

Surname	Centre Number	Candidate Number
Other Names		2



GCE AS/A level

1091/01

CHEMISTRY – CH1

A.M. THURSDAY, 9 January 2014

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
Section A 1.5.	10	
Section B 6.	8	
7.	15	
8.	19	
9.	18	
10.	10	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:

- calculator;
- copy of the **Periodic Table** supplied by WJEC.
Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.

Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The **QWC** label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the continuation page(s) at the back of the booklet, taking care to number the question(s) correctly.

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SECTION A

Answer **all** questions in the spaces provided.

1. An element, X, has an atomic number of 9 and forms an ion X^- . State which **one** of the following shows the numbers of protons and electrons in this **ion**. [1]

	protons	electrons	
A	8	9	
B	9	8	
C	9	9	<input type="checkbox"/>
D	9	10	

2. State which **one** of the following shows the mass of aluminium that contains the same number of atoms as there are molecules in 11.0 g of carbon dioxide, CO_2 . [1]

A	6.75 g	
B	13.5 g	
C	27.0 g	<input type="checkbox"/>
D	54.0 g	

3. The isotope ^{32}P is radioactive. It decays by β -emission and has a half-life of 14 days.

(a) State what is meant by β -emission. [1]

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(b) Give the mass number **and** symbol of the atom formed by the loss of one β -particle from an atom of ^{32}P . [1]

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(c) State what is meant by the term *half-life*. [1]

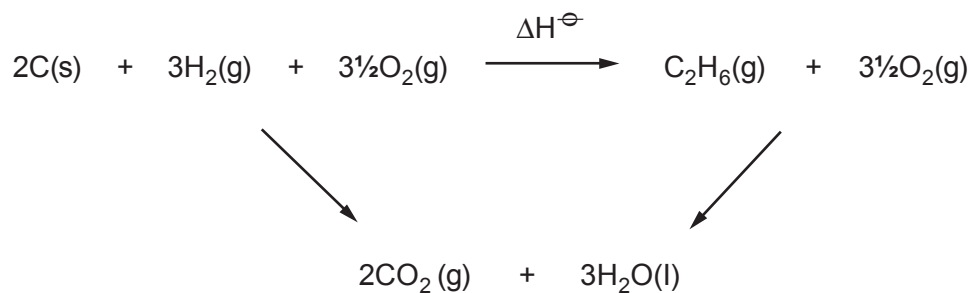
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(d) Calculate how long it will take a sample of ^{32}P to decay from 8 g to 1 g. [1]

Time taken = days

4. Study the following energy cycle.



Use the values in the table below to calculate the enthalpy change of reaction, ΔH^\ominus .

[2]

Substance	Enthalpy change of combustion, $\Delta H_c^\ominus / \text{kJ mol}^{-1}$
carbon	-394
hydrogen	-286
ethane	-1560

$$\Delta H^\ominus = \dots\dots\dots \text{kJ mol}^{-1}$$

5. Silver tarnishes because it reacts with hydrogen sulfide in the air to form silver sulfide.

A 1.24 g sample of silver sulfide contains 0.16 g of sulfur. Calculate the empirical formula of this compound. **Show your working.** [2]

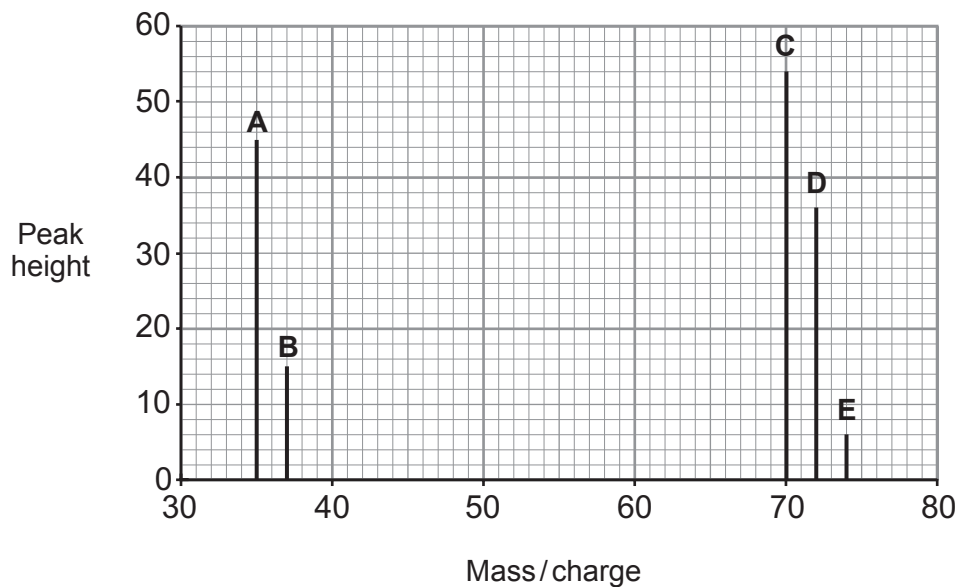
Empirical formula

Section A Total [10]

SECTION B

Answer all questions in the spaces provided.

6. (a) The mass spectrum of chlorine, Cl_2 , is shown below.



- (i) Identify the positive ions that are responsible for the peaks **B** and **C**. [2]

Peak **B**

Peak **C**

- (ii) Use the mass spectrum to calculate the ratio of peak height **C** : peak height **E**. [2]

Ratio

- (iii) Explain why the peak heights of **C** and **E** are in this ratio. [2]

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(b) Another element in Group 7 is bromine, Br.

Its mass spectrum shows that bromine has two naturally-occurring isotopes. The abundance of each isotope is given below.

Isotope	Percentage abundance/%
^{79}Br	50.69
^{81}Br	49.31

Calculate the relative atomic mass of bromine, giving your answer to **four** significant figures. [2]

Relative atomic mass =

Total [8]

(b) State, giving a reason, which oxide is the more efficient catalyst. [1]

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(c) In the experiment with oxide **A**, calculate the volume of oxygen evolved

(i) during the first minute, [1]

.....

(ii) during the third minute. [1]

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(d) Explain the difference between the answers in (c)(i) and (c)(ii). [2]

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(e) Give a reason why the total volume of oxygen obtained in the two experiments is the same. [1]

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(f) If Trystan repeated the experiment using 5 cm^3 of the original hydrogen peroxide solution diluted with 95 cm^3 of water, state the final volume of oxygen that would be evolved. [1]

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(g) If he carried out the experiments at 45 °C instead of 35 °C, state what effect this would have on the time required to obtain the final volume of oxygen. Use collision theory to explain your answer.

[3]
QWC [1]

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Total [15]

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- (c) (i) Hydrogen has a first ionisation energy of 1312 kJ mol^{-1} .
Explain why helium has a higher first ionisation energy than hydrogen. [2]

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- (ii) Beryllium and magnesium are both in Group 2 of the Periodic Table.
Explain why beryllium has a higher first ionisation energy than magnesium. [2]

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- (iii) The table below gives the first three ionisation energies for boron and potassium.

Element	Ionisation energy / kJ mol^{-1}		
	1st	2nd	3rd
B	800	2420	3660
K	419	3051	4412

- I Suggest why compounds containing B^{3+} ions are unlikely to exist. [1]

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- II Write an equation to represent the **second** ionisation energy of potassium. [1]

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- III State how the first three ionisation energies of calcium would differ from those of potassium. [2]

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Total [19]

9. (a) State what is meant by the term *standard molar enthalpy change of formation*. [2]

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- (b) (i) Write an equation to represent the standard molar enthalpy change of formation, ΔH_f^\ominus , of $\text{H}_2\text{O}(\text{g})$. [1]

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- (ii) The standard molar enthalpy change of formation, ΔH_f^\ominus , of $\text{H}_2\text{O}(\text{g})$ is -242 kJ mol^{-1} . Using this value and the average bond enthalpies given in the table below, calculate the average bond enthalpy of the O — H bond in H_2O . [2]

Bond	Average bond enthalpy/ kJ mol^{-1}
H — H	436
O = O	496

Average bond enthalpy of O — H bond = kJ mol^{-1}

- (c) Hydrogen has been proposed as a possible alternative to petrol as a fuel for cars. One suggestion is to store the hydrogen in the car as solid magnesium hydride, MgH_2 , and generate it as required by heating.

- (i) I Give **one** advantage of using hydrogen in place of petrol as a fuel for cars. [1]

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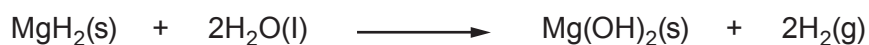
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- II Give **one** advantage of storing the fuel in the car in the form of magnesium hydride rather than hydrogen gas. [1]

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- (ii) One possible disadvantage of using magnesium hydride arises from its reaction with water.



Suggest why magnesium hydride's reaction with water could be a problem. [1]

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- (iii) The fuel tank of one type of hydrogen-powered car holds 70 kg of magnesium hydride.

Calculate the volume of hydrogen gas, measured at room temperature and pressure, which would be produced if this amount of magnesium hydride reacted with water. [3]

[1 mol of gas molecules occupies 24 dm³ at room temperature and pressure]

Volume of hydrogen gas = dm³

- (d) Methanol can be produced industrially by passing carbon monoxide and hydrogen over a catalyst at high temperatures and pressures.



- (i) State how the equilibrium yield of methanol is affected by an increase in temperature and in pressure. [1]

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- (ii) Explain your answer to part (i). [2]

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- (e) Many catalysts are very expensive but their use does allow the chemical industry to operate more profitably. Explain why the use of catalysts provides economic and environmental benefits.

[3]

QWC [1]

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Total [18]

10. (a) Sodium carbonate can be manufactured in a two-stage process as shown by the following equations.



Calculate the maximum mass of sodium carbonate which could be obtained from 900 g of sodium chloride. [3]

Maximum mass of sodium carbonate = g

- (b) Sodium carbonate can form a hydrate, $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$.

When 4.64 g of this hydrate was heated, 2.12 g of anhydrous Na_2CO_3 remained.

- (i) State the mass of water in 4.64 g of the hydrate. [1]

- (ii) Calculate the number of moles of sodium carbonate and the number of moles of water in 4.64 g of the original hydrate. Use these values to calculate the value of x in $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$. [2]

$x = \dots\dots\dots$

QUESTION 10 CONTINUES ON PAGE 16

- (c) Hannah is given an impure sample of anhydrous sodium carbonate and she carries out an experiment to determine the percentage of sodium carbonate in the sample. She finds that she needs 18.0 cm^3 of hydrochloric acid of concentration 0.50 mol dm^{-3} to react completely with 0.55 g of the impure sample. The impurity does not react with hydrochloric acid. The equation for the reaction is given below.



- (i) Calculate the number of moles of HCl used in the titration. [1]

Number of moles of HCl = mol

- (ii) Deduce the number of moles of Na_2CO_3 that reacted with the HCl. [1]

- (iii) Calculate the mass of Na_2CO_3 in the sample. [1]

Mass of Na_2CO_3 in sample = g

- (iv) Calculate the percentage by mass of Na_2CO_3 in the sample. [1]

Percentage by mass = %

Total [10]

Section B Total [70]

END OF PAPER



GCE AS/A level

1091/01-A

**CHEMISTRY – PERIODIC TABLE
FOR USE WITH CH1**

A.M. THURSDAY, 9 January 2014

