AP CHEMISTRY

TOPIC 3: GASES, TEST REVIEW, MORE PROBLEMS

Day 44:

- Boyle, Charles, and Avogadro: Gas Laws
- Ideal Gas Law
- Gas Stoichiometry
- Gas Density

- Gas Molar Mass
- Dalton's Law of Partial Pressures
- Gas collection over Water
- Kinetic Molecular Theory of Gases

- Effusion and Diffusion
- Root mean square velocity
- Real Gases (van der Waals)

---

1) A student adds 23.0 grams of dry ice (CO_2) to a empty balloon. What will be the new volume of the balloon at STP after all the dry ice sublimes?

Answers:

Original Volume of balloon will be zero (no gas within the balloon when CO_2 was a solid)

$$\textbf{PV=nRT} \; ; \quad V = \frac{nRT}{P}$$

$$n = \frac{23.0 \ g \ CO_2}{} \times \frac{1 \ mol \ CO_2}{44.011 \ g} = 0.5226 \ mol \ CO_2$$

$$V = \frac{(0.5226 \ mol)(0.0821 \ atm \cdot L)(273 \ K)}{(1 \ atm)(mol \cdot K)} = 11.7 \ L$$

2) Given the equation:

__2__ $H_3C_6H_5O_{7\,(l)}$ + __9__ $O_{2\,(g)}$ → __8__ $H_2O_{(g)}$ + __12__ $CO_{2\,(g)}$

What mass of oxygen (at STP) must be reacted to produce 65.0 liters of CO_2 at STP?

Answers:

$$\textbf{PV=nRT} \; ; \quad n = \frac{PV}{RT}$$

$$n = \frac{(1 \ atm)(mol \cdot K)(65.0 \ L)}{(0.0821 \ atm \cdot L)(273 \ K)} = 2.90 \ mol \ CO_2$$

$$\frac{2.90 \ mol \ CO_2}{} \times \frac{9 \ mol \ O_2}{12 \ mol \ CO_2} \times \frac{32.00 \ grams}{1 \ mol \ O_2} = 69.6 \ g \ O_2$$

3) A mixture of gases contains about 21.0 % oxygen gas and 39.0 % nitrogen gas and 39.0 % argon gas. What is the density of mixture of gases at 55.0 ^{0}C and 1.75 atm?

Answers:

Molar Mass of the mixture of gases = 21% is O_2 , 39% is N_2 , 40% is Ar

$$M_{Gases} = (0.21)(32.0\,\tfrac{g}{mol}) + (0.39)(28.014\,\tfrac{g}{mol}) + (0.40)(39.948\,\tfrac{g}{mol}) = 33.625\,\tfrac{g}{mol}$$

$$\frac{m}{V} = \frac{PM}{RT}$$

$$\frac{m}{V} = \frac{(1.75\ atm)\left(mol \cdot K\right)(33.625\ g)}{(0.0821\ atm \cdot L)(328\ K)\left(mol\right)} = 2.19\ \frac{g}{L}$$

3) A 9.00 liter gas sample at 175 ^{0}C and 978.2 torr contains 45.0 % neon and 55.0 % xenon gas by mass. What are the partial pressures of the individual gases?

Answers:

If we had a 100 gram sample of gas, we would have 45 g Ne and 55 g Xe.

$$n_{Ne} = \frac{45.0\ g\ Ne}{} \times \frac{1\ mol\ Ne}{20.179\ g} = 2.230\ mol\ Ne$$

$$n_{Xe} = \frac{55.0\ g\ Xe}{} \times \frac{1\ mol\ Xe}{131.29\ g} = 0.4189\ mol\ Xe$$

$$2.230\ mol\ Ne\ +\ 0.4189\ mol\ Xe\ =\ 2.6489\ mol\ gas$$

$$P_{Ne}\ =\ \left(\frac{2.230\ mol}{2.6489\ mol}\right)\ 978.2\ torr\ = 823.5\ torr$$

$$P_{Xe}\ =\ \left(\frac{0.4189\ mol}{2.6489\ mol}\right)\ 978.2\ torr\ = 154.7\ torr$$

5) A mixture of 73.65 grams of oxygen gas and 28.36 grams of helium is placed in a 33.54 liter container at 102.0 ^{0}C. Calculate the partial pressure of each gas and the total pressure.

Answers:

$$n_{O_2} = \frac{73.65\ g\ O_2}{} \times \frac{1\ mol\ O_2}{32.00\ g} = 2.3016\ mol\ O_2$$

$$n_{He} = \frac{28.36\ g\ He}{} \times \frac{1\ mol\ He}{4.0026\ g} = 7.0853\ mol\ He$$

$$P_{O_2} = \frac{nRT}{V} = \frac{(2.3016\ mol)(0.0821\ atm \cdot L)(375\ K)}{(33.54\ L)(mol \cdot K)} = 2.113\ atm$$

$$P_{He} = \frac{nRT}{V} = \frac{(7.0853\ mol)(0.0821\ atm \cdot L)(375\ K)}{(33.54\ L)(mol \cdot K)} = 6.504\ atm$$

$$P_{total} = P_{O_2} + P_{He} = 2.113\ atm + 6.504\ atm = 8.617\ atm$$

6) Calculate the pressure exerted by 50.3 moles of Cl_2 gas in 40.0. liter container at 22.0 ^{0}C using van der Waal's equation and constants from the example problems page (from Day 41) .

$$\left(P + \frac{n^2 a}{V^2}\right) \times \left(V - nb \right) = nRT$$

$$P = \frac{nRT}{V - nb} - \frac{n^2 a}{V^2}$$

$$P = \left(\left(\frac{(50.3\ mol)(0.0821\ atm \cdot L)(mol)(295\ K)}{\left(40.0\ L - \left(50.3\ mol \times 0.0562\ L\right)\right)(mol \cdot K)} \right) - \left(\frac{(50.3\ mol)^2}{(40.0\ L)^2} \left(\frac{6.49\ atm^2 \cdot L^2}{mol^2} \right) \right) \right)$$

$$P = 32.77\ atm - 10.26\ atm = 22.51\ atm$$