O Level Pure Chemistry Structured

The Mole Concept and Stoichiometry Test 2.0

Q1

Elements W, X, Y and Z are all in the same period but in different groups of the Periodic Table.
W reacts with oxygen to form W_2O, a strongly basic oxide.
X reacts with oxygen to form XO_2, an acidic oxide and a gas at room temperature.
The oxide of Y is Y_2O_3, which can react with both an acid and a base.
Z produces an ion Z^-.

Use the information given to answer the following questions:

(a) Place X, Y, W and Z to their respective groups in the Periodic Table.

.....

.....[2]

(b) Write the formulae for the sulfate and hydride of W.

.....[1]

(c) What type of bonding is present in the oxide XO_2? Give a reason for your answer.

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.....[2]

(d) Write the formula for the compound formed between Y and Z.

.....[1]

(e) Write the equation for the reaction that occurs when element W reacts with oxygen. Include state symbols.

.....[2]

[Total: 8]

Q2

A student buys and tests some tablets that contain aspirin, [redacted]-COOH.
He performs a titration experiment using a crushed tablet and 0.10 mol/dm^3 of aqueous sodium hydroxide to determine the mass of aspirin contains in one tablet.

His results show that the volume of aqueous sodium hydroxide needed for neutralisation is 16.70 cm^3. The relative molecular mass of aspirin is 180.

(a) With the help of an equation for the reaction between aspirin and aqueous sodium hydroxide, determine the mass of aspirin contains in one tablet. Show all working.

[3]

(b) Some tablets that contain aspirin also contain citric acid.
The student does another titration using one of these tablets.

Explain why the mass of aspirin you calculate from his titration results is incorrect.

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.....[2]

Q3

A student carried out an experiment to investigate the relationship between the mass of zinc used in a reaction and the volume of hydrogen gas liberated.
In the experiment he added pieces of zinc to 50 cm^3 of hydrochloric acid and recorded the volume of the gas collected. The table shows the student's results.

mass of zinc /g	volume of hydrogen collected / cm^3
0.1	33
0.2	66
0.3	99
0.4	132
0.5	165
0.6	198
0.7	225
0.8	225

The reaction of zinc and hydrochloric acid is

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(a) (i) Using the equation, calculate the theoretical volume of hydrogen liberated when 0.5 g of zinc was used. [2]

(ii) Using information from the table, suggest why the answer in **a (i)** is different from the one obtained in the experiment assuming that there is no loss in gas collected. [1]

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(b) Suggest why the volume of the hydrogen collected is different for 0.1 g to 0.6 g of zinc but remains the same for 0.7 g and 0.8 g. [2]

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(c) Using information from the table, calculate the concentration of the acid used in this experiment. [3]

(d) The experiment was repeated using hydrochloric acid which was warmed to 60°C. Using the collision theory explain why a shorter time was observed to collect the hydrogen gas. [2]

Q4

The table below shows the enthalpy change of combustion for alkanes and alcohols.

alkane	formula	M_r	enthalpy change of combustion (kJ / mol)	alcohol	formula	M_r	enthalpy change of combustion (kJ / mol)
methane	CH_4	16	-890	methanol	CH_3OH	32	-726
ethane	C_2H_6	30	-1560	ethanol	C_2H_5OH	46	-1367
propane	C_3H_8	44	-2219	propanol	C_3H_7OH	60	-2021
butane	C_4H_{10}	58	-2877	butanol	C_4H_9OH	74	-2676

(a) (i) Describe the trend in enthalpy change of combustion for both alkanes and alcohols.

.....[1]

(ii) Suggest a reason to explain the trend described in a(i).

.....

.....[1]

(b) Which fuel, methane or methanol, produce a sootier flame when 1 g of it is burnt completely? Explain your answer by means of calculation.

[2]

(c) Methane has been found trapped in ice about 500 m to 2000 m below the ocean surface. This frozen fuel is known as methane hydrate. When a sample of 1 cm^3 of methane hydrate was brought to room temperature and pressure, 160 cm^3 of methane gas was produced.

Explain, in terms of particles, how 160 cm^3 of methane gas can be contained in 1 cm^3 of methane hydrate.

.....

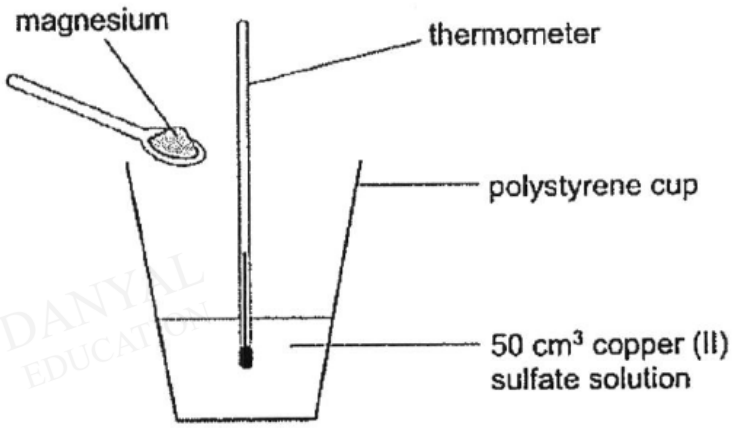
.....[2]

(d) Calculate the amount of energy contained in 1 cm^3 of methane hydrate. Give your answer in J, corrected to three significant figures.

[3]

Q5

A pupil investigated the reaction between powdered magnesium and copper (II) sulfate as shown in the diagram below.



The results of the experiment, using different mass of magnesium, are shown in the table below.

Mass of magnesium / g	Maximum temperature rise / °C
0.2	3.5
0.4	6.0
0.6	8.0
0.8	9.0
1.0	9.0

(a) Write the ionic equation, with state symbols, for the reaction above. [2]

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(b) Using the information given, calculate the concentration of Cu^{2+} ions, in mol/dm³ of the solution. [2]

(c) Suggest two observations, other than a change in temperature, which will happen if 1.5 g of magnesium is added to 50 cm³ of the copper (II) sulfate solution. [2]

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Answers

The Mole Concept and Stoichiometry Test 2.0

Q1

a	X – Group VI, Y – Group III, W – Group I, Z – Group VII [4√ – 2m, 3√ – 2√ - 1m, 1√ – 0m] [reject X – Gp IV as carbon is in different period from Y, W and Z]	2
b	W_2SO_4 and WH [reject HW] [both answer must be correct to score 1m]	1
c	covalent bonding [1] As XO_2 forms an acidic oxide, X must be a non-metal. Covalent bond is formed between non-metallic elements. Or Covalent compound has a low boiling point as it exists as a gas at room temperature. [1]	2
d	YZ_3	1
e	$4W(s) + O_2(g) \rightarrow 2W_2O(s)$ [1m for balanced equation; 1m for correct state symbols]	2

Q2

a

equation : [redacted]-COOH + NaOH → [redacted]-COONa + H_2O [1]

No. of mole of NaOH = conc x vol
= 0.10 x 0.0167
= 0.00167 mol

From the equation, 1 mole of sodium hydroxide reacts with 1 mole of aspirin.
No. of mole of aspirin = 0.00167 mol [1]

Mass of aspirin = mol x Mr
= 0.00167 x 180
= 0.3006 g
= 0.301 g (3 s.f.) [1]
[accept 301 mg]

b Citric acid also reacts with aqueous sodium hydroxide. The volume of aqueous sodium hydroxide used is higher than expected. [1] Hence the calculated mass of aspirin would be higher than the actual mass. [1]

Q3

a	i	Moles of 0.5 g of zinc $= \frac{0.5}{65}$ $= 0.007692$ Mole ratio: 1mole Zn:1 mole H_2 Moles of H_2 = 0.007692 [1] Volume of H_2 = 0.007692 x 24000 = 184.6 cm^3 = 185 cm^3 [1] or 0.185 dm^3 (3 sf)	2
	ii	The zinc samples are impure.	1
b		In the experiments when 0.1 g to 0.6 g of zinc were used , zinc is the limiting reagent. Or HCL is in excess[1] From 0.7 g of zinc, HCl is the limiting reagent. Or zinc is in excess [1]	2
c		Moles of $H_2 = \frac{225}{24000}$ = 0.009375 [1] Moles of HCl = 0.009375 x 2 = 0.01875 [1] Concentration of HCl $= \frac{1000}{50}$ x 0.01875 = 0.375 mol/dm^3 [1]	3
d		increase in frequency of effective collisions [1] increase in kinetic energy/move faster/ more particles that possess the minimum activation energy[1]	2

Q4

(a)	(i)	As molecular size /mass // number of carbon atoms per molecule increases, the enthalpy change of combustion increases.
	(ii)	More carbon and hydrogen atoms present // Additional CH_2 unit as Mr increases, so there are more C-H bonds to be broken, resulting in higher energy level of reactants. [1]
(b)		% mass of carbon in methane = 12 / 16 X 100 = 75% % mass of carbon in methanol = 12 / (12 +16 + 4) X 100 = 37.5% Since methane has a higher percentage mass of carbon, it burns with a sootier flame. Working [1], conclusion [1] Accept if calculation of mass or mole of C is used. Max 1m if calculation of carbon dioxide is used, provided correct conclusion is given.
(c)		Molecules in methane gas are widely spaced // far apart from each other [1], so they can be pushed closer together // but in methane hydrate solid they are very closely packed to fit into a smaller volume. [1] Reject: the methane particles can be compressed.
(d)		mole of methane = 160 / 1000 / 24 = 0.006666 mol [1] energy = 0.006666 X 890 = 5.932 kJ = 5930 J Correct ans [1], 3sf [1] Reject if no units. Full credit given to: 890 X 1000 = 890 000 J/mol 2m if only mole is calculated: conversion [1], correct mol [1]

Q5

(a)	$Mg\ (s) + Cu^{2+}\ (aq) \rightarrow Cu\ (s) + Mg^{2+}\ (aq)$	2
(b)	No. of moles of Mg = 0.8 / 24 = **0.0333 mol**	1
	Concentration of Cu^{2+} = 0.0333 / 0.05 = **0.667 mol/dm^3**	1
(c)	**Pink / reddish-brown solid is formed.**	1
	Blue solution decolourises.	1