Pressure is defined as force/area, which is measured in units of \( \frac{\text{lb}}{\text{in}^2} \) (psi) or \( \frac{\text{N}}{\text{m}^2} \) (Pa), atm, mmHg (torr) or kPa.

At sea level, the air pushes down with a pressure of 1 atm = 14.7 psi = 760 mmHg = 760 torr = 101.3 kPa.

You can convert from one unit to the other with conversion factors such as \( \frac{760 \text{ mmHg}}{101.3 \text{ kPa}} \) or \( \frac{101.3 \text{ kPa}}{760 \text{ mmHg}} \).

Example: 500 mmHg \times \frac{101.3 \text{ kPa}}{760 \text{ mmHg}} = 66.6 \text{ kPa}

A manometer is used to measure pressure.

PE = potential energy changes which are times when the heat energy separates the molecules from solid to liquid or liquid to gas.

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NRG is REQUIRED

solid → liquid melting or fusion

liquid → gas vaporization

evaporation or boiling

solid → gas sublimation

NRG is RELEASED

liquid → solid freezing

gas → liquid condensation

gas → solid solidification

The energy involved in the phase change is calculated using

heat of fusion (solid → liquid or liquid → solid)

heat of vaporization (liquid → gas or gas → liquid)
11 • Phases of Matter
Assumptions of the Kinetic Molecular Theory
(5 of 8)

- Gases are tiny particles separated by large areas of empty space.
- Molecules are in constant, random motion.
- Pressure results from collisions of the gas molecules with the walls of the container.
- Molecules of an “ideal” gas show no attraction or repulsion for each other. “Real” gases have intermolecular forces of attraction (IMF’s) that are strongest in solids and weakest in gases.
- Some molecules are moving fast, some are moving slowly, temperature is a measure of the average KE… corresponds to the average speed.
(Relate this to the KE distribution curve Fig 11-13.)

11 • Phases of Matter
Vapor Pressure, IMF’s, and KE
(6 of 8)

Vapor pressure is the push exerted by the particles of vapor that escape from a liquid (or solid). It is a good measure of the IMF’s of a substance.

Large vapor pressure = small IMF’s
(particles can easily escape the liquid to become vapor)

Small vapor pressure = large IMF’s
(particles are tightly held as a liquid)

Greater temperature (KE) allows more particles to escape against the IMF’s and so as temp ↑, vapor pressure ↑.

11 • Phases of Matter
Boiling Point
(7 of 8)

Boiling occurs when the vapor pressure of a substance = the air pressure above the liquid.

You can make a liquid boil by increasing the vapor pressure of the liquid (heating it up) or by lowering the air pressure above the liquid. Both were demonstrated.

Use a chart of vapor pressure values or a graph to determine the vapor pressure needed to boil at various temperature and pressure conditions..

↑ boiling points (BP) ~ ↑ IMF’s ~ ↓ vapor pressures.

Altitude (low air pressure) lowers the boiling temperature of water in an open container (increases cooking time).

11 • Phases of Matter
Solids, Liquids, and Gases
(8 of 8)

For most substances, the solid is the most dense form of matter because the atoms are packed together tightly.

Water is unique: when the solid forms, the molecules spread out and form a stable, but less dense pattern, ice.