

Ionic Bonding

Total Marks : 20

Q1.

Calcium oxide is an ionic solid.

Figure 5 shows the arrangement of electrons in a calcium atom and in an oxygen atom.

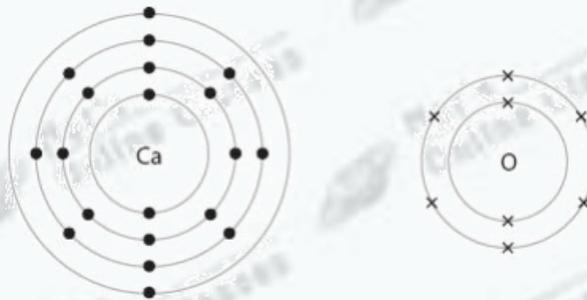


Figure 5

Complete Figure 6 to show the electronic configurations and charges of the calcium ion and the oxide ion.

Use dots to show the electrons originally in the calcium atom and crosses to show the electrons originally in the oxygen atom.



(3)

charge on ion charge on ion
.....

Figure 6

(Total for question = 3 marks)

Q2.

* Figure 6 shows some properties of three substances, **A**, **B** and **C**.

substance	melting point in °C	ability to conduct electricity	
		solid	molten
A	1180	poor	good
B	1538	good	good
C	115	poor	poor

Figure 6

Deduce, using the information in Figure 6, the structure and bonding of substances **A**, **B** and **C**, explaining their properties in terms of their structure and bonding.

(6)

(Total for question = 6 marks)

Q3.

Figure 1 shows the dot and cross diagram for a molecule of ammonia.

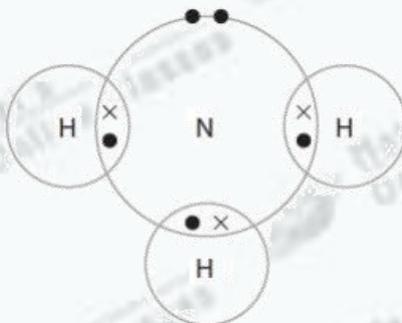


Figure 1

Ammonia reacts with nitric acid to form ammonium nitrate.

(i) Complete the word equation for this reaction.

..... + →

(1)

(ii) An ammonium ion has the formula NH_4^+ .

A nitrate ion has the formula NO_3^- .

Which of the following is the formula for ammonium nitrate?

- A $(\text{NH})_4\text{NO}_3$
- B $(\text{NH}_4\text{NO})_3$
- C NH_4NO_3
- D $(\text{NHNO})_{12}$

(1)

(iii) Explain why farmers spread ammonium nitrate on their fields.

(2)

.....
.....

(Total for question = 4 marks)

Q4.

An ion of element **X** can be represented as



This ion of element **X** has 54 electrons.

Calculate the number of protons and the number of neutrons in this ion.

(2)

number of protons

number of neutrons

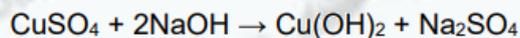
(Total for question = 2 marks)

Q5.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

When copper sulfate solution reacts with sodium hydroxide solution, a precipitate of copper hydroxide and a solution of sodium sulfate are formed.

The equation is



The formula of the sodium ion is Na^+ .

What is the formula of the sulfate ion?

(1)

- A SO_4^+
- B SO_4^-
- C SO_4^{2+}
- D SO_4^{2-}

(Total for question = 1 mark)

Q6.

Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

(i) Describe the test to show that the gas is hydrogen.

(2)

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.....

.....

.....

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni²⁺.

(2)

.....

.....

.....

.....

(Total for question = 4 marks)

Mark Schemes :

Q1.

Question number	Answer	Additional guidance	Mark
	<p>charge on ion $+2$ charge on ion -2</p> <p>(3)</p> <ul style="list-style-type: none">• correct dots for calcium ion (1)• correct 2 dots and 6 crosses for the oxide ion (1)• correct charges $2+/+2$ and $2-/-2$ (1)	ignore arrows showing movement of electrons	(3) EXP

Q2.

Question number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Substance A</p> <ul style="list-style-type: none">• giant ionic structure• (high melting point) strong electrostatic attractions between ions• due to a lot of energy required to overcome strong forces• (electrical conductivity) in solid ions strongly attracted in lattice ions cannot move, so poor conductor when solid• when molten ions free to move, so good conductor when molten <p>Substance B</p> <ul style="list-style-type: none">• metallic structure• (high melting point) strong attraction between metal ions and delocalised electrons• due to a lot of energy required to overcome strong forces between particles in solid• (electrical conductivity) in solid delocalised electrons• free to move throughout metallic lattice, so good conductor when solid• delocalised electrons and ions free to move when molten, so good conductor when molten <p>Substance C</p> <ul style="list-style-type: none">• covalent simple molecular• (low melting point) weak intermolecular forces/ attractions between molecules• little energy needed to separate molecules, so low melting point• (electrical conductivity) in solid and when molten no delocalised electrons or ions to carry charge, so poor conductor	(6) AO1 / AO3

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1-2	<u>Additional guidance</u> Identifies correct structure types OR explains a property of one substance	<u>Possible candidate responses</u> <ul style="list-style-type: none"> A – giant ionic, B – metallic, C – simple molecular High mp (for A or B) due to strong bonds (between atoms / ions) Low mp for C due to weak intermolecular forces A conducts when molten – ions can move B conducts when solid / molten – electrons can move C does not conduct – no free ions or electrons can't move
Level 2	3-4	<u>Additional guidance</u> Identifies correct structure type for one substance AND explains at least one property of that substance OR explains at least two properties	<u>Possible candidate responses</u> <ul style="list-style-type: none"> A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move B – metallic AND high mp due to strong bonds between {atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move

Level 3	5-6	<u>Additional guidance</u> Identifies correct structure types and explains properties for least two substances	<u>Possible candidate responses</u> <ul style="list-style-type: none"> A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move AND / OR <ul style="list-style-type: none"> B – metallic AND high mp due to strong bonds between {atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move AND / OR <ul style="list-style-type: none"> C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move
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Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	<ul style="list-style-type: none"> • Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. (AO3)
Level 2	3-4	<ul style="list-style-type: none"> • Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently (AO3)
Level 3	5-6	<ul style="list-style-type: none"> • Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. (AO3)

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	ammonia + nitric acid → ammonium nitrate	accept reactants in either order ignore formula	(1) AO 2 1

Question Number	Answer	Mark
(ii)	C NH ₄ NO ₃ 1. The only correct answer is C <i>A is factually incorrect</i> <i>B is factually incorrect</i> <i>D is factually incorrect</i>	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation linking two from: <ul style="list-style-type: none"> • as a fertiliser (1) • contains (a high percentage of) nitrogen (1) • help promote plant growth / increases crop yield (1) 	allow make crops grow faster ignore use as a pesticide	(2) AO 1 1

Q4.

Question number	Answer	Mark
	number of protons = 52 (1) number of neutrons = 125 - number of protons (1) (= 73)	(2) AO2

Q5.

Question number	Answer	Mark
	D: SO ₄ ²⁻	(1) comp

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	A description including <ul style="list-style-type: none">• apply lighted splint (1)• (squeaky) pop (1)	allow flame / ignite gas / fire ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking <ul style="list-style-type: none">• loss of electron(s) (1)• two electrons (1)	allow gains two electrons for 1 mark zero marks overall if sharing of electrons / gain or loss of protons / positive electrons marks can be awarded for suitably drawn diagram / half equation	(2) AO 1 1