11 • Phases of Matter
Pressure Definition and Units
(1 of 8)

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

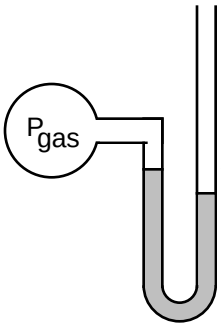
At **sea level**, the air pushes down with a pressure of
1 atm = 14.7 psi = **760 mmHg** = **760 torr** = **101.3 kPa**

You can **convert** from one unit to the other with conversion factors such as $\frac{760\ mmHg}{101.3\ kPa}$ or $\frac{101.3\ kPa}{760\ mmHg}$

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

11 • Phases of Matter
Manometers and Measuring Pressure
(2 of 8)

A **manometer** is used to measure pressure.

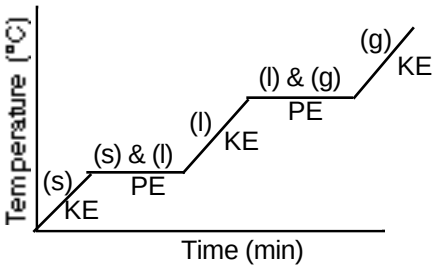


If difference in height is 155 mm and atmospheric pressure = 100 kPa,

convert the difference in the mercury levels to kPa and subtract from the air pressure because you can SEE that the air pressure is greater than the gas pressure.

A **barometer** is a special case of a manometer.

11 • Phases of Matter
Heating Curve and Energy Changes
(3 of 8)



KE = kinetic energy changes which are times when the heat energy speeds up the molecules.

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

11 • Phases of Matter
Names of Phase Changes and Energy
(4 of 8)

NRG is REQUIRED	**NRG is RELEASED**
solid → liquid melting or fusion	**liquid → solid** freezing
liquid → gas vaporization evaporation or boiling	**gas → liquid** condensation
solid → gas sublimation	**gas → solid** solidification

The **energy** involved in the phase change is <u>calculated</u> 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.

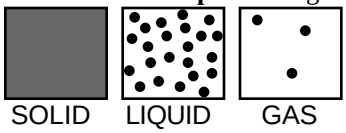
You can make a liquid boil by **increasing** the **vapor pressure** of the liquid (heating it up) or by **lowering** the **air pressure** above the liquid. Both were demonstrated.

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**.

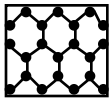
Altitude (low air pressure) lowers the boiling temperature of water in an open container (increases cooking time).

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**.



SOLID WATER