Chem Unit 11 Gases
Charles' Law

Charles' Law: Temperature and Volume relationships in gases

Review:

- As you know Boyle's Law deals with the P & V relationship in gases when everything else is held constant.
- You also know that the relationship between P & V is ***inverse***.

Notes / Demonstrations:

- Today we look at another relationship … between T & V. Jacques Charles, 1746-1823 first studied this aspect of gases. What he found was that T & V are directly related when everything else is kept constant.
- His experiment began with a volume of gas at a certain temperature. He then cooled the gas and measured the new volume!
- He also extrapolated the data … absolute zero. (Real vs. Ideal gases issues!)

Charles' Law:

- T & V are ***directly*** related.
- $V_1 / T_1 = V_2 / T_2$ (always use temperatures in Kelvin [K = °C + 273])

Practical Applications:

- Tire pressure after driving.
- Hot Air Balloon
- Food storage containers
- Incinerating an aerosol can or lightbulb

Examples: V_1 T_1 V_2 T_2

(1) 5.0 L of a gas at 293 K will have what volume at 323 K?

$\frac{T_2 V_1}{T_1} = V_2$ $\quad \frac{323\text{K} \mid 5.0\text{L}}{293\text{K}} = 5.5\text{ L}$

(2) 325 mL of a gas at 298 K will have what volume at 12.0 °C?

V_1 T_1 V_2 $T_2 = 285.0\text{K}$

$V_2 = \frac{T_2 V_1}{T_1}$ $\quad \frac{285.0\text{K} \mid 325\text{mL}}{298\text{K}} = 311\text{ mL}$

Cautions:

1. Always watch your units … use the same volume units on both sides.
2. All temperatures in Kelvin (no negative values)
3. Use common sense … think about your answer!

Assignment:

1. Read 13.3 (pp. 407 - 412)
2. Work problems on p. 436: 13-16

Additional Problems: V_1 $T_1 = 301\ K$

(1) **A child blows a 250 cm^3 bubble that contains air at 28°C. As the bubble rises it cools. If there is no change in pressure, what volume will the bubble have at 18°C?**

$T_2 = 291\ K$

$$V_2 = \frac{T_2 V_1}{T_1} \qquad \frac{291\ K \mid 250\ cm^3}{301\ K} = \boxed{240\ cm^3}$$

V_1 $T_1 = 298\ K$

(2) **A 24 L sample of nitrogen gas is cooled from 25°C to a final temperature of -100.°C. What is the new volume of the gas?**

$T_2 = 173\ K$

$$V_2 = \frac{T_2 V_1}{T_1} \qquad \frac{173\ K \mid 24\ L}{298\ K} = \boxed{14\ L}$$

(3) **The label on an aerosol spray can contains a warning that the can should not be heated to over 54°C because of the danger of explosion. Although the pressure in an aerosol can also increase if it is heated, calculate the potential volume of the gas in a 500. mL aerosol can when it is heated from 25°C to 54°C if the pressure remains constant?** $298 = T_1$ $T_2 = 327\ K$

$$V_2 = \frac{T_2 V_1}{T_1} \qquad \frac{327\ K \mid 500.\ mL}{298\ K} = \boxed{549\ mL}$$