Math Gas Law Questions (for Introductory Chemistry)

1. Convert 4.9×10^2 atm to torr. torr is the same as mm Hg

$$(4.9 \times 10^2 \text{ atm})\left(\frac{760. \text{ torr}}{\text{atm}}\right) = 3.7 \times 10^5 \text{ torr}$$

2. A flexible vessel contains 35 L of gas when the pressure is 1.2 atm. What will the volume be when the pressure is 0.76 atm, the temperature remaining constant? ~~Which gas law is relevant?~~ V ↑ as P ↓

$$35 \text{ L}\left(\frac{1.2 \text{ atm}}{0.76 \text{ atm}}\right) = 55 \text{ L}$$

3. A sample of gas in a balloon at 5.56 L and 17.0°C is heated to 37.0°C. What is the new volume of the gas assuming the pressure is unchanged. Which gas law is relevant? V ↑ as T ↑

$$5.56\text{L}\left(\frac{310.15\text{K}}{290.15\text{K}}\right) = 5.94\text{L}$$

→ 300.00 K

4. The volume of a sample of gas measured at 26.85°C and 1.00 atm is 10.0 L. What must the final temperature (in Celsius) be in order for the gas to have a final volume of 7.50 L at 1.50 atm pressure? Which gas law is relevant? T ↑ as P ↑ and T ↓ as V ↓

$$T_2 = \left(\frac{1.50 \text{ atm}}{1.00 \text{ atm}}\right)\left(\frac{7.50 \text{ L}}{10.0 \text{ L}}\right)(300.00 \text{ K}) = 337.5 \text{ K} \Rightarrow 64.4\ °\text{C}$$

$PV = nRT$

$$\frac{PV}{T} = nR = \text{const} \Rightarrow \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_2 = \frac{P_2V_2T_1}{P_1V_1}$$

5. How many moles of gas are in a gas sample occupying 1.42 L at 581 mm Hg and 307 K? Which gas law is relevant? ______________

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(581 \text{ mm Hg})\left(\frac{1 \text{ atm}}{760 \text{ mm Hg}}\right)(1.42 \text{ L})}{\left(0.0821 \frac{\text{L atm}}{\text{mol K}}\right)(307 \text{ K})} = 0.0431 \text{ mol}$$

6. An ideal gas at 400 K and 380 mm Hg is contained in a flexible vessel. Its volume is halved but its final pressure is unchanged. What is the final temperature in K? Which gas law is relevant? T ↓ as V ↓

let $V_2 = \frac{1}{2}V_1$ (final volume half of initial vol.)

$$T = 400\text{K}\frac{V_2}{V_1} = 400\text{K}\frac{1/2 V_1}{V_1} = (400\text{K})\left(\frac{1}{2}\right) = 200\text{K}$$

7. At 25.0°C and 1.30 atm pressure, it is found that 3.02 L of gas weighs 7.70 g. The calculated molecular mass of the gas is? [Hint: use PV=nRT to establish the number of moles. This is the number of moles in 7.70 g. Now calculate the molecular mass] $PV = nRT$

298.15K

① $$n = \frac{PV}{RT} = \frac{(1.30 \text{ atm})(3.02 \text{ L})}{\left(0.0821 \frac{\text{L atm}}{\text{mol K}}\right)(298.15\text{K})} = 0.16039 \text{ mol}$$

② $$M_w = \frac{g}{mol} = \frac{7.70 g}{0.16039 \text{ mol}} = 48.0 \text{ g/mol}$$

8. (Partial pressure) A sample containing a mixture of helium, neon, and argon has a total pressure (P_t) of 662 mm Hg (Torr). If P_{He} = 341 Torr and P_{Ne} = 112 Torr, what is Pa_{Ar}?

$$P_{tot} = P_{He} + P_{Ne} + P_{Ar}$$

$$P_{Ar} = P_{tot} - P_{He} - P_{N_2} = 662 \text{ torr} - 341 \text{ torr} - 112 \text{ torr} = 209 \text{ torr}$$

9. (Partial pressure) A container at 1 atm (P_t = 1 atm) has the following composition: P_{N_2} = 573 Torr, P_{O_2} = 100 Torr, P_{CO_2} = 40 Torr, and P_{H_2O} = 47 Torr. What is the percent of volume % of O_2? What is the mole % of O_2?

Note $$P_{N_2} + P_{O_2} + P_{CO_2} + P_{H_2O} = 573 \text{ torr} + 100 \text{ torr} + 40 \text{ torr} + 47 \text{ torr}$$

$$= 760 \text{ torr} = 1\text{atm} = \text{total pressure}$$

$$\%\ O_2 = \text{mol}\ \%\ O_2 = \text{vol}\ \%\ O_2 = \frac{P_{O_2}}{P_{total}} = \frac{100 \text{ torr}}{760 \text{ torr}} \times 100\% = 13.2\%$$