Surname	Centre Number	Candidate Number
Other Names		2

GCE AS – NEW

B410U10-1

S17-B410U10-1

Part of WJEC

CHEMISTRY – AS component 1

The Language of Chemistry, Structure of Matter and Simple Reactions

FRIDAY, 26 MAY 2017 – MORNING

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 8.**	**10**	
Section B	**9.**	**13**	
	10.	**15**	
	11.	**15**	
	12.	**13**	
	13.	**14**	
	Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Booklet** supplied by WJEC.

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 assessment of the quality of extended response (QER) will take place in **Q.10***(b)*.

If you run out of space, use the additional 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. Complete the electronic configuration for the ion Ni^{2+}. [1]

$1s^2\ 2s^2$ ....

2. The half-life of a radioactive isotope is 12 days. If a 3.0 g sample of the isotope is left for 24 days, what mass of the isotope will remain? [1]

Mass = ... g

3. *(a)* Define *electronegativity*. [1]

....

....

(b) On each of the diagrams of molecules below label any permanent dipoles. [1]

Cl—Cl F—Cl

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4. Dinitrogen tetroxide, N_2O_4, and nitrogen dioxide, NO_2, can exist in equilibrium.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

(a) Write the expression for the equilibrium constant, K_c, for this reaction. [1]

K_c =

(b) A 1 dm^3 volume of an equilibrium mixture contained 0.2 mol of N_2O_4 and 1.6 mol of NO_2. Calculate the value of K_c. Include the unit. [1]

K_c = ...

Unit ....

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5. Calcium carbonate, $CaCO_3$, decomposes significantly at temperatures above 800 °C. Suggest a temperature at which barium carbonate, $BaCO_3$, would decompose significantly. Give a reason for your suggestion. [1]

....

....

6. Give the oxidation state of vanadium in the ion VO_3^-. [1]

....

7. Name **two** substances whose aqueous solutions can be mixed to produce the insoluble compound copper(II) hydroxide. [1]

.... and ....

8. Balance the equation below. [1]

$$3Cu(s) + \ldots\ldots HNO_3(aq) \longrightarrow \ldots\ldots Cu(NO_3)_2(aq) + \ldots\ldots NO(g) + \ldots\ldots H_2O(l)$$

10

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SECTION B

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

9. Using ideas that you have studied in your Chemistry course comment on and explain the following observations.

(a) The conductivity of aluminium is different from that of sodium. [2]

....

....

....

....

(b) When solid iodine is heated gently a purple vapour is seen but, even at high temperatures, diamond does not melt. [4]

....

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....

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....

....

(c) The melting temperature of magnesium oxide is much higher than the melting temperature of sodium chloride. [3]

....

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(d) In two separate experiments aqueous chlorine was added to aqueous sodium bromide and aqueous bromine was added to aqueous sodium chloride.

In each case an orange/brown solution was seen at the end of the addition. [4]

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13

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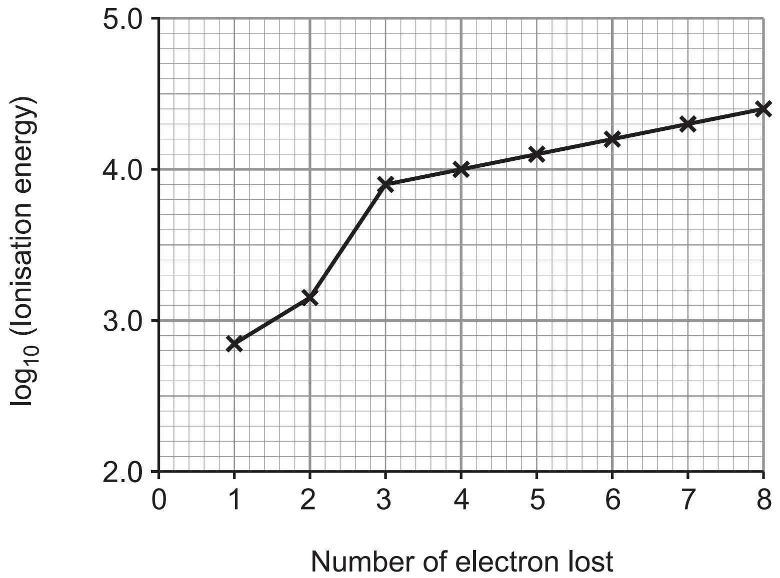
10. *(a)* Some students were discussing ionisation energies.

(i) State the meaning of the term *standard molar first ionisation energy*. [2]

....

....

(ii) The graph below shows the logarithm of the first eight successive ionisation energies for element **X**.



I. Explain why successive ionisation energies increase. [2]

....

....

....

II. Use the graph to determine in which group of the Periodic Table element **X** is found. Explain your answer. [2]

....

....

....

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(b) The students used a hydrogen discharge tube and observed some coloured lines. One said that these visible lines could be used to determine the value of the first ionisation energy of hydrogen.

(i) Discuss whether you agree with this student's suggestion. You should include an explanation of how spectral lines are produced and how they can be used to determine ionisation energy. [6 QER]

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(ii) A spectral line with a frequency of 3.28×10^{15} Hz was formed when an atom of hydrogen was ionised.

Calculate the first ionisation energy of hydrogen in kJ mol^{-1}. Give your answer to the appropriate number of significant figures. [3]

Ionisation energy = ... kJ mol^{-1}

15

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11. *(a)* When acids are being used chemists often refer to the pH of the solution.

(i) State what is meant by pH. [1]

....

(ii) Calculate the pH of 0.50 mol dm^{-3} hydrochloric acid. [1]

pH = ...

(iii) Explain the observation that the pH of 0.10 mol dm^{-3} ethanoic acid, CH_3COOH, is higher than the pH of 0.10 mol dm^{-3} hydrochloric acid. [3]

....

....

....

....

....

(b) Water is able to act as a base as it can accept H^+ to form H_3O^+.

(i) Draw a dot and cross diagram to show the arrangement of electrons in H_3O^+. Show outer electrons only. [2]

(ii) Name the type of bond present between H_2O and the H^+ added to form H_3O^+. [1]

....

(iii) Suggest a value for the bond angle between the O—H bonds in H_3O^+. Explain your answer. [3]

....

....

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(c) An equilibrium exists, in aqueous solution, between chromate(VI) ions, CrO_4^{2-}, and dichromate(VI) ions, $Cr_2O_7^{2-}$.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$

yellow orange

(i) State le Chatelier's principle. [2]

....

....

....

(ii) Describe what is seen when aqueous sodium hydroxide is added to an orange solution containing dichromate(VI) ions. Explain your answer. [2]

....

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15

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12. *(a)* Caroline was investigating the number of moles of water of crystallisation, x, in hydrated barium chloride, $BaCl_2.xH_2O$. She was told that x is a whole number.

She followed an instruction sheet.

- Weigh an empty crucible with its lid.
- Add the hydrated salt to the crucible and weigh crucible, lid and salt.
- Place the lid on the crucible and heat salt for 3 minutes.
- Cool and reweigh the crucible, lid and contents.
- Heat for another 2 minutes and cool and reweigh again.

Caroline obtained the following results.

	Mass / g
Crucible + lid	13.132
Crucible + lid + $BaCl_2.xH_2O$	15.051
Crucible + lid + contents (after 1st heating)	14.787
Crucible + lid + contents (after 2nd heating)	14.777

(i) Use the data to determine the value of x in the formula $BaCl_2.xH_2O$.
You **must** show your working. [4]

x = ...

(ii) Why did the instructions say that the lid should be in place when the heating was carried out? [1]

....

....

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(iii) Ethan said that Caroline's method was inaccurate, even though she had carried out the experiment carefully and recorded all her results correctly.

Suggest **two** ways in which Caroline could make her experiment more accurate. Explain your answers. [4]

Suggestion 1

....

....

....

Suggestion 2

....

....

....

(iv) Caroline agreed that her experiment had been inaccurate but said that it gave the correct answer for x. Comment on why Caroline was correct and that accuracy need not be high in this experiment to determine the value of x. [1]

....

....

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(b) Caroline used the barium chloride as one of the reagents to identify the ions present in an aqueous solution **W**. Solution **W** contains only two ions.

The reagents were added to small volumes of solution **W** and the following observations were made.

Test	Observation
add aqueous sodium hydroxide	no visible reaction
add aqueous barium chloride	white precipitate formed
add dilute nitric acid	vigorous effervescence seen

(i) From these observations name **one** ion present in solution **W**. [1]

....

(ii) The observations allowed Caroline to eliminate some metal ions as being present in **W**. Suggest **one** metal ion that she eliminated. [1]

....

(iii) Write the **ionic** equation for the reaction between aqueous solutions of barium chloride and **W**. Include state symbols. [1]

....

13

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13. A group of students was given a mineral sample that came from a region where both magnesite, $MgCO_3$, and dolomite, $CaMg(CO_3)_2$, were known to exist. They decided to analyse the sample by titration.

They added 4.77 g of the mineral to 100 cm^3 of 2.06 mol dm^{-3} hydrochloric acid. They titrated 25.0 cm^3 samples of the solution formed against 1.00 mol dm^{-3} sodium hydroxide. The results of these titrations are given in the table.

Titration number	1	2	3
Final burette reading / cm^3	23.20	24.50	23.00
Initial burette reading / cm^3	0.10	1.10	0.00
Titre / cm^3	....	....	....

(a) Explain why universal indicator is not used to show the end-point of a titration. [1]

....

....

(b) **Complete the table** and use the data to calculate a mean titre suitable for use in the calculation involved in the analysis of the sample. [1]

Mean titre = ... cm^3

(c) Calculate the number of moles of hydrochloric acid that reacted with the mineral sample. [4]

n(HCl) = ... mol

Examiner only

(d) Complete the **ionic** equation for the reaction between carbonate ions and acid and hence calculate the number of moles of carbonate present in the mineral sample. [1]

$$CO_3^{2-} + \dots\dots\dots\; H^+ \longrightarrow CO_2 + \dots\dots\dots\dots\dots\dots\dots\dots$$

$n(CO_3^{2-})$ = ... mol

(e) Calculate the relative formula mass of the carbonate and hence state whether the mineral is magnesite or dolomite. Assume that the mineral is a pure compound. [1]

M_r = ...

....

....

(f) A burette can be read to an accuracy of $\pm 0.05\,cm^3$.

Calculate the maximum percentage error in any of the **titres** in the table. [2]

Percentage error = ... %

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(g) The students extended their investigation by measuring the volume of carbon dioxide released when a 4.59 g sample of the mineral reacted with an excess of acid. They collected 1.31 dm^3 of gas measured at 25 °C and at 1.01×10^5 Pa.

(i) Use the ideal gas equation, pV = nRT, to calculate the number of moles of carbon dioxide formed. Show your working. [3]

$n(CO_2)$ = ... mol

(ii) Show whether or not this extension confirms the conclusion reached in part *(e)*. [1]

....

....

14

END OF PAPER

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For continuation only.