at school, but may be most useful to them after they have left it.

As a class, no doubt at the present day the far greater number of our schoolmasters are not qualified to give this instruction, but there are many, and that number, I hope, increasing, who are;—to such, although the following pages may not add much to their knowledge, they may perhaps suggest something in the way of imparting it, and in bringing it to bear upon their teaching. They will also point out to others some things with which they may easily make themselves acquainted, and a few simple experiments which are easily tried.

Among the more striking of these things will be such as the following: the elastic and other properties of air—the nature of aeriform fluids—of water—how the pressure of fluid bodies differs from that of solids—how these properties enable man to turn them to useful purposes, such as windmills, watermills, etc.

Civilized man is able to take advantage of these properties, and avail himself of them as motive powers in the business of life; the *savage, on the contrary, observes the* trees torn up by the winds, stones and rubbish carried down by mountain torrents, but is unable to turn this observation to any useful purpos .

Archbishop Whateley, in his "Introductory Lectures on Political Economy," observes: "Many of the commonest arts, which are the most universal among mankind, and which appear the simplest, and require but a ve y humble degree of intelligence for their exercise, are yet such that we must suppose various accidents to have occurred, and to have been noted—many observations to have been made and combined—and many experiments to have been tried—in order to their being originally invented.

"And the difficulty must have been much greater, before the invention and the familiar use of writing had enabled each generation to record for the use of the next, not only its discoveries, but its observations and incomplete experiments. It has often occurred to me that the longevity of the antediluvians may have been a special provision to meet this difficulty in those early ages which most needed such help. Even now that writing is in use, a single individual, if he live long enough to follow up a train of experiments, has a great advantage in respect of discoveries over a succession of individuals; because he will recollect, when the occasion arises, many of his former observations, and of the ideas that had occurred to his mind, which, at the time, he had not thought worth recording. But previous to the use of writing, the advantage of being able to combine in one's own person the experience of several centuries, must have been of immense importance; and it was an advantage which the circumstances of the case seemed to require."

And first, of the atmosphere—a sphere of air surrounding the earth—has substance and weight, but is invisible—elastic, can be squeezed into a less space by pressure—expands again when the pressure is removed—expands by heat and contracts by cold. This may easily be made intelligible to them in the following way:

Take a tumbler and invert it—or better, take a jar used for gases, with an air-tight stopper, and placing its mouth horizontally on the surface of the water, in a pneumatic trough, or in any vessel of sufficient depth, having a shelf for support, show them, by letting them feel it, the difficulty of pressing the jar down—it offers resistance—increase the pressure, the air occupies less and less space, but the water inside the glass does not rise so high as on the outside;—difference owing to what?—point out. Diminish the pressure, it again expands, showing its elasticity. Of course the attention of the children must be called to the surface of the water inside and outside the jar.

Take out the stopper, the jar sinks by its own weight, proving clearly that the resistance was offered by the air.

Again, allow the jar to fill with water, put in the stopper, and raise the jar nearly to the surface of the water in the trough—explain why the column of water is supported, and would be supported if the jar were 33 feet high at the ordinary pressure of the atmosphere—take out the stopper, the water immediately falls;—or while the column of water remains, show how the jar may be filled with air, by carrying down successive tumblers of it until the jar is filled.

From this, the method first used of taking down barrels of air into a diving bell is easily understood.

Why is it necessary to have a vent-peg in a barrel—or how does it happen that the tea-pot sometimes will not pour? etc.

Air expands by heat. Experiment: a half-blown bladder placed before the fire, the wrinkles disappear, the air expanding it; remove it, the air again contracts.

Place the same under the receiver of an air-pump, it expands from diminished external pressure.

Air has weight. A bottle exhausted of the air is lighter than when full—difference, the weight of a volume of air equal to the contents of the bottle—this means air at the ordinary temperature and pressure of the atmosphere—100 cubic inches dry pure air weigh 31·0117 grains, being for a cubic yard 4½ oz. Balance the bottle when full of air at one end of the scale-beam; then take it off and exhaust it by means of the air-pump, and when again suspended, the other end of the beam will preponderate; restore the equilibrium by pieces of paper, etc.

Drinking through a straw. The teacher, taking a straw and a basin of water, shows them, if the mouth or orifice of the straw is not wholly immersed, or under water, the water will not rise; wholly covered—when they begin to draw out the air the water immediately rises, and why?—What takes place if a hole is made in it above the surface of the water? Water does not rise.—What if you plunge it deeper, so that the hole made in the straw is below the surface?—It immediately rises again.—Reasons for all this, which, if they *comprehend, they will at once* understand the barometer and common pump.

A model in glass of a common pump will be found a very instructive piece of apparatus, and if fitted into a small glass cylinder which can be made air-tight at pleasure by means of a screw, it becomes a much more useful and perfect instrument for teachers, as the pump will work or not, according as the vessel in which the water is, is made air-tight, or not air-tight.

Again a piece of wet leather with a string attached, called a sucker;—press it with the foot against a stone—remove the air between the leather and the stone,—leather, say a square piece three inches on a side, ought to support 9 × 15 pounds, only supports, say 80lbs.—reason why? The vacuum not complete. Then take a circular piece, three inches diameter, let them find the area, and calculate how much it ought to support. This is the principle on which a fly is able to walk along a pane of glass, or across the ceiling.

The common syringe. The pop-gun they are in the habit of making out of a piece of the elder tree—how, by pressing down the rod, the elasticity of the air forces out the pellet at the other end; when they cease to press the rod of it down, the elasticity of the air within forces it back.

A pair of common bellows. Show them the construction—the valve, or trap-door in the bottom board, opening only inwards—the bellows fill with air when the boards are separated—valve shuts down, and the air goes out at the nozzle when they are pressed together—will not work when turned upside down, why?—the current of air makes the fire burn better; the reasons for all this. The teacher should have a pair of bellows, and show what takes place at each movement of the board, and let them handle them themselves.

The barometer. The teacher shows them the instrument, how constructed, and what it is for;—pressure of the air supports a column of mercury about 30 inches—a column of water about 33 feet—the height of the column being less in proportion as the specific gravity of the fluid is greater—not so high if carried to the top of a mountain, and why?—temperature at which water boils varies with the height of the barometer—boils at a less heat on the top of a mountain than at the bottom. The mode of ascertaining the height of mountains by means of the barometer.—Why this method is more to be relied on in tropical climates than in high latitudes, etc.

Pascal, in France, about the year 1647, was the first to make this experiment, which he did at the summit and foot of a mountain in Auvergne, called Le Puy-de-Dôme, the result of which led him to conclude that the air had weight. He also tried it at the top of several high towers, which convinced him of the weight of the atmosphere.

To register the daily altitudes of the barometer and the thermometer, would be a very useful exercise for the pupil-teacher—and in its bearings branches out into a great many things.

The principle of the common pump might now be explained—how the atmospheric pressure which supports the mercury enables them to pump up water—having a model of a pump, or even with paper and pasteboard, showing the kind of tubes and nature of the valves, this may be clearly explained—pointing out how the valves act at each separate movement up and down of piston-rod—the limit to which water can be raised—the experiment of Torricelli, etc.

Supposing the atmospheric pressure about 15lbs. on the square inch—how much on five square inches?—how much on five inches square?—on a square three inches on a side:—on the surface of the floor or the table?—making them have recourse to the two-foot rule; pressure on the animal body, etc., and how counteracted. A fish under water has the pressure of the air, 15lb. on a square inch,