Name _____ Hour _____

Combined Gas Law

Honors Chemistry

Solve the following <u>assuming constant mass</u>. (All answers should be in Kelvin, liters, or atmospheres!)

1. A balloon is 3.0-liters with a pressure of 1.5-atm at a temperature of 20°C If the pressure changes to 2.5-atm and temperature of 30°C, what will the new volume of the balloon be?

$P_1 = 1.5\,atm$ $P_2 = 2.5\,atm$
$V_1 = 3.0\,L$ $V_2 = ?$
$T_1 = 293\,K$ $T_2 = 303\,K$

$$V_2 = \frac{P_1 \times V_1 \times T_2}{T_1 \times P_2} = \frac{(1.5\,atm)(3.0\,L)(303\,K)}{(293\,K)(2.5\,atm)} = \boxed{1.9\,L}$$

2. A balloon is 256-mL with a pressure of 96.0-kPa at a temperature of 25°C If the volume changes to 251-mL and temperature of 50°C , what will the new pressure in the balloon be?

$P_1 = .948\,atm$ $P_2 = ?$
$V_1 = .256\,L$ $V_2 = .251\,L$
$T_1 = 298\,K$ $T_2 = 323\,K$

$$P_2 = \frac{P_1 \times V_1 \times T_2}{T_1 \times V_2} = \frac{(.948\,atm)(.256\,L)(323\,K)}{(298\,K)(.251\,L)} = \boxed{1.05\,atm}$$

3. A balloon is 2.5-liters, with a pressure of 0.79-atm at a temperature of 22°C If the pressure changes to 760-torr and a volume of 1.8-liters, what will the new temperature be?

$P_1 = .79\,atm$ $P_2 = 1.0\,atm$
$V_1 = 2.5\,L$ $V_2 = 1.8\,L$
$T_1 = 295\,K$ $T_2 = ?$

$$T_2 = \frac{P_2 \times V_2 \times T_1}{P_1 \times V_1} = \frac{(1.0\,atm)(1.8\,L)(295\,K)}{(0.79\,atm)(2.5\,L)} = \boxed{269\,K}$$

4. A 750-mL balloon at 0.0°C decreased in size to a new volume of 500-mL at 202.6-kPa at a temperature of 25°C. What was the original pressure of the balloon?

$P_1 = ?$ $P_2 = 2.000\,atm$
$V_1 = .750\,L$ $V_2 = .500\,L$
$T_1 = 273\,K$ $T_2 = 298\,K$

$$P_1 = \frac{P_2 \times V_2 \times T_1}{T_2 \times V_1} = \frac{(2.0\,atm)(.500\,L)(273\,K)}{(298\,K)(.750\,L)} = \boxed{1.221\,atm}$$

5. A balloon had a pressure of 0.856-atm at 100°C. It increased in temperature to 150°C with a pressure of 1.18-atm and a volume of 225-mL. What was the original volume of the balloon?

$P_1 = .856\,atm$ $P_2 = 1.18\,atm$
$V_1 = ?$ $V_2 = .225\,L$
$T_1 = 373\,K$ $T_2 = 423\,K$

$$V_1 = \frac{P_2 \times V_2 \times T_1}{T_2 \times P_1} = \frac{(1.18\,atm)(.225\,L)(373\,K)}{(423\,K)(.856\,atm)} = \boxed{.274\,L}$$

6. A balloon is 1.5-L with a pressure of 1.12-atm at a temperature of 15°C. If the volume changes to 2.5-L and temperature of 30°C, what will the new pressure in the balloon be?

$P_1 = 1.12\,atm$ $P_2 = ?$
$V_1 = 1.5\,L$ $V_2 = 2.5\,L$
$T_1 = 288\,K$ $T_2 = 303\,K$

$$P_2 = \frac{P_1 \times V_1 \times T_2}{T_1 \times V_2} = \frac{(1.12\,atm)(1.5\,L)(303\,K)}{(288\,K)(2.5\,L)} = \boxed{0.707\,atm}$$

7. A 125-mL balloon at 1.23-atm decreased in size to a new volume of 100-mL with a pressure of 0.987-atm at a temperature of 75°C. What was the original temperature of the balloon?

$P_1 = 1.23\,atm$ $P_2 = 0.987\,atm$
$V_1 = .125\,L$ $V_2 = .100\,L$
$T_1 = ?$ $T_2 = 348\,K$

$$T_1 = \frac{P_1 \times V_1 \times T_2}{P_2 \times V_2} = \frac{(1.23\,atm)(.125\,L)(348\,K)}{(.987\,atm)(.100\,L)} = \boxed{542\,K}$$

Ideal Gas Law

Honors Chemistry

Solve the following using the Ideal Gas Law. All answers should be in grams, Kelvin, liters, or atmospheres!)

1. What mass of oxygen will occupy a volume of 2.5 L at 1.2-atm and 25 °C?

$P = 1.2\text{ atm}$ $n = ?$
$V = 2.5\text{ L}$ $T = 298\text{ K}$

$$n = \frac{PV}{RT} = \frac{(1.2\text{ atm})(2.5\text{ L})}{(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(298\text{ K})} = .123\text{ mol}$$

$$\frac{.123\text{ mol } O_2}{1} \times \frac{32\text{ g } O_2}{1\text{ mol } O_2} = 3.9\text{ g } O_2$$

2. What volume will 56.0-grams of nitrogen gas occupy at 0.95-atm and 20 °C?

$P = .95\text{ atm}$ $n = 2\text{ mol}$
$V = ?$ $T = 293\text{ K}$

$$\frac{56\text{ g } N_2}{1} \times \frac{1\text{ mol } N_2}{28\text{ g } N_2} = 2\text{ mol } N_2$$

$$V = \frac{nRT}{P} = \frac{(2\text{ mol})(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(293\text{K})}{.95\text{ atm}} = 51\text{ L}$$

3. What pressure will be exerted by 25-g of CO_2 at a temperature of 25 °C and volume of 500-mL?

$P = ?$ $n = .568\text{ mol}$
$V = .5\text{ L}$ $T = 298\text{ K}$

$$\frac{25\text{g } CO_2}{1} \times \frac{1\text{ mol}}{44\text{g}} = .568\text{ mol } CO_2$$

$$P = \frac{nRT}{V} = \frac{(.568\text{mol})(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(298\text{K})}{.5\text{ L}} = 28\text{ atm}$$

4. At what temperature will 5.00 g of Cl_2 exert a pressure of 1.18-atm at a volume of 750-mL?

$P = 1.18\text{ atm}$ $n = .07\text{ mol}$
$V = .75\text{L}$ $T = ?$

$$\frac{5.00\text{g } Cl_2}{1} \times \frac{1\text{ mol}}{71\text{g}} = .07\text{ mol } Cl_2$$

$$T = \frac{PV}{nR} = \frac{(1.18\text{ atm})(.75\text{L})}{(.07\text{mol})(.0821\frac{\text{L}\cdot\text{atm}}{\text{K}\cdot\text{mol}})} = 154\text{ K}$$

5. What is the density of NH_3 at 1.05-atm and 25 °C? *(Hint: which components of the ideal gas law are used in density?)* $D = \frac{m}{V}$

$P = 1.05\text{atm}$ $n = ?$
$V = ?$ $T = 298\text{ K}$

$$\frac{P}{RT} = \frac{n}{V} \qquad \frac{1.05\text{atm}}{(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(298\text{K})} = \frac{n}{V} \rightarrow \frac{.043\text{ mol}}{\text{L}} \times \frac{17\text{g}}{1\text{ mol}} = .73\text{g/L}$$

6. What mass of nitrogen gas will occupy a volume of 347-mL at 8.79-atm and 27 °C?

$P = 8.79\text{ atm}$ $n = ?$
$V = .347\text{L}$ $T = 300\text{K}$

$$n = \frac{PV}{RT} = \frac{(8.79\text{atm})(.347\text{L})}{(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(300\text{K})} = .124\text{ mol}$$

$$\frac{.124\text{ mol } N_2}{1} \times \frac{28\text{ g}}{1\text{ mol}} = 3.47\text{g}$$

7. What volume will 454 grams of hydrogen gas occupy at 106.37 kPa and 25 °C?

$P = 1.05\text{ atm}$ $n = 227\text{ mol}$
$V = ?$ $T = 298\text{ K}$

$$\frac{454\text{g } H_2}{1} \times \frac{1\text{ mol}}{2\text{g}} = 227\text{ mol}$$

$$V = \frac{nRT}{P} = \frac{(227\text{ mol})(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol K}})(298\text{K})}{1.05\text{ atm}} = 5290\text{L}$$

8. How many grams of CO_2 exert a pressure of 1.05-atm at a volume of 32.5 L and a temperature of 32 °C?

$P = 1.05\text{ atm}$ $n = ?$
$V = 32.5\text{L}$ $T = 305\text{K}$

$$n = \frac{PV}{RT} = \frac{(1.05\text{atm})(32.5\text{L})}{(.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(305\text{K})} = 1.36\text{ mol}$$

$$\frac{1.36\text{ mol}}{1} \times \frac{44\text{ g}}{1\text{ mol}} = 60.0\text{g}$$