for its purification. L. Oppenheim *(Jour. prakt. Chem.,* 1857, 71, p. 279) fuses the commercial selenium with potassium cyanide in a stream of hydrogen, takes up the melt in water and passes air through the solution; the precipitated tellurium is filtered off, and the solution then supersaturated with hydrochloric acid, when selenium is gradually deposited. E. Divers, *(Chem. News,* 1885, 51, p. 199) dissolves the element in boiling concentrated sulphuric acid and reduces the resulting selenious acid with sulphur dioxide, filters off the precipitate and washes it with water and alcohol. The resulting product, however, still contains traces of sulphur. C. Hugot *(Ann. chim. phys.,* 1900 (7), 21, p. 34) converts the element by dilute nitric acid into selenium dioxide which is then sublimed, and dissolved in water. Any sulphuric acid present is removed by baryta water, the precipitated barium sulphate filtered off, the solution acidified by hydrochloric acid and reduced by sulphur dioxide.

Several allotropic forms of selenium have been described, but the work of A. P. Saunders *(Jour. Phys. Chem.,* 1900, 4, p. 423) seems to establish that the element exists in three distinct forms, namely *liquid selenium* (which includes the vitreous, soluble and amorphous forms), *crystalline red selenium* (which includes, perhaps, two very closely allied forms), and *crystalline, grey* or *metallic selenium.* Liquid selenium becomes more and more viscous in character as its temperature falls from 220° C. to 60° C.; it is soft at about 60°, but is hard and brittle between 30° and 40°. It shows a conchoidal fracture. The amorphous variety, which only differs from the vitreous form in its state of aggregation, is obtained by reducing solutions of selenious acid with sulphur dioxide. It is slightly soluble in carbon bisulphide. The red crystalline variety is obtained by crystallization of selenium from carbon bisulphide, or by leaving the amorphous form in contact with the same solvent. The grey crystalline form is obtained by heating the other varieties, and is the most stable form from ordinary temperatures up to 217°. All varieties of selenium dissolve in concentrated sulphuric acid, forming a green solution (see also R. Marc, *Ber.,* 1906, 39, p. 697; and W. Oechsner de Coninck, *Comples rendus,* 1906, 143, p. 682). A colloidal selenium was obtained by C. Paal and C. Koch *(Ber.,* 1905, 38, p. 526) by reducing selenious acid dissolved in an aqueous solution of sodium protalbate with hydrazine hydrate and hydrochloric acid, the precipitate obtained being then dissolved in sodium carbonate. The specific gravity of selenium is 4·8; the specific heat varies from 0∙0716 to 0∙1147, depending upon the particular form. Selenium combines directly with hydrogen when heated in the gas, and with fluorine in the cold. It bums with a blue flame when heated in the air or in oxygen, at the same time giving a characteristic smell of rotten horse­radish, a reaction which serves for the recognition of the element. It combines directly with nitrogen, phosphorus, antimony and carbon, and with all the metals (except gold) to form selenides, of which those of the alkali and alkaline earth metals are soluble in water. Metallic selenium is a conductor of electricity, and its conductivity is increased by light; this property has been utilized in apparatus for transmitting photographs by telegraphy (sec Telegraph).

*Seleniuretted Hydrogen,* H2Se, is obtained by the direct union of its constituent elements in the heat; by the decomposition of various selenides with mineral acids; by the decomposition of aluminium selenide, or phosphorus selenide with water; by the action of selenium on a concentrated solution of hydriodic acid; and by heating selenium with colophene (H. Moissan), or better with paraffin wax (H. Wuyts and A. Stewart, *Bull. Soc. chim. Belg.,* 1909, 23, p. 9). It is a colourless gas which possesses a characteristic smell, more unpleasant than sulphuretted hydrogen. Its physiological effects are much more persistent and injurious than sulphuretted hydrogen, producing temporary paralysis of the olfactory nerves and inflammation of the mucous membrane. It may be liquefied, the liquid boiling at -41° to -42°C. and becoming solid at -68°C. (K. Olszewski). It is somewhat soluble in water and forms a hydrate. It is decomposed by heat, burns with a blue flame, and behaves as a reducing agent. It precipitates many of the heavy metals as selenides when passed into solutions of their salts. Its aqueous solution is unstable, gradually depositing red selenium on standing. *Selenium fluoride,* SeF4, is obtained as a colourless liquid by the direct action of fluorine or selenium (P. Lebeau, *Comptes rendus,* 1907, 144, p. 1042). It boils at about 100°C., attacks glass readily, is decomposed by water, and dissolves iodine. *Selenium dichlοride,* Se2Cl2, is obtained by the action of chlorine on selenium; by the action of phosphorus pentachloride on selenium or the dioxide; by the action of hydrochloric acid on seleno-sulphur trioxide (E. Divers, *Chem. News,* 1884, 49, p. 212): 2S∙SeO3+2HCl=H2SO4+

S∙SeO3∙SeCl2(+H2O)->Se2Cl2+SO2(OH)Cl; and by heating selenium and selenium tetrachloride to 100° C. in a sealed tube. It is a yellowish-brown oily liquid which commences to distil at 130° C. with partial decomposition into selenium and the tetrachloride. It is decomposed by water with formation of selenium and selenious acid : 2Se2C12+3H2O = H2SeO3+3Se+4HCl. *Selenium tetrachloride,* SeCl4, is obtained by passing excess of chlorine over selenium; by the action of phosphorus pentachloride on selenium dioxide: SeO2+PCl5 = SeOCl2+POCl3; 3SeOCl2+2POCl3=3SeCl4+P2O5;and by the action of thionyl chloride on selenium oxychloride. It is a white solid which can be obtained crystalline by sublimation in a current of chlorine. It dissociates when heated, and is decomposed by water with production of selenious acid. It dissolves selenium. Similar bromides and iodides are known. *Selenyl chloride,* SeOCl2, is formed when selenium tetrachloride is heated with the dioxide to 150°C. (R. Weber, *Pogg.Ann.,* 1859, 184, p. 615), or when the dioxide is heated with common salt; 2SeO2+2NaCl=SeOCl2+Na2SeO3. It is a yellow-coloured liquid which solidifies at o° C., and fumes on exposure to air. It combines with titanium and tin bichlorides and with antimony trichloride, and it is decomposed by water.

*Selenium dioxide,* SeO2, is prepared by burning selenium in oxygen, or by oxidizing selenium with nitric acid and heating the residue. It may also be prepared by the action of selenium on sulphur oxyfluoride (H. Moissan, *Bull. Soc. chιm.,* 1902 (3). 27, p. 251): 2SO2F2+Se+SiO2=SeO2+2SO2+SiF4. It crystallizes in needles

or prisms and volatilizes when heated, giving a pale yellow vapour. It is very hygroscopic, and dissolves in water and alcohol. It reacts with the caustic alkalis to form selenites, and combines directly with hydrocyanic acid. It is decomposed by hydriodic acid with liberation of selenium and iodine, and by ammonia with formation of selenium and nitrogen. *Selenious acid,* H2SeO3, is obtained in the crystalline form when a solution of selenium dioxide in water is concentrated over sulphuric acid. It effloresces on exposure to air. Oxidizing agents readily convert it into selenic acid, whilst reducing agents transform it into selenium. It yields normal, acid and super-acid salts *(e.g.* KHSeO3∙H2SeO2). It is decomposed by many acids with liberation of selenium. *Selenic acid,* H2SeO4, was discovered by E. Mitscherlich *(Pogg. Ann.,* 1827, 85, p. 623). Its salts, the selenates, are obtained by the oxidation of the selenites, and the free acid may be obtained by the decomposition of the lead or barium salt. It is also obtained in the electrolysis of solutions of selenious acid (C. Manuelli and G. Lazzarini, *Gazz.,* 1909, 39, 1, p. 50). The acid crystallizes in hexagonal prisms and melts at 58° C. It dissolves in water and, yields a hydrate of composition H2SeO4·H2O. It is very hygroscopic, dissolves sulphur readily and acts on organic compounds in a manner similar to sulphuric acid. It decomposes when strongly heated. The selenates are isomorphous with the chromates and sulphates. A compound of selenium and sulphur has been described as resulting from the action of sulphuretted hydrogen on selenious acid, but A. Gutbier *(Zeit. anorg. Chem.,* 1905, 43, p. 384) is of the opinion that in this reaction, at ordinary temperature, a simple reduction takes place, leading to the formation of a mixture of sulphur and selenium. *Selenium sulphoχide,* SeSO3, is formed as a yellowish crystalline mass when selenium is warmed with sulphur trioxide. It decomposes when heated above 350 C., and also in the presence of water. A compound of composition, SeSO5, has been obtained by the addition of selenium dioxide to sulphuric acid saturated with sulphur trioxide (R. Metznen, *Ann. chim. phys.,* 1898, (7), 15, p. 203). It crystallizes in colourless needles. *Setenosulphurιc acid,* H2SeSO3, is only known in the form of its salts, which are usually obtained by the action of selenium on solutions of the metallic sulphites, a seleno- trithionate being simultaneously produced. The salts are unstable and readily decompose when heated. *Selenotrithionic acid,* H2SeS2O5, is also obtained in the form of its potassium salt by the action of potassium hydrogen sulphite on a selenosulphate. It is readily decomposed by acids with liberation of sulphur dioxide and selenium.

*Nitrogen selenide,* N2Se2, is formed by the decomposition of selenium chloride with ammonia (A Verneuil, *Bull. soc. chim.,* 1882, 38, p. 548). It crystallizes readily from benzene or acetic acid and ex­plodes when subjected to shock or when heated. It is also obtained when dry ammonia gas is passed into a dilute solution of selenyl chloride in benzene, the precipitate produced being digested with potassium cyanide to remove any selenium (V. Lenher and E. Wolcsensky, *Jour. Amer. Chem. Soc.,* 1907, 29, p. 215). It is a brick- red powder which explodes when heated to 130° C. *Selenium cyanide,* Se(CN)2, is obtained by decomposing silver selenocyanide with cyanogen iodide, or by the action of silver cyanide on a solution of selenium bromide in carbon bisulphide. It crystallizes in tables and is very soluble in water. A more complex cyanide, Se3(CN)2, is obtained by passing a current of chlorine and air into an aqueous solution of potassium selenocyanîde (A. VerneuÜ, *Ann. chim. phys.,* 1886 (6), 9, p. 289). It crystallizes in golden yellow needles and is decomposed by boiling water: 2Se3(CN)2+2H2O = 4HCN + SeO2 + 5Se. When heated to 180° C. *in vacuo* it yields the simple cyanide Se(CN)2. *Potassium selenocyanide,* KSeCN, is obtained by the action of selenium on a concentrated aqueous solution of potassium cyanide, or by heating selenium with anhydrous potassium ferrocyanide (W. Crookes, *Ann.,* 1851, 78, p. 177). It crystallizes in needles.