

$$\#31 \quad \frac{0.416 \text{ g Kr}}{83.8 \text{ g/mol Kr}} = 0.005 \text{ mol} \times 22.4 \text{ L/mol} = 0.112 \text{ L}$$

ps 432

$$\#32 \quad \frac{0.860 \text{ g}}{19.2 \text{ L}} = \frac{0.655 \text{ g}}{x \text{ L}} \quad x = \underline{\underline{14.6 \text{ L}}}$$

$$\#33 \quad 4.5 \text{ kg} = 4500 \text{ g} \quad \text{C}_2\text{H}_4 = 24 + 4 = 28 \text{ g/mole}$$

$$4500 \text{ g} / 28 \text{ g/mole} = 160.7 \text{ moles} \times 22.4 \text{ L/mole} = \underline{\underline{3600 \text{ L}}}$$

$$\#41 \quad T = 298 \text{ K}$$

$$V = 0.044 \text{ L}$$

$$P = 3.81 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{3.81 \text{ atm} \times 0.044}{0.0821 \times 298}$$

$$n = \underline{\underline{0.0069 \text{ moles}}} = 6.9 \times 10^{-3} \text{ moles}$$

$$\#42 \quad n = 2.49 \text{ moles}$$

$$V = 1.0 \text{ L}$$

$$P = 143 \text{ kPa}$$

$$R = 8.314$$

$$T =$$

$$PV = nRT$$

$$T = \frac{PV}{nR} = \frac{143 \times 1}{8.314 \times 2.49}$$

$$T = 6.907 \text{ K}$$

$$-273 = -266^\circ \text{C}$$

$$\#43 \quad V =$$

$$n = 0.323 \text{ mol}$$

$$T = 265 \text{ K}$$

$$P = 0.9 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{0.323 \times 0.0821 \times 265}{0.9}$$

$$= 7.51 \text{ L}$$

#44

$$P =$$

$$n = 0.108$$

$$T = 293 \text{ K}$$

$$V = 0.505 \text{ L}$$

$$R_{\text{atm}} = 0.0821$$

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = \frac{0.108 \times 0.0821 \times 293}{0.505}$$

$$P = 5.14 \text{ atm}$$

#45

$$T = ?$$

$$n = 0.047 \text{ mol}$$

$$V = 1.2 \text{ L}$$

$$P = 0.988 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$T = \frac{PV}{nR}$$

$$T = \frac{0.988 \times 1.2}{0.047 \times 0.0821}$$

$$T = 307 \text{ K}$$

#46

$$MM = 70 \text{ g/mol}$$

$$V = 2.0 \text{ L}$$

$$P = 117 \text{ kPa}$$

$$T = 35.1^\circ\text{C} = 308.1$$

$$n =$$

$$R = 8.314$$

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{117 \times 2}{8.314 \times 308.1}$$

$$n = 0.09 \text{ moles}$$

$$g = \text{moles} \times \frac{\text{g}}{\text{mole}} = 0.09 \text{ moles} \times 70 \frac{\text{g}}{\text{mole}} = 6.45 \text{ g}$$

#47

$$V = 0.6 \text{ l}$$

$$P = 1 \text{ atm}$$

$$T = 22^\circ\text{C} = 295 \text{ K}$$

$$n =$$

$$R = 0.0821$$

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{1 \times 0.6}{0.0821 \times 295}$$

$$n = 0.025 \text{ moles} \times 28 \text{ g/mole} = 0.694 \text{ g}$$

#48 $T = 273$

$$P = 1 \text{ atm}$$

$$n = 1$$

$$44 \text{ g/mole in } 22.4 \text{ l}$$

$$1 \text{ mole} = 22.4$$

$$\frac{44 \text{ g}}{22.4 \text{ l}} = 1.96 \text{ g/l}$$

#49 $D = 1.09 \text{ g/ml}$

$$P = 1.02 \text{ atm}$$

$$T = 298 \text{ K}$$

$$R = 0.0821$$

$$D = \frac{M_m P}{RT}$$

$$M_m = \frac{RTD}{P}$$

$$= \frac{0.0821 \times 298 \times 1.09}{1.02}$$

$$= 26.1 \text{ g/mol}$$

#50 $T = 273$

$$P = 1 \text{ atm}$$

$$D = ?$$

$$M_m = 39.9 \text{ g/mol}$$

$$R = 0.0821$$

$$D = \frac{M_m P}{RT}$$

$$\frac{39.9 \times 1}{0.0821 \times 273}$$

$$D = 1.78 \text{ g/ml}$$

NAME: _____ DATE: _____

Ideal Gas Law Intro from Avogadro's Law

If you know that any gas occupies 22.4 liters of volume at STP if you have one mole of it, you can use this figure to calculate a conversion factor to use in ANY gas situation!!! All the data must be from actual measurements to work.

For any gas, PV divided by nT, is equal to the same number. This number takes the variable R and lets you equate the quantities of pressure x volume and the number of moles x temperature. The law is best known as PV=nRT. R takes on various values depending on the pressure units used. Be sure to pick the correct value for it. You do not need to memorize it, just look it up.

So, for any sample of gas you can calculate the unknown variable given the others. This is particularly useful for determining the number of moles (grams and particles too) of a given sample of gas as well as its molar mass. Avogadro's law of 22.4 liters per mole at STP is useful for this as well. Molar mass can then be used to determine the formula for the gas.

If 9.006 grams of a gas are enclosed in a 50.00 liter vessel at 273.15 K and 2.000 atmospheres of pressure, what is the molar mass of the gas? What gas is this?

$$\begin{aligned}
 M &= 9.006 \text{ g} & P &= 2 \text{ atm} & PV &= nRT & g/mol &= \frac{9.006 \text{ g}}{4.46 \text{ moles}} = 2.01 \text{ g/mol} \\
 V &= 50 \text{ L} & R &= 0.0821 & n &= \frac{PV}{RT} = \frac{2 \text{ atm} \times 50 \text{ L}}{0.0821 \times 273.15 \text{ K}} = 4.46 \text{ moles} & &= \text{H}_2 \\
 T &= 273.15 \text{ K} & n &= & & & &
 \end{aligned}$$

At STP 150.0 mL of an unknown gas has a mass of 0.250 gram. Calculate its molar mass.

$$\begin{aligned}
 T &= 273 & V &= 0.150 \text{ L} \\
 P &= 1 \text{ atm} & n &= \frac{PV}{RT} = \frac{1 \times 0.150 \text{ L}}{0.0821 \times 273 \text{ K}} = \frac{0.25 \text{ g}}{0.00669 \text{ moles}} = 37.37 \text{ g/mole} \\
 R &= 0.0821 & & & & & &
 \end{aligned}$$

1.089 g of a gas occupies 4.50 L at 20.5 °C and 0.890 atm. What is its molar mass?

$$\begin{aligned}
 M &= 1.089 \text{ g} & P &= 0.89 \text{ atm} & \frac{PV}{RT} &= \frac{0.89 \times 4.5 \text{ L}}{0.0821 \times 293.5 \text{ K}} = \frac{1.089}{0.2166 \text{ moles}} \\
 V &= 4.5 & n &= & & & &= 20.16 \text{ g/mol} \\
 T &= 293.5 \text{ K} & R &= 0.0821 & & & &
 \end{aligned}$$

0.190 g of a gas occupies 250.0 mL at STP. What is its molar mass? What gas is it? Hint - calculate molar mass of the gas.

$$\begin{aligned}
 M &= 0.190 \text{ g} & T &= 273 \\
 V &= 0.25 & R &= 0.0821 \\
 P &= 1 \text{ atm} & n &= \frac{PV}{RT} = \frac{1 \times 0.25}{0.0821 \times 273} = \frac{0.19 \text{ g}}{0.0112 \text{ mol}} = 16.96 \\
 & & & & & & &= 16.96 \text{ g/mol} \\
 & & & & & & &= (\text{NH}_3)?
 \end{aligned}$$

125. 96.0 g. of a gas occupies 48.0 L at 700.0 mm Hg and 20.0 °C. What is its molecular weight?

$$\begin{aligned}
 \text{Mass} &= 96 \text{ g} & T &= 20^\circ\text{C} = 293 \text{ K} & n &= \frac{PV}{RT} = 1.838 \text{ mole} \\
 V &= 48 \text{ L} & n &= & &= \frac{700 \times 48}{62.4 \times 293} & \text{MM} &= \frac{96 \text{ g}}{1.838 \text{ mole}} = 52.23 \text{ g/mole} \\
 P &= 700 \text{ mmHg} & R &= 62.4 & & & &
 \end{aligned}$$

126. 20.83 g. of a gas occupies 4.167 L at 79.97 kPa at 30.0 °C. What is its molecular weight?

$$\begin{aligned}
 \text{Mass} &= 20.83 & T &= 30^\circ\text{C} = 303 \text{ K} & n &= \frac{PV}{RT} = \frac{79.97 \times 4.167}{8.314 \times 303} \\
 V &= 4.167 & n &= & &= 0.132 \text{ mole} & & \\
 P &= 79.97 \text{ kPa} & R &= 8.314 & & & & \\
 & & & & & & & \text{MM} = \frac{20.83 \text{ g}}{0.132 \text{ mole}} = 157.8 \text{ g/mole}
 \end{aligned}$$

127. At STP 3.00 liters of an unknown gas has a mass of 9.50 grams. Calculate its molar mass.

$$\begin{aligned}
 \frac{3 \text{ L}}{22.4 \text{ L/mole}} &= 0.134 \text{ moles} \\
 \frac{9.5 \text{ g}}{0.134 \text{ moles}} &= 70.9 \text{ g/mole}
 \end{aligned}$$

128. At STP 0.250 liter of an unknown gas has a mass of 1.00 gram. Calculate its molar mass.

$$\begin{aligned}
 \frac{0.25 \text{ L}}{22.4 \text{ L/mole}} &= 0.0112 \text{ moles} \\
 \frac{1 \text{ g}}{0.0112 \text{ mole}} &= 89.29 \text{ g/mole}
 \end{aligned}$$