Paper : Physical Chemistry (I A)
Topic : Physical Properties of liquids

Dr. Om Prakash Singh,
Dept. of Chemistry,
Maharaja Coll., Ara.

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The normal boiling point for water is 100°C. This observed boiling point is high enough as compared to the expected value. The predicted boiling point for H_2O is very low i.e. below −62°C. This anomalous boiling point for water (i.e. 100°C) is the result of hydrogen bonding between water molecules.

Hydrogen bonding is also responsible for the expansion of water when it freezes. The water molecules in the solid state have tetrahedral arrangement for the two lone pairs of electrons and two single bonds radiating out from the oxygen. The lone pairs on the 'O' atom can be attracted to nearby water molecules through hydrogen bonds resulting a cage like structure.

Molar Volume :- At standard temperature and pressure (STP) the molar volume (V_m) is defined as the volume occupied by one mole of a chemical element or compound. It can be calculated by dividing the molar mass (M) by mass density (ρ). The formula of the molar volume is expressed as

$$V_m = \frac{M}{\rho}$$

The standard temperature used is 273 K or 0°C. Standard pressure is 1 atmosphere, i.e. 760 mm of Hg.

From the above expression we can also say that the molar volume is directly proportional to the molar mass and inversely proportional to density.

Molar volume can be simply found by dividing the volume of a sample by the number of moles of that sample i.e. $V_m = \frac{V}{n}$

For an ideal mixture containing N components, the molar volume is the weighted sum of the molar volumes of its individual components.

For a real mixture the molar volume can not be calculated without knowing the density:

$$V_m = \frac{\sum_{i=1}^{N} x_i M_i}{\rho_{mixture}}$$

There are many liquid-liquid mixtures, for instance mixing pure ethanol and pure water, which may experience contraction or expansion upon mixing. This effect is called 'excess volume'.

Molar volume has the SI unit cubic metres per mole (m^3/mol), although it is typically more practical to use the units cubic decimetres per mole (dm^3/mol) for gases and cubic centimetres per mole (cm^3/mol) for liquids and solids.

At STP all ideal gases with their one mole acquires the volume of 22.4 L.

Liquid water has a mass density of 1 g mL^{-1}. Since water has a molecular weight of 18 g mol^{-1}, 1 mole will have a mass of 18 g. From the density this should have a volume of only 18 mL. Clearly this is a lot less than an ideal gas at STP which is more than 1000 times larger in terms of its molar volume.

Vapour Pressure :- When a liquid is placed in an open vessel, it evaporates. The molecules in the liquid are moving with different kinetic energies. The molecules that possess above-average kinetic energies can overcome the intermolecular forces that hold them in the liquid. These energetic molecules escape from the liquid surface as vapour. The process by which molecules of a liquid go into the gaseous state (vapours) is called Vaporisation or Evaporation.

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