CHAPTER VI.

SOLIDS.

General Properties of Solids. Solids differ from gases and liquids in possessing definite, individual forms. Matter in the solid state is capable of resisting considerable shearing and tensile stresses. In terms of the kinetic theory of matter, the mutual attractive forces exerted by the molecules of solids must be regarded as superior to the attractive forces between the molecules of gases and liquids. With one or two exceptions all solids expand when heated, but there is no simple law expressing the relation between the increment of volume and the temperature. Rigidity is another characteristic property of solids, it being much more apparent in some than in others. Many solids are constantly undergoing a process of transformation into the gaseous state at their free surfaces, such a change being known as *sublimation.* Just as when a gas is sufficiently cooled it passes into the liquid state, so on cooling a liquid below a certain temperature, it passes into the solid state. The reverse transformations are also possible, a solid being liquefied when sufficiently heated, and the resulting liquid completely vaporized if the heating be continued. Heat energy is required to effect transition from the solid to the liquid state, just as heat energy is required to effect transition from the liquid to the gaseous state.

Obviously a substance in the solid state contains less energy than it does in the liquid state. The number of calories required to melt 1 gram of a solid substance is called its *heat of fusion.* It is often difficult to decide whether a substance should be classified as a solid or as a liquid. For example the behavior of certain amorphous substances such as pitch, amber and glass, is similar to that of a very viscous, inelastic liquid. Solids are generally classified as *crystalline* or *amorphous.* In crystalline solids the molecules are supposed to be arranged in some definite order, this arrangement manifesting itself in the crystal form. An amorphous solid on the other hand may be considered as a liquid possessing great viscosity and small elasticity. The physical properties of amorphous solids have the same values in all directions, whereas in crystalline solids the values of these properties are different in different directions. When an amorphous solid is heated it gradually softens and eventually acquires the properties characteristic of a liquid, but during the process of heating there is no definite point of transition from the solid to the liquid state. On the other hand when a crystalline solid is heated there is a sharp change from one state to the other at a definite temperature, this temperature being termed the *melting-point.*

Crystallography. The study of the definite geometrical forms assumed by cyrstalline solids is termed *crystallography.* The number of crystalline forms known is exceedingly large, but it is possible to reduce the many varieties to a few classes or systems by referring their principle elements — the planes — to definite lines called axes. These axes are so drawn within the crystal that the crystal surfaces are symmetrically arranged about them. This system of classification was proposed by Weiss in 1809. He showed that notwithstanding the multiplicity of crystal forms encountered in nature, it is possible to consider them as belonging to one or the other of six systems of crystallization.

The six systems of Weiss are as follows: —

1. *The Regular System.* Three axes of equal length, intersecting each other at right angles, (Fig. 40 a).

2. *The Tetragonal System.* Two axes of equal length and the third axis either longer or shorter, all three axes intersecting at right angles, (Fig. 41 a).

3. *The Hexagonal System.* Three axes of equal length, all in the same plane and intersecting at angles of 60°, and a fourth axis, either longer or shorter and perpendicular to the plane of the other three (Fig. 42 a).

4. *The Rhombic System.* Three axes of unequal length, all intersecting each other at right angles (Fig. 43 a).

5. *The Monoclinic System.* Three axes of unequal length, two

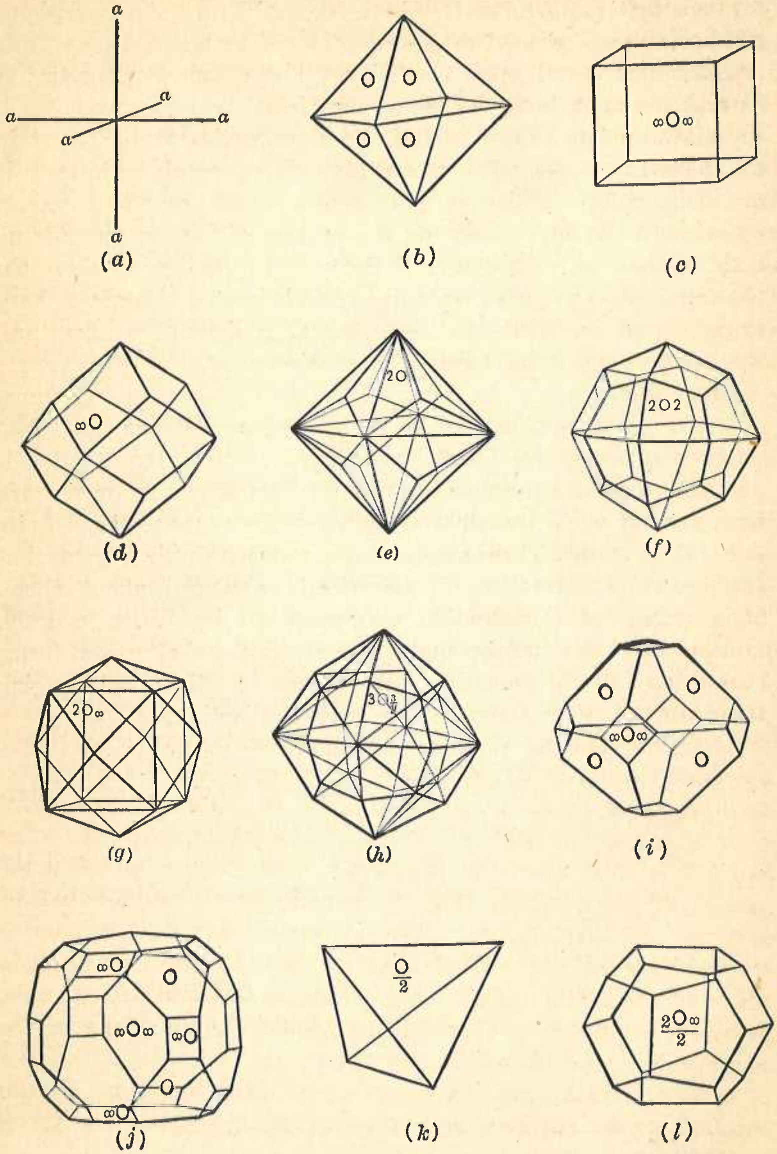

Fig. 40.