in Japan would cause here. How far away must the sun be! yet it takes light but little more than eight minutes to traverse that tremendous distance. What must be the speed of light? It can travel farther in one minute than the ball as it rushes from the cannon's mouth could go in a year and a half; yet it takes light three years and a half to come from the nearest of those stars, while there are others you can see whose light, arriving only now, left them more than a thousand years ago.

But stranger than all this are the tales light tells. You know that the telephone conveys to you not merely the words but also the tones of a speaker's voice, so, light, though only a rush of waves, each so short that a thousand of the longest of them one after another would not measure the thickness of a single sheet of the paper I hold in my hand, that light reveals to us what the stars are made of, and what state they are in. It tells us that the stars we see with the naked eye, and a thousand times as many that the telescope discovers to us, all belong to one system in which our sun is a small star, and there are other systems as far removed from each other as systems, as the stars are from each other as stars. Some of these systems, when, perhaps ten thousand years ago, the light which is only now arriving with its story left them, were mere whirling rings of gas; others were condensed like our own system into separate suns, each shrouded like our own sun in heavy clouds of metallic vapors; and still other systems had sunk to slow-swinging clusters of fast cooling solid stars.

But the story of light ends not here. Within our own system it tells of at least one cold, dark, dead world, the companion of the star *Algol*, and it has told us of stars that have burst forth in terrible conflagration, such that were the like to happen to our own sun, this solid earth would, almost in the twinkling of an eye, return to the vapor from which it came.

Light tells us also of strange worlds where there are two suns, one blood-red, the other deepest emerald. Strange indeed must be the changes beheld by the dweller on a planet of such a system, as it swings slowly to and fro, his world now glowing a fiery red anon all pale green, and then flaming yellow, under the scorching glare of two suns.

But not of the stars alone are Nature's marvellous stories. She will tell of wonderful things on the earth; of the whirling dance of atoms in every leaping flame; of the clash of the grappling molecules as they build and unbuild in secret the forms of all visible things; of the fairy chains that are woven by the power that sculptures crystals; of the marvels of the magnet that man has taught to speak; of the stroke of the hurtling thunderbolt; of the crash of the down-rushing avalanche; of the awful fires of the volcano; of the mighty throes of the earthquake.

She will tell how the solid rocks unfold the tale of ancient life, and how that same life under different forms still throbs and pulses everywhere, from the eternal snows on the highest mountain peaks and in the wastes of farthest Greenland; from the boiling springs of New Zealand and the alkaline lakes of La Plata, to the deepest depths of ocean, where dwell, amid darkness and eternal silence, those strange fish who never rise to within a mile of the surface, and to whom daylight means death.

She will tell how every stagnant pool and every slimy puddle is peopled by countless myriads of living creatures to whom a water-drop is a vast dominion, and a day a lifelong age.

She will tell how at the bottom of the ocean, unmoved by the fiercest blasts of the tempest, unswayed by the rush of the mightiest tidal wave, lies the oozy mother of all living things, slow pulsing to and fro with earth's procession, each mighty throb lasting 26,000 years!

ELEMENTARY CHEMISTRY.

It is much to be regretted that Elementary Chemistry is not more extensively taught in our Public Schools. There is no subject on the programme more useful, and certainly none half so interesting. The time required need not be more than an hour a week, say the last hour on Friday afternoon. Nor must it be supposed that even that hour would be lost to other studies, for the change of thought would act much like the rotation of crops in agriculture. The introduction of experimental chemistry would brighten up the school, and would impart greater intelligence for the acquisition of other kinds of knowledge. With regard to the method of teaching it, perhaps we cannot do better than give a brief series of lessons. Example is better than precept. We may say, however, that a recitation of mere facts, or descriptions of apparatus and experiments, is worthless. It must never be forgotten that chemistry is peculiarly an experimental science, and while the value of the facts obtained is great, yet its chief value depends on the facilities which it affords for cultivating the powers of observation, and for teaching the methods of experimental induction. It is not expected of the teacher to make chemists, but to teach his pupils to understand, or at least to appreciate the methods and inductive logic of physical science. The elementary facts of chemistry can be efficiently taught only by leading the pupil to observe for himself the phenomena in which they appear, and any attempt to learn them by rote from a text-book will not only fail in its immediate object, but miss the chief end of education. The apparatus required need not cost much. But the cost would be much in another way. To teach chemistry in this way would not demand a very extensive knowledge of the subject on the part of the teacher, but it demands the power of seeing for himself, and of making the pupils see for themselves. We have, however, every confidence on the part of teachers, that these difficulties will be overcome. The importance of the subject both from a practical and from an educational point of view will gradually lead to the means of its attainments.

Exp. 1. Take a piece of fine platinum wire about 5 inches long and weigh it carefully. Hold in the flame of the spirit-lamp and observe that it glows as long as held there. Remove it, and it resumes its original state. Weigh it and the weight is the same as before heating. The change from cold to red-hot, and from red-hot to cold again is only a *temporary* change. The metal is unchanged in form and substance.

Exp. 2. Take a piece of magnesium ribbon about 5 inches long and carefully weigh it. Observe that it resembles the platinum in many respects such as lustre, tenacity, &c. Hold it in the flame of the spirit-lamp till it begins to glow. Remove it, holding it at an angle of 45°, and over a piece of blackened paper to receive the product of the combustion. Observe that it emits much light, gives out white fumes, and *leaves a white substance behind which* is utterly unlike the metal which produced it. Now carefully weigh the white substance, and it will be found that it does not weigh the same as the original magnesium. In this case the metal has undergone a *permanent* change.

Physical and Chemical Changes. The temporary change in the platinum wire is not accompanied by any change in composition, and is called a *physical change*, and *heat, the force that produced* it is called a *physical* force, the permanent change in the magnesium wire which is accompanied by an entire change in its composition is called a *chemical* change, and the force which produced it is called a *chemical* force. The science of chemistry is almost entirely occupied with the nature and effects of this force. Its operations are spoken of as *chemical* action.

Chemical Action Produced by Various Agents. In the preceding experiment chemical action was brought about by heat. It is also produced by other physical forces such as Light and Electricity, of which examples will occur further on. But it is more usually brought about by chemical force, that peculiar force already spoken of, called also Chemical Affinity, Chemical Attraction, and Chemism. We shall usually speak of it as chemical affinity.

Characteristics of Chemical Affinity.

Exp. 3. Take two tumblers and hold them mouth downwards for a few seconds over a spirit-lamp until they become slightly warm. Into one put a few drops of ammonia, into the other a few drops of hydrochloric acid and shake well. Now bring the tumblers together mouth to mouth. Observe, that whereas the contents of both were colorless gases, both are now filled with white fumes, which settles on the sides of the tumblers in the form of a white powder. (1). Hence *under the influence of Chemical Affinity colorless gases may unite to form a solid.*

Exp. 4. Fill a test-tube, to the height of about two inches, with water, and add as much calcium chloride as the water will dissolve. The solution in the test-tube is now said to be *saturated*. Take the same quantity of dilute sulphuric acid (1 of acid to 4 of water), and add it all at once to the solution of calcium chloride. Shake gently, and a white solid is formed. (2). Hence *under the influence of Chemical Affinity liquids often become solids.*

Exp. 5. Rub together in a mortar a small quantity of alum and acetate of lead. The mixture becomes liquid. (3). Hence *under the influence of Chemical Affinity solids may become liquids.*

Exp. 6. Take a thin slice of phosphorus, taking care to cut it under water. Dry well with blotting paper and do not handle after drying. Place it on a plate and sprinkle a little iodine upon it. Cover with a wide-mouthed bottle. The two substances will com-