# Pre-AP Chemistry/AP Chemistry
## Unit #17—Gas Laws

### *BOYLE'S LAW*

**A sample of helium gas in a balloon is compressed from 4.0 L to 2.5 L at a constant temperature. If the pressure of the gas at 4.0 L is 210 kPa, what is the pressure at 2.5 L?**

$$\frac{210\ \text{kPa}}{} \left| \frac{1\ \text{atm}}{101.3\ \text{kPa}} \right. = 2.073\ \text{atm}$$

$$\frac{(4.0\ \text{L})(2.073\ \text{atm})}{2.5\ \text{L}} = 3.317\ \text{atm}$$

**Carbon dioxide is used for various applications in science. A sample of carbon dioxide gas has a volume of 12.00 L at a pressure of 3.564 atm. What is the volume of the carbon dioxide gas if the pressure is increased to 7.667 atm?**

$$\frac{(12.0\ \text{L})(3.564\ \text{atm})}{7.667\ \text{atm}} = 5.578\ \text{L}$$

### *CHARLES'S LAW*

**A gas sample at 40 $^{o}$C occupies a volume of 2.32 L. If the temperature is raised to 75 $^{o}$C, what will the volume be?**

$$40\ ^{o}\text{C} + 273.15\ \text{K} = 313.15\ \text{K}$$

$$75\ ^{o}\text{C} + 273.15\ \text{K} = 348.15\ \text{K}$$

$$\frac{(2.32\ \text{L})(348.15\ \text{K})}{313.15\ \text{K}} = 2.579\ \text{L}$$

**Hydrogen gas is placed into a container that has a temperature of 900 K at a volume of 350 mL. What is the temperature when the volume is decreased to 200 mL?**

$$\frac{350\ \text{mL}}{} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right. = 0.350\ \text{L}$$

$$\frac{200\ \text{mL}}{} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right. = 0.200\ \text{L}$$

$$\frac{(0.200\ \text{L})(900\ \text{K})}{0.350\ \text{L}} = 514.286\ \text{K}$$

### *GAY-LUSSAC'S LAW*

**The pressure of a gas in a tank is 3.20 atm at 22 $^{o}$C. If the temperature rises to 60 $^{o}$C, what will the gas pressure be in the tank?**

$$22\ ^{o}\text{C} + 273.15\ \text{K} = 295.15\ \text{K}$$

$$60\ ^{o}\text{C} + 273.15\ \text{K} = 333.15\ \text{K}$$

$$\frac{(3.20\ \text{atm})(333.15\ \text{K})}{295.15\ \text{K}} = 3.612\ \text{atm}$$

**Methane gas is placed into a tank at a pressure of 610 kPa and temperature of 700 K. What is the temperature of the gas if the pressure decreases to 255 kPa?**

$$\frac{610\ \text{kPa}}{} \left| \frac{1\ \text{atm}}{101.3\ \text{kPa}} \right. = 6.022\ \text{atm}$$

$$\frac{255\ \text{kPa}}{} \left| \frac{1\ \text{atm}}{101.3\ \text{kPa}} \right. = 2.517\ \text{atm}$$

$$\frac{(2.517\ \text{atm})(700\ \text{K})}{6.022\ \text{atm}} = 292.609\ \text{K}$$

### *AVOGADRO'S LAW*

**The volume of a 0.365 mole sample of oxygen gas is 150 mL. If the student increased the moles to 4.59 moles, what will the volume of the oxygen gas sample be in the container?**

$$\frac{150\ \text{mL}}{} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right. = 0.150\ \text{L}$$

$$\frac{(4.59\ \text{mol})(0.150\ \text{L})}{0.365\ \text{mol}} = 1.886\ \text{L}$$

**Hydrogen gas is placed into a container that has 1.334 moles at a volume of 350 mL. How many moles of the gas will be present if the volume is decreased to 200 mL?**

$$\frac{350\ \text{mL}}{} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right. = 0.350\ \text{L}$$

$$\frac{200\ \text{mL}}{} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right. = 0.200\ \text{L}$$

$$\frac{(1.334\ \text{mol})(0.200\ \text{L})}{0.350\ \text{L}} = 0.762\ \text{mol}$$

### *IDEAL GAS LAW*

**At what temperature does 16.3 grams of nitrogen gas have a pressure of 1.25 atm in a 25.L tank?**

$$\frac{16.3\ \text{g}\ N_2 \mid 1\ \text{mol}\ N_2}{\mid 20.014\ \text{g}\ N_2} = 0.582\ \text{mol}\ N_2$$

$$\frac{(1.25\ \text{atm})(25.0\ \text{L})}{(0.582\ \text{mol})(0.08206\ \text{Latm/Kmol})} = 654.328\ \text{K}$$

**What will be the new volume if 125 mL of helium gas at 100 $^{o}$C and 0.981 atm is cooled to 25 $^{o}$C and the pressure increases to 1.15 atm?**

$$\frac{125\ \text{mL} \mid 1\ \text{L}}{\mid 1000\ \text{mL}} = 0.125\ \text{L}$$

$$100\ ^{o}\text{C} + 273.15\ \text{K} = 373.15\ \text{K}$$

$$\frac{(0.981\ \text{atm})(0.125\ \text{L})}{(0.08206\ \text{Latm/Kmol})(373.15\ \text{K})} = 0.004\ \text{mol He}$$

$$25\ ^{o}\text{C} + 273.15\ \text{K} = 298.15\ \text{K}$$

$$\frac{(0.004\ \text{mol})(0.08206\ \text{Latm/Kmol})(298.15\ \text{K})}{1.15\ \text{atm}} = 0.085\ \text{L}$$

### *STANDARD TEMPERATURE AND PRESSURE CONDITIONS*

**Calculate the amount of moles and grams present of 36.56 L of nitrogen gas at STP conditions.**

$$\frac{36.56\ \text{L}\ N_2 \mid 1\ \text{mol}\ N_2}{\mid 22.4\ \text{L}\ N_2} = 1.632\ \text{mol}\ N_2$$

$$\frac{1.632\ \text{mol}\ N_2 \mid 28.014\ \text{g}\ N_2}{\mid 1\ \text{mol}\ N_2} = 45.719\ \text{g}\ N_2$$

**Calculate the volume of 0.869 moles of oxygen gas at STP conditions.**

$$\frac{0.869\ \text{mol}\ O_2 \mid 22.4\ \text{L}\ O_2}{\mid 1\ \text{mol}\ O_2} = 19.466\ \text{L}\ O_2$$

**Calculate the volume of 156.798 grams of carbon dioxide at STP conditions.**

$$\frac{156.798\ \text{g}\ CO_2 \mid 1\ \text{mol}\ CO_2}{\mid 44.009\ \text{g}\ CO_2} = 3.563\ \text{mol}\ CO_2$$

$$\frac{3.563\ \text{mol}\ CO_2 \mid 22.4\ \text{L}\ CO_2}{\mid 1\ \text{mol}\ CO_2} = 79.808\ \text{L}\ CO_2$$