ART. XIII.—CHEMICAL RELATIONS OF HEAT. WITH EXPERIMENTS. BY PROFESSOR LAWSON, PH. D., L. L. D., *Dalhousie College.*

HE explained the nature of heat as a form of force, co-relative with light, mechanical energy, electricity, magnetism, and chemical affinity, showing the one to be convertible into the other. These forces influence matter; upon the varying degrees of heat depends the condition of matter, whether it exists as a solid, a liquid, or a gas. Water is solid at low temperatures, when we give it more heat, raising the temperature to 32°, it becomes a mobile liquid; if the temperature be raised to 212°, the water has its condition changed to that of an invisible gas, which we commonly call steam. As soon as the excess of heat above 212° is removed, the gas (or steam) passes back into the liquid state, and then if further reduced (below 32°) into a solid, which is the present condition of all surface water in this part of the world, except in the deep sea or in deep lakes, &c., where it has not been cooled down to that temperature. In still waters, however, a foot or two of the surface forms our ice-bridges and skating ponds).

Illustrations were given to show that when a liquid passes into a gaseous state it absorbs heat, which it necessarily takes from surrounding bodies, and makes them cold. Ammonia, ether, alcohol, vinegar, all readily volatilise, pass into the gaseous state, and the absorption of heat, to enable them to do so, necessarily produces a sensation of cold on the skin. The most remarkable body shown was sulphur dioxide, which, when poured on the back of the hand, evaporates instantaneously, produces intense cold, and freezes the flesh if used in too great quantity. The freezing of the hand in this way presents all the uncomfortable and dangerous symptoms of natural freezing at an excessively low temperature in an extreme climate. The evaporation of sulphur dioxide *in a current of air* produces a still lower temperature, freezing mercury, which does not solidify till the temperature goes down to 39° below zero. All these temperatures are of the Fahrenheit scale, the only one known in Nova Scotia except in scientific laboratories, where the Centigrade system is coming into use, and must in time prevail.

Professor Lawson entered into a full description of sulphur dioxide, which is always produced as a gas when sulphur is burnt in the air or oxygen; it is also produced in the burning of coals containing pyrites or sulphur compounds; and the wilting of house plants, and probably the occurrence of coughs and colds in winter, are to some extent due to its occurrence in sitting rooms. Its old name is sulphurous acid gas. It is known also by the names of sulphurous oxide, sulphurous anhydride, &c., but every one is familiar with it by smell, as that of the "smell" of burning sulphur. The gas extinguishes flame, and the burning of sulphur is a common remedy for extinguishing a fire in a chimney. However, several metals will burn in the gas, decomposing it—as, for example, potassium, which forms polysulphide, sulphate, and thiosulphate; when simply heated to about 2200°, it is decomposed into free S and O. It has decided bleaching properties, and is used for wool, silk, sponge, isinglass, and other animal substances that would be injured by chlorine; also for straw hats and willow baskets. A solution of the gas will remove fruit stains and wine stains from linen. It acts as a disinfectant, an antiseptic, and has been used in preserving meat; it is also an arrester of fermentation, on account of which wine and beer casks are sulphured, and sulphites are used in breweries and sugar factories. It preserves vellum and catgut. One of its most remarkable effects is that produced by its inhalation; it is not only irritating, like hydrochloric acid gas, and suffocating, like chlorine, but, when inhaled in a concentrated form, it *immediately* produces catarrh and sore throat, with all the ordinary symptoms of the natural malady, from which both the Professor and his assistants (Messrs. Lindsay and Stewart, medical students) had suffered more or less during successive investigations.

The gas is 2½ times the weight of atmospheric air (sp. gr., 2·25). It is very soluble in water, which absorbs about 40 times its bulk of the gas at ordinary temperatures; the solution, when exposed to air in a bottle, changes slowly to solution of H 2 S O 4. At low temperatures a crystallized hydrate of sulphurous acid is obtained. In preparing the gas for condensation, the tubes must be kept dry, otherwise this hydrate forms in them and stops them up. At zero F, which may be readily attained by a freezing mixture of old frozen snow and salt (newly-fallen snow does not answer well,) the sulphur dioxide gas is easily condensed to a liquid, which is heavier than water, sp. gr.=2·38). The boiling temperature of this liquid, however, is 14°, and when in sealed tubes (if the temperature be raised to 60°, that of ordinary air) it exerts a pressure of 2½ atmospheres. At between 105° and 110° below zero the liquid freezes into solid crystals, which are heavier than the liquid. To succeed perfectly in showing the boiling of the liquid dioxide by heat of the hand, it is necessary to have a twist of cotton, enveloping freezing mixture, around the top of the tube, to provide for rapid condensation; or the tube may be fitted with an encircling short piece of much wider tube at the top to contain the freezing mixture.

The next experiment was a very remarkable one. A platinum crucible was made red-hot, the dioxide was thrown into it, and immediately passed into the spheroidal state, water was added, and the red-hot crucible became filled with ice—the whole having cooled down in half a minute from red-hot to a temperature far below freezing, and under favorable circumstances it would reach 40° below zero, so that even mercury could be frozen.

Professor Lawson, in referring to the great opportunities which we have in this climate of studying the effects of heat, exhibited a large bottle containing several pounds of glacial sulphuric acid that had separated and crystallized spontaneously from a solution of ferrous sulphate in oil of vitriol during the recent severe weather. The small portion of solution left in the bottle had a sp. gr. of 1.612.