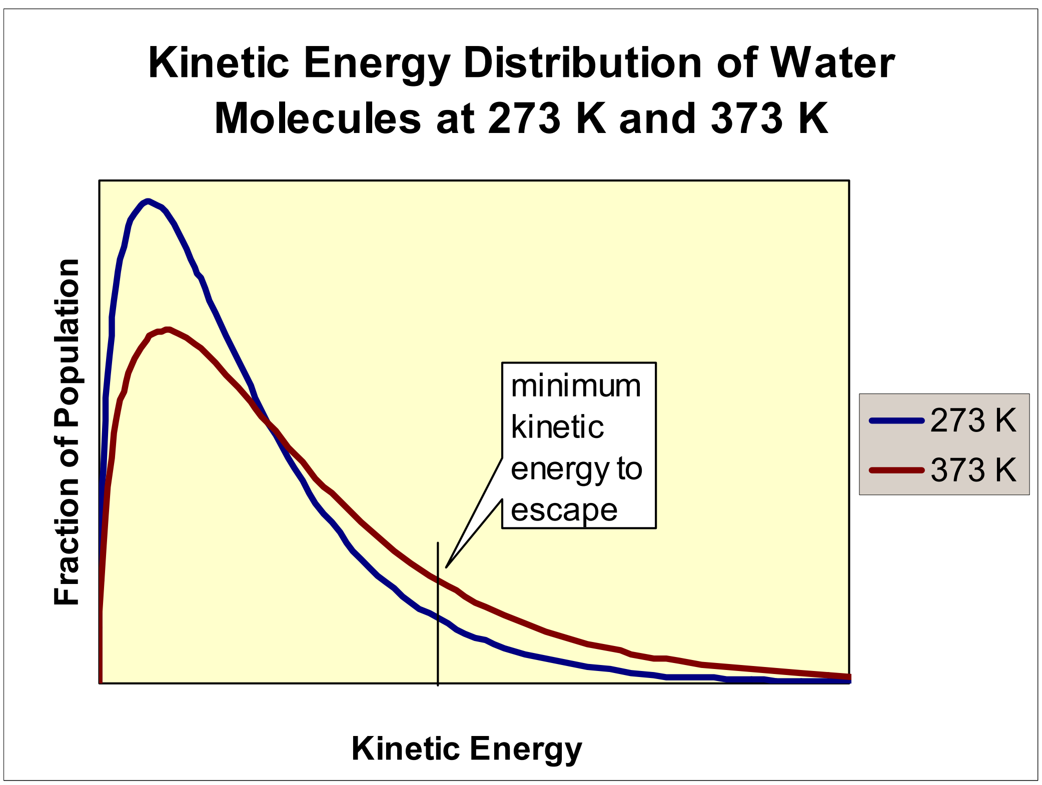
Evaporation

- ✔ All liquids have a tendency to lose molecules through **evaporation**.

- ✔ A molecule escapes into the vapor when it has enough kinetic energy to overcome the attractive forces between molecules within the liquid.

- ✔ At higher temperatures a larger portion of the population has the necessary kinetic energy to escape the liquid, K_{esc}.

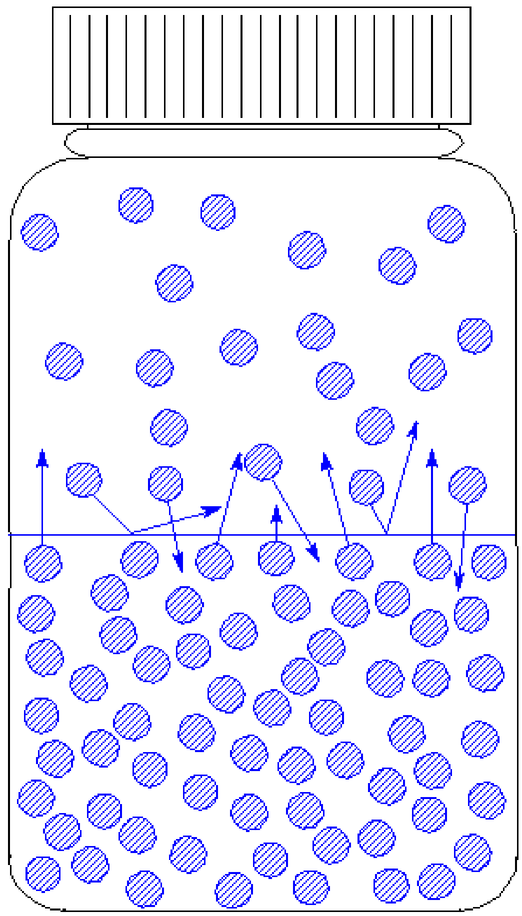


Enthalpy of Vaporization, Volatility, and Boiling Points

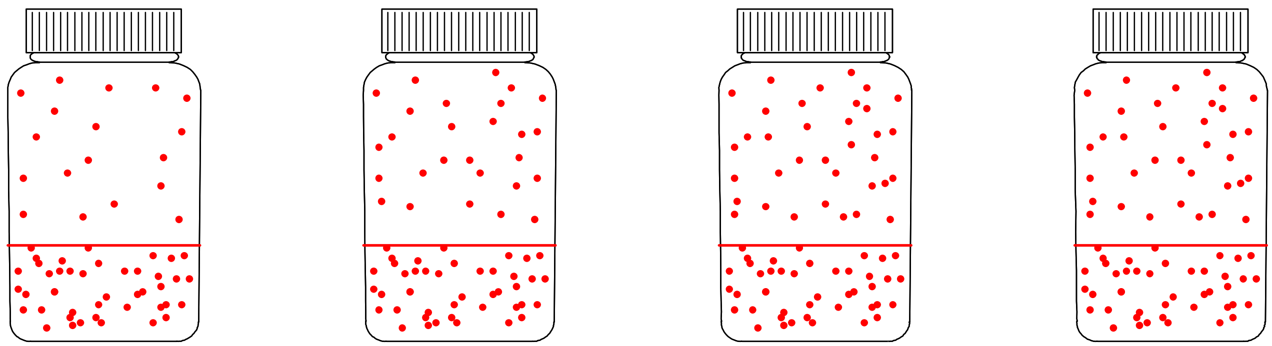
✔ **Volatile** substances (L., *volare* = to fly) have low values of ΔH_{vap} and require less heat to escape their liquid phases, implying a lower K_{esc}

Substance	Formula	ΔH^{o}_{vap} (kJ/mol)	b.p. (°C)
water	H_2O	40.7	100.0
ethanol	C_2H_5OH	38.6	78.5
carbon tetrachloride	CCl_4	30.0	76.7
diethyl ether	$(C_2H_5)_2O$	26.0	34.6

Evaporation-Condensation in a Closed Container



Development of Liquid-Vapor Equilibrium



t_0 t_1 $t_2 = t_{eq}$ $t_3 > t_{eq}$

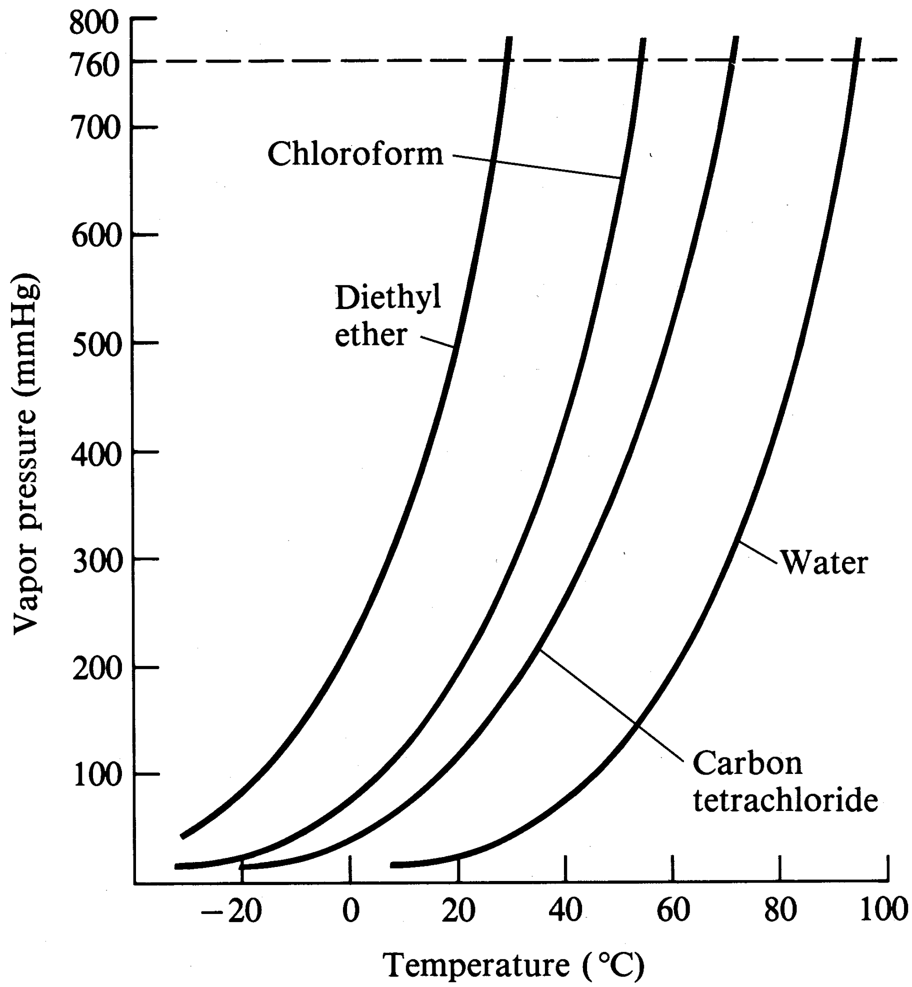
☞ The partial pressure of the vapor in equilibrium with the liquid is the **vapor pressure**.

☞ The vapor pressure depends upon the following:

1. The nature of the liquid (ΔH_{vap})
2. The kinetic energy of the molecules ($\propto T$)
3. The vapor concentration ($\propto T$)

☞ All vapor pressures increase with increasing temperature.

Vapor Pressure vs. Temperature for Typical Liquids



Critical Point

✔ More applied pressure is required to condense a vapor at higher temperature.

✔ Higher temperature means more rapid molecular motion, which makes it more difficult to establish the attractive forces needed for condensation.

☞ The limit on the ability to condense a vapor with applied pressure at high temperature defines the **critical point**.

- ✏ The **critical temperature**, T_c, is the point above which a gas cannot be liquified, regardless of the pressure.

- ✏ The **critical pressure**, P_c, is the minimum pressure needed to cause condensation at the critical temperature.

✔ Water's critical point is the T_c = 374 °C and P_c = 217.7 atm.

Supercritical Fluids

☞ Above the critical point the substance exists as a **supercritical fluid**.

✔ Supercritical fluids have high kinetic energy molecules forced together by high pressures.

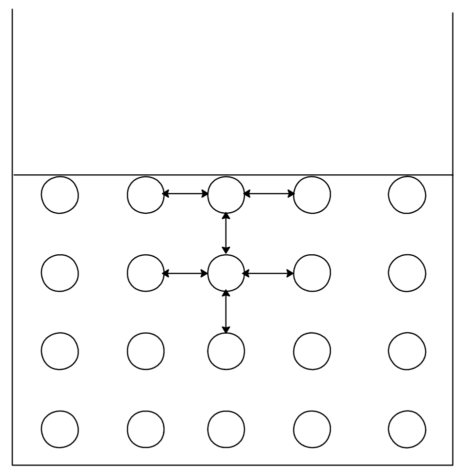
- ✏ Densities are similar to liquid densities.
- ✏ Can have useful properties as solvents.

✔ Supercritical CO_2 is produced above T_c = 30.99 °C and P_c = 72.8 atm.

- ✏ Good solvent for oils, but not polar substances.
- ✏ Used for decaffeinating coffee and a new dry cleaning method.

Surface Tension of Liquids

✔ The absence of intermolecular attractions above the surface of liquid creates a barrier or "skin".



✔ Surface tension allows light objects with greater density than water to "float" on the surface (e.g., powdered sulfur, water bugs).

✔ Surface tension causes water to “bead” on a polished metal surface.