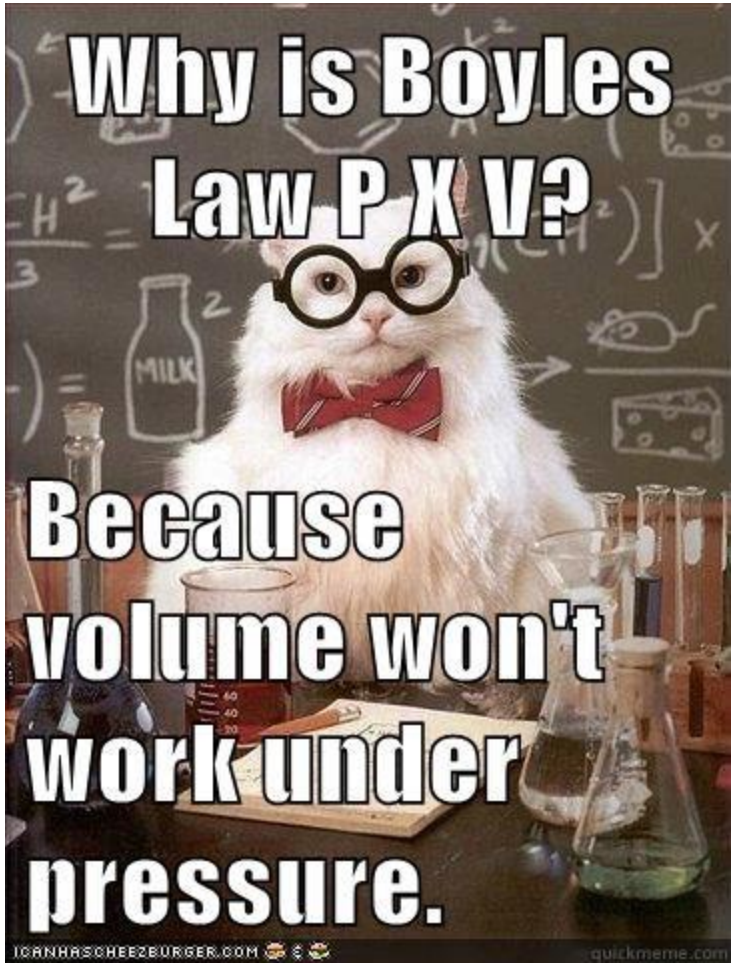
Boyle's Law



Outcomes:

- Experiment to develop the relationship between pressure and volume of a gas using visual, numerical and graphical representations. *Include: contribution of Boyle*

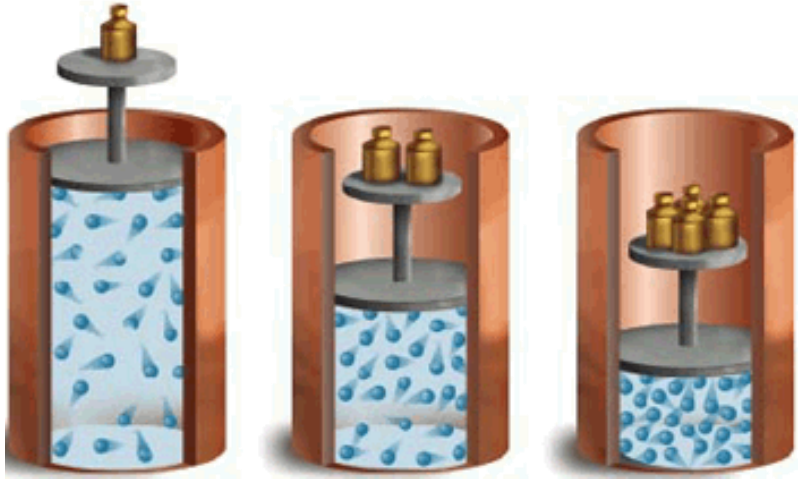
A bit about gases…

You have seen the use of air for its **CUSHIONING** effect in **TIRES**, air **MATTRESSES**, air-bag **SUSPENSION**, etc.

http://www.futureonehomes.com/how-to-use-the-air-mattress-in-your-design/

http://photo.indexbuzz.net/photo/2070423/air_bag_suspension

This is possible because gases can be **COMPRESSED**, since their particles are well **SEPARATED**.

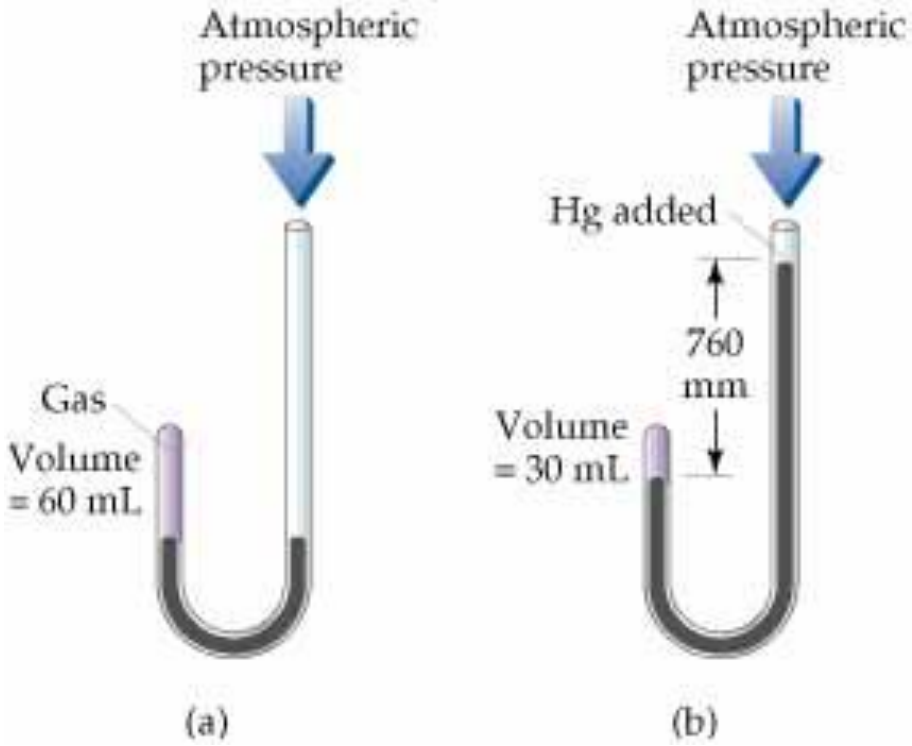


http://factfile.org/10-facts-about-boyles-law

Robert Boyle (1627-1691)

http://www.newworldencyclopedia.org/entry/Robert_Boyle

- Researched the "**SPRING**" of air.
- He trapped a fixed amount of air in a "**J-TUBE**" with **MERCURY**.
- He then changed it's **PRESSURE** by **ADDING**/**REMOVING** mercury, and measured its **VOLUME**.



http://wps.prenhall.com/wps/media/objects/3311/3391331/blb1003.html

Note: the **AMOUNT** of **GAS** and the **TEMPERATURE** remained **CONSTANT**.

Robert Boyle (1627-1691)

- He noticed that as he **INCREASED** the **PRESSURE**, the **VOLUME** of the air **DECREASED**
  → ***Inverse relationship***

- He then tried to find a mathematical relationship between pressure and volume of a gas…

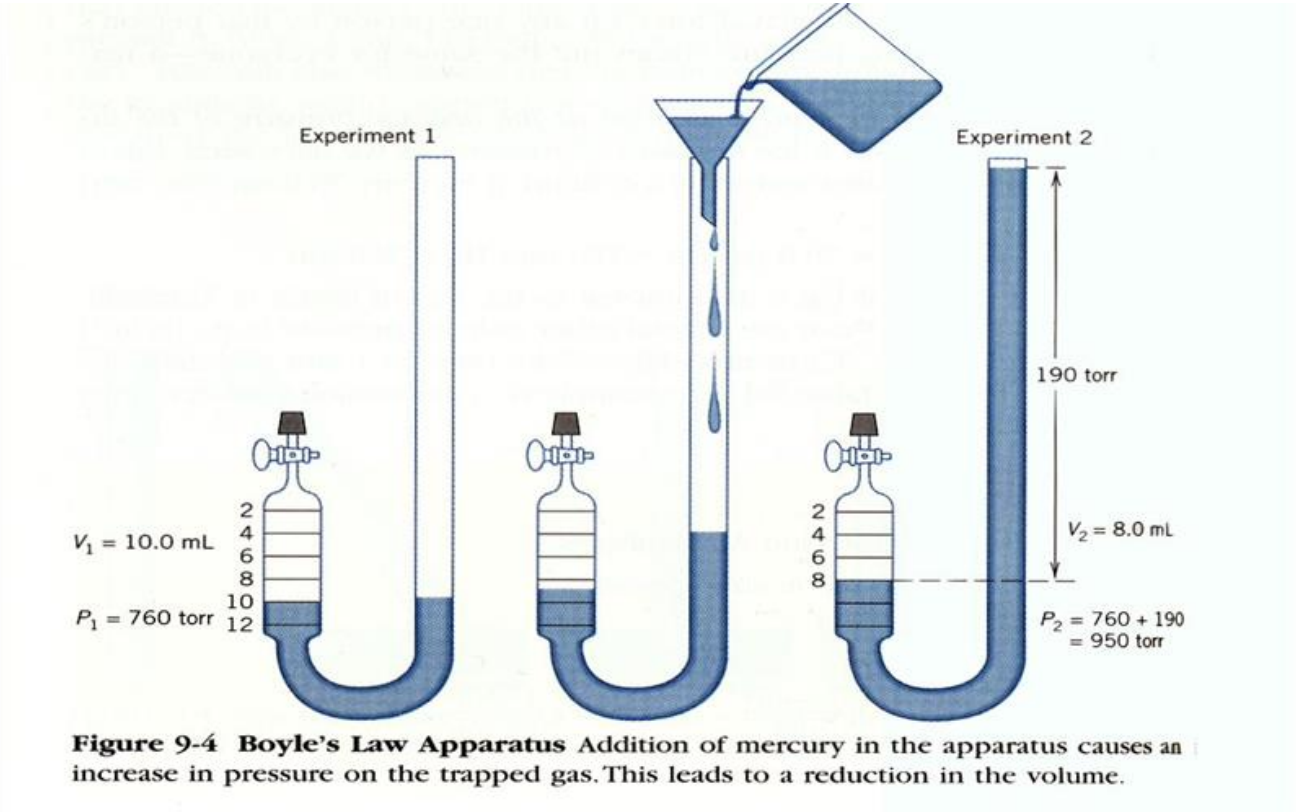


Figure 9-4 Boyle's Law Apparatus Addition of mercury in the apparatus causes an increase in pressure on the trapped gas. This leads to a reduction in the volume.

Robert Boyle (1627-1691)

Boyles law simulation…

Notice the downward slope of the curve, indicating an inverse relationship.

To see if there is indeed a relationship, let's ***multiply the pressure and the volume for each trial***. Record your answers in the space below.

Trial: 1. _____

2. _____

3. _____

4. _____

Robert Boyle (1627-1691)

Questions:

1. What do you notice about the values of your results?

2. Is the difference between your results significant?

3. Based on your results, state (in words) what you think Boyle's Law may be.

4. Now state your law as a formula.

Boyle's Law

Boyle's Law:

"If the temperature remains constant, the product of the pressure and the volume of a gas has a constant value"

The formula for this statement is:

$$PV = k_1$$

Where: P = **PRESSURE** (in ***atm, mmHg, kPa, mbar***)

V = **VOLUME** (***l, cm³***, etc)

k_1 = **A CONSTANT**

Boyle's Law

This formula allows us to calculate quantities without having measured them. Suppose you perform two trials:

Trial 1: ***Pressure = P_1*** ***Volume = V_1***
Trial 2: ***Pressure = P_2*** ***Volume = V_2***

According to Boyle's law:

$$P_1V_1 = k_1, \quad \underline{\textbf{AND}} \quad P_2V_2 = k_1$$

Therefore:

$$P_1V_1 = P_2V_2$$

Note!

- Whenever doing problems involving Boyle's law, you **MUST** ensure that the **UNITS** are the **SAME** for both **PRESSURE** and **VOLUME**. (ie. You cannot use the formula with atm and kPa)

Boyle's Law

Example:

A gas is in a 545cm^3 container at a pressure of 608mmHg. If the volume is increased to 1065cm^3, what is the new pressure. (temperature remains constant)

Boyle's Law

Example

You have volunteered to decorate the gym with 300 helium balloons for a dance.

You can get a 25L helium tank with a pressure of 30.0atm. Each balloon will hold 2.5L of helium at a pressure of 1.04atm. Will one tank be enough? (assume no change in temperature)

Boyle's Law

Try this one…

A gas has a volume of 25L at a pressure of 760mmHg. What would be the new volume if the pressure was changed to 1.25atm?