Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL

2410U10-1

S18-2410U10-1

CHEMISTRY – AS unit 1
The Language of Chemistry, Structure of Matter and Simple Reactions

TUESDAY, 22 MAY 2018 – MORNING

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 6.**	**10**	
Section B	**7.**	**12**	
	8.	**15**	
	9.	**15**	
	10.	**13**	
	11.	**15**	
	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. Do not use gel pen or correction fluid.

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.11***(a)*(i).

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. For the ionic compound caesium chloride, state the coordination number of the chloride ion. [1]

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2. The first four ionisation energies for an element are shown in the table below.

Ionisation energy / kJ mol^{-1}			
1st	2nd	3rd	4th
548	1060	4120	5440

State to which group in the Periodic Table the element belongs. [1]

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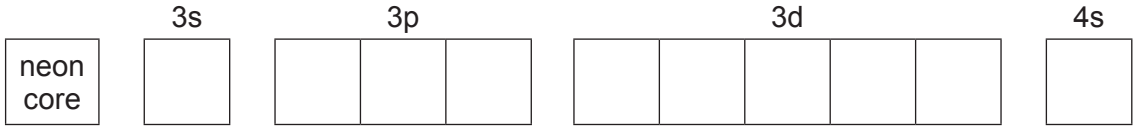
3. By inserting arrows to represent electrons, complete the electronic structure of a chromium atom. [1]



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4. Phosphorus(V) chloride reacts with water to form phosphoric acid and hydrogen chloride. The reactants and products are shown in the equation below but the equation is **not** balanced.

..... PCl_5 + ... H_2O ⟶ ..... H_3PO_4 + ... HCl

(a) Balance the equation. [1]

(b) Calculate the atom economy for the formation of phosphoric acid in this reaction. [2]

Atom economy = ... %

5. *(a)* Give the meaning of the term *electronegativity*. [1]

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(b) Explain why electronegativity increases across a period in the Periodic Table. [1]

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6. Bromine is produced commercially from the bromide ions in sea water by reaction with chlorine.

(a) Give the **ionic** equation for this reaction. [1]

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(b) Describe a test, apart from the use of chlorine, to show that a solution contains bromide ions. Give the reagent(s) and observation(s). [1]

Reagent(s) .....

Observation(s) .....

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SECTION B

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

7. *(a)* Melting temperatures vary down groups and across periods.

(i) Explain why chlorine is a gas but iodine is a solid at room temperature and pressure. [3]

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(ii) Explain why sodium has a lower melting temperature than aluminium. [1]

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(iii) Explain why silicon has a higher melting temperature than phosphorus. [1]

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(b) State and explain how you would expect the first ionisation energy of nitrogen to compare with the first ionisation energy of oxygen. [2]

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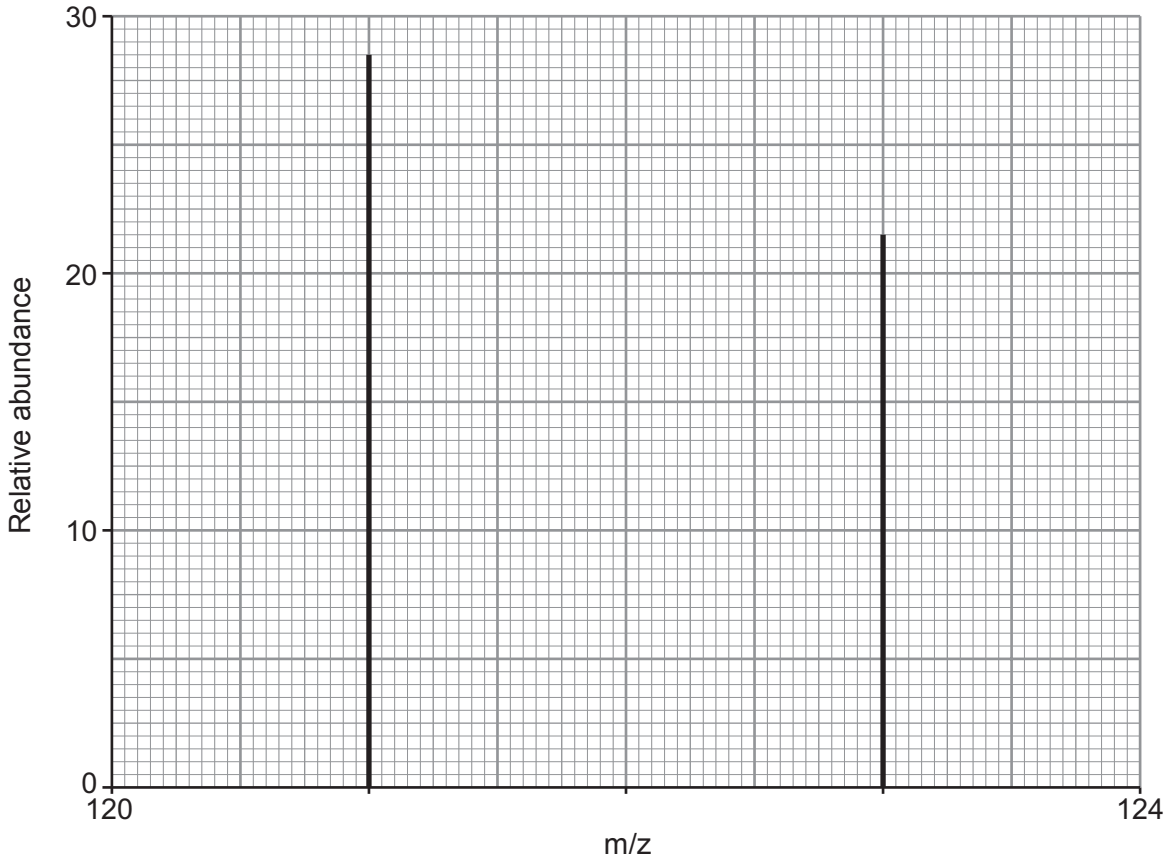
(c) Antimony is in Group 5. Its mass spectrum shows that it has two stable isotopes.



Calculate the relative atomic mass of antimony. You **must** show your working. [2]

Relative atomic mass = ...

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(d) Although radiation from radioisotopes is harmful to health many beneficial uses of radioactivity have been found.

The table below gives some information about four radioactive isotopes.

Isotope	Radiation emitted	Half-life
^{90}Sr	β	28 years
^{99}Tc	γ	6 hours
^{210}At	α	8.1 hours
^{228}Th	α	1.9 years

Use **all** the data given to choose which isotope is the most suitable to use as a tracer in medicine. Explain your answer. [3]

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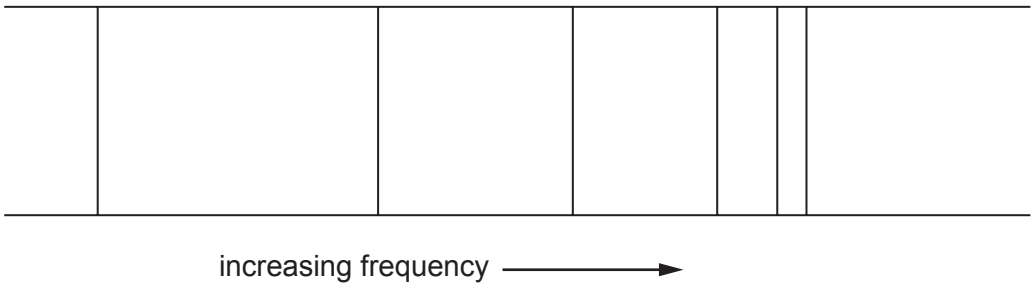
8. *(a)* The diagram below shows part of the atomic emission spectrum of hydrogen.



(i) Use the letter **A** to label the line of longest wavelength on the diagram. [1]

(ii) Explain why hydrogen atoms emit only certain definite frequencies of visible light. [2]

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(b) The ionisation energy of a hydrogen atom is 2.18×10^{-21} kJ.

(i) Explain what this statement means. [2]

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(ii) Calculate the minimum frequency of radiation required to ionise a hydrogen atom in its ground state. [3]

Frequency = ... s^{-1}

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(c) Hydrazine is a compound of hydrogen and nitrogen only. It is a colourless, flammable liquid which was used in various rocket fuels.

0.160 g of hydrazine on vaporisation at 398 K and 1 atm pressure has a volume of 163 cm^3.

Calculate its volume at 273 K and 1 atm pressure and hence show that its molecular formula is N_2H_4. [3]

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(d) (i) Draw a dot and cross diagram to show the electron arrangement in hydrazine, N_2H_4. Show outer electrons only. [2]

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(ii) Hydrazine contains polar covalent bonds between nitrogen and hydrogen atoms. State what is meant by a *polar* covalent bond. [1]

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(e) Hydrazine acts as a base in a similar way to ammonia.

Suggest an equation for the equilibrium formed when hydrazine dissolves in water. [1]

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9. Ascorbic acid, $C_6H_8O_6$, is the main component of vitamin C tablets. Its name is derived from *a-* (meaning "no") and *scorbutus* (scurvy), the disease caused by a deficiency of vitamin C. A student was asked to find the percentage of ascorbic acid in identical vitamin C tablets.

She was told to use the following method.

- Fill a burette with 0.100 mol dm^{-3} sodium hydroxide solution.
- Weigh a conical flask and record its mass.
- Add a vitamin C tablet to the flask, reweigh it and record its mass.
- Add about 50 cm^3 of deionised water to the flask and swirl to break up the tablet.
- Heat the flask gently for 5 to 10 minutes.
- After the solution has cooled add a few drops of a suitable indicator.
- Carry out a rough titration of this solution with the sodium hydroxide solution.
- Accurately repeat the procedure several times and calculate a mean titre.

(a) A **three** decimal place balance was used. The mass of each vitamin C tablet was 500 mg.

Calculate the maximum percentage error in the weighing of the tablet.
You **must** show your working. [2]

Maximum percentage error = ... %

(b) (i) Suggest why she did not need to measure the volume of water accurately. [1]

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(ii) Suggest why she heated the flask for 5 to 10 minutes. [1]

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(c) The student used the results from three titrations to calculate a mean titre. Some of her results are shown below.

Titration	1	2	3
Final reading / cm^3	26.90	26.90	
Initial reading / cm^3	0.25	0.15	0.20
Titre / cm^3	26.65	26.75	

Mean titre = 26.73 cm^3

Determine the **final reading** for the third titration. [2]

Final reading = ... cm^3

(d) Ascorbic acid can decompose upon exposure to air. If this reaction occurred before the titration was completed, state how it might affect the titration results. Explain your answer. [2]

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(e) The equation for the reaction between ascorbic acid and sodium hydroxide is given below.

$$C_6H_8O_6 + NaOH \longrightarrow C_6H_7O_6Na + H_2O$$

M_r 176

The percentage of ascorbic acid is identical in each 500 mg tablet. Calculate the percentage of ascorbic acid in each vitamin C tablet. [3]

Percentage ascorbic acid = ... %

(f) Sulfuric acid and hydrochloric acid are strong acids.

(i) Calculate the pH of a solution of 0.010 mol dm^{-3} sulfuric acid, H_2SO_4. [2]

pH = ...

(ii) When hydrochloric acid is heated with MnO_2 it reacts according to the following equation.

$$MnO_2(s) + 4HCl(aq) \longrightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

Explain why this can be classified as a redox reaction. [2]

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10. *(a)* Nitrogen can react with hydrogen to form ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

A mixture of N_2 and H_2 is left to react at a certain temperature, until it reaches equilibrium. The equilibrium mixture has the following composition.

N_2	$1.16\,mol\,dm^{-3}$
H_2	$1.60\,mol\,dm^{-3}$
NH_3	$0.752\,mol\,dm^{-3}$

(i) A student said that the equilibrium must lie to the left because the concentrations of nitrogen and hydrogen are greater than that of ammonia. Is he correct?

Justify your answer by calculating a value for K_c for this equilibrium.
Give the unit for K_c. [4]

K_c = ...

Unit .....

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(ii) When the temperature is increased the equilibrium yield of NH_3 decreases. The student said that the reaction is endothermic. Is he correct?

Justify your answer by using Le Chatelier's principle. [2]

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(b) Ammonia can be used as part of the nitrophosphate process to produce the fertiliser diammonium hydrogenphosphate (DAP) which has the formula $(NH_4)_2HPO_4$.

$$Ca(NO_3)_2 + 4H_3PO_4 + 8NH_3 \longrightarrow CaHPO_4 + 2NH_4NO_3 + 3(NH_4)_2HPO_4$$

M_r 132

Calculate the maximum mass of DAP, in kg, that could be made from 1.00 tonne of ammonia. [3]

Maximum mass = ... kg

(c) Calculate the volume, in cm^3, that 2.54×10^{-3} mol of nitrogen occupies at a temperature of 120 °C and a pressure of 101 kPa. [4]

Volume = ... cm^3

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11. *(a)* A solution contains one cation and up to three different anions. The anions possibly present are carbonate, chloride and sulfate.

(i) Devise a plan that unambiguously proves which anions are present in the mixture.

You should also give any observations and conclusions that enable you to identify the anions. [6 QER]

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(ii) A student said that the cation in the mixture can only be sodium since all the possible anions form a soluble salt with sodium. Is he correct?

Justify your answer and state how you could prove if the statement were true. [2]

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(b) A student is given four materials and asked to identify the **type of structure** present in each one by carrying out a series of tests.

She is told that the maximum temperature of a Bunsen burner flame is about 800 °C. She is also told that in at least one case, it will **not** be possible to come to a definite conclusion.

Her results are shown in the table below.

	A	**B**	**C**	**D**
Melting temperature / °C	100	>800	>800	>800
Solubility in water	soluble	insoluble	insoluble	soluble
Conductivity of solid	none	none	good	none
Conductivity of solution	none			good

(i) Use the information in the table to identify each type of structure.
Where a definite conclusion cannot be reached explain your reasoning. [4]

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QUESTION CONTINUES ON PAGE 18

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(ii) For **one** of the materials where the type of structure could not be identified, suggest what further test(s) are needed to identify the type of structure. [2]

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(iii) Suggest why it is difficult to identify a material as a metal when it is in powdered form. [1]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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