Atoms, Molecules & Stoichiometry

Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Atoms, Molecules & Stoichiometry
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 2

Time Allowed: **62 minutes**

Score: **/51**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Define the term *mole*.

.....

..... [1]

(b) 10 cm^3 of a gaseous hydrocarbon, C_xH_y, was reacted with 100 cm^3 of oxygen gas, an excess.

The final volume of the gaseous mixture was 95 cm^3.

This gaseous mixture was treated with concentrated, aqueous sodium hydroxide to absorb the carbon dioxide present. This reduced the gas volume to 75 cm^3.

All gas volumes were measured at 298 K and 100 kPa.

(i) Write an equation for the reaction between sodium hydroxide and carbon dioxide.

..... [1]

(ii) Calculate the volume of carbon dioxide produced by the combustion of the hydrocarbon.

volume of CO_2 produced = ... cm^3 [1]

(iii) Calculate the volume of oxygen used up in the reaction with the hydrocarbon.

volume of O_2 used = ... cm^3 [1]

(iv) Use your answers to **(b)(ii)** and **(b)(iii)**, together with the initial volume of hydrocarbon, to balance the equation below.

.....C_xH_y + ...O_2 → .....CO_2 + zH_2O [2

(v) Deduce the values of *x*, *y* and *z* in the equation in **(iv)**.

x = ...

y = ...

z = ...

[3]

(c) Another hydrocarbon, **W**, with the formula C_4H_8, reacts with hydrogen bromide, HBr, to give two products **X** and **Y**. **X** and **Y** are structural isomers of molecular formula C_4H_9Br.

Reaction of **X** with aqueous alkali produces an alcohol, **Z**, that has **no** reaction with acidified dichromate(VI).

(i) Give the structures **and** names of the compounds **W**, **X**, **Y**, and **Z**

W

....

Y

....

[4]

(ii) When **W** reacts with hydrogen bromide, more **X** than **Y** is produced. Explain why.

.....

.....

.....

..... [2]

[Total: 15]

2 **(a)** Successive ionisation energies for the elements magnesium to barium are given in the table.

element	1st ionisation energy / kJ mol^{-1}	2nd ionisation energy / kJ mol^{-1}	3rd ionisation energy / kJ mol^{-1}
Mg	736	1450	7740
Ca	590	1150	4940
Sr	548	1060	4120
Ba	502	966	3390

(i) Explain why the first ionisation energies decrease down the group.

.....

.....

.....

..... [3]

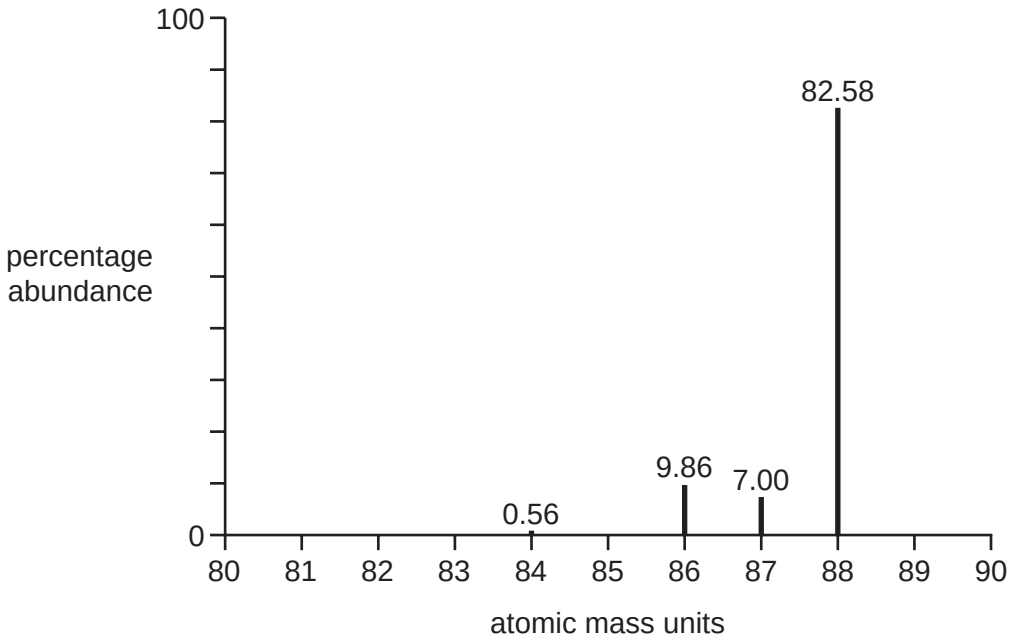
(ii) Explain why, for each element, there is a large increase between the 2nd and 3rd ionisation energies.

.....

.....

..... [2]

(b) A sample of strontium, atomic number 38, gave the mass spectrum shown. The percentage abundances are given above each peak.



(i) Complete the full electronic configuration of strontium.

$1s^2\ 2s^2\ 2p^6$ ..... [1]

(ii) Explain why there are four different peaks in the mass spectrum of strontium.

.....

..... [1]

(iii) Calculate the atomic mass, A_r, of this sample of strontium.
Give your answer to **three** significant figures.

A_r = ... [2]

(c) A compound of barium, **A**, is used in fireworks as an oxidising agent and to produce a green colour.

(i) Explain, in terms of electron transfer, what is meant by the term *oxidising agent*.

.....

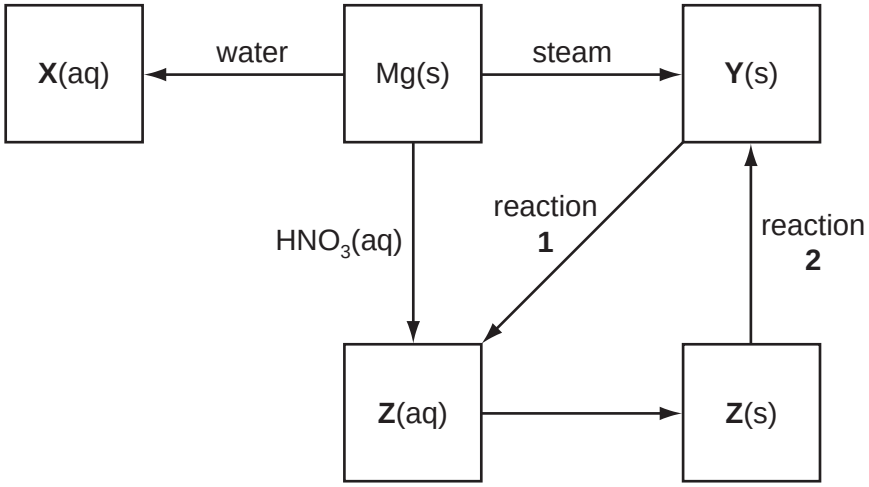
..... [1]

(ii) **A** has the following percentage composition by mass: Ba, 45.1; C*l*, 23.4; O, 31.5.

Calculate the empirical formula of **A**.

empirical formula of **A** ..... [3]

(d) Some reactions involving magnesium and its compounds are shown in the reaction scheme below.



(i) Give the **formulae** of the compounds **X**, **Y** and **Z**.

X .....

Y .....

Z .....

[3]

(ii) Name the reagent needed to convert **Y**(s) into **Z**(aq) in reaction **1** and write an equation for the reaction.

reagent .....

equation .....

[2]

(iii) How would you convert a sample of **Z**(s) into **Y**(s) in reaction **2**?

..... [1]

(iv) Give equations for the conversions of Mg into **X**, and **Z**(s) into **Y**.

Mg to **X** .....

Z to **Y** .....

[2]

[Total: 21]

3 Compound **Q** is a viscous liquid which is very soluble in water.
The M_r of **Q** is 90.0.

Three possible structures for **Q** are shown below.

R	**S**	**T**
$HOCH_2CH_2CO_2H$	$HOCH_2CO_2CH_3$	$HCO_2CH_2CH_2OH$

(a) (i) What type of isomerism do **R**, **S** and **T** show?

.....

(ii) What oxygen-containing functional groups are present in **R**, **S** and **T**?
Give their **full names**.

R ..... and .....

S ..... and .....

T ..... and .....

(iii) Which functional group(s) in **(ii)** will react with sodium carbonate?

.....

(iv) Which functional group(s) in **(ii)** will react with sodium metal?

.....

[6]

(b) When 0.002 mol of **Q** is reacted with an excess of solid sodium carbonate, Na_2CO_3, 24 cm^3 of carbon dioxide, measured at room temperature and pressure, is produced.

(i) Calculate the amount, in moles, of carbon dioxide produced in this reaction.

(ii) Hence calculate the amount, in moles, of carbon dioxide produced by 1 mol of **Q**.

[2]

When 0.002 mol of **Q** is reacted with an excess of metallic sodium, 48 cm^3 of hydrogen, measured at room temperature and pressure, is produced.

(c) (i) Calculate the amount, in moles, of hydrogen molecules produced in this reaction.

(ii) Hence calculate the amount, in moles, of hydrogen molecules produced by 1 mol of **Q**.

[2]

(d) Use your answers to **(b)** and **(c)** to deduce which structure, **R**, **S** or **T**, corresponds to the structure of **Q** and write balanced equations for the reactions that occurred.

identity of **Q** is .....

equation for reaction with sodium carbonate

.....

equation for reaction with sodium metal

..... [5]

[Total: 15]