QUANTITATIVE EQ BOOKLET ANSWERS

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1. At a high temperature, calcium oxide reacts with carbon to form calcium carbide, CaC_2.

$$CaO(s) + 3C(s) \rightarrow CaC_2(s) + CO(g)$$

(a) Calcium oxide reacts with carbon to make 128 g of calcium carbide. Calculate

(i) the relative formula mass of calcium carbide.

$Ca + C + C = 40 + 12 + 12$

$= 64$

(1)

(ii) the amount, in moles, of calcium carbide made in the reaction.

$n = \frac{m}{M_r} = \frac{128}{64} = 2$

(1)

(iii) the minimum amount, in moles, of carbon that is required to make this amount of calcium carbide.

ratio $CaC_2 : C$

$\Rightarrow 1 : 3$ ie 6 moles C needed

$\therefore 2 : 6$

(1)

(iv) the minimum mass, in g, of carbon required.

$m(C) = n \times M_r = 6 \times 12$

$= 72\ g$

(1)

(b) Calcium carbide reacts with water to make the gas ethyne, C_2H_2, and a compound of calcium.

(DATA INTERP/ APPLICATION OF KNOWLEDGE)

(i) Complete the chemical equation for this reaction:

$CaC_2 + 2H_2O \rightarrow C_2H_2 + \ldots Ca(OH)_2 \ldots$

(1)

(ii) Ethyne, C_2H_2, is highly flammable.

(ORGANIC)

Predict the products of the complete combustion of ethyne.

H_2O / water

CO_2 / carbon dioxide

(2)

1.

Leave blank

2. (a) Copper(II) carbonate reacts with dilute hydrochloric acid.
The equation for the reaction is

$$CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of copper(II) carbonate was added to a solution containing 0.200 mol of hydrochloric acid.

(i) Calculate the amount, in moles, of copper(II) carbonate that will react with 0.200 mol of hydrochloric acid.

ratio $HCl = CuCO_3$

$2 = 1$

$0.20 : 0.10$ ∴ 0.1(00) moles

(1)

(ii) Calculate the mass, in grams, of this amount of copper(II) carbonate.

- $m(CuCO_3) = n \times M_r = 0.1 \times 123.5 \Rightarrow 12.35g$
- $M_r(CuCO_3) = 63.5 + 12 + 3(16) = 123.5$

(2)

(iii) Calculate the volume of carbon dioxide gas at room temperature and atmospheric pressure that will be formed in this reaction.
(The volume of 1 mol of any gas at room temperature and atmospheric pressure is 24 dm^3).

- ratio $HCl = CO_2$

$2 = 1$

$0.2 : 0.1$

- $vol = n \times 24$

$= 0.1 \times 24$

$= 2.4\ dm^3$. (or $2400\ cm^3$)

(2)

3 (a) A 5.55 g sample of calcium chloride ($M_r = 111$) is dissolved in water to make a solution.

(i) Calculate the amount, in moles, in the sample of calcium chloride.

$n = m/M_r = 5.55/111$

$= 0.05$

(2)

(ii) What amount, in moles, of sulphuric acid is needed to react completely with the calcium chloride solution?

EQU missed off the O *

$CaCl_2 + H_2SO_4 \rightarrow CaSO_4 + 2HCl$

1 : 1 ratio

∴ 0.05.

(1)

(iii) Calculate the relative formula mass of calcium sulphate. Use data from the Periodic Table on page 2.

$Ca + S + 4(O) = 40 + 32 + 4(16)$

$= 136$

(1)

(iv) Calculate the mass, in grams, of calcium sulphate formed.

ratio $CaCl_2 : CaSO_4$

1 : 1 ∴ 0.05 : 0.05

mass $CaSO_4 = n \times M_r = 0.05 \times 136$ **(2)**

$= 6.8\,g$

Leave blank

(b) The following equation represents a reaction used to prepare the salt lead(II) nitrate.

$$PbCO_3(s) + 2HNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

In this experiment the amount of nitric acid used was 0.0400 mol.

(i) The concentration of the dilute nitric acid used was 0.500 mol dm^{-3}. Calculate the volume, in cm^3, of dilute nitric acid used.

$V = \frac{n}{c} = \frac{0,0400}{0,500}$

$= 0,08\ dm^3$

$= 80\ cm^3$

(3)

(ii) In this experiment, 0.0200 mol of carbon dioxide gas was produced. Calculate the volume, in cm^3, that this amount of carbon dioxide occupies at room temperature and pressure (rtp).
(molar volume of any gas = 24 000 cm^3 at rtp)

$Vol = n \times 24,000$

$= 0,0200 \times 24,000$

$= 480\ cm^3$

(1)

Q10

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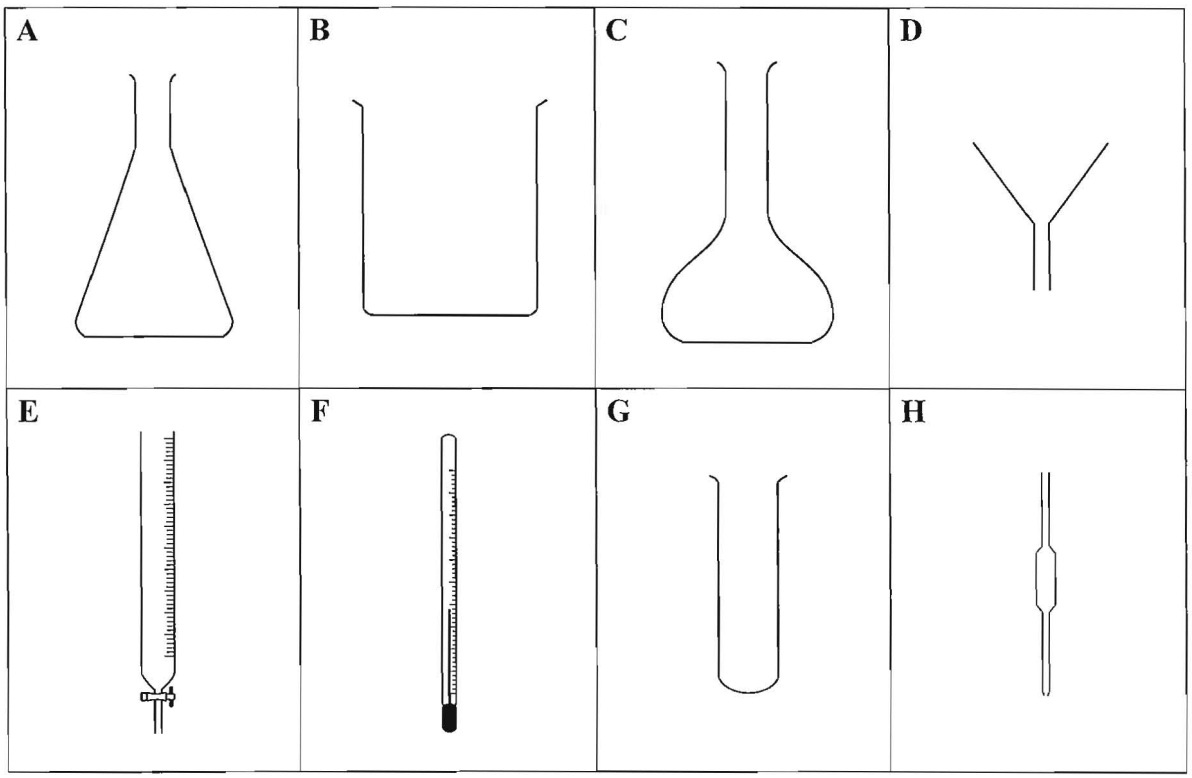
4 An oven cleaner contains the alkali sodium hydroxide.

(a) A solution of the oven cleaner in distilled water is titrated with hydrochloric acid. Some of the following pieces of apparatus are used in this experiment.



Choose from the letters **A** to **G** to identify the pieces of apparatus in the table below.

Name of apparatus	Letter
Beaker	B
Burette	E
Conical flask	A
Funnel	D
Pipette	H

(5)

(b) It is important to wear eye protection when using an alkali.
What property of alkalis makes this safety precaution necessary?

corrosive / irritant

(1)

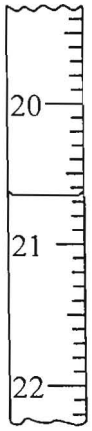
5

Leave blank

(c) The diagrams show the readings on the burette before and after a student added the hydrochloric acid in one titration.

before

after



Use the diagrams to help you complete the table.

Burette reading after adding acid (cm^3)	20.65
Burette reading before adding acid (cm^3)	1.80
Volume of acid added (cm^3)	18.85

(3)

(d) A second student did the titration four times.
The table shows the results.

Burette reading after adding acid (cm^3)	21.10	20.90	21.80	40.95
Burette reading before adding acid (cm^3)	0.30	0.80	1.45	20.50
Volume of acid added (cm^3)	20.80	20.10	20.35	20.45
Titration results to be used (✓)			✓	✓

(i) Which titration results should be used to calculate the average volume of acid added? Place ticks (✓) in the table.

(1)

(ii) Use your ticked results to calculate the average volume of acid added.

$$\frac{(20.35 + 20.45)}{2} = 20.40 \text{ (or } 20.4)$$

(2)

Q1

Leave blank

5. A student wanted to find the concentration of a solution of nitric acid.

She placed a 25.0 cm^3 sample of the nitric acid solution in a conical flask and titrated it with 0.200 mol dm^{-3} sodium hydroxide solution, using phenolphthalein as an indicator. The phenolphthalein changed colour after she added a total of 21.05 cm^3 of the sodium hydroxide solution.

The equation for the reaction is:

$$NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$$

(a) State the colour change of the phenolphthalein.

Colourless to pink

(2)

(b) (i) Calculate the amount, in moles, of sodium hydroxide used in the titration.

- $n = CV$
- $= 0,200 \times 0,0215$
- $= 0,00421$

(2)

(ii) Calculate the concentration, in mol dm^{-3}, of the nitric acid.

ratio is 1:1 ∴ 0,00421 nitric acid needed

- $C = \frac{n}{V} = \frac{0,00421}{0,025}$
- $= 0,168(4)$ mol/dm^3

(2)

(c) (i) Calculate the relative formula mass of sodium nitrate.

$Na + N + 3(O)$

$\Rightarrow 23 + 14 + 3(16) = 85$

(1)

5 (cont)

(ii) Calculate the mass of sodium nitrate formed in the titration.

$m = n \times Mr$

$= 0.00421 \times 85$

$= 0.35785\ g$ (or $0.358\ g$)

(2)

6 (a) The reaction between dilute phosphoric acid and sodium hydroxide solution is represented by the equation

$$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$$

A sample of sodium hydroxide solution was titrated against dilute phosphoric acid. It was found that 25.0 cm^3 of sodium hydroxide solution was neutralised by 12.30 cm^3 of phosphoric acid of concentration 0.150 mol dm^{-3}.

(i) Calculate the amount, in moles, of phosphoric acid used in the titration.

$n = CV$

$= 0.150 \times 0.0123$

$= 0.001845$ (or 0.00185)

(2)

(ii) Calculate the amount, in moles, of sodium hydroxide that would react with this amount of phosphoric acid.

ratio H_3PO_4 : $NaOH$

1 : 3

$\therefore 0.001845 : (3 \times 0.001845)$

$\Rightarrow 0.005535$

(1)

(iii) Calculate the concentration, in mol dm^{-3}, of the sodium hydroxide solution.

$C = \frac{n}{V} = \frac{0.005535}{0.025}$

$= 0.2214\ mol/dm^3$

(2) **Q9**

(Total 16 marks)