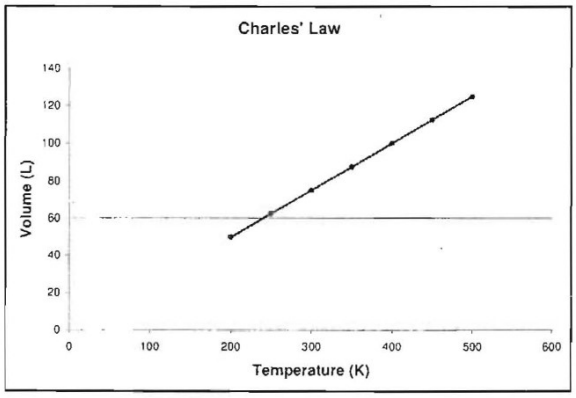
Charles' Law

Chem Worksheet 14-2

Name _____

Jacques Charles made the observation the volume of a gas is directly proportional to the Kelvin temperature of the gas. If the Kelvin temperature is doubled, the volume also doubles. The equation for this relationship is $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, where V represents volume and T represents temperature. The volume of a gas can be measured in liters, milliliters, cubic meters, or a variety of other units, but the temperature must be converted to kelvins. This relationship is only observed when the pressure remains constant.



USEFUL EQUATIONS

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\qquad T_K = T_C + 273$

$1\ \text{mL} = 1\ \text{cm}^3$ $\qquad T_c = \frac{5}{9}(T_f - 32)$

$1\ \text{L} = 1000\ \text{mL}$

example

A gas sample with a volume of 35 mL is heated from 25°C to 425°C. What is the new volume? Assume a constant pressure.

- list the variables: $V_1 = 35\ \text{mL}$ $\quad T_1 = 25°\text{C} = 298\ \text{K}$ $\quad T_2 = 425°\text{C} = 698\ \text{K}$

- substitute into the equation: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\qquad \frac{35\ \text{mL}}{298\ \text{K}} = \frac{V_2}{698\ \text{K}}$

- solve by cross-multiplying: $(35\ \text{ml}) \times (698\ \text{K}) = V_2 \times (298\ \text{K})$ $\qquad \frac{(35\ \text{ml}) \times (698\ \text{K})}{298\ \text{K}} = \frac{V_2 \times (298\ \text{K})}{298\ \text{K}}$ $\qquad V_2 = 82\ \text{mL}$

Solve the following problems. Assume that the pressure does not change.

1. According to the graph, when the Kelvin temperature of a gas is doubled, what happens to the volume?
2. Using the graph, estimate the Kelvin temperature that the gas sample would reach a volume of 140 L.
3. A 240 mL sample of argon gas at 270 K is cooled until the volume is 180 mL. What is the new temperature?
4. A container of oxygen with a volume of 60 L is heated from 300 K to 400 K. What is the new volume?
5. When a piston with a volume of 35 mL is heated from 25°C to 323°C it expands. Assuming the pressure on the piston remains the same, determine the new volume of the cylinder.
6. A balloon with a volume of 5.3 L is taken from an indoor temperature of 24°C to the outdoors. The volume of the balloon outside is 4.9 L. Determine the Celsius temperature outside.
7. A movable piston contains a sample of 680 mL of neon gas with a temperature of -5°C. When the piston is heated the sample expands to a volume of 1.32 L. What is the new temperature of the neon gas?
8. A helium balloon has a volume of 2600 cm^3 when the temperature is 21°C. What is the volume of the balloon when it's placed in a freezer with a temperature of -15°C?
9. The Kelvin temperature of sample of 650 cm^3 sample of ammonia gas is doubled. What is the new volume of the gas? Assume that the pressure stays constant.
10. A movable piston is allowed to cool from 392°F to 104°F. If the initial volume is 105 mL, what will be the new volume?