Burning of Gasoline

a) $C_8H_{18\,(l)} + \frac{25}{2}O_{2\,(g)} \longrightarrow 8CO_{2\,(g)} + 9H_2O_{(l)}$

or $2C_8H_{18\,(l)} + 25O_{2\,(g)} \longrightarrow 16CO_{2\,(g)} + 18H_2O_{(l)}$

b) combustion

c) Yes, it is redox.

1) Element (O_2) becomes part of a compound (CO_2, H_2O)

2) Change in oxidation states

$$\overset{}{C_8}\overset{+1}{H_{18}} + \frac{25}{2}\overset{\varnothing}{O_2} \longrightarrow 8\overset{+4}{C}\overset{-2}{O_2} + 9\overset{+1}{H_2}\overset{-2}{O}$$

2 carbons are −3, 6 carbons are −2

oxidation (C_8H_{18} → CO_2)

reduction (O_2 → CO_2, H_2O)

d) $C_8H_{18} + \frac{25}{2}O_2 \longrightarrow 8CO_2 + 9H_2O$

50.0 kg ? kg

$$\frac{50.0\text{ kg}}{1}\cdot\frac{1000\text{ g}}{1\text{ kg}}\cdot\frac{1\text{ mol }C_8H_{18}}{114.26\text{ g}}\cdot\frac{9\text{ mol }H_2O}{1\text{ mol }C_8H_{18}}\cdot\frac{18.02\text{ g}}{1\text{ mol }H_2O}\cdot\frac{1\text{ kg}}{1000\text{ g}} = 70.9_7\text{ kg of }H_2O$$

(154 kg CO_2)

e) $$\frac{50.0\text{ kg}}{1}\cdot\frac{1000\text{ g}}{1\text{ kg}}\cdot\frac{1\text{ mol }C_8H_{18}}{114.26\text{ g}}\cdot\frac{25\text{ mol }O_2}{2\text{ mol }C_8H_{18}} = 5.46_{998}\times10^3\text{ mol }O_2 = n$$

$$PV = nRT \longrightarrow V = \frac{nRT}{P} = \frac{(5.46_{998}\times10^3\text{ mol})(0.0821\ \frac{L\cdot atm}{mol\cdot K})(298\text{ K})}{1.00\text{ atm}}$$

$$= 1.33_{83}\times10^5\text{ L}$$

f)

$$\frac{70.9_{7}\ \text{kg}\ H_2O}{1}\left|\frac{1000\ \text{g}}{1\ \text{kg}}\right|\frac{1\ \text{mol}\ H_2O}{18.02\ \text{g}} = 3.93_{84}\times 10^{3}\ \text{mol}\ H_2O$$

$$PV = nRT \longrightarrow P = \frac{nRT}{V} = \frac{(3.93_{84}\times 10^{3}\ \text{mol})\left(0.0821\ \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)313\ \text{K}}{20.0\ \text{L}}$$

$$P = 1.01_{21}\times 10^{5}\ \text{atm}\ ! \qquad (8.99\times 10^{4}\ \text{atm}\ CO_2)$$

$$\frac{1.01_{21}\times 10^{5}\ \text{atm}}{1}\left|\frac{760\ \text{mmHg}}{1\ \text{atm}}\right. = 7.69_{17}\times 10^{7}\ \text{mmHg}$$

$$\frac{7.69_{17}\times 10^{7}\ \text{mmHg}}{1}\left|\frac{1\ \text{cmHg}}{10\ \text{mmHg}}\right|\frac{1\ \text{inHg}}{2.54\ \text{cmHg}} = 3.02_{82}\times 10^{6}\ \text{inHg}$$

$$2\overset{+1\ -1}{HBr}_{(g)} + \overset{+1\ +4\ -2}{Li_2CO_3}_{(aq)} \longrightarrow \overset{+1\ -2}{H_2O}_{(l)} + \overset{+4\ -2}{CO_2}_{(g)} + 2\overset{+1\ -1}{LiBr}_{(aq)}$$

) double replacement

) not redox
1) DR rxns are never redox
2) oxidation states do not change, see part a

d) $2HBr + Li_2CO_3 \longrightarrow H_2O + CO_2 + 2LiBr$

P = 656 mmHg | 147.8 g
T = 42 °C
V = ?
n = ?

$$\frac{147.8\ \text{g}\ Li_2CO_3}{1}\left|\frac{1\ \text{mol}\ Li_2CO_3}{73.892\ \text{g}}\right|\frac{2\ \text{mol HBr}}{1\ \text{mol}\ Li_2CO_3} = 4.000_{43}\ \text{mol HBr}$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(4.000_{43}\ \text{mol})\left(0.0821\ \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(315\ \text{K})}{\frac{656\ \text{mmHg}}{760\ \text{mmHg/atm}}} = 119._{86}\ \text{L}$$

Does this make sense? Sure! 1 mol of gas occupies 22.4 L at 0°C + 1 atm. Since the T is higher and P is lower, the volume should be $> (22.4 \times 4)$

e) $PV = nRT \rightarrow PV = \text{constant} \times T$ (n, R constant)

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

$$V_2 = \frac{P_1V_1}{T_1}\cdot\frac{T_2}{P_2} = \frac{(656\ \text{mmHg})(120\ \text{L})}{315\ \text{K}}\cdot\frac{293\ \text{K}}{690.\ \text{mmHg}} = 106\ \text{L}$$

What is the effect on the pressure of gas sample if you simultaneously decrease its volume to 1/3 of the original volume and double its Kelvin temperature?

$PV = nRT$ What's held constant? n and R, so $PV = \text{constant} \times T$ or $\frac{PV}{T} = \text{constant}$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \longrightarrow P_2 = \frac{P_1 V_1}{T_1} \cdot \frac{T_2}{V_2} \quad \text{and} \quad V_2 = \frac{V_1}{3}, \quad T_2 = 2T_1$$

$$P_2 = \frac{P_1 V_1}{T_1} \cdot \frac{2T_1}{V_1} \cdot 3 \longrightarrow P_2 = 6P_1$$

a smaller volume and higher temperature would increase pressure.

A sample of the deadly gas, HCN, has a mass of 1.75 grams. What would be its volume at 25 °C and 750 mmHg?

1.75 g → convert to moles $\frac{1.75\ \text{g}}{1} \Big| \frac{1\ \text{mol}}{27.03\ \text{g}} = 0.0647_{43}$ mol (n)

25 °C → convert to K $273 + 25 = 298$ K (T)

750 mmHg → convert to atm $\frac{750\ \text{mmHg}}{1} \Big| \frac{1\ \text{atm}}{760\ \text{mmHg}} = 0.986_{84}$ atm (P)

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

$$V = \frac{(0.0647_{43}\ \text{mol})\left(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(298\ \text{K})}{0.986_{84}\ \text{atm}} = 1.60_{51}\ \text{L}$$

A certain gas mixture contains 1.25 moles of N_2, 3.50 moles of O_2, and 5.00 moles of He. If the total pressure of the mixture is 15.0 atm, what are P_{N2}, P_{O2}, and P_{He}?

$P_{TOTAL} \propto n_{TOTAL}$ (Dalton's Law)

$P_T = P_{N_2} + P_{O_2} + P_{He}$ so... $n_T = n_{N_2} + n_{O_2} + n_{He}$

$P_T = \frac{n_T RT}{V} = \frac{n_{N_2} RT}{V} + \frac{n_{O_2} RT}{V} + \frac{n_{He} RT}{V}$ $= 1.25 + 3.50 + 5.00 = 9.75$ moles

$P_{N_2} = 15.0\ \text{atm}\left(\frac{1.25}{9.75}\right) = 1.92$ atm

$P_{O_2} = 15.0\ \text{atm}\left(\frac{3.50}{9.75}\right) = 5.38$ atm

$P_{He} = 15.0\ \text{atm}\left(\frac{5.00}{9.75}\right) = 7.69$ atm

$1.92 + 5.38 + 7.69 = 14.99$ atm ≈ 15.0 atm