CHEMISTRY

GAS LAWS

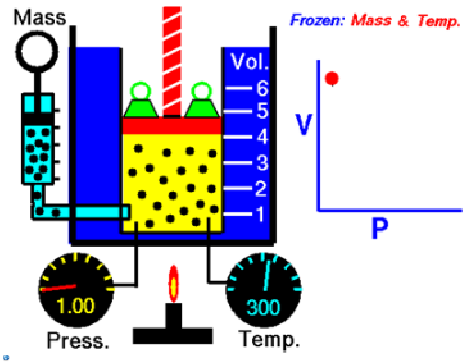
Boyle's Law

In 1662, Robert Boyle stated that:

- *The volume of any given amount of gas, at a constant temperature, varies inversely with the applied pressure.*

→ As pressure INCREASES, volume DECREASES.

$$V \alpha \frac{1}{P}$$



http://www.youtube.com/watch?v=YU2PSHeFSlA

Algebra then leads to …

$$P_1V_1 = P_2V_2$$

P_1 – Initial Pressure
V_1 – Initial Volume
P_2 – Final Pressure
V_2 – Final Volume

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Ex: *A sample of helium gas is collected at room temperature in a 4.50 L balloon at 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 will the final volume of the balloon become?*

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THE KELVIN SCALE AND ABSOLUTE ZERO

If one were to cool an object, the particles within that object would slow down and come closer together. This begs the question, how cold can you make an object so that matter slows to a stop?

The theoretical point, called ***Absolute Zero***, was determined by Lord Kelvin to be -273 *°C.* In theory, at this temperature, individual particles would stop moving.

This gave rise to the Kelvin temperature scale which states that -273 *°C* is equal to 0 K. The Kelvin scale does not use a degree sign and each unit on the Kelvin scale is exactly the same as the units on the Celsius scale.

$$T_K = {}^\circ C + 273$$

$${}^\circ C = T_K - 273$$

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The Kelvin scale is widely used in chemistry because it lacks negative values (since nothing can be colder than absolute zero). This avoids confusion in the wordplay that associates temperature calculations.

Ex:

- *What is the temperature of something that is twice as warm as 5 ºC?*

- *What is the temperature of something that is twice as warm as -5 ºC?*

Ex: *Convert 20 ºC to Kelvin.*

Ex: *Convert -20 ºC to Kelvin.*

Ex: *Convert 353 K to ºC.*

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GAS LAWS

Pg. 514 #1-10, and Pg. 518 #13-18

Practice Problems

Note: Assume that the temperature and amount of gas are constant in all of the following problems.

1. 1.00 L of a gas at 1.00 atm pressure is compressed to 0.437 L. What is the new pressure of the gas?
2. A container with a volume of 60.0 mL holds a sample of gas. The gas is at a pressure of 99.5 kPa. If the container is compressed to one-quarter of its volume, what is the pressure of the gas in the container?
3. Atmospheric pressure on the peak of Mount Everest can be as low as 0.20 atm. If the volume of an oxygen tank is 10.0 L, at what pressure must the tank be filled so that the gas inside would occupy a volume of 1.2×10^3 L at this pressure?
4. If a person has 2.0×10^2 mL of trapped intestinal gas at an atmospheric pressure of 0.98 atm, what would the volume of gas be (in litres) at a higher altitude that has an atmospheric pressure of 0.72 atm?
5. Decaying vegetation at the bottom of a pond contains trapped methane gas. 5.5×10^2 mL of gas are released. When the gas rises to the surface, it now occupies 7.0×10^2 mL. If the surface pressure is 101 kPa, what was the pressure at the bottom of the pond?
6. The volume of carbon dioxide in a fire extinguisher is 25.5 L. The pressure of the gas in this can is 260 psi. What is the volume of carbon dioxide released when sprayed if the room pressure is 15 psi?
7. A 50.0 mL sample of hydrogen gas is collected at standard atmospheric pressure. What is the volume of the gas if it is compressed to a pressure of 3.50 atm?
8. A portable air compressor has an air capacity of 15.2 L and an interior pressure of 110 psi. If all the air in the tank is released, what volume will that air occupy at an atmospheric pressure of 102 kPa?
9. A scuba tank with a volume of 10.0 L holds air at a pressure of 1.75×10^4 kPa. What volume of air at an atmospheric pressure of 101 kPa was compressed into the tank if the temperature of the air in the tank is the same as the temperature of the air before it was compressed?
10. An oxygen tank has a volume of 45 L and is pressurized to 1200 psi.
    a. What volume of gas would be released at 765 torr?
    b. If the flow of gas from the tank is 6.5 L per minute, how long would the tank last?
13. What is the relationship between the temperature and volume of a gas at constant pressure and amount?
14. What is absolute zero, and what is its significance?
15. Examine the graph in **Figure 11.14**. What do all the graph lines have in common?
16. Make the following temperature conversions.
    a. 27.3°C to K
    b. −25°C to K
    c. 373.2 K to °C
    d. 23.5 K to °C
17. Why is it necessary to keep the pressure of a gas constant when studying the relationship between temperature and volume of a gas?
18. A teacher pours liquid nitrogen at a temperature of 77 K over a balloon. Predict the changes that would occur to the balloon.

1. 2.29 atm
2. 398 kPa
3. 24 atm
4. 0.27 L
5. 1.3×10^2 kPa
6. 440 L
7. 14.3 mL
8. 1.1×10^2 L
9. 1.73×10^3 L
10. a. 3.6×10^2 L
    b. 5.6×10^2 min
13. 1.29 L
14. 95 L
15. 561 cm^3
16. 539 K
17. 308 K
18. 27°C