# Gas laws and Gas Stoichiometry - Notes

Unit 09, Chemistry Themed

# What is pressure and why do we care about it?

- Pressure is a measure of how widely distributed a force is
- See the snow shoes? Snow shoes spread out a person's weight so they can walk ON snow and not fall through it.
- Pressure is Force/area – like pounds per square inch, psi (or $lb/in^2$)
- You might fill your car tires to 35 psi, your bike might take 70 psi
- In chemistry, and in tires, gases exert pressure. Air molecules fly around at about 1000 mph (this speed is NOT related to wind) – collisions of air ($N_2$ and $O_2$) molecules within a container is what we call pressure

# What is pressure and why do we care about it?

- In chemistry we care study gases in containers to learn how they generate pressure. What are some examples of gas containers?
  - Balloon
  - Tire
  - Propane tank (for your gas grill at home)
  - Oxygen tank (for someone that needs it medically)
- Gas pressure depends on
  - T: Temperature – heat up a gas and the molecules move faster resulting in more collisions within the container (higher pressure)
  - n: Number of molecules – more gas molecules means more collisions
  - V: Volume – Bigger containers mean fewer gas molecule collisions with the container – on average, fewer molecules will happen to be near the container walls if the space is vast

# Units of pressure

- Pressure units vary and you are expected to be familiar with a few of the common ones (you won't have to memorize any numbers)
  - **Atm** stands for "atmospheres". The approximate pressure of earth's atmosphere.
  - **mmHg** stands for millimeters of mercury. Gas pressure can be measured by a column of liquid. Mercury is so dense that a column of mercury 760 mm tall exerts the same pressure as miles of air. So, we make pressure measurement devices using mercury.
  - **Torr** is the same as mmHg. Atmospheric pressure is about 760 Torr.
  - **kPa** is short for kilopascal. A pascal is the basic metric system unit for pressure and means a Newton of force distributed over a meter squared of area. When you take physics you will use a Newton a lot.
  - **Psi** is pounds per square inch. These are non-metric "English units". This is the unit you will see mostly in your every day life, so you should be familiar with it.
- 1 atm = 760 mmHg = 760 Torr = 101.3 kPa = 14.7 psi

# Converting between pressure units

- 1 atm = 760 mmHg = 760 Torr = 101.3 kPa = 14.7 psi
- The above equalities will be available to you during testing – no need to memorize their numeric values
- Use the equality the fits to make a conversion factor and then use a t-chart
- Example: The air pressure on the barometer says it's 735 mmHg right now. How many psi is this?
- Given = 735 mmHg, Conversion factor (equality): 760 mmHg = 14.7 psi

$$735 \text{ mmHg} \times \frac{14.7 \text{ psi}}{760 \text{ mmHg}} = 14.2 \text{ psi}$$

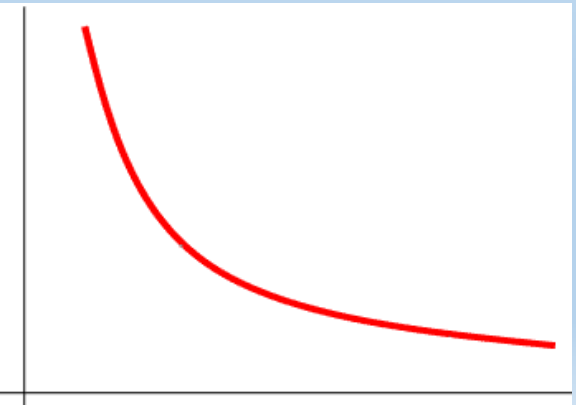
# Mathematical Relationships

- Measured data often follows patterns
- We expect you can see data tables and recognize two common relationships
- You NEED to be able to recognize these patterns from sets of data, not just the P, V, T examples done in class. You also needs to know graphical shapes (below)

**A x B = constant**

When A values increase,

B values decrease



**A/B = constant**

When A values increase,

so do B values

# Mathematical Relationships - gases

- For the variables P, V and T the relationships are:
  - PV = constant (Boyle's law), V/T = constant (Charles's law), P/T = constant (John's law)
  - You don't need to memorize which law is which
  - These three laws merge to become the combined gas law: PV/T = constant
  - Make sure T is ALWAYS in Kelvins only and P, V may be any units (but SAME throughout problem)
- Combined gas law is useful when something changes (P, V or T), so:

$P_1V_1/T_1 = P_2V_2/T_2$

- Ideal gas law: PV = nRT
  - An "equation of state" – nothing changes; also, moles are part of problem
  - Use ONLY proper units for each: P (atm), V (liters), n (moles), T (Kelvins)
  - R = 0.0821 L-atm/mol-K (you must memorize the number, not the units)
  - Easy way to remember: 0.08 is legal limit and 21 is