Surname	StemUp Model Solution	Centre Number	Candidate Number
First name(s)			2

wjec cbac

GCE AS

B410U10-1

S25-B410U10-1

eduqas Part of WJEC

TUESDAY, 13 MAY 2025 – MORNING

CHEMISTRY – AS component 1

The Language of Chemistry, Structure of Matter and Simple Reactions

1 hour 30 minutes

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1. to 7.	10	
Section B	8.	6	
	9.	11	
	10.	12	
	11.	9	
	12.	17	
	13.	15	
	Total	80	

B410U101
01

ADDITIONAL MATERIALS

- A calculator, pencil and ruler
- **Data Booklet** supplied by WJEC

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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

Section A Answer **all** questions.
Section B Answer **all** questions.

Write your answers in the spaces provided in this booklet. 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.

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 **Q13**(c).

JUN25B410U10101

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

SECTION A

Answer **all** questions.

1. Give the meaning of the term electronegativity. [1]

The ability of an atom to attract the bonding pair of electrons in a covalent bond.

2. Describe how flame tests are carried out and how they can be used to differentiate between sodium chloride and potassium chloride. Give the expected observation for both compounds. [2]

Dip a clean wire loop (moistened with conc. HCl) into each sample and hold it in a blue (non-luminous) Bunsen flame.

Sodium chloride gives a yellow flame; potassium chloride gives a lilac flame.

3. State what happens to the atomic number and the mass number of a nucleus when it emits a β-particle. [1]

The atomic number increases by one and the mass number stays the same.

4. State why only the Lyman series is used to determine the ionisation energy for a hydrogen atom. [1]

Only the Lyman series has transitions involving $n = 1$ (the ground state), so its convergence limit gives the energy to remove the electron from $n = 1$.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

5. An oxide of phosphorus was analysed and was found to contain 49.3% phosphorus and 50.7% oxygen by mass.

Determine the empirical formula of this compound. [2]

$P : O = 49.3 \div 31.0 : 50.7 \div 16.0$

$= 1.59 : 3.17$

$= 1 : 2$

Empirical formula PO_2

6. Write an equation for the reaction of fluorine with iron to form iron(III) fluoride. [1]

$2Fe + 3F_2 \rightarrow 2FeF_3$

7. (a) Explain why metals are good conductors of electricity. [1]

Metals contain delocalised electrons which are free to move and carry a current.

(b) State **one** other physical property of metals. [1]

high melting temperature (also malleable, ductile)

10

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

SECTION B

Answer **all** questions.

8. A gas syringe is filled with an equilibrium mixture of brown nitrogen dioxide and colourless dinitrogen tetroxide.

$$\underset{\text{brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)}$$

(a) State how the colour will change, if at all, when the pressure is decreased.

Explain your answer. [2]

The mixture becomes more brown (darker).

Lowering the pressure moves the equilibrium position to the left, the side with more moles of gas (2 mol NO_2 : 1 mol N_2O_4), so more NO_2 forms.

(b) Write the expression for the equilibrium constant, K_c, for this reaction.

Give its unit, if any. [2]

$$K_c = \frac{[N_2O_4]}{[NO_2]^2}$$

Unit $mol^{-1}\ dm^3$

(c) Under certain conditions the value of this equilibrium constant increases.

State how the colour will change. Explain your answer. [2]

If K_c increases there are more products at equilibrium: the position moves to the right, forming more N_2O_4 and less NO_2.

So the mixture becomes less brown (paler).

6

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

9. Promethium is a lanthanoid and a radioactive element. Very little occurs naturally.

(a) ^{135}Pm decays by positron emission. Give the symbol and mass number of the element formed. [1]

^{135}Nd (neodymium-135)

(b) Isotopes of promethium, such as ^{135}Pm, can be synthesised and their half-lives can be studied.

State what is meant by the term half-life. [1]

The time taken for the mass (amount) of an isotope to decay to half of its original value.

(c) The decay of another radioactive element was studied by recording the variation in the mass of a sample over time. The following data were obtained.

Time / s	Mass of sample / g
0	5.40
60	2.33
120	1.01
180	0.43
240	0.19
300	0.08

(i) Identify the mass reading that has the **largest** percentage error.

Calculate this percentage error. Assume that it is based on one weighing only. [2]

The smallest reading, 0.08 g, has the largest percentage error.

balance reads to 0.01 g so uncertainty = ±0.005 g

% error = (0.005 ÷ 0.08) × 100

Percentage error = 6.25 %

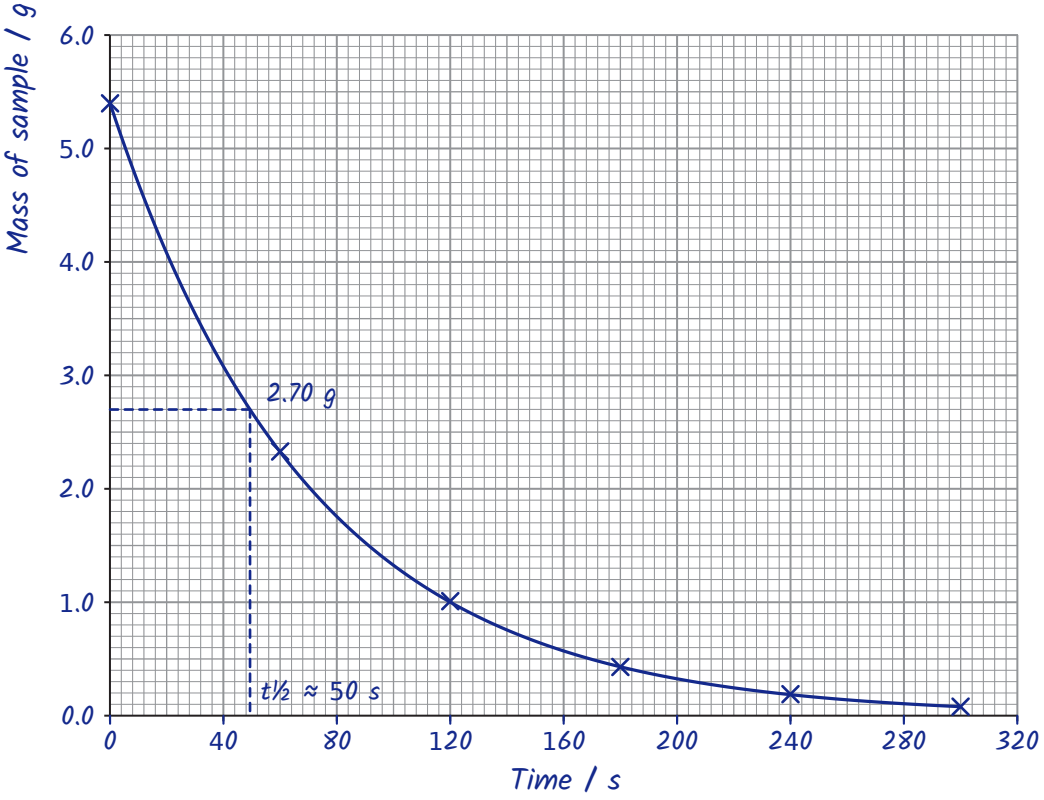
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(ii) Plot a graph of the mass of sample against time.

Label the axes and choose a suitable scale. [3]



(iii) Use the graph to determine the half-life of the isotope. Show clearly how you get your answer. [2]

half of the initial mass = 5.40 ÷ 2 = 2.70 g

horizontal line drawn from 2.70 g across to the curve, then down to the time axis

time read from the graph = 50 s

Half-life = 50 s

B410U101
07

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(d) Naturally occurring chromium has four stable isotopes.

Calculate its relative atomic mass using the following information.

Show your working and give your answer to **four** significant figures. [2]

Mass number	50	52	53	54
Percentage abundance / %	4.345	83.79	9.501	2.365

$A_r = [(50 \times 4.345) + (52 \times 83.79) + (53 \times 9.501) + (54 \times 2.365)] \div 100$

$= (217.25 + 4357.08 + 503.553 + 127.71) \div 100$

$= 5205.593 \div 100 = 52.05593$

Relative atomic mass = 52.06

11

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

10. A student was investigating the reaction between magnesium and hydrochloric acid under standard laboratory conditions.

(a) Write an **ionic** equation for the reaction between hydrochloric acid and magnesium. [1]

$Mg + 2H^+ \rightarrow Mg^{2+} + H_2$

(b) (i) Calculate the minimum volume of 4.20 mol dm^{-3} hydrochloric acid required to react with 0.100 mol of magnesium.

Give your answer in **cm^3** and to an **appropriate** number of significant figures. [3]

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

moles of H^+ (HCl) required = $2 \times 0.100 = 0.200$ mol

$V = n \div c = 0.200 \div 4.20 = 0.0476\ dm^3$

$= 0.0476 \times 1000 = 47.6\ cm^3$ (3 s.f.)

Volume of hydrochloric acid = 47.6 cm^3

(ii) Name the piece of apparatus most suitable for measuring this volume of solution. [1]

burette

(iii) Calculate the number of hydrogen ions present in this volume. [1]

number of $H^+ = 0.200 \times 6.02 \times 10^{23}$

Number of hydrogen ions = 1.20×10^{23}

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) Calculate the minimum mass of magnesium required to produce 30.0 cm^3 of hydrogen gas measured at 25 °C. Assume an excess of hydrochloric acid is used. [2]

$n(H_2) = 30.0 \div 1000 \div 24.5 = 1.22 \times 10^{-3}$ mol

$Mg : H_2 = 1 : 1$, so $n(Mg) = 1.22 \times 10^{-3}$ mol

mass = $1.22 \times 10^{-3} \times 24.3 = 2.98 \times 10^{-2}$ g

Mass of magnesium = 2.98×10^{-2} g

(d) Calculate the pH of 4.20 mol dm^{-3} hydrochloric acid. [2]

HCl is a strong acid, so $[H^+] = 4.20$ mol dm^{-3}

$pH = -\log[H^+] = -\log(4.20)$

pH = −0.623

(e) Suggest an approximate pH for a 4.20 mol dm^{-3} solution of ethanoic acid.

Explain why this pH is different to that calculated in part (d). [2]

pH about 2.5. Ethanoic acid is a weak acid: it is only partially dissociated, so $[H^+]$ is much lower than 4.20 mol dm^{-3} and the pH is higher.

12

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

11. A student made a solution of a metal hydroxide by dissolving 20.25 g of the solid in deionised water to make 250 cm^3 of solution. She titrated 25.0 cm^3 samples of this solution against 1.00 mol dm^{-3} hydrochloric acid using an appropriate indicator.

The results of these titrations are given in the table.

Titration number	1	2	3
Final burette reading / cm^3	24.50	23.60	25.20
Initial burette reading / cm^3	0.20	0.00	1.50
Titre / cm^3	24.30	23.60	23.70

(a) Use the data in the table to calculate an accurate mean titre. [1]

titres 2 and 3 are concordant (within 0.10 cm^3), titre 1 is not used

mean = (23.60 + 23.70) ÷ 2

Mean titre = 23.65 cm^3

(b) Given that the hydroxide and the acid react in a 1:2 ratio, calculate the concentration of the hydroxide solution. [3]

n(HCl) = 1.00 × 23.65 ÷ 1000 = 0.02365 mol

hydroxide : acid = 1 : 2, so n(hydroxide) = 0.02365 ÷ 2 = 0.011825 mol

concentration = 0.011825 ÷ 0.0250

Concentration = 0.473 mol dm^{-3}

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) Using the data in the question and your answer from part (b), calculate the relative formula mass of the metal hydroxide and hence deduce the identity of the metal. [4]

n(hydroxide) in 250 cm^3 = 0.473 × 250 ÷ 1000 = 0.11825 mol

M_r = mass ÷ moles = 20.25 ÷ 0.11825 = 171.25

Relative formula mass = 171.25

formula $M(OH)_2$ (reacts 1 : 2 with HCl)

A_r of metal = 171.25 − (2 × 17.01) = 137.23

Metal barium (Ba)

(d) State why the student's method would not work with magnesium hydroxide. [1]

Magnesium hydroxide is insoluble, so a solution cannot be made.

9

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

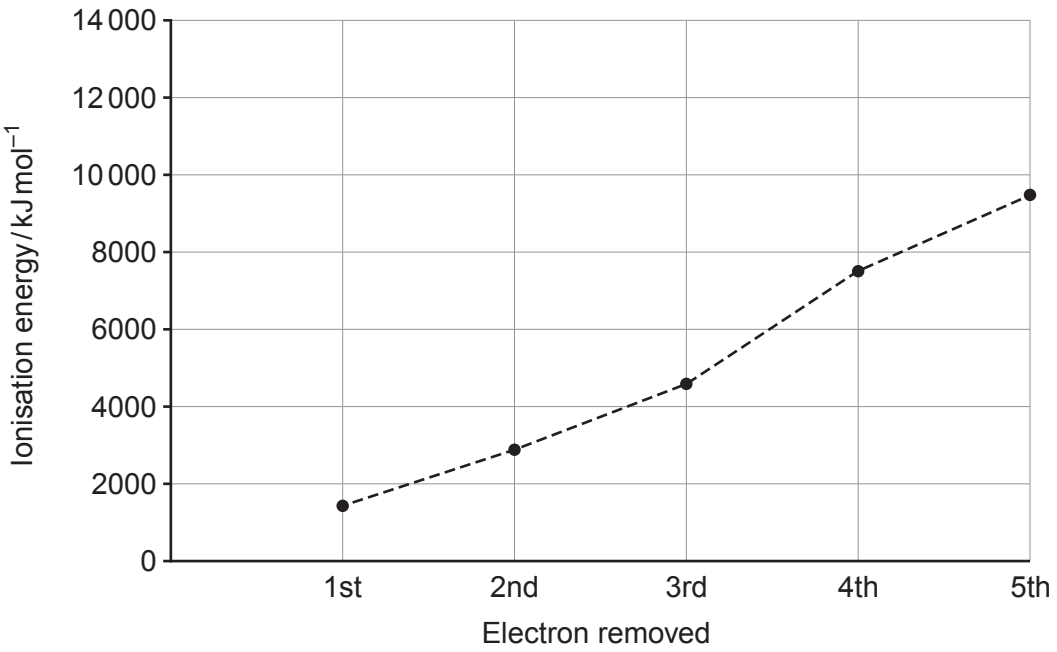
12. (a) Give the electronic configuration of a nitrogen atom. [1]

$1s^2\ 2s^2\ 2p^3$

(b) State and explain the general trend in the first ionisation energy across Period 2. [2]

It increases across the period, due to increasing nuclear charge (number of protons) with electrons in the same shell.

(c) The graph below shows the first five successive ionisation energy values for a nitrogen atom.



(i) Explain why the second ionisation energy is greater than the first ionisation energy. [1]

The second electron is being removed from a positive ion, so there is a greater attraction between the nucleus and the electron being removed.

(ii) Explain why the fourth ionisation energy is slightly higher than expected. [1]

The fourth electron removed is an s electron (2s); it is in a lower sub-shell, closer to the nucleus, than the 2p electrons removed before it.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(d) Nitrogen exists as molecules with a relative formula mass of 28. The relative formula mass of an ammonia molecule is lower than that of nitrogen but its boiling temperature is much higher than the boiling temperature of nitrogen.

Explain this difference in boiling temperature. [3]

Nitrogen has only (weak) van der Waals forces between its non-polar molecules.

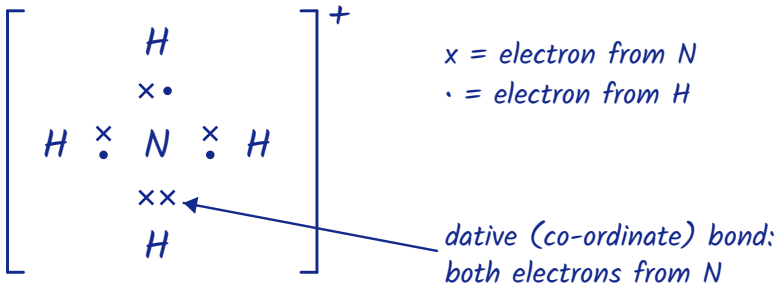
Ammonia has hydrogen bonding (as well as van der Waals forces) between the molecules, as N–H is very polar and N has a lone pair.

Hydrogen bonding is stronger than van der Waals forces, so more energy is needed to separate the ammonia molecules.

(e) Ammonia is more reactive than nitrogen and forms many compounds.

(i) Ammonia forms compounds containing the ammonium ion, NH_4^+.

Describe the bonding in an ammonium ion. Include a dot and cross diagram in your answer. [3]



Three N–H covalent bonds, each a shared pair (one electron from N, one from H).

One co-ordinate (dative covalent) bond: the N lone pair is donated to H^+, so N provides both electrons.

© WJEC CBAC Ltd.

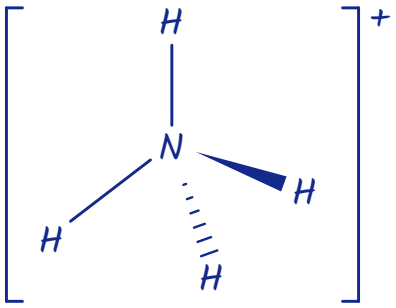
stemup.co.uk

Examiner only

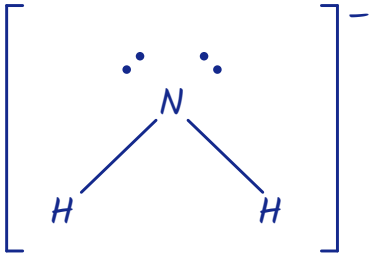
(ii) Ammonia can also form amide ions, NH_2^-.

Ammonium ions and amide ions both have the same number of electron pairs.

Use your knowledge of VSEPR theory to explain the shapes of both ions and the bond angles seen. [3]



tetrahedral, 109.5°



V-shaped (bent), 105°

Electron pairs repel to be as far apart as possible. NH_4^+ has four bonding pairs: tetrahedral, 109.5°.

NH_2^- has two bonding pairs and two lone pairs: V-shaped (bent). Lone pairs repel more than bonding pairs, so the angle is smaller, 105°.

(iii) Sodium amide, $NaNH_2$, is formed from the reaction of sodium and ammonia. Hydrogen is the only other product.

Write an equation for this reaction. [1]

$2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2$

(iv) Sodium amide can be further reacted to produce sodium azide, NaN_3. It is a crystalline solid with a high melting temperature.

Suggest the type of structure present and give **one** other physical property of sodium azide. [2]

Giant ionic (lattice) structure.

It is soluble in water.

17

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

13. (a) Potassium chlorate, $KClO_3$, undergoes thermal decomposition to form potassium chloride and oxygen only.

(i) Give the oxidation number of chlorine in potassium chlorate. [1]

+5

(ii) Write an equation for this reaction. [1]

$2KClO_3 \rightarrow 2KCl + 3O_2$

(iii) Calculate the volume of oxygen that would be produced by the complete decomposition of 1.35 g of potassium chlorate at 650 K and a pressure of 1 atm. [3]

$M_r(KClO_3) = 39.1 + 35.5 + (3 \times 16.0) = 122.6$

$n(KClO_3) = 1.35 \div 122.6 = 0.01101$ mol

$n(O_2) = 0.01101 \times 3/2 = 0.0165$ mol

$pV = nRT$, so $V = nRT \div p$

$V = (0.0165 \times 8.31 \times 650) \div 1.01 \times 10^5$

$V = 8.83 \times 10^{-4}$ m^3

Volume of oxygen = 8.83×10^{-4} m^3

(iv) Suggest how you would prove that complete decomposition had been achieved. [1]

Heat and weigh repeatedly until the mass is constant.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(b) Three strips of white filter paper were soaked in three different potassium halides – chloride, bromide and iodide. The paper strips were dried.

Describe a simple laboratory test (**not** involving the use of silver nitrate solution) to identify the halide on each strip. Give the results for each strip. [3]

Dip each strip into (conc.) chlorine water, $Cl_2(aq)$, and observe the colour.

Stays colourless (no change): potassium chloride.

Turns orange: potassium bromide, $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

Turns brown: potassium iodide, $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

Chlorine is a stronger oxidising agent than bromine and iodine, so it displaces them from their halides.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) A student is given 5.00 g of a solid mixture of calcium chloride and sodium chloride and asked to determine the percentage by mass of calcium chloride in the mixture by gravimetric analysis.

Describe the method the student should use to obtain the required data. Give details of how the percentage is calculated. [6 QER]

Separation: dissolve the 5.00 g of mixture in deionised water in a beaker and stir until all the solid dissolves.

Add excess sodium carbonate solution: the calcium ions form a white precipitate of insoluble calcium carbonate, $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$, while the sodium chloride stays in solution.

Weigh a dry filter paper, then filter the mixture through it. Wash the residue with deionised water to remove soluble NaCl and excess Na_2CO_3.

Test the filtrate with more sodium carbonate solution to check precipitation is complete; if more precipitate forms, add more sodium carbonate solution and refilter.

Dry the filter paper and residue in a warm oven and weigh; repeat drying and weighing until constant mass.

Data: mass of $CaCO_3$ = mass of (dry filter paper + residue) − mass of filter paper.

Calculation: moles of $CaCO_3$ = mass of $CaCO_3$ ÷ $M_r(CaCO_3)$ (100.1).

Moles of $CaCl_2$ = moles of $CaCO_3$ (1 : 1 ratio). Mass of $CaCl_2$ = moles × $M_r(CaCl_2)$ (111.1).

Percentage by mass of $CaCl_2$ = (mass of $CaCl_2$ ÷ 5.00) × 100.

15

END OF PAPER

© WJEC CBAC Ltd.

stemup.co.uk

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

Examiner only

© WJEC CBAC Ltd.

stemup.co.uk