SL & HL Answers to Reacting masses & volumes questions

1. Amount of zinc = 1.20/65.38 = 1.84×10^{-2} mol

Amount of copper(II) sulfate = $50/1000 \times 2.00 \times 10^{-1} = 1.00 \times 10^{-2}$ mol

Zinc is in excess and copper(II) sulfate is the limiting reagent

Maximum amount of copper deposited = 1.00×10^{-2} mol

Mass of copper deposited = $1.00 \times 10^{-2} \times 63.55 = 6.36 \times 10^{-1}$ g (0.636 g)

2. Amount of hydrochloric acid = $150/1000 \times 1.00 = 1.50 \times 10^{-1}$ mol

Amount of calcium carbonate = $10.0/[40.08 + 12.01 + (3 \times 16.00)] = 1.00 \times 10^{-1}$ mol

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

Calcium carbonate is in excess and the hydrochloric acid is the limiting reagent

Amount of carbon dioxide produced = ½ x 1.50×10^{-1} mol = 7.50×10^{-2} mol

Mass of carbon dioxide produced = $7.50 \times 10^{-2} \times 44.01 = 3.30$ g

3. Amount of ethanol = $9.36/[(2 \times 12.01) + (6 \times 1.01) + 16.00] = 2.03 \times 10^{-1}$ mol

Maximum amount of ethene that could be formed = 2.03×10^{-1} mol

Maximum mass of ethene that could be formed = $2.03 \times 10^{-1} \times [(2 \times 12.01) + (4 \times 1.01)] = 5.696$ g

Percentage yield = $(2.12/5.696) \times 100 = 37.2$ %

4. Volume = $67.2 \times \frac{302}{295} \times \frac{9.38 \times 10^4}{1.06 \times 10^5} = 60.9$ cm^3

or just work out from first principles that increasing the pressure will decrease the volume and increasing the temperature will increase the volume so the new volume = original volume x $(9.38 \times 10^4)/(1.06 \times 10^5) \times (29.0 + 273)/(22.0 + 273) = 60.9$ cm^3.

5. $n = PV/RT$

$n = (1.01 \times 10^5) \times (2.50 \times 10^{-3})/ (8.31 \times 292) = 1.04 \times 10^{-1}$ mol

Molar mass of gas = $4.59/1.04 \times 10^{-1} = 44.1$ g mol^{-1}

6. All hydrocarbons (represented by C_xH_y) combust completely to give carbon dioxide and water

$$C_xH_y(g) + (x + y/4)O_2(g) \rightarrow xCO_2(g) + y/2H_2O(l)$$

After the reaction the volume of the carbon dioxide produced and the excess oxygen = 1000 cm^3

Volume of carbon dioxide = 800 cm^3 so volume of excess oxygen = 200 cm^3

200 cm^3 of C_xH_y reacts with 1300 cm^3 of O_2 to produce 800 cm^3 of CO_2

I volume of C_xH_y reacts with 6.5 volumes of O_2 to produce 4 volumes of CO_2

Equal volumes of different gases under the same conditions contain the same number of particles

$x = 4$ and $(x + y/4) = 6.5$ so $y = 10$

The molecular formula of the hydrocarbon is C_4H_{10}