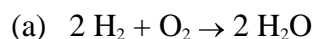


1990 B Answer:



mol H_2 = mol O_2 initially, but 2 mole H_2 react for every 1 mol of O_2 , therefore, O_2 is left.

$$P_T = P_{\text{H}_2} + P_{\text{O}_2} + P_{\text{H}_2\text{O}}$$

$$1146 \text{ mm Hg} = P_{\text{H}_2} + P_{\text{O}_2} + 24 \text{ mm Hg}$$

$$P_{\text{H}_2} + P_{\text{O}_2} = 1122 \text{ mm Hg}$$

$$1122 \text{ mm Hg} / 4 = P_{\text{O}_2} \text{ left } (1/2 \text{ of initial } P_{\text{O}_2} \text{ which is } 1/2 \text{ total})$$

$$P_{\text{O}_2} = 280.5 \text{ mm Hg}$$

$$n = \frac{PV}{RT} = \frac{(\frac{280.5}{760} \text{ atm})(0.500 \text{ L})}{(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(298 \text{ K})} = 7.55 \times 10^{-3} \text{ mol O}_2$$

(b)

$$\frac{280.5 \text{ mmHg}}{298 \text{ K}} = \frac{P_{\text{O}_2}}{363 \text{ K}}; P_{\text{O}_2} = 342 \text{ mmHg}$$

$$P_T = P_{\text{O}_2} + P_{\text{H}_2\text{O}} = (342 + 526) \text{ mm Hg} = 868 \text{ mm Hg}$$

$$n = \frac{PV}{RT} = \frac{(\frac{526}{760} \text{ atm})(0.500 \text{ L})}{(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(363 \text{ K})} = 0.0116 \text{ mol}$$

(c)

1993 B Answer:

- Reducing the temperature of a gas reduces the average kinetic energy (or velocity) of the gas molecules. This would reduce the number (or frequency) of collisions of gas molecules with the surface of the balloon; [OR decrease the momentum change that occurs when the gas molecules strike the balloon surface]. In order to maintain a constant pressure vs the external pressure, the volume must decrease.
- The molecules of the gas do have volume, when they are cooled sufficiently, the forces of attraction that exist between them cause them to liquefy or solidify.
- The molecules of gas are in constant motion so the HCl and NH_3 diffuse along the tube. Where they meet, $\text{NH}_4\text{Cl}_{(s)}$ is formed. Since HCl has a higher molar mass, its velocity (average) is lower, therefore, it doesn't diffuse as fast as the NH_3 .
- The wind is moving molecules of air that are going mostly in one direction. Upon encountering a flag, they transfer some of their energy (momentum) to it and cause it to move (flap!).

1994 Answer:

$$\begin{aligned} \text{(a)} \quad P_{\text{H}_2} &= P_{\text{atm}} - P_{\text{H}_2\text{O}} = (745 - 23.8) \text{ mm Hg} \\ &= 721.2 \text{ mm Hg} \end{aligned}$$

$$n = (PV)/(RT) = (721.2 \text{ mm Hg} \times 90.0 \text{ mL}) / (62400 \text{ mm Hg.mL/mol.K} \times 298.15\text{K})$$

$$= 3.49 \times 10^{-3} \text{ mol}$$

$$(b) \quad n_{\text{H}_2\text{O}} = (23.8 \text{ mm Hg} \times 90.0 \text{ mL}) / (62400 \text{ mm Hg.mL/mol.K} \times 298.15\text{K}) \times 6.022 \times 10^{23} \text{ molecules/mol}$$

$$= 6.93 \times 10^{19} \text{ molecules}$$

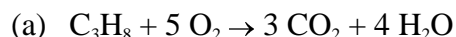
$$(c) \quad (\text{mass}_{\text{H}_2})(\text{velocity}_{\text{H}_2})^2 = (\text{mass}_{\text{H}_2\text{O}})(\text{velocity}_{\text{H}_2\text{O}})^2$$

$$2(v_{\text{H}_2})^2 = 18(v_{\text{H}_2\text{O}})^2$$

$$v_{\text{H}_2}^2 / v_{\text{H}_2\text{O}}^2 = 9; v_{\text{H}_2} / v_{\text{H}_2\text{O}} = 3$$

(d) H₂O deviates more from ideal behavior:

1995 Answer:



$$(b) \quad 10.0 \text{ g C}_3\text{H}_8 \times 1 \text{ mol C}_3\text{H}_8 / 44.0 \text{ g} \times 5 \text{ mol O}_2 / 1 \text{ mol C}_3\text{H}_8 = 1.14 \text{ mol O}_2$$

$$V_{\text{O}_2} = \frac{nRT}{P} = \frac{(1.14 \text{ mol})(0.0821 \frac{\text{L.atm}}{\text{mol.K}})(303 \text{ K})}{1.00 \text{ atm}}$$

$$= 28.3 \text{ L O}_2; 28.3 \text{ L} / 21.0\% = 135 \text{ L of air}$$

$$(c) \quad \Delta H_{\text{comb}}^{\circ} = [\Delta H_{f(\text{CO}_2)}^{\circ} + \Delta H_{f(\text{H}_2\text{O})}^{\circ}]$$

$$- [\Delta H_{f(\text{C}_3\text{H}_8)}^{\circ} + \Delta H_{f(\text{O}_2)}^{\circ}]$$

$$-2220.1 = [3(-393.5) + 4(-285.3)] - [X + 0]$$

$$X = \Delta H_{\text{comb}}^{\circ} = -101.7 \text{ kJ/mol}$$

$$(d) \quad q = 30.0 \text{ g C}_3\text{H}_8 \times 1 \text{ mol} / 44.0 \text{ g} \times 2220.1 \text{ kJ} / 1 \text{ mol} = 1514 \text{ kJ}$$

$$q = (m)(C_p)(\Delta T)$$

$$1514 \text{ kJ} = (8.00 \text{ kg})(4.18 \text{ J/g.K})(\Delta T)$$

$$\Delta T = 45.3^{\circ}$$

1996 Answer:

(a) CO₂; according to Avogadro's Hypothesis, they all contain the same number of particles, therefore, the heaviest molecule, CO₂ (molar mass = 44), will have the greatest mass.

(b) all the same; at the same temperature all gases have the same kinetic energy.

(c) CO₂; since they are all essentially non-polar, the largest intermolecular (London) force would be greatest in the molecule/atom with the largest number of electrons.

(d) He; it has the smallest size and has the greatest particulate speed and, therefore, it's the easiest to penetrate the wall and effuse.