

Please write clearly in	block capitals.
Centre number	Candidate number
Surname	
Forename(s)	
Candidate signature	I declare this is my own work.

AS CHEMISTRY

Paper 1 Inorganic and Physical Chemistry

Monday 18 May 2020

Morning

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Advice

You are advised to spend about 65 minutes on Section A and 25 minutes on Section B.



For Examiner's Use			
Question	Mark		
1			
2			
3			
4			
5			
6			
7			
8			
Section B			
TOTAL			



	Section A
	Answer all questions in this section.
0 1	This question is about atomic structure.
0 1. 1	There is a general trend for an increase in ionisation energy across Period 3. Give one example of an element that deviates from this trend.
	Explain why this deviation occurs. [3 marks]
	Element
	Explanation
0 1.2	Give an equation, including state symbols, to represent the process that occurs when
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]
0 1.2	Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of sodium is measured. [1 mark]







A student dissolves an unknown mass of sodium hydroxide in water to make 200 cm³ of an aqueous solution.

A 25.0 cm³ sample of this sodium hydroxide solution is placed in a conical flask and is titrated with 0.150 mol dm⁻³ sulfuric acid.

The equation for this reaction is shown.

 $2 \text{ NaOH}(aq) + \text{H}_2 \text{SO}_4(aq) \rightarrow \text{Na}_2 \text{SO}_4(aq) + 2 \text{H}_2 \text{O}(\text{I})$

Table 1 shows the results of the titrations.

Titration	Rough	1	2	3
Final reading / cm ³	20.75	40.35	21.05	40.60
Initial reading / cm ³	0.00	20.75	1.20	21.05
Titre / cm ³	20.75	19.60	19.85	19.55

Table 1

0 2 . 1 Calculate the mass of sodium hydroxide used to make the original solution.

[5 marks]

Mass of sodium hydroxide

_ g



02.2	The student uses a funnel to fill the burette with sulfuric acid before starting the titration. After filling, the student forgets to remove the funnel from the top of the burette.	Do not write outside the box
	Suggest why this might affect the titre volume recorded. [1 mark]	
02.3	State one advantage of using a conical flask rather than a beaker for the titration. [1 mark]	
		7
	Turn over for the next question	
	Turn over ►	



0 3	This question is about time o	f flight (TOF) n	nass spectror	netry.			
0 3.1	Define the term relative atom	ic mass.			[2 mark	(s]	
					-	-	
03.2	A sample of krypton is ionise	d using electro	on impact.				
	The mass spectrum of this sa	ample of krypto	on has four pe	eaks.			
	Table 2 shows data from this	Table 2 shows data from this spectrum.					
	Table 2						
	m/z	82	83	84	86		
	Relative intensity	6	1	28	8		
	Calculate the relative atomic	mass (A _r) of th	nis sample of	krypton.			
	Give your answer to 1 decima	al place.			[2 mark	re]	
						. 	

A_r _____



Do not write outside the box

Do not write outside the 0 3.3 box In a TOF mass spectrometer, ions are accelerated to the same kinetic energy (KE). The kinetic energy of an ion is given by the equation $KE = \frac{1}{2}mv^2$ Where: KE = kinetic energy / J m = mass / kg $v = \text{speed} / \text{m} \text{s}^{-1}$ In a TOF mass spectrometer, each ⁸⁴Kr⁺ ion is accelerated to a kinetic energy of 4.83×10^{-16} J and the time of flight is 1.72×10^{-5} s Calculate the length, in metres, of the TOF flight tube. The Avogadro constant, $L = 6.022 \times 10^{23} \text{ mol}^{-1}$ [4 marks] 8 Length of flight tube m

Turn over for the next question



Turn over ►

0 4	This question is about enthalpy changes.	Do not w outside box
04.1	State the meaning of the term enthalpy change as applied to a chemical reaction. [1 mark]	
04.2	A student determines the enthalpy change for the reaction between calcium carbonate and hydrochloric acid.	
	$CaCO_3(s) + 2 HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(I)$	
	The student follows this method:	
	 measure out 50 cm³ of 1.00 mol dm⁻³ aqueous hydrochloric acid using a measuring cylinder and pour the acid into a 100 cm³ glass beaker weigh out 2.50 g of solid calcium carbonate on a watch glass and tip the solid into the acid stir the mixture with a thermometer record the maximum temperature reached 	
	The student uses the data to determine a value for the enthalpy change.	
	Explain how the experimental method and use of apparatus can be improved to provide more accurate data.	
	Describe how this data from the improved method can be used to determine an accurate value for the temperature change.	
	[6 marks]	





0 9

Turn over ►

		Do not write
04.3	In a different experiment 50.0 cm ³ of 0.500 mol dm ⁻³ aqueous hydrochloric acid are reacted with 50.0 cm ³ of 0.500 mol dm ⁻³ aqueous sodium hydroxide.	outside the box
	NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H ₂ O(I) $\Delta H = -57.1 \text{ kJ mol}^{-1}$	
	The initial temperature of each solution is 18.5 °C	
	Calculate the maximum final temperature of the reaction mixture.	
	Assume that the specific heat capacity of the reaction mixture, $c = 4.18$ J K ⁻¹ g ⁻¹	
	Assume that the density of the reaction mixture = 1.00 g cm^{-3} [5 marks]	
	Final temperature °C	
0 4 . 4	Suggest how, without changing the apparatus, the experiment in Question 04.3 could be improved to reduce the percentage uncertainty in the temperature change.	
	[1 mark]	
		1



0 5	This question is about Group 2 elements and their compounds.	Do not write outside the box
0 5.1	Explain why the melting point of magnesium is higher than the melting point of sodium	
	[2 marks]	
0 5.2	Give an equation to show how magnesium is used as the reducing agent in the extraction of titanium.	
	Explain, in terms of oxidation states, why magnesium is the reducing agent. [2 marks]	
	Equation	
	Explanation	
	Question 5 continues on the next page	



Turn over ►

0 5 . 3 State what is observed when dilute aqueous sodium hydroxide is added to separate solutions of magnesium chloride and barium chloride.

[2 marks]

Observation with magnesium chloride	
Observation with barium chloride	



6

0 6	This question is about shapes of molecules and ion	S.		טס not write outside the box
	Draw the shape of NCl $_3$ and of NCl $_4^+$			
	Include any lone pairs of electrons that influence the	e shape.		
	Name the shape of NCl_3			
	State and explain the bond angle in NCl_4^+		[5 marks]	
	Shape of NCl ₃	Shape of NCl₄ ⁺		
	Name of shape of NCl_3			
	Bond angle in NCl4 ⁺			
	Explanation of bond angle in NCl₄ ⁺			
				5
	Turn over for the next question	on		



Turn over ►

0 7	This question is about Group 7 elements and their compounds	Do not write outside the box
	Chloring is used to treat water even though it is toxic to humans	
	Cive one reason why water is treated with chloring	
	Explain why chloring is added to water even though it is toxic	
	Cive an equation for the reaction of chloring with cold water	
	[3 marks]	
	Reason	
	Explanation	
	Equation	



Do not write outside the 0 7 . 2 Solid sodium iodide reacts with concentrated sulfuric acid to form iodine and sulfur in a redox reaction. Give a half-equation to show the conversion of iodide ions to iodine. Give a half-equation to show the conversion of sulfuric acid to sulfur. Give an overall equation for this redox reaction. Identify one other sulfur-containing reduction product formed when solid sodium iodide reacts with concentrated sulfuric acid. [4 marks] Half-equation for the conversion of iodide ions to iodine Half-equation for the conversion of sulfuric acid to sulfur **Overall equation** Other sulfur-containing reduction product Question 7 continues on the next page



Turn over

		Do not write
	A student completes an experiment to determine the percentage by mass of sodium chloride in a mixture of sodium chloride and sodium iodide.	outside the box
	The student uses this method.	
	 600 mg of the mixture are dissolved in water to form a solution. An excess of aqueous silver nitrate is added to the solution. This forms a precipitate containing silver chloride and silver iodide. Excess dilute ammonia solution is then added to the precipitate. The silver chloride dissolves. The silver iodide is filtered off from the solution, and is then washed and dried. 	
	The mass of the silver iodide obtained is 315 mg	
07.3	Silver nitrate is added to the solution.	
	Suggest why an excess is used. [1 mark]	
0 7.4	Calculate the amount, in moles, of silver iodide obtained.	
	$M_{\rm r}({\rm Agl}) = 234.8$	
	Amount of silver iodide mol	



0 7.5	Calculate, using your answer to Question 07.4 , the mass, in grams, of sodium iodide in the mixture.	Do not write outside the box
	<i>M</i> _r (Nal) = 149.9 [1 mark]	
	Mass of sodium iodide g	
0 7.6	Calculate, using your answer to Question 07.5 , the percentage by mass of sodium chloride in the mixture.	
	[2 marks]	
		12
	Percentage of sodium chloride	
	furn over for the next question	
	Turn over ▶	•





Table	3
-------	---

Table 3 shows the student's results.

Gas syringe

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm ³
Volume reading on gas syringe after injecting	178.0 cm ³
Pressure of gas in syringe	100 kPa
Temperature of oven	120 °C



	Calculate the M_r of A .	Do not write outside the box
	Give your answer to 3 significant figures.	
	The gas constant, <i>R</i> = 8.31 J K ⁻¹ mol ⁻¹ [4 marks]	
	Мг	
08.2	The student noticed that some of the liquid injected into the gas syringe did not vaporise.	
	Explain the effect that this has on the M_r calculated by the student. [2 marks]	
	Question 8 continues on the next page	



Turn over ►

 Table 3 is repeated here.

Table 3

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm ³
Volume reading on gas syringe after injecting	178.0 cm ³
Pressure of gas in syringe	100 kPa
Temperature of oven	120 °C

0 8 3 Each reading on the balance used to record the mass of the fine needle syringe and contents had an uncertainty of ±0.001 g

Calculate the percentage uncertainty in the mass of liquid **A** injected in this experiment.

[1 mark]

7

Percentage uncertainty



	Section B		Do not w outside box
	Answer all questions in this section.		
Only one For each	answer per question is allowed. answer completely fill in the circle alongside the appropriate answer		
CORRECT ME			
If you war	nt to change your answer you must cross out your original answer as	s shown.	
lf you wis as shown	h to return to an answer previously crossed out, ring the answer you	now wish to select	
You may Do not us	do your working in the blank space around each question but this wise additional sheets for this working.	ill not be marked.	
09	Which atom has the smallest number of neutrons?	[1 mark]	
	A ³ H	0	
	B ⁴ He	0	
	C ⁵He	0	
	D ⁴ Li	0	
10	Which species contains bonds that have different polarities?	[1 mark]	
	A NH4 ⁺	0	
	B CCl ₄	0	
	C CH₃Cl	0	
	D H ₃ O ⁺	0	











1 7	Which property increases down Group 7?		[1 mark]	Do not write outside the box
	A ability to oxidise a given reducing agent	0		
	B boiling point	0		
	C electronegativity	0		
	D first ionisation energy	0		
1 8	Which of these elements has the highest melting point?		[1 mark]	
	A Argon	0		
	B Chlorine	0		
	C Silicon	0		
	D Sulfur	0		
19	Which statement is not always correct for a reaction at equilibrium?			
	reactants ≓ products		[1 mark]	
	A The concentrations of the reactants and products are equal.	0		
	B The equilibrium can be achieved starting from the reactants.	0		
	C The equilibrium can be achieved starting from the products.	0		
	D The rate of the forward reaction is equal to the rate of the reverse reaction.	0		



2 0	Two reactions of iron with oxygen a	are shown.		Do not outsid bo
	$Fe(s) + \frac{1}{2}O_2(g) \rightarrow FeO(s)$	$\Delta H = -272 \text{ kJ mol}^{-1}$		
	$2Fe(s)+\frac{3}{2}O_2(g)\to Fe_2O_3(s)$	$\Delta H = -822 \text{ kJ mol}^{-1}$		
	What is the enthalpy change, in kJ	mol^{-1} , for this reaction?		
	2FeO($(s) + \frac{1}{2}O_2(g) \rightarrow Fe_2O_3(s)$	[1 mark]	
	A +550		0	
	B –278		0	
	C –1094		0	
	D –1372		0	
2 1	Which compound contains chlorine	e in an oxidation state of +1?	[1 mark]	
	A Cl ₂ O		0	
	B KClO ₃		0	
	C CIF ₃		0	
	D CCl ₄		0	
	Turn over for t	the next question		





2 6





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



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



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



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





Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2020 AQA and its licensors. All rights reserved.



