GAS LAWS

Unit Learning Goal

Throughout this unit we will be working on **ALL** of our overall learning goals for this course.

Remember our unit goal with respect to **<u>understanding concepts</u>** is:

We are learning about the laws that explain the behavior of gases and how to solve problems related to these laws.

We are learning about the applications of these laws as they pertain to the world around us.

To support this learning goal today's learning goal is…

- We are learning about Boyle's Law.

Introduction to Gas Laws

The gas laws look at four factors:

1. **Volume (L)**
   - Volume of a container
2. **Temperature (K)**
   - Measure of kinetic energy
3. **Pressure (kPa)**
   - $P = F/A$ (N/m^2)
4. **Mass (g)**

The Law of Proportionality

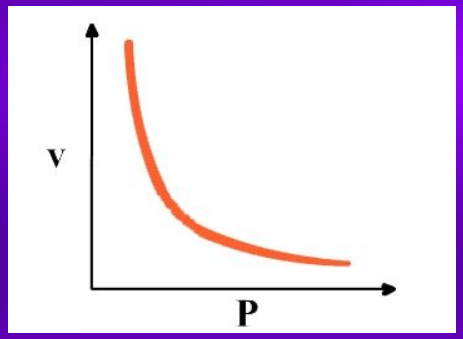
If $a \ \alpha \ b$ we will introduce a constant "k"

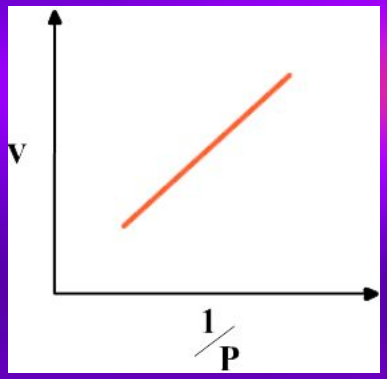
Then $a = kb$

Boyle's Law

The **volume** of a fixed mass of gas varies *inversely* with the applied **pressure** when the temperature is kept constant.

$$V \propto \frac{1}{P} \; for \; T = constant$$





Thus $V = k\left(\frac{1}{P}\right)$

We can rearrange this formula to yield $PV = k$

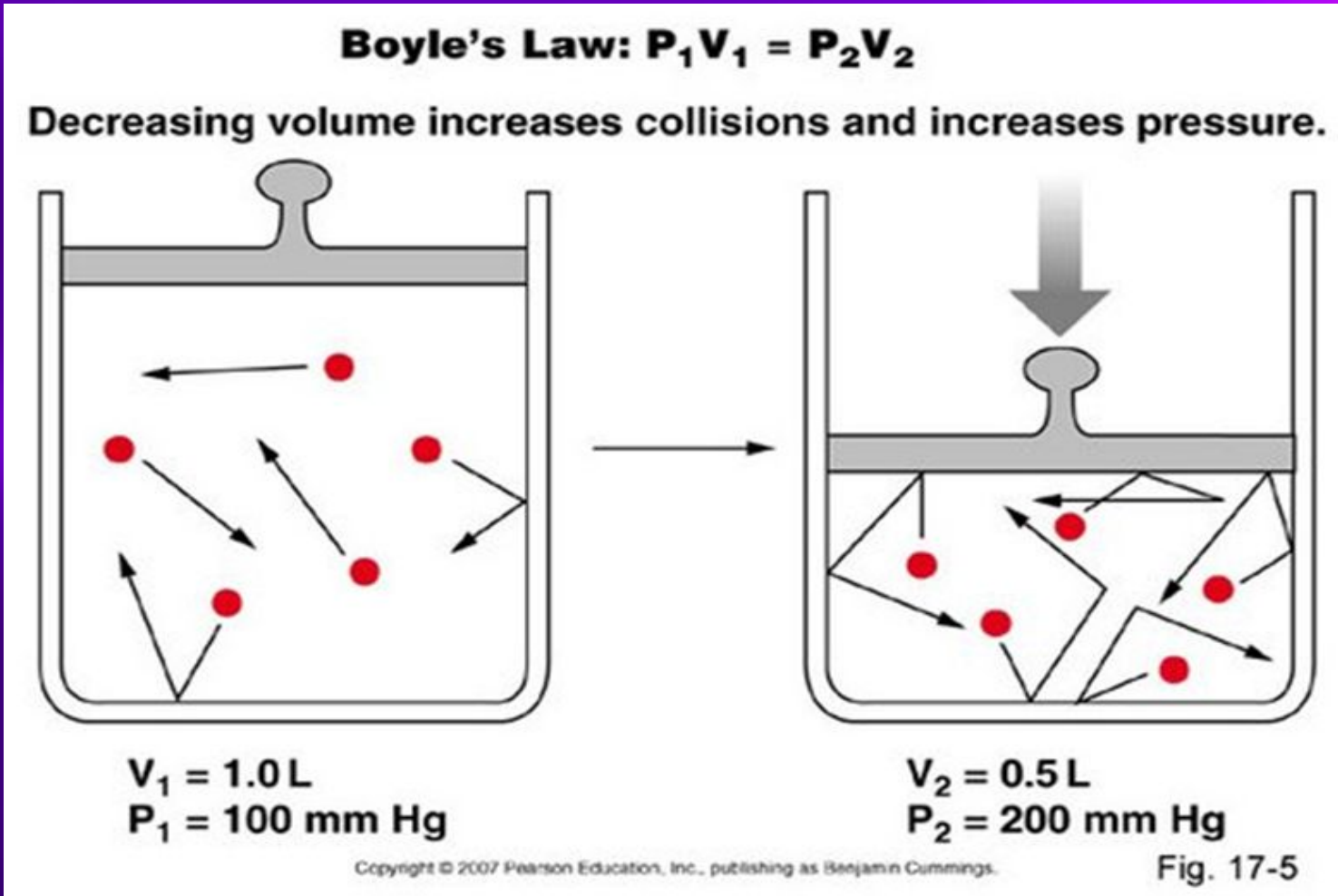
Since k is a constant, it is true for a gas at any pressure!

Thus, for case 1 (initial conditions) and case 2 (final conditions)

$$P_1 V_1 = P_2 V_2$$

Boyle's Law

$$P_1 V_1 = P_2 V_2$$



Boyle's Law

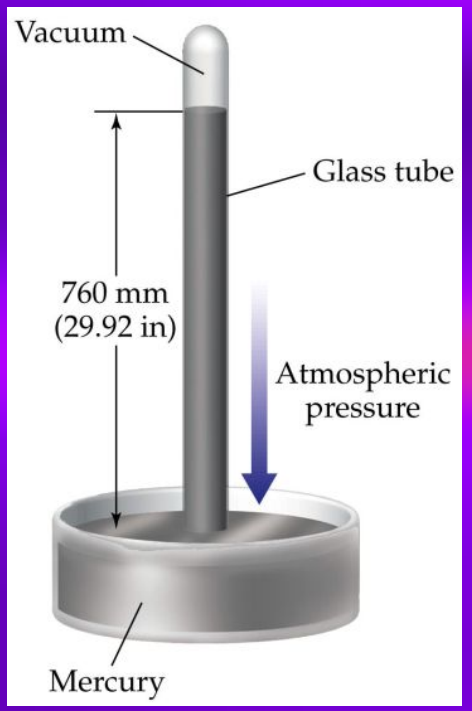
The Units!

Volume must be measured in litres (L) or cubic centimetres (cm^3) and pressure usually in kilopascals (kPa), but other units are accepted.

Standard atmospheric pressure at 0°C is 101.3 kPa

Numerous units may be used for pressure

atm	atmospheres
mm Hg	millimeters of mercury
torr	torr
psi	pounds per square inch



101.3 kPa = 1 atm = 760 mm Hg = 760 torr = 14.7 psi

Boyle's Law

Sample Problem:

A 4.50 L balloon filled with helium is collected at room temperature and standard atmospheric pressure. The balloon is then submerged in a tub of water, also at room temperature such that the external pressure is increased to 110.2 kPa.

What is the final volume of the balloon?

- P_1 = 101.3 kPa
- V_1 = 4.50 L
- P_2 = 110.2 kPa
- V_2 = ?

$$V_1P_1 = V_2P_2$$

(4.50L) (101.3 kPa) = V_2 (110.2 kPa)

4.137 L = V_2

the unit for answer is in L (volume)
the volume of the balloon has decreased due to increase in pressure

Applications of Boyle's Law

You have probably been well acquainted with Boyle's law for most of your life and haven't even realized it. We experience examples of it on a regular basis. Several times a day, we might use it as a tool, while we also sometimes recognize it as a killer.

Please take a moment and look at a couple of these examples.

Practice explaining these phenomena using Boyle's Law

- Spray Paint
- The Syringe
- The Soda Can
- The Bends

Success Criteria

By the end of this lesson…

- ❑ I can explain Boyle's Law as it pertains to the world around me.
- ❑ I can solve problems related to Boyle's Law.