Melting point

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The temperature at which a solid changes to a liquid. For pure substances, the melting or fusion process occurs at a single temperature, the temperature rise with addition of heat being arrested until melting is complete. The direct transition from solid phase to gas phase is not properly called melting, but preferably, sublimation.

Melting points reported in the literature, unless specifically stated otherwise, have been measured under an applied pressure of 1 atm (≃100 kilopascals), usually 1 atm of air. (The solubility of air in the liquid is a complicating factor in precision measurements.) The Clapeyron equation for the pressure dependence of the absolute melting temperature T_m is the equation below,

$$\frac{dT_m}{dP} = \frac{T_m \Delta V_f}{\Delta H_f}$$

where ΔV_f is the change in volume, ΔH_f the heat absorbed during the fusion process, and P the applied pressure. Upon melting, all substances absorb heat, and most substances expand; consequently an increase in pressure normally raises the melting point. A few substances, of which water is the most notable example, contract upon melting; thus, the application of pressure to ice at 0°C (32°F) causes it to melt. Large changes in pressure are required to produce significant shifts in the melting point; a pressure of 10 atm (1 megapascal) lowers the melting point of ice by only 0.075°C (0.135°F).

A sufficient decrease in temperature at ordinary pressures causes all pure substances except helium to freeze to solids; the lowest normal melting point is that of hydrogen, at 14 K (−434°F) and one of the highest is that of rhenium, at 3700 K. Liquid helium can be transformed into a solid only by applying a pressure in excess of 25 atm (2500 kPa).

For solutions of two or more components, the melting process normally occurs over a range of temperatures, and a distinction is made between the melting point, the temperature at which the first trace of liquid appears, and the freezing point, the higher temperature at which the last trace of solid disappears, or equivalently, if one is cooling rather than heating, the temperature at which the first trace of solid appears. Measurement of the freezing point of a solution and the difference between it and the freezing point of the pure solvent provides a convenient method of determining the molecular weight of a dissolved solute, because the freezing point depression of a solution is proportional to the molality of the solute. *See also:* PHASE EQUILIBRIUM; SOLUTION; SUBLIMATION; TRIPLE POINT.

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Additional Readings

W. H. Brown et al, *Introduction to General, Organic, and Biochemistry*, 9th ed., Brooks/Cole, Belmont, CA, 2010

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S. S. Zumdahl and D. J. Decoste, *Basic Chemistry*, 7th ed., Brooks/Cole, Belmont, CA, 2010