

Write your name here

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**Pearson**  
**Edexcel GCE**

Centre Number

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Candidate Number

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# Chemistry

**Advanced Subsidiary**

**Paper 1: Core Inorganic and Physical Chemistry**

Tuesday 22 May 2018 – Morning

**Time: 1 hour 30 minutes**

Paper Reference

**8CH0/01**

**Candidates must have: Scientific calculator  
Data Booklet**

Total Marks

## Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

## Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- For the question marked with an **asterisk** (\*), marks will be awarded for your ability to structure your answer logically showing the points that you make are related or follow on from each other where appropriate.
- A Periodic Table is printed on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Check your answers if you have time at the end.
- Show all your working in calculations and include units where appropriate.

Turn over ►

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**Pearson**

Answer ALL questions.

Some questions must be answered with a cross .  
If you change your mind about an answer, put a line through the box   
and then mark your new answer with a cross .

1 This question is about covalent bonds.

(a) State what is meant by the term covalent bond.

(2)

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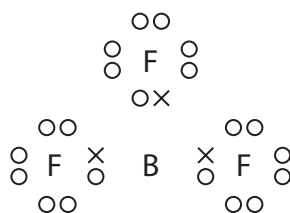
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(b) Draw a diagram of the ammonia molecule, clearly showing its shape.  
Include any lone pairs of electrons and the value of the bond angle.

(2)

(c) The dot-and-cross diagram of  $\text{BF}_3$  is



What is the bond angle in  $\text{BF}_3$ ?

(1)

- A  $90^\circ$
- B  $107^\circ$
- C  $109.5^\circ$
- D  $120^\circ$



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(d) (i) Ammonia and boron trifluoride react to form a compound  $\text{NH}_3\text{BF}_3$  which contains a dative covalent bond. Each of the molecules,  $\text{NH}_3$  and  $\text{BF}_3$ , has a different feature of its electronic structure that allows this to happen. Use these two different features to explain how a dative covalent bond is formed. (2)

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(ii) During this reaction, the bond angles about the nitrogen atom and the boron atom change. State the new  $\text{H—N—H}$  and  $\text{F—B—F}$  bond angles. (2)

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**(Total for Question 1 = 9 marks)**



2 This question is about hydrogen, the element with atomic number  $Z = 1$ .

- (a) (i) Hydrogen has two stable isotopes,  ${}^1_1\text{H}$  and  ${}^2_1\text{H}$ . Complete the table to show the number of subatomic particles present in the nuclei of these two isotopes of hydrogen.

(1)

Isotope	Number of protons	Number of neutrons
${}^1_1\text{H}$		
${}^2_1\text{H}$		

- (ii) Use the data in the table to explain the term isotopes.

(2)

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- (b) The relative atomic mass of hydrogen in the Periodic Table is 1.0. This is correct to two significant figures.

The table gives data for the relative isotopic mass and natural abundance of the two stable isotopes of hydrogen.

Isotope	Relative isotopic mass	Percentage abundance
${}^1_1\text{H}$	1.007825	99.9885
${}^2_1\text{H}$	2.014101	0.0115

- (i) Using the data in the table, give a reason why it can be estimated that the relative atomic mass of hydrogen is greater than 1.0.

(1)

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(ii) Calculate the relative atomic mass of hydrogen from these data, giving your answer to **four** decimal places.

(2)

(c) (i) Write an equation to represent the first ionisation energy of hydrogen. Include state symbols.

(2)

(ii) The sequence of the first three elements in the Periodic Table is hydrogen, helium and then lithium.

Explain why the first ionisation energy of hydrogen is less than that of helium, but greater than that of lithium.

(4)

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(d) Hydrogen can be placed in several different positions in periodic tables. One is immediately above lithium in Group 1. Another is in the centre of the first row, as shown in the Periodic Table on the back cover.

Criticise the position of hydrogen immediately above lithium by giving one reason in favour and two against.

(3)

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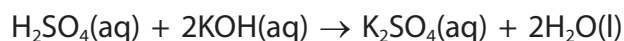
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**(Total for Question 2 = 15 marks)**



- 3 The reaction of sulfuric acid with potassium hydroxide is a neutralisation. The equation for this reaction is



A titration was carried out using the following method.

1. Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
2.  $25.0\text{ cm}^3$  of sulfuric acid solution, concentration  $0.0800\text{ mol dm}^{-3}$ , was transferred to a conical flask.
3. Three drops of phenolphthalein indicator were added to the sulfuric acid.
4. Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
5. Repeat titrations were carried out until concordant titres were obtained.

- (a) Select the most appropriate piece of apparatus to measure the  $25.0\text{ cm}^3$  of sulfuric acid.

(1)

- A burette
- B measuring cylinder
- C pipette
- D volumetric flask

- (b) What is the colour of the solution when neutralisation has just occurred?

(1)

- A colourless
- B orange
- C pale pink
- D red



- (c) (i) Complete the table of results for titration number 1, using the diagrams to find the initial and final burette readings.

(2)

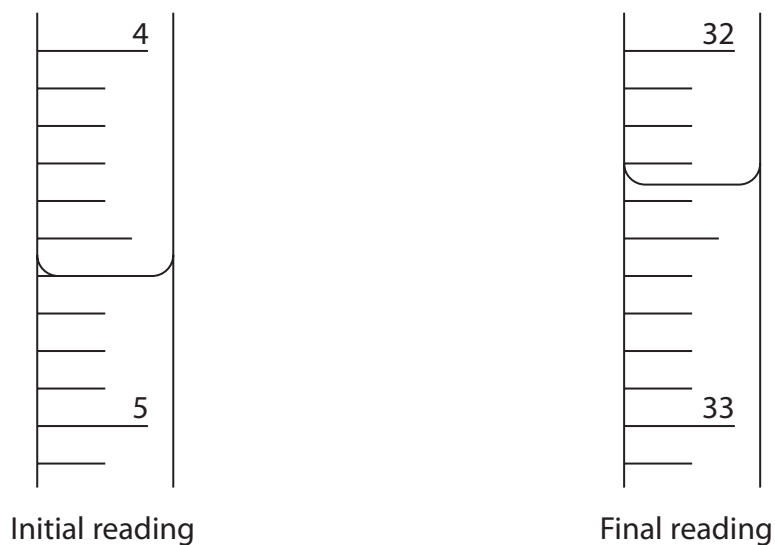


Table of results

Titration number	Final reading / cm <sup>3</sup>	Initial reading / cm <sup>3</sup>	Titration volume / cm <sup>3</sup>
1			
2	28.05	1.10	26.95
3	37.65	10.20	27.45
4	32.05	5.00	27.05

- (ii) The best value for the mean titre of this reaction is

(1)

- A 27.00 cm<sup>3</sup>
- B 27.15 cm<sup>3</sup>
- C 27.25 cm<sup>3</sup>
- D 27.30 cm<sup>3</sup>





(iii) Calculate the concentration, in  $\text{mol dm}^{-3}$ , of the potassium hydroxide solution, giving your answer to an appropriate number of significant figures.

(3)

(Total for Question 3 = 8 marks)

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- 4 An ionic compound contains a metal cation and a non-metal anion in a 1 : 1 ratio, and water of crystallisation. The compound can be represented as  $MN \cdot xH_2O$ , where  $x$  is the number of moles of water of crystallisation per mole of  $MN$ .

A sample of  $MN \cdot xH_2O$  was dissolved in distilled water to produce a colourless solution, with a concentration of about  $0.5 \text{ mol dm}^{-3}$ .  $2 \text{ cm}^3$  of the resulting solution was transferred to each of two test tubes.

The following tests were carried out to identify the ions present.

(a) **Test 1**

- (i) Addition of a few drops of a solution of barium chloride to one of the test tubes gave a white precipitate.

Identify, by name or formula, **two** possible anions that would give this result.

(1)

- (ii) Addition of  $1 \text{ cm}^3$  of dilute hydrochloric acid to the test tube in (a)(i) resulted in no further change.

Give the **formula** of the anion.

(1)

- (iii) What is the charge on the cation?

(1)

- A** +1
- B** -1
- C** +2
- D** -2



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(b) **Test 2**

A flame test on a sample of solid  $MN \cdot xH_2O$  gave no change in the flame colour.

Give a possible identity of the cation, M.

(1)

- (c) Heating the hydrated compound results in the formation of the anhydrous ionic solid MN by the following reaction:



Heating a sample of the hydrated compound reduced the mass to 48.9% of its original value.

Use this information and your answer to (a)(ii) and (b) to calculate the value of x.

[ *Note: If you have been unable to identify MN, you may use this hydrated compound,  $CoCl_2 \cdot yH_2O$  in which the sample reduced in mass to 54.6% of its original value. Use this information to calculate the value of y.* ]

(4)

**(Total for Question 4 = 8 marks)**



- 5 A student made crystals of a metal chloride,  $JCl_2 \cdot 6H_2O$ , by reacting the metal carbonate,  $JCO_3$ , with hydrochloric acid,  $HCl(aq)$ . The product was purified.

Procedure

Step 1  $150\text{ cm}^3$  of hydrochloric acid, concentration  $0.80\text{ mol dm}^{-3}$ , was transferred to a  $400\text{ cm}^3$  conical flask. The flask was warmed gently using a Bunsen burner. A spatula measure (about 1.0 g) of metal carbonate was added to the acid.

Step 2 When the reaction in Step 1 was finished, more metal carbonate was added until the metal carbonate was in excess.

Step 3 The resulting mixture was filtered into an evaporating basin.

Step 4 The evaporating basin was heated using a Bunsen burner to concentrate the solution. The concentrated solution was allowed to cool and crystallise.

Step 5 Once crystal formation was complete, the resulting mixture was filtered for a second time.

Step 6 The resulting white crystals were rinsed with a small volume of ice-cold water.

The equation for the reaction between the metal carbonate and hydrochloric acid is



- (a) (i) Describe **two** observations that the student might make which show that the reaction in Step 1 has finished.

(2)

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- (ii) State the purpose of the filtration in Step 3.

(1)

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(iii) Explain the use of a small volume of ice-cold water in Step 6.

(2)

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(b) The student obtained a mass of 14.26 g of hydrated crystals.  
Assuming that the percentage yield is 100%, use the information in the procedure  
to give a possible identity of J.

(5)

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(c) The student was surprised by the white colour of the crystals of  $JCl_2 \cdot 6H_2O$  in Step 6. This did not agree with the possible identity for J from the calculation in (b). The student decided to perform a flame test on the crystals.

(i) Explain why the student was surprised and decided to carry out a flame test. (2)

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(ii) The flame test colour was crimson red. Identify J. (1)

- A barium
- B calcium
- C lithium
- D strontium

(iii) Calculate the actual percentage yield of the reaction, which produced 14.26 g of crystals.

Give your answer to **two** significant figures. (2)

(Total for Question 5 = 15 marks)



6 Chlorine and iodine are in the same group in the Periodic Table.

- (a) (i) Complete the electronic configuration of chlorine using the s, p, d notation. (1)

1s<sup>2</sup>.....

- (ii) Explain why iodine and chlorine have many similar chemical reactions. (2)

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(b) Members of the same group sometimes react in different ways.

Iodine and chlorine react differently with thiosulfate ions, S<sub>2</sub>O<sub>3</sub><sup>2-</sup>.  
Iodine gives S<sub>4</sub>O<sub>6</sub><sup>2-</sup>, whilst chlorine gives SO<sub>4</sub><sup>2-</sup>.

- (i) Complete the table by identifying the oxidation numbers of sulfur in the three sulfur-containing ions. (2)

Ion	Oxidation number of sulfur
S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	
SO <sub>4</sub> <sup>2-</sup>	
S <sub>4</sub> O <sub>6</sub> <sup>2-</sup>	

(ii) The equation for the reaction of iodine with thiosulfate ions is



State, in terms of electrons, why iodine is classified as an oxidising agent in this reaction. (1)

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(iii) Use your answer to b(i) to show that chlorine is a stronger oxidising agent than iodine.

(1)

(iv) Chlorine reacts in aqueous solution with  $S_2O_3^{2-}$  to give  $SO_4^{2-}$ .  
The ionic half-equation for the reaction of chlorine is



Write the ionic half-equation for the reaction of aqueous  $S_2O_3^{2-}$  to give  $SO_4^{2-}$ .  
State symbols are not required.

(2)

(v) Use your answer to (b)(iv) and the half-equation for chlorine, to write the overall ionic equation for the reaction between chlorine and thiosulfate ions.  
State symbols are not required.

(1)

**(Total for Question 6 = 10 marks)**

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(Total for Question 7 = 6 marks)



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8 This question is about ionic bonding.

(a) The elements sodium and fluorine react together to form an ionic compound.

(i) Select the correct equation for this reaction.

(1)

- A**  $\text{Na(s)} + \text{F(g)} \rightarrow \text{NaF(s)}$
- B**  $2\text{Na(s)} + \text{F}_2\text{(g)} \rightarrow 2\text{NaF(s)}$
- C**  $\text{Na(s)} + \text{F}_2\text{(g)} \rightarrow \text{NaF}_2\text{(s)}$
- D**  $2\text{Na(s)} + \text{F(g)} \rightarrow \text{Na}_2\text{F(s)}$

(ii) Draw dot-and-cross diagrams of the ions in sodium fluoride, showing all the electrons.

Use your diagram to explain why the ions are described as isoelectronic.

(3)

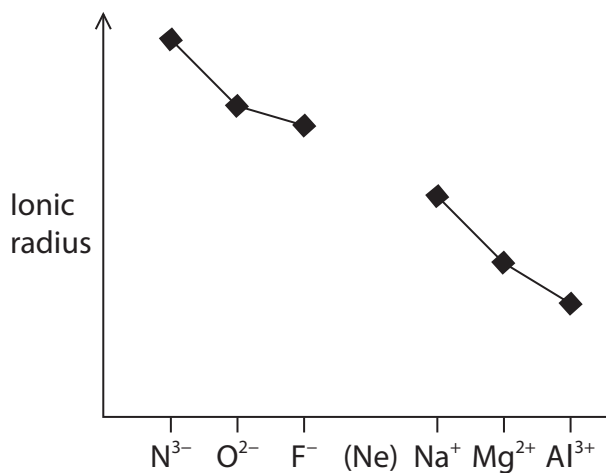
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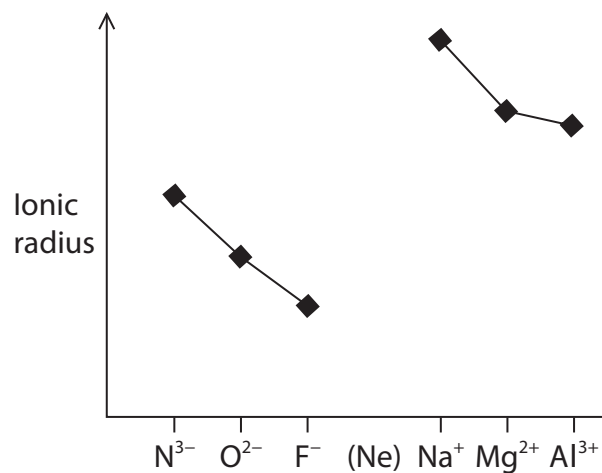


(iii) Which diagram shows the trend in ionic radius for the isoelectronic ions  $N^{3-}$  to  $Al^{3+}$ ? (1)

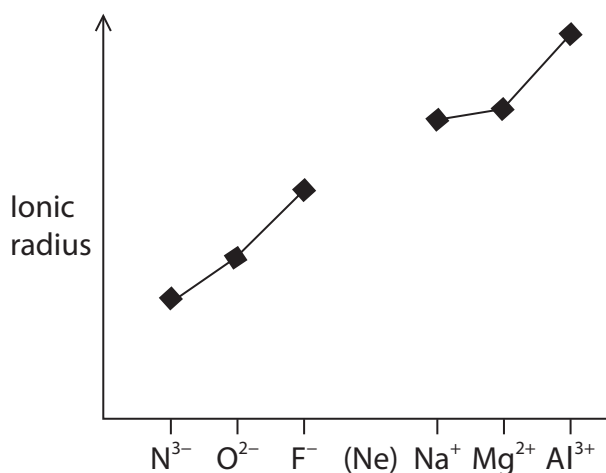
A



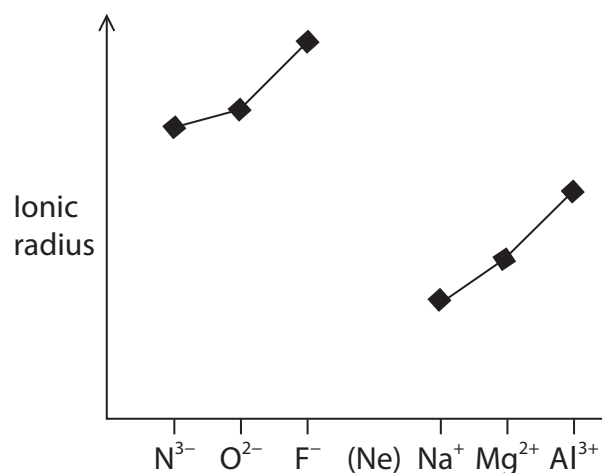
B



C



D



(iv) Explain your answer to (a)(iii) in terms of the structure of the ions. (2)

(2)

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- (b) The strength of ionic bonding in different compounds can be compared by using the amount of energy required to separate the ions. Some values for this energy are given in the table.

Compound	Amount of energy required to separate the ions / $\text{kJ mol}^{-1}$
LiF	1031
KF	817
CaF <sub>2</sub>	2957

Using the data provided, explain how changes in the cation affect the bond strength in an ionic compound.

(2)

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**(Total for Question 8 = 9 marks)**

**TOTAL FOR PAPER = 80 MARKS**



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# The Periodic Table of Elements

	1	2											3	4	5	6	7	0 (8)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	
			Key																
			relative atomic mass																
			atomic symbol																
			name																
			atomic (proton) number																
6.9	Li lithium 3	9.0	Be beryllium 4											10.8	12.0	14.0	16.0	19.0	4.0
23.0	Na sodium 11	24.3	Mg magnesium 12	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	69.7	72.6	74.9	79.0	79.9	20.2	
39.1	K potassium 19	40.1	Ca calcium 20	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ne neon 10	
85.5	Rb rubidium 37	87.6	Sr strontium 38	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	27.0	28.1	31.0	32.1	35.5	39.9	
132.9	Cs caesium 55	137.3	Ba barium 56	Zr zirconium 40	Nb niobium 41	Mo molybdenum 42	Tc technetium 43	Ru ruthenium 44	Rh rhodium 45	Pd palladium 46	Ag silver 47	Cd cadmium 48	Indium 49	Sn tin 50	Sb antimony 51	Te tellurium 52	I iodine 53	Xe xenon 54	
[223]	Fr francium 87	[226]	Ra radium 88	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	[209]	[210]	[222]	
				Hf hafnium 72	Ta tantalum 73	W tungsten 74	Re rhenium 75	Os osmium 76	Ir iridium 77	Pt platinum 78	Au gold 79	Hg mercury 80	Tl thallium 81	Pb lead 82	Bi bismuth 83	Po polonium 84	At astatine 85	Rn radon 86	
				[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	Elements with atomic numbers 112-116 have been reported but not fully authenticated							
				Rf rutherfordium 104	Db dubnium 105	Sg seaborgium 106	Bh bohrium 107	Hs hassium 108	Mt meitnerium 109	Ds darmstadtium 110	Rg roentgenium 111								
				140	141	144	[147]	150	152	157	159	163	165	167	169	173	175		
				Ce cerium 58	Pr praseodymium 59	Nd neodymium 60	Pm promethium 61	Sm samarium 62	Eu europium 63	Gd gadolinium 64	Tb terbium 65	Dy dysprosium 66	Ho holmium 67	Er erbium 68	Tm thulium 69	Yb ytterbium 70	Lu lutetium 71		
				232	[231]	238	[237]	[242]	[243]	[247]	[245]	[251]	[254]	[253]	[256]	[254]	[257]		
				Th thorium 90	Pa protactinium 91	U uranium 92	Np neptunium 93	Pu plutonium 94	Am americium 95	Cm curium 96	Bk berkelium 97	Cf californium 98	Es einsteinium 99	Fm fermium 100	Md mendelevium 101	No nobelium 102	Lr lawrencium 103		
				* Lanthanide series															
				* Actinide series															

