of which he discovered the hydro-carbon toluene. But he soon abandoned organic chemistry, and his most important work was in inorganic and thermal chemistry. In 1850 he discovered anhy­drous nitric acid, a substance interesting not only in itself but as the first obtained of an important group, the so-called “anhy- drides ” of the monobasic acids. In 1855 he succeeded in obtaining aluminium in mass. This metal, of which clay is the hydrated silicate, is of course one of the most abundant of metals, but was not obtained in the metallic state until Wohler in 1827 decomposed its chloride by means of potassium. The aluminium thus prepared was in the form of a fine powder, and, although the isolation of the metal was of great theoretical importance, there did not seem much prospect of a practical application of the discovery. In 1845 Wohler returned to the subject and by using large quantities of material obtained small globules of an obviously metallic character. Deville, who knew only Wohler’s paper of 1827, set to work to prepare aluminium, not for the sake of the metal itself, but with the view of procuring by the action of aluminium on chloride of aluminium a lower chloride from which a series of new compounds corresponding to the ferrous salts might be obtained. He did not succeed in this, but he did succeed in producing globules of aluminium of considerable size. This led him to perfect the process, and ultimately he devised a method by which aluminium could be prepared on a large scale. The first use to which he put the metal was to make a medal with the name of Wohler and the date 1827. In connexion with the preparation of aluminium may be mentioned Deville’s investigations, partly with Wohler, into the allotropic forms of silicon and boron.

Along with Debray, Deville studied the platinum metals ; their object was on the one hand to prepare the six metals in a state of purity and on the other to obtain a suitable metal for the standard metre. In the course of these investigations large quantities of platinum and of the alloys of platinum and iridium were fused and cast, @@1 and the methods used for obtaining the necessary high temperatures were applied to the fusion of other refractory metals, such as cobalt, nickel, chromium, and manganese.

Along with Troost, Deville devised a method for determining the density of vapours at very high temperatures and applied it to the cases of sulphur, selenium, tellurium, zinc, cadmium, and many other substances boiling at temperatures up to 1400° C. The interesting and important results have been already described (see Chemistry and Molecule). Deville made a large number of ingenious experiments on the artificial production of minerals. Among these may be specially mentioned the formation of apatite and isoinorphous minerals and of crystallized oxides. Deville and Caron found that when the vapour of a metallic fluoride acts on fused boracic acid the fluorine and the oxygen change places, a metallic oxide remains in crystals, while the gaseous fluoride of boron escapes. In this way they prepared corundum (crystallized oxide of aluminium) and sapphire, ruby and emerald ; coloured forms of corundum were obtained by mixing small quantities of fluoride of chromium with the fluoride of aluminium. Another method discovered by Deville for the preparation of crystallized oxides is of great interest. When an amorphous oxide—such as amorphous ferric oxide—is heated to redness and exposed to a slow current of hydrochloric acid gas, it gradually changes into a crystal­line oxide of the same composition. In this way Deville obtained hæmatite, tinstone, periclase, and other crystalline oxides. This conversion of an amorphous into a crystalline substance without change of composition, by the action of a gas (in this case hydrochloric acid) which itself undergoes no change, is one of those mysterious processes which used to be referred to a “catalytic force” or called “actions by contact”; like many such actions, this has been shown by Deville to belong to the same class of phenomena as dissociation.

This leads us to Deville’s greatest contribution to general chemistry. Many chemical actions have been long known which take place either in the one or the other sense according to certain conditions. For instance, if a tube containing metallic iron is heated to redness and steam passed through it, water is decomposed, black oxide of iron is formed, and hydrogen escapes. If, on the other hand, the tube is filled with black oxide of iron and hydrogen passed through, the oxide is reduced and water is formed. Both of these opposite changes occur at the very same temperature. Again, a solution of sulph-hydrate of potassium is completely decomposed by passing a current of carbonic acid gas through it for a sufficient time, sulphuretted hydrogen being given off and bicarbonate re­maining in solution. But exactly the opposite happens if we begin with bicarbonate and pass sulphuretted hydrogen gas through it: carbonic acid gas escapes and the solution ultimately contains nothing but sulph-hydrate. An imperfect, unsatisfactory ex­planation of some of the phenomena of which these are examples was given by Berthollet; it remained for Deville to give a general theory and show their relation to such physical phenomena as

@@@1 The metre commission fused a quarter of a ton of the alloy at a single operation.

evaporation and condensation. This he did by his experimental work on “ Dissociation ” and his theoretical discussion of the facts in papers published in the *Comptes Rendus.* He gave a very com­plete and clear account of the whole subject in a lecture delivered before the Chemical Society of Paris in 1866.

As illustrations we shall take a few cases as different from one another as possible.

It has long been known that carbonate of lime—limestone— when heated is decomposed into quicklime and carbonic acid gas, and that this decomposition takes place the more quickly the more thoroughly the carbonic acid produced is removed. Sir James Hall showed that, if the carbonate of lime is heated in a closed vessel strong enough to resist the pressure of the carbonic acid gas, it can be fused, only a small part undergoing decomposition. Deville examined this relation quantitatively and showed that, if in a closed vessel we have quicklime, carbonate of lime, and carbonic acid gas, the pressure of the *carbonic acid gas* depends on the temperature only, and is quite independent of the quantity of the quicklime or of the carbonate of lime, as long as there is some, however little, of both, and is also quite uninfluenced by the presence of other gases. It will be seen that this case exactly resembles that of the evaporation of water. In a closed vessel containing liquid water and water-vapour the pressure of the *water-vapour* depends on the temperature only and is independent of the quantity of liquid water, as long as there is any, and is not influenced by the presence of other gases. In both cases, if we disturb the equilibrium and then leave tilings to themselves the equilibrium is restored. If in the first case we diminish the pressure of the carbonic acid gas, some carbonate of lime decomposes, yielding carbonic acid gas until the pressure is raised to what it was ; if we increase the pressure, some of the carbonic acid combines with quicklime until the pressure is reduced to what it was before. In the second case, if we diminish the pressure, some of the liquid water evaporates ; if we increase it, some of the water-vapour condenses, and so the pressure is restored. Rise of temperature causes in the one case evaporation of water, in the other decomposition of carbonate of lime,—in both increase of pressure. Lowering of temperature causes in the one case condensation of water-vapour, in the other combination of quicklime and carbonic acid gas,—in both diminution of pressure.

As a second instance we may take the dissociation of water. Just as water-vapour condenses into liquid water under certain conditions, but always with the evolution of heat (latent heat of vapour), so the mixture of oxygen and hydrogen in the proper proportion to form water combines, under certain conditions, to form water-vapour, but always with the evolution of heat (heat of combination). In both cases we have change of state but no change of composition, and in both we have evolution of heat. In the first case we can reverse the process: heat the liquid water, heat becomes latent, liquid water changes into water-vapour. There is a certain definite pressure of water-vapour corresponding to the temperature: raise the temperature, more water evaporates, the pressure of water- vapour increases. It occurred to Deville, to whom both changes were equally physical, that in the second case the process should be reversible also,—that on heating the water-vapour it ought to decompose into oxygen and hydrogen, heat disappearing here also, and that, as there is a definite pressure of water-vapour correspond­ing to the temperature (often called the tension of water-vapour), so there should be a definite ratio of the pressure of hydrogen and oxygen to that of water-vapour (the tension of dissociation). Deville showed in the most conclusive manner that this is the case and devised ingenious arrangements for proving the actual occurrence of dissociation.

Another case very fully investigated by Deville is that already mentioned,—viz., the action of water-vapour on iron, and of hydrogen on oxide of iron. He showed that, for a fixed temperature, water-vapour and hydrogen are in equilibrium in presence of iron and oxide of iron when the pressures of the two gases, hydrogen and water-vapour, are in a certain ratio quite independent of the quantity of the iron or of the oxide of iron, as long as there is some of each. If the ratio is changed, say by increasing the pressure of the water-vapour, chemical action takes place: water is decomposed, oxide of iron is formed, and hydrogen set free. Again, if the pressure of the water-vapour is diminished, part of the hydrogen acts on oxide of iron, reducing it and forming water. In both cases the ratio of pressures is restored. This gives an easy explanation of the apparently anomalous results mentioned above. When a current of hydrogen is passed over oxide of iron the water-vapour produced is swept away as fast as it is formed ; the ratio of the pressure of hydrogen to that of water-vapour is therefore always greater than that required for equilibrium and reduction of iron, and formation of water goes on continuously until all the oxide of iron is reduced. In the same way, a current of water-vapour carries away the hydrogen as fast as it is produced; the ratio of the pressure of hydrogen to that of water-vapour is always less than that required for equilibrium, and the oxidation of iron and production of hydrogen goes on until no metallic iron remains. Exactly the same explanation applies to the action of carbonic acid gas on solution of sulph-