the tops of walls, of the footpaths, and of the roofs of houses on bright winter mornings. They are covered with hoar-frost. This hoar-frost is formed on the walls and roofs, &c., just as they have seen it formed on their test-tubes. They give off so much heat that they become very cold, and the air in contact with them gives up its moisture, but the moisture itself is cooled down so much that it is changed into ice, and is deposited on the bodies in that form. This hoar-frost or rime, for it is called by both these names, is nothing but frozen dew. Sometimes the rime is so thick that if you draw your hand along a rime-covered wall, you can collect quite a handful of it. Find out if any of the children ever have gathered rime in this way. Explain that when so gathered it feels and looks very like snow.

Experiment VII Rime, the children may be told, feels harder and crisper than snow. Though it is white like snow, can be crushed together like snow, and is melted by the heat of the hand just as snow is, it has not the deliciously soft feeling of the snow, nor, if they could examine it through a microscope, would they find that it resembled snow. The rime or hoar-frost is made up of very small separate pieces of ice; but though the snow is made up also of pieces of ice, these are not entirely separate, but are arranged so that they form the most lovely patterns. Of these snow-crystals, or snow-flowers as they are sometimes called, an almost infinite variety of different forms have been observed. Show the class pictures of these snow-crystals, and let them notice that the simplest form assumed is that of a star with six rays; and that this character of structure is preserved no matter how beautiful and complicated the form assumed by the snow-flakes.



Snow-crystals

Glaciers:Experiments with Ice 1
SUMMARY

1. Ice when heated becomes _ _ _ _ _.

2. Ice is _ _ _ _ _ _ _ than water and is brittle like glass.

3. It is colourless and transparent, but when pounded it is _ _ _ _ _.

4. Ice closes up behind a wire drawn through it, just as _ _ _ _ _ _ _ would.

5. Dew is moisture deposited on bodies colder than the _ _ _ around.

6. When the bodies are very cold the dew takes the form of _ _ _ _-_ _ _ _ _.

7. Snow is formed in _ _ _ -sided crystals.

✂----------

Answers: 1. Ice when heated becomes **water**. 2. Ice is **lighter** than water and is brittle like glass. 3. It is colourless and transparent, but when pounded it is **white**. 4. Ice closes up behind a wire drawn through it, just as **treacle** would. 5. Dew is moisture deposited on bodies colder than the **air** around. 6. When the bodies are very cold the dew takes the form of **hoar-frost**. 7. Snow is formed in **six**-sided crystals.

Write three or four sentences about water, ice and glaciers here. Mention your experiments.

Draw your own snow-flake here. Use your compass to help you make a six-sided figure.

Glaciers: Experiments with Ice 2[12]

Objects

Teacher. -Block of Ice[13], Ground Ice; Beaker with Solution of Bicarbonate of Soda; Beaker with Solution of Tartaric Acid[14]; Candle, Common Salt, Metal Can[15], Bullet-mould[16], Vessel with Water.

Experiments

I. Into solution of bicarbonate of soda pour solution of tartaric acid.

II. Mix in metal vessel pounded ice and common salt.

III. Put pounded ice into mould, and squeeze the parts of the mould firmly together.

IV. Show ice-worn rocks[17] and picture of glacier.

V. Get child to put lumps of ice into water.

Explain to the children that ice and snow have so very much to do with shaping the hills and valleys, and that water in the form of ice plays such an important part as the carrier of material from one part of the earth's surface to another, that you find it necessary to continue the study of the subject.[18] Remind them of the beautiful shapes the snow-flakes take, the wonderful snow-crystals, and question them as to the colour of snow. Remind them that colourless water in the shape of spray or foam was white, that ground ice was white, and that ground glass was white.

Experiment I. Snow is white on account of the air mixed with it.

Show the children the beakers containing the solutions. Get one of them to come out and light a candle. Let him hold the lighted candle behind each of the beakers in turn, and question the class with regard to the contents. These are colourless and, like glass, transparent. They can see the candle when it is held behind either. Get another child to come forward, and while the first holds the candle behind the solution of bicarbonate of soda, let the second pour into it the solution of tartaric acid. The children will see at once that the mixture bubbles up, ceases to be transparent, and takes a milky-white colour. As soon as the gas ceases to bubble through and break up the liquid, it becomes again perfectly colourless. The whiteness, therefore, must have been caused by the gas bubbling up through and breaking up the liquid. Tell the class that snow is made up very largely of air, which separates and breaks up the ice-crystals, and that, when the air is driven out – as they will see in a later experiment – the snow ceases to be white, and becomes colourless ice. Question as to what causes the snow to be white. Refer to the cases of ground glass, &c., and question about them. Tell the class that it takes nine, or ten parts of snow to yield, when melted, one part of water.

Experiment II. Mix pounded ice and common salt in a metal vessel, and let the children mix ice and salt in their test-tubes. Observe that the outside of the vessel soon becomes covered over with hoar-frost. The class will notice that this hoar-frost is formed by the coldness of the vessel freezing

12 From Frew, David, *Object Lessons in Geography and Science Part 2* (London, 1900)

13 Ordinary ice cubes from the fridge are fine.

14 We used citric acid as this was all we had. It worked fine.

15 Empty baked bean can or similar.

16 Like Pa's in *The Little house on the Prairie* I suppose! Not having one of these we used a pair of plastic drinking beakers putting the crushed ice into one and then ramming it down hard with the other pushed inside it.

17 We had none of these but found pictures in an encyclopaedia.

18 The Ice Age brought on by the conditions after the Flood of Noah's day can be mentioned here.

the vapour deposited on it from the air round it. The children may be told that as people go up a hill, or rise above the earth in a balloon, it gets colder and colder, and in the higher regions of the air it becomes so cold that the vapour which the air contains is changed into snow. It is in the form of snow that moisture falls high up among the mountains, mostly a thin, dry, powdery snow, not unlike the rime they see on the metal vessel.

The snow-line is the level above which snow does not melt even in summer.
Snow can fall only when the temperature of the air at the place is at or below the freezing-point of water. In winter it falls in the valleys, but as summer advances the height at which it falls retreats farther and farther up the mountain. In all high mountains, however, there is a point where the snow lies all the year round, and above which the moisture that falls, even in the warmest part of the year, must fall in the form of snow. The level above which this always happens is often spoken of as the snow-line. The quantity of snow that falls on the part of mountains that rise above this level varies very much, but is nearly always very considerable.

Experiment III. Pieces of ice, when pressed together, reseal

Pound some ice very fine, crush it into an ordinary bullet-mould or a mould used for making golf balls, and press the parts of the mould together. Add more pounded ice and repeat the pressure. The class will notice that after a little the ice in the mould becomes apparently a single solid piece. Question the children as to what happens when they try to make snow-balls. If the snow be very dry it will not hold together, but when the heat of their hands, or the pressure, has melted part of it, then it forms a ball. If they go on pressing the ball, more of the ice is melted, more of the air is driven out, and the snow-ball is changed by slow degrees into a ball of ice.

Glaciers are rivers of ice fed by the snow. Explain that this is pretty nearly a picture of what happens to the snow that falls in the valleys high up among the mountains. The heat of the sun during the day melts a part of the surface, and the water trickles through the snow, to be turned into ice in the colder central parts. It is also pressed by the snow above till all the air is driven out, and what fell as almost dry, powdery snow is turned into ice. This ice, which is being constantly pressed farther and farther down the valley by the new snow that falls, is a real river of ice, fed by the snows, which, in the form of ice, it slowly carries down into the valleys, where it is melted. This ice-river is called a glacier, and where it ends in a valley, it invariably gives rise to a stream. The ice, like the snow-line, comes farther down the valley in the winter, and in summer retreats up the hill. The stream which rises in a glacier, therefore, does not, like an ordinary stream, rise always at the same place, for in winter its source is much nearer the mouth of the valley than in summer.

Experiment IV. The snow that slides down a mountain slope is called an avalanche.

Place a black-board in front of the class in a sloping position,[19] so as to represent a hillside. Get one of the children to come out and lay on the sloping black-board[20] one book above another. Let the class notice that he can lay several above each other, but that a time soon comes when the books begin to topple over and to roll down the slope of the board. Let another child try with cards. Question the children as to what happens to the snow that falls on the roofs of the houses in winter. They must have noticed that when the fall was very heavy the snow rolled down the roof and fell in a great heap. When the snow gathers on the side of a mountain as it does on the roof of a house, and goes on gathering till it becomes top-heavy and begins to roll down it forms in its descent what is known as an **avalanche.** These avalanches are sometimes very destructive, overwhelming fields and

19 We found the angle quite crucial. Too steep and the books slide away at once. Too shallow and such a huge stack is needed before any topping occurs that damage to books would result. Experiment with this before you let little ones try it.

20 Any board will do of course.

houses, and sometimes entire villages. Remind the children that as a contrast the glacier, though it does its work like other workers, silently, is really the means by which the snow accumulations are carried off.

Glaciers deepen and widen the valleys.

Show the class a picture of a glacier. Explain that many people have been for years observing the motion of these to find, if they could, a satisfactory explanation of it. If a line of wooden pegs be driven into the ice, it is found, the day after, that they have altered their relative positions, and that the pegs towards the middle have moved more rapidly down the valley than those towards the side. The motion is usually found to be very slow – not more than a few inches in the twenty-four hours; but the whole moves onward like a stream. Remind the children that in the lesson on ice they found that it might be compared to treacle or any other viscous fluid than to an ordinary solid.

As the glacier moves down the valley it widens and deepens it, scraping the sides and bottom of the channel, and by means of the stones it carries with it, scratching the rocks that form the sides and bottom of its channel, and carrying with it a huge mass of earth and stones torn out of the bosom of the solid hills. The glacier usually ends in an ice-cave from which issues a stream. The Rhine, the Rhone, the Ganges, &c., have their origin in such an ice-cave. Show the children specimens of ice-marked stones and compare them with water-worn gravel.

Experiment V.

Remind the class that in some parts of the world it is very cold, and there the glaciers often end only in the sea. Get one of the children to come out and put a piece of ice in a beaker of water. Let the class observe that the ice floats in the water. Explain that when a glacier reaches the sea the lower end of it is pushed out and out, till the pressure of the water on it breaks it off. These **icebergs,** as they are called, are then carried away, and in some parts they form a real danger to ships. They are often of very great size, and by cooling the air in their neighbourhood give rise to fogs. Like the glaciers, the icebergs carry with them huge masses of stones and other waste matter from the land. This, as they melt, falls to the bottom of the sea. In this way great banks are formed, and some of these, like the Newfoundland banks, are excellent feeding-grounds for the fish with which they swarm.

SUMMARY
1. Snow is white on account of the air mixed with it.
2. The snow-line is the level above which snow does not melt even in summer.
3. Pieces of ice, when pressed together, reseal.
4. Glaciers are rivers of ice fed by the snows.
5. A snow-slide on a mountain side is called an avalanche.
6. Glaciers deepen and widen the valleys in which they flow.
7. An iceberg is the lower part of a glacier pushed into the sea and floated off.

Glaciers:Experiments with Ice 2
SUMMARY

1. Snow is white on account of the _____ mixed with it.

2. The snow-line is the level above which snow does not _____ even in summer.

3. Pieces of ice, when pressed together, _____.

4. Glaciers are rivers of ice fed by the_____.

5. A snow-slide on a mountain side is called an _____.

6. Glaciers _____ and _____ the valleys in which they flow.

7. An _____ is the lower part of a glacier pushed into the sea and floated off.

8. There are no iceberg-forming glaciers in Switzerland because these are only found in the very _____ _____ of the world and Switzerland has no coast.

✂----------

air, avalanche, cold, deepen, iceberg, latitudes, melt, reseal, snows, widen