CHURCH OF BORKI, RUSSIA.

Our readers will remember the catastrophe of Borki in 1889, the news of which stupefied Russia with astonishment. The train which carried the imperial family was derailed, but by a miracle the illustrious travelers escaped with a few insignificant wounds, while other persons lost their lives.

The Russians considered this preservation of the sovereign and his followers as a providential interposition, and at once made a vow to construct a church on the spot where the accident took place, as a thank offering to God for having preserved the Czar to his beloved subjects.

In four years the sum necessary for the construction of the edifice was collected, and the church, which is a masterpiece of architecture, was lately dedicated by the emperor in person.

Alexander III. was at Borki at this touching ceremony when he received the dispatch announcing the death of Carnot. The news brought tears to the eyes of the emperor, who could not help thinking there was some connection between this tragic death and the danger which he escaped on this very spot.—Le Monde Illustré.

Some Peculiarities of Water.

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It is a common saying that the greatest blessings we enjoy cost us nothing. This is especially true of those two main factors which produce health—fresh air and pure water. We can imagine the demand there would be for clear pure water, and the way in which it would be appreciated, if it were as rare and costly as wine. Not only is it lightly valued, but many intelligent people know very little about the nature of water. I propose, therefore, to say something about this well-known substance, which yet remains to many people so much unknown.

Water in many ways stands alone as perhaps the most singular of all substances studied by students of physics. To illustrate this, let us first consider the manner in which water behaves when it is heated. Take some ice-cold water—that is, water at the temperature of 0° Centigrade (or 32° on Fahrenheit's scale)—and gradually heat it. It will be found that instead of expanding when it grows hotter, as nearly all solids and liquids do, it contracts; in other words, its density increases as the heat is applied, until its temperature rises to 4° C. It has now reached the temperature at which its density is greatest, and after this it begins to expand like an ordinary substance, slower at first and more quickly afterward, till it reaches the temperature of 100° C. (or 212° F.), the boiling point of water; when, however much it is heated, it grows no hotter, all the heat being used in changing the water into steam, that is, in separating the molecules or minute particles of the liquid water to such a distance apart that it becomes a gas, and then exists as steam at the temperature of 100° C. As is well known, the heat required to turn one pound of water at 100° C. into steam at the same temperature is as much as is required to raise the temperature of five hundred and thirty-six pounds of water through 1° C.

This peculiarity of water, that it at first gets heavier when it is heated from the freezing point, makes a very great difference to the inhabitants of the earth, for if water conducted itself as other liquids, consider what would happen to lakes and sheets of water in winter. As the surface of the water was cooled down by contact with the frosty air the topmost layer would grow heavier and sink to the bottom, while its place would be supplied by warmer water from below, and this would go on till the whole of the water in the lake attained the freezing point and then it would freeze from top to bottom, producing a great mass of ice which would take a long time to melt. What actually happens is as follows: The water gets colder at the top and therefore heavier, and sinks till the temperature of 4° C. throughout the whole mass is arrived at. Then as the surface layers cool still further they become lighter than those below, and therefore do not sink, but remain at the top till they fall to 0° C., or freezing point, and then change into solid ice. In this way a crust of immovable ice is formed on the top, while the water below it may be somewhat higher in temperature than the freezing point, and as ice is a bad conductor and it cannot sink downward, the heat escapes but slowly from the water underneath, which is thus preserved from freezing. The result of all this is that we enjoy a temperate climate. If the lakes froze throughout, the fish would all be killed, and summer heat might scarcely suffice to melt the masses of ice which would remain at the bottom while only the surface water was warmed.

Most substances occupy a less space in the solid than in the liquid state; some, however, expand on solidifying, and water belongs to the second and smaller class. An obvious result of this is that ice floats on the top of water, and another result known to us all is that when water freezes in a pipe, the force with which it expands on changing to its solid condition is very apt to burst the pipe, with effects which are often unpleasant on the arrival of the thaw. This expanding force is of extraordinary magnitude, and hollow bombs made of strong and thick metal have been burst by being first filled with water and then thrown out into the open air on a frosty day. When this was done, after a time the metal balls were heard to explode with a report like that of a gun, and the contents forced themselves out in the form of ice.

Substances which, like water, expand when they freeze have their freezing point lowered by pressure. So water when exposed to great pressure freezes at a temperature below 0° C.—that is, it remains liquid, even although it has fallen below the point at which in ordinary circumstances it turns solid. This lowering of the freezing point is but small; for an increase of pressure of one atmosphere—that is, about fourteen pounds on the square inch—the lowering is 0·0075° C., or roughly speaking, under the pressure of one ton weight per square inch ice melts at one degree Centigrade under its ordinary melting point. The pressure of one atmosphere—that is, the pressure of the air above us—is equal to the pressure of thirty-two feet of water; therefore, at a depth of about thirty-two feet in the sea, or in a lake, the pressure is two atmospheres. Now at great depths in the sea the pressure at which the water there exists is much increased, and thus its freezing point is lowered. Besides this, the presence of the salts dissolved in sea water causes its freezing point to be lower.

The fact that the freezing point of water is lowered by pressure has an important bearing on the phenomena of glacier action. If a piece of wire be slung over a block of ice and weights suspended at the ends, it is found on looking at the ice after a time that the wire has penetrated into it, and if the block be left with the weighted wire pressing against it, in course of time the wire will be seen to have made its way completely through the ice. But the block will not be divided in two by this process; the ice closes together again behind the wire, and at the end remains as before, a solid block, with perhaps a line of bubbles marking the course taken by the wire through it. This peculiar behavior of the ice is called regelation, and may be explained by the lowering of the temperature of freezing produced by pressure. Under the wire there is an increased pressure so that the ice melts, but the water thus formed is below the freezing point, so that it at once becomes ice again behind the wire. Similarly broken pieces of ice near its melting point can be squeezed together in a press so as to form a solid block.

Effects like this occur in glaciers. Under pressure at certain points the ice is melted; thus water, occupying less bulk, is formed and the pressure at the particular point is relieved, being passed on to another portion of the mass. But the water formed, being lower in temperature than the surrounding ice, almost immediately resolidifies. Thus the ice behaves as if it had plasticity and was a viscous solid, like wax.

It has also been suggested that ice does not melt suddenly at one particular temperature, but passes through an intermediate viscous state, and that there is a continuous change of temperature from that of cold, hard ice to liquid water; ice thus behaving like a substance such as paraffin wax, which gradually melts, passing through a viscid condition, though in ice the change is much more rapid. If this is so, we can understand why two pieces of ice near the melting point, when placed together, should unite in one block even without pressure, for the hard ice would be at a lower temperature than the surface layer of water between the two pieces of ice, and the latter would therefore soon solidify.

This curious property of ice under pressure accounts for the readiness with which snowballs can be made by squeezing in the hands. When the snow is considerably below the freezing point the manufacture of snowballs becomes more difficult, and does not take place till the snow is somewhat warmed by the hands.

Another peculiarity of water is that it is less compressible at high temperatures than at low. In winter it is more readily reduced in bulk than in summer. This is contrary to the behavior of most liquids at ordinary temperatures, such as alcohol or ether, whose compressibility is increased by a rise of temperature.

In an account of the behavior of water mention must be made of what is known as capillary phenomena. When the end of a tube, with a fine bore, is plunged beneath the surface in a basin of water, it is noticed that the water rises in the tube and stands at a higher level than that of the water surface in the basin. Also when water is sprinkled on a surface which it does not wet, such as velvet, it does not spread over the surface, but stands in isolated beads or drops. In fact, water behaves as if it were surrounded by a contractile skin, and a drop of water may be roughly compared to a fluid contained in an elastic India rubber bag. This peculiarity in the surface layer of water is called superficial tension, and its amount may be measured by noting the height to which water rises in a tube of known diameter, for the tension round the circumference of the top of the column of water balances the weight of the water raised. It may be also measured by observations on the size of drops. It is explained by the different condition of the particles in the surface layer of the water, which on the side next the free air are not under the attraction of other water particles, and so differ from the particles in the midst of the water, which are surrounded on all sides by their neighbors and exposed equally all round to their attraction. It is owing to this surface tension that the pressure inside a soap bubble is greater than the pressure of the atmosphere outside. The velocity of small ripples on the surface of a smooth pond depends on the superficial tension, while the behavior of large waves is controlled by gravity.

The passage of water along the pores of rocks is much facilitated by this capillary action, and has important consequences in the geological effects produced. Water is thus able to penetrate deep down through the crevices of rock, even against considerable pressure exerted against it by steam, and changes in the structure of the rocks are produced by the contained water when under pressure and raised in temperature in the interior of the earth's crust.

By application of great pressure the temperature of vaporization of water may be much raised, and this superheated water has been shown to have considerably augmented chemical activity, and to be able to dissolve and alter glass. The importance of this in the explanation of geological processes is obvious when we consider the great quantity of interstitial water contained in all the rocks of the earth's crust.

What the exact constitution of water or any other liquid is still remains very much a mystery. The molecules or particles of the liquid seem to be able to move about with considerable freedom, but when it becomes solid their position is much more fixed. Why water stuff should occupy a greater space in the solid than in the liquid state no one has been able to explain. One peculiarity of water particles we can observe when we see them in the form of snow, and that is that they arrange themselves in crystals of the hexagonal system. This is well shown in the beautiful minute six-rayed stars of various shapes which are to be seen in freshly fallen snow.

Water boils when the pressure of its vapor produced by heating just exceeds the pressure of the external atmosphere. Thus the temperature at which boiling takes place depends on the atmospheric pressure, and, as is well known, is lower on the top of a mountain than at its base, so that cooking operations become more difficult at a high-lying place such as Quito on the Andes. Also from this cause the temperature of boiling water is less when the barometer is low. Thus we see that while the melting point of ice is lowered by pressure, the point of vaporization of water is raised by increasing the pressure. The law is that when a substance contracts on changing its state, as ice does on becoming water, the temperature at which the change occurs is lowered by pressure; when the change of state is accompanied by expansion, as when water becomes steam, the effect of pressure is to raise the temperature at which the change takes place. An interesting and readily performed experiment on the effect of pressure on the boiling point is the following: Boil some water in a flask; while boiling is going on, cork the flask and remove the source of heat; when the glass vessel has somewhat cooled down, squeeze a sponge saturated with cold water over the flask, and boiling will be seen to recommence. This is owing to the fact that the sudden application of the cold water outside condenses the vapor above the hot water within, and thus considerably reduces the pressure above it, so that bubbles of vapor can be again formed in the liquid and boiling is renewed.

Water consists of the two gases, oxygen and hydrogen, combined together, and it may be decomposed into its elements. If a current of electricity from a battery consisting of several voltaic cells be sent between two plates of platinum placed opposite each other in a vessel of water, bubbles of gas will be observed to rise from the plates while the current passes; these are produced by the splitting up of the water particles, and in course of time the whole of the water may be thus changed into its constituent gases. By collecting the gas given off at the plates in separate jars, it is found that the gas set free at one plate consists of hydrogen, while that collected at the other plate is oxygen, and that the volume of the hydrogen is almost exactly double that of the oxygen. Thus water consists of two volumes of hydrogen combined with one volume of oxygen, and if the combination takes place at a temperature above the boiling point of water, it is found that the volume of steam produced is two-thirds that of the united volumes of the two gases. By placing hydrogen and oxygen gases together in a jar, in the proportion by volume of two to one, and then bringing the mouth of the jar to a flame, a loud explosion occurs; the gases have combined together, and the sides of the vessel are seen to be covered with a dew of condensed drops of water.—Knowledge.

IT has been computed that the death rate of the globe is 68 per minute, 97,790 per day, or 35,717,790 per year. The birth rate is 70 per minute, 100,800 per day, or 36,817,200 per year, reckoning the year to be 365¼ days in length.