Questions and Mark Scheme from OCR AS GCE CHEMISTRY A with links to video explanations on Youtube

F321/01 Atoms, Bonds and Groups

January 2013

Duration: 1 hour

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Boomer Publications

Tell me the answer

1 Tungsten metal is used in the manufacture of some types of steel. Tungsten has an atomic number of 74.

a) Tungsten has many isotopes.

i) Explain what is meant by *isotopes*. (1)

ii) The mass number of one isotope of tungsten is 184. Complete the table below to show the atomic structure of this tungsten Isotope. (1)

Protons	Neutrons	Electrons

iii) What is used as the standard measurement of relative isotopic mass? (1)

Forward

Explain this to me

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1 Tungsten metal is used in the manufacture of some types of steel. Tungsten has an atomic number of 74.

a) Tungsten has many isotopes.

i) Explain what is meant by *isotopes*. (1)

Atom(s) of an element with different numbers of neutrons/with different masses ✓

ii) The mass number of one isotope of tungsten is 184. Complete the table below to show the atomic structure of this tungsten Isotope. (1)

Protons	Neutrons	Electrons
74	110	74 ✓

iii) What is used as the standard measurement of relative isotopic mass? (1)

^{12}C OR C-12 OR carbon 12 OR carbon-12 ✓

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>Atom(s) of an element

AND

with different numbers of neutrons (and with different masses) ✓</td><td>1</td><td>ALLOW for ‘atoms of an element’:
Atoms of the same element
OR atoms with the same number of protons
OR atoms with the same atomic number

IGNORE ‘different relative atomic masses’
IGNORE different mass number
IGNORE same number of electrons
DO NOT ALLOW different numbers of electrons
DO NOT ALLOW ‘atoms of elements’ for ‘atoms of an element’
DO NOT ALLOW ‘an element with different numbers of neutrons’ (ie atom(s) is essential)</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>Protons</th><th>Neutrons</th><th>Electrons</th><th></th></tr><tr><td>74</td><td>110</td><td>74</td><td>✓</td></tr></table></td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td>^{12}C OR C-12 OR carbon 12 OR carbon-12 ✓</td><td>1</td><td>IGNORE 1/12th AND amu</td></tr>
</table>

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Tell me the answer

b) In the manufacture of tungsten metal, an oxide of tungsten, WO_3, is reacted with hydrogen gas.

$$WO_3(s) + 3H_2(g) \longrightarrow W(s) + 3H_2O(g)$$

i) Using oxidation numbers, show what has been oxidised and what has been reduced in this reaction.

oxidised.....

reduced..... (2)

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Forward

Explain this to me

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b) In the manufacture of tungsten metal, an oxide of tungsten, WO_3, is reacted with hydrogen gas.

$$WO_3(s) + 3H_2(g) \longrightarrow W(s) + 3H_2O(g)$$

i) Using oxidation numbers, show what has been oxidised and what has been reduced in this reaction.

oxidised..... H (oxidation number has increased) from H=0 to H=+1 ✓

reduced..... W (oxidation number has decreased) from W=+6 to W=0 ✓ (2)

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(b)	**(i)**	(Oxidised): H (oxidation number has increased) from H = 0 to H = +1 ✓ (Reduced): W (oxidation number has decreased) from W = +6 to W = 0 ✓	2	**ALLOW** 6+ **OR** 6 **OR** 1+ **OR** 1 **ALLOW** one mark for correct oxidation number changes H = 0 to H = +1 **AND** W = +6 to W = 0 **ALLOW** oxidation states written above the equation if not seen in the text BUT **IGNORE** oxidation states written above the equation if seen in the text **ALLOW** for one mark: (Oxidised) H has increased by 1 **AND** (Reduced) W has decreased by 6 **IGNORE** WO_3 is reduced **IGNORE** references to electron loss / gain if correct **DO NOT ALLOW** incorrect references to electron loss / gain **DO NOT ALLOW** 'H oxidised and W reduced' without reference to oxidation number changes

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Tell me the answer

ii) A chemist reacts 11.59g of WO_3 with hydrogen gas.

Calculate the volume of hydrogen gas, in dm^3, required to completely react with the mass of WO_3 at room temperature and pressure. (3)

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ii) A chemist reacts 11.59g of WO_3 with hydrogen gas.

Calculate the volume of hydrogen gas, in dm^3, required to completely react with the mass of WO_3 at room temperature and pressure. (3)

IF answer = 3.6(0) (dm^3) award 3 marks

Amount of WO_3 = (11.59/231.8 =) 0.05(00) (mol) ✓

Amount of H_2 = 0.0500 x 3 = 0.15(0) (mol) ✓

Volume of H_2 = 0.150 x 24.0 = 3.6(0) (dm^3) ✓

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Question			Answer	Marks	Guidance
1	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **IF answer = 3.6(0) (dm^3) award 3 marks**	3	**If there is an alternative answer, check to see if there is any ECF credit possible using working below** **ALLOW** calculator value or rounding to 2 significant figures or more BUT **IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2 if wrong M_r produces such numbers throughout. **IF** answer **= 1.2(0)** dm^3 award 2 marks (not multiplying by 3)
			Amount of WO_3 = (11.59 / 231.8 =) 0.05(00) (mol) ✓		**ALLOW** use of inexact M_r (eg 232) – if it still gives 0.05
			Amount of H_2 = 0.0500 x 3 = 0.15(0) (mol) ✓		**ALLOW** amount of WO_3 x 3 correctly calculated for 2nd mark
			Volume of H_2 = 0.150 x 24.0 = 3.6(0) (dm^3) ✓		**ALLOW** amount of H_2 x 24.0 correctly calculated for 3rd mark **ALLOW** 1 mark for **incorrect** amount of WO_3 x 24.0 (not multiplied by 3 ie scores third mark only)
			Total	**8**	

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Tell me the answer

2 Simple molecules are covalently bonded.

(a) State what is meant by the term *covalent bond*. (1)

b) Chemist are able to predict the shape of a simple covalent molecule from the number of electron pairs surrounding the central atom.

i) Explain how this enables chemists to predict the shape. (2)

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Explain this to me

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2 Simple molecules are covalently bonded.

(a) State what is meant by the term *covalent bond*. (1)

A shared pair of electrons ✓

b) Chemist are able to predict the shape of a simple covalent molecule from the number of electron pairs surrounding the central atom.

i) Explain how this enables chemists to predict the shape. (2)

Pairs of (electrons surrounding a central atom) repel ✓

The shape is determined by the number of bond pairs
AND
The number of lone pairs (of electrons) ✓

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Question			Answer	Marks	Guidance
2	(a)		A shared pair of electrons ✓	1	**DO NOT ALLOW** 'shared electrons'
	(b)	(i)	**Pairs** of (electrons surrounding a central atom) repel ✓ The shape is determined by the number of bond pairs **AND** the number of lone pairs (of electrons) ✓	2	**ALLOW** alternative phrases/words to repel eg 'push apart' **ALLOW** lone pairs repel **OR** bond(ing) pairs repel **ALLOW** 'the number of bonding pairs and number of lone pairs decides the orientation of the surrounding atoms' **ALLOW** 'how many' for 'number of' **ALLOW** the second mark for a response which has 2 of the following **including at least one** shape involving lone pairs (of electrons) BUT mark incorrect responses first 2 bonding pairs = linear 3 bonding pairs = trigonal planar 4 bonding pairs = tetrahedral 6 bonding pairs = hexagonal 3 bonding pairs and 1 lone pair = pyramidal 2 bonding pairs and 2 lone pairs = non-linear **IGNORE** 'number of electron pairs decides shape of molecule' as this is in the question

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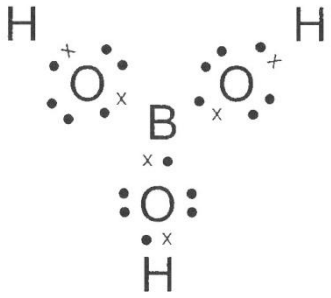
Tell me the answer

ii) The '*dot-and-cross*' diagram of the simple covalent molecule, H_3BO_3 is shown below.



Predict the O-B-O and B-O-H angles in a molecule of H_3BO_3.

O-B-O = ...° B-O-H = ...° (2)

c) Give an example of a simple covalent molecule which has all the bond angles equal to 90° (1)

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Explain this to me

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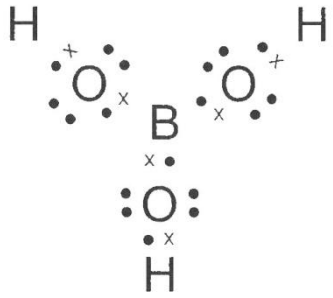
ii) The '*dot-and-cross*' diagram of the simple covalent molecule, H_3BO_3 is shown below.



Predict the O-B-O and B-O-H angles in a molecule of H_3BO_3.

O-B-O = 120 ..... ° B-O-H = 104.5 ..... ° (2)

c) Give an example of a simple covalent molecule which has all the bond angles equal to 90° (1)

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SF_6 **OR** sulfur hexafluoride **OR** sulfur (VI) fluoride

	(ii)	O–B–O = 120° ✓ B–O–H = 104.5° ✓	2	**ALLOW** 104–105°
(c)		SF_6 **OR** sulfur hexafluoride **OR** sulfur(VI) fluoride ✓	1	**ALLOW** XeF_4 **DO NOT ALLOW** SCl_6 **DO NOT ALLOW** stated complexes (simple molecule is asked for)
		Total	**6**	

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3 Successive ionisation energies provide evidence for existence of different shells in atoms.

a) Define, in words, *the term first ionisation energy*. (3)

b) i) Write and equation to represent the **second** ionisation energy of oxygen. Include state symbols. (1)

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Explain this to me

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3 Successive ionisation energies provide evidence for existence of different shells in atoms.

a) Define, in words, *the term first ionisation energy*. (3)

Energy (needed) to remove an electron ✓

from **each atom** in **one mole** ✓

of **gaseous atoms** ✓

b) i) Write and equation to represent the **second** ionisation energy of oxygen. Include state symbols. (1)

$O^+(g) \longrightarrow O^{2+}(g) + e^-$ ✓

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Question			Answer	Marks	Guidance
3	(a)		Energy (needed) to remove an electron ✓ from **each atom** in **one mole** ✓ of **gaseous atoms** ✓	3	**ALLOW** 'energy to remove one mole of electrons from one mole of gaseous atoms' for three marks **IGNORE** 'element' **ALLOW** 'energy needed to remove an electron from one mole of gaseous atoms to form one mole of gaseous 1+ ions' for two marks For third mark: **ALLOW** ECF if wrong particle is used in second marking point but is described as being gaseous eg 'molecule' instead of 'atom' **IGNORE** equations
	(b)	(i)	$O^+(g) \rightarrow O^{2+}(g) + e^-$ ✓	1	**ALLOW** $O^+(g) - e^- \rightarrow O^{2+}(g)$ **ALLOW** e for electron (ie charge omitted) **IGNORE** states on the electron

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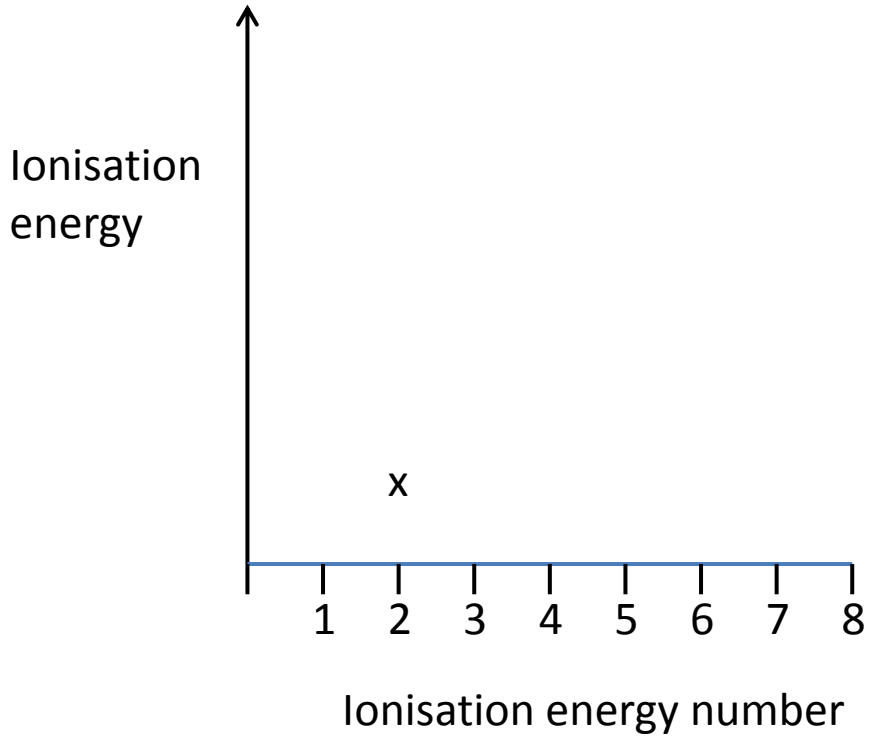
Tell me the answer

ii) On the axes below, add crosses to estimate the successive ionisation energies of oxygen. The second ionisation energy has been added for you. It is **not** necessary to join your points. (2)



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Explain this to me

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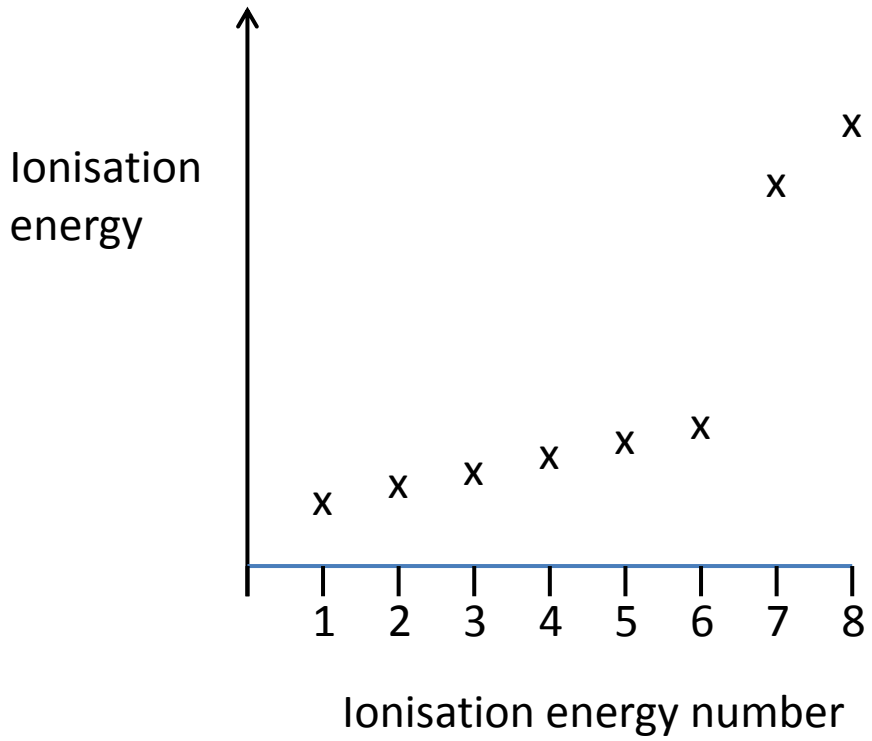
ii) On the axes below, add crosses to estimate the successive ionisation energies of oxygen. The second ionisation energy has been added for you. It is **not** necessary to join your points. (2)



All eight ionisation energies showing an increase ✓

The biggest increase between the sixth and seventh ionisation energy
AND
8^{th} ionisation energy is higher than 7^{th} ✓

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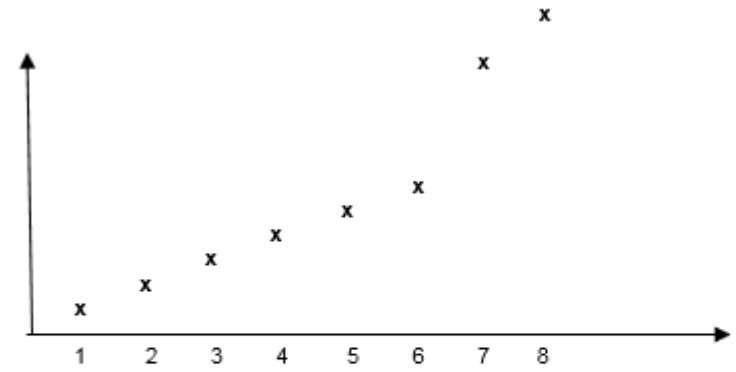
	(ii)	 All eight ionisation energies showing an increase ✓ The biggest increase between the sixth and seventh ionisation energy **AND** 8th ionisation energy is higher than 7th ✓	2	**IGNORE** the 2p/2s true jump **IGNORE** line if seen **IGNORE** 0, if included by candidate **IGNORE missing** 1st IE point BUT **DO NOT ALLOW** first ionisation energy higher than second **DO NOT ALLOW** either mark if ionisations energies 3 to 8 inclusive are not shown Place tick for second mark on the x-axis between 6 and 7

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Tell me the answer

c) The first ionisation energy of oxygen is **less** than the first ionisation energy of fluorine. Explain why. (3)

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Explain this to me

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c) The first ionisation energy of oxygen is **less** than the first ionisation energy of fluorine. Explain why. (3)

Nuclear Charge mark

O has (one) less proton(s) **OR** O has smaller nuclear charge **OR** F has (one) more proton(s) **OR** F has greater nuclear charge ✓

Atomic radius/shielding mark

(Outermost) electrons are in the same shell **OR** energy level **OR** (Outermost) electrons experience the same shielding **OR** Atomic radius of O is larger **OR** Atomic radius of F is smaller ✓

Nuclear attraction mark

Less nuclear attraction (on outermost electrons) in O **OR** (outer) electrons are attracted less strongly (to the nucleus) in O **OR** More nuclear attraction (on outermose electrons) in F **OR** (outer) electrons are attracted more strongly (to the nucleus) in F ✓

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Question			Answer	Marks	Guidance
3	(c)			3	**Use annotations ie ticks crosses ECF ^ etc for this part** Comparison should be used for each mark. Look for ORA from perspective of F throughout. **ALLOW** all three marks applied to 'as you go across the period' BUT assume the response refers to 'as you go across the period' if not stated
			Nuclear charge mark O has (one) less proton(s) **OR** O has smaller nuclear charge **OR** F has (one) more proton(s) **OR** F has greater nuclear charge ✓		**ALLOW** O has lower proton number BUT **IGNORE** O has lower atomic number **IGNORE** O has a smaller nucleus **IGNORE** 'O has a smaller charge' ie must be nuclear charge **IGNORE** 'O has smaller effective nuclear charge'
			Atomic radius/shielding mark (Outermost) electrons are in the same shell **OR** energy level **OR** (Outermost) electrons experience the same shielding **OR** Atomic radius of O is larger **OR** Atomic radius of F is smaller ✓		**ALLOW** sub-shell for shell but **IGNORE** orbitals **ALLOW** shielding is similar **ALLOW** outermost electrons of O are further **DO NOT ALLOW** 'distance is the same' for second mark
			Nuclear attraction mark Less nuclear attraction (on outermost electrons) in O **OR** (outer) electrons are attracted less strongly (to the nucleus) in O **OR** More nuclear attraction (on outermost electrons) in F **OR** (outer) electrons are attracted more strongly (to the nucleus) in F ✓		**ALLOW** 'less nuclear pull' for 'less nuclear attraction' **DO NOT ALLOW** 'less nuclear charge' instead of 'less nuclear attraction' for the third mark **IGNORE** 'not pulled as close' for 'pulled less strongly'

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Tell me the answer

d) When oxygen reacts with metals it forms oxide ions.
Write the electron configurations, in terms of sub-shells, of an oxygen atom and an oxide ion. Hence, explain why this reaction of oxygen is typical of a non-metal.

Oxygen atom.....

Oxide ion.....

(2)

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Explain this to me

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d) When oxygen reacts with metals it forms oxide ions.
Write the electron configurations, in terms of sub-shells, of an oxygen atom and an oxide ion. Hence, explain why this reaction of oxygen is typical of a non-metal.

Oxygen atom..... $1s^2\ 2s^2\ 2p^4$ .....

AND

Oxide ion..... $1s^2\ 2s^2\ 2p^6$ .....

(2)

(In the reaction) oxygen has formed a **negative ion** (by gaining (two) electrons)

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Question			Answer	Marks	Guidance
3	(d)		$1s^2\ 2s^2\ 2p^4$ **AND** $1s^2\ 2s^2\ 2p^6$ ✓ (In the reaction) oxygen has formed a **negative ion** (by gaining (two) electrons) ✓	2	**ALLOW** subscripts, capitals **ALLOW** oxidation number of oxygen has decreased **ALLOW** non metals form negative ions **IGNORE** oxygen has gained electrons (this is shown in the electron configurations)

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Tell me the answer

e) Many ions contain oxygen combined with atoms of other elements.

For example, the nitrate(V) ion has the formula NO_3^-.

i) In the table below, write the formula of the sulfate(IV) ion and the chlorate(III) ion. (2)

Ion	Ionic charge	Formula
Nitrate(V)	1^-	NO_3^-
Sulfate(IV)	2-	
Chlorate(III)	1-	

ii) Write the formula of aluminium nitrate(V). (1)

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Explain this to me

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Ion	Ionic charge	Formula
Nitrate(V)	1^-	NO_3^-
Sulfate(IV)	$2-$	SO_3^{2-} ✓
Chlorate(III)	$1-$	ClO_2^- ✓

ii) Write the formula of aluminium nitrate(V). (1)

$Al(NO_3)_3$

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	(e)	**(i)**	SO_3^{2-} ✓ ClO_2^- ✓	2	
		(ii)	$Al(NO_3)_3$ ✓	1	

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Tell me the answer

iii) Aluminium nitrate(V) can be made by reacting a base with an acid.

For this reaction, name a suitable base and write the formula of the acid.

name of base.....

formula of the acid..... (2)

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Explain this to me

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iii) Aluminium nitrate(V) can be made by reacting a base with an acid.

For this reaction, name a suitable base and write the formula of the acid.

name of base..... Aluminium oxide OR aluminium hydroxide ✓

formula of the acid..... HNO_3 ✓ (2)

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		(iii)	Aluminium oxide **OR** aluminium hydroxide ✓ HNO_3 ✓	2	**IGNORE** correct formula (ie Al_2O_3 or $Al(OH)_3$) **DO NOT ALLOW** correct name with incorrect formula **IGNORE** correct name (ie nitric acid or nitric(V) acid) **DO NOT ALLOW** correct formula with incorrect name **ALLOW** one mark for Al_2O_3 or $Al(OH)_3$) **AND** nitric acid or nitric(V) acid (ie name answer and formulae answer has been transposed)
			Total	**16**	

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Tell me the answer

4 The Group 2 element barium was first isolated by Sir Humphrey Davy in 1808. Barium has a giant metallic structure and a melting point of 725°C.

a) Describe, with the aid of a labelled diagram, the structure and bonding in barium and explain why barium has a high melting point.

Include the correct charges on the metal particles in your diagram. (3)

In your answer, you should use appropriate technical terms, spelled correctly.

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Explain this to me

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4 The Group 2 element barium was first isolated by Sir Humphrey Davy in 1808. Barium has a giant metallic structure and a melting point of 725°C.

a) Describe, with the aid of a labelled diagram, the structure and bonding in barium and explain why barium has a high melting point.

Include the correct charges on the metal particles in your diagram. (3)

In your answer, you should use appropriate technical terms, spelled correctly.

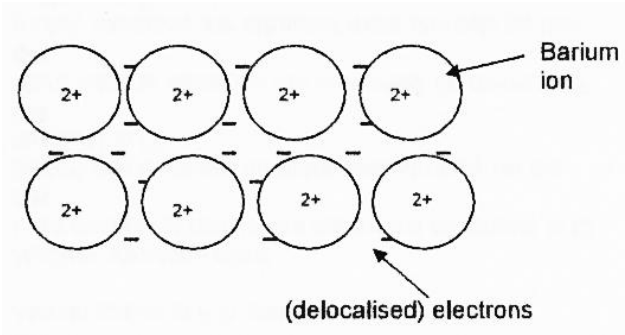

Diagram showing regular arrangement of labelled 'Ba^{2+}' ions or '2+ ions' and some attempt to show electrons ✓

Scattering of labelled electrons between other species
AND
Statement anywhere of delocalised electrons (can be in text or in diagram) ✓

The attraction between (positive) ions and (delocalised) electrons is strong ✓

'electrons' needs to be spelt correctly to get 3rd mark

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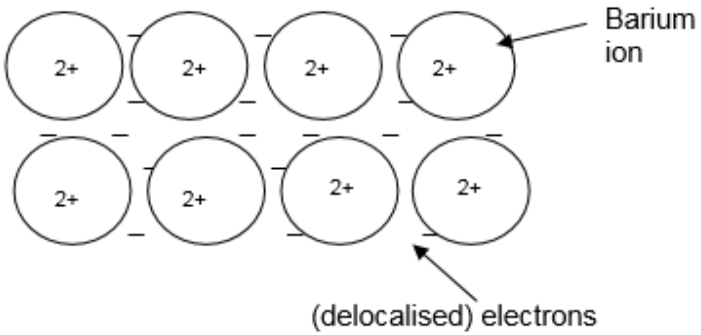
Question	Answer	Marks	Guidance
4 (a)	 Diagram showing a regular arrangement of **labelled** '**Ba^{2+} ions**' or '**2+ ions**' and some attempt to show electrons ✓ Scattering of labelled electrons between other species **AND** statement anywhere of **delocalised** electrons (can be in text or in diagram) ✓ The attraction between (positive) ions and (delocalised) electrons is strong ✓	3	Regular arrangement must have at least two rows of correctly charged ions and a minimum of two ions per row **ALLOW** as label: positive ions, cations if correct charge is seen within circle **ALLOW** for labelled Ba^{2+} ions: circles with **Ba^{2+}** inside **DO NOT ALLOW** incorrect charge for ions eg + , 3+ etc **DO NOT ALLOW** for label of ions: nuclei **OR** positive atom **OR** protons **ALLOW** e^- or 'e' or – as symbol for electron within the lattice for first marking point if not labelled as 'electrons'. **ALLOW** mobile or 'sea of' for delocalised *Quality of written communication:* 'electron(s)' spelled correctly and used in context for the **third** marking point **ALLOW** a lot of energy is needed to break **OR** overcome the attraction between (positive) ions and (delocalised) electrons **IGNORE** 'heat' but **ALLOW** 'heat energy' **DO NOT ALLOW** references to incorrect particles or incorrect attractions eg 'intermolecular attraction' **OR** 'nuclear attraction' **IGNORE** 'strong metallic bonds' without seeing correct description of metallic bonding

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Tell me the answer

b) A chemist reacts barium with water. A solution is formed which conducts electricity.

i) Write the equation for the reaction of barium with water. Include state symbols. (2)

ii) Predict a value for the pH of the resulting solution. (1)

iii) Give the **formula** of the negative ion responsible for the conductivity of the solution formed. (1)

c) Heartburn is a form of indigestion caused by an excess of stomach acid. State a compound of magnesium that could be used to treat heartburn. (1)

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Explain this to me

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b) A chemist reacts barium with water. A solution is formed which conducts electricity.

i) Write the equation for the reaction of barium with water. Include state symbols. (2) $Ba(s) + 2H_2O(l) \longrightarrow Ba(OH)_2(aq) + H_2(g)$

$Ba(OH)_2$ as product Rest of equation + state symbols ✓

i) Predict a value for the pH of the resulting solution. (1)

Any value or the range $7 < pH \leq 14$ ✓

iii) Give the **formula** of the negative ion responsible for the conductivity of the solution formed. (1)

OH^- or HO^- ✓

c) Heartburn is a form of indigestion caused by an excess of stomach acid. State a compound of magnesium that could be used to treat heartburn. (1)

Magnesium hydroxide or magnesium oxide ✓

Back to Question

Question			Answer	Marks	Guidance
4	(b)	(i)	$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$ $Ba(OH)_2$ as product ✓ Rest of equation + state symbols ✓	2	**ALLOW** multiples
		(ii)	Any value or the range $7 < pH \leq 14$ ✓	1	**DO NOT ALLOW** if pH 7 is in a quoted range
		(iii)	OH^- **OR** HO^- ✓	1	**DO NOT ALLOW** Ba^{2+} **DO NOT ALLOW** any reference to electrons
	(c)		Magnesium hydroxide **OR** magnesium oxide ✓	1	**ALLOW** magnesium carbonate **ALLOW** correct formulae: $Mg(OH)_2$, MgO, $MgCO_3$ **IGNORE** 'milk of magnesia'

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Tell me the answer

d) In an experiment, a student makes a solution of strontium chloride, $SrCl_2$, by adding excess dilute hydrochloric acid to strontium carbonate.

i) Describe what the student would observe and write the equation for the reaction.

observations.....

.....

.....

equation.....(2)

ii) Draw a '*dot-and-cross*' diagram to show the bonding of strontium chloride. Show **outer** electrons only. (2)

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Explain this to me

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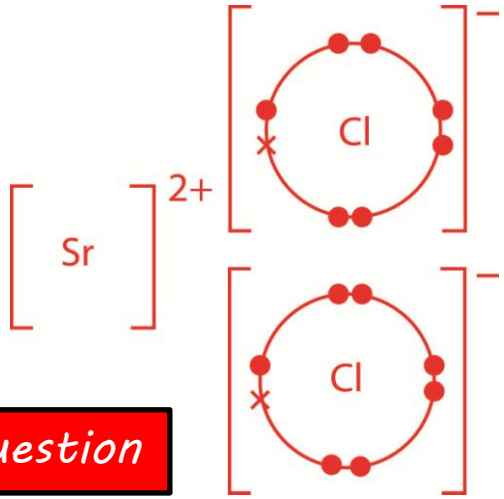
d) In an experiment, a student makes a solution of strontium chloride, $SrCl_2$, by adding excess dilute hydrochloric acid to strontium carbonate.

i) Describe what the student would observe and write the equation for the reaction.

observations..... Effervescence OR fizzing OR bubbling OR gas produced **AND** strontium carbonate **OR** solid dissolves **OR** disappears **OR** a colourless solution is formed ✓

equation..... $SrCO_3 + 2HCl \longrightarrow SrCl_2 + H_2O + CO_2$ ✓ .....(2)

ii) Draw a '*dot-and-cross*' diagram to show the bonding of strontium chloride. Show **outer** electrons only. (2)



Strontium ion with eight (or no) outermost electrons **AND** 2 x chloride (ions) with '*dot-and-cross*' outermost octet ✓

correct charges ✓

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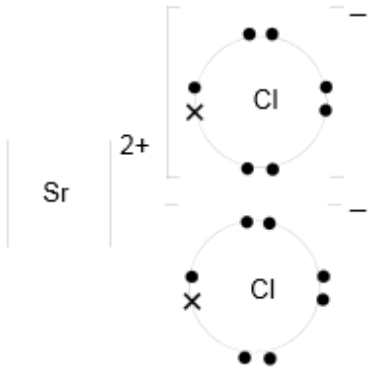
	(d)	(i)	Effervescence **OR** fizzing **OR** bubbling **OR** gas produced **AND** Strontium carbonate **OR** solid dissolves **OR** disappears **OR** a colourless solution is formed ✓ $SrCO_3 + 2HCl \rightarrow SrCl_2 + H_2O + CO_2$ ✓	2	**DO NOT ALLOW** 'carbon dioxide produced' without 'gas' **DO NOT ALLOW** 'hydrogen gas produced' **OR** any other named gas **ALLOW** 'it' for strontium carbonate **ALLOW** strontium for strontium carbonate if $SrCO_3$ seen in equation **IGNORE** 'reacts' **IGNORE** references to temperature change **IGNORE** 'steam produced' **IGNORE** state symbols

Question			Answer	Marks	Guidance
4	(d)	(ii)	 Strontium ion with eight (or no) outermost electrons **AND** 2 x chloride (ions) with '*dot-and-cross*' outermost octet ✓ correct charges ✓	2	**For first mark**, if eight electrons are shown in the cation then the 'extra' electron in the anion must match symbol chosen for electrons in the cation **IGNORE** inner shell electrons Circles **not** essential **ALLOW** One mark if both electron arrangement and charges are correct but only one Cl is drawn **ALLOW** $2[Cl^-]$ $2[Cl]^-$ $[Cl^-]_2$ (brackets not required) **DO NOT ALLOW** $[Cl_2]^-$ $[Cl_2]^{2-}$ $[2Cl]^{2-}$ $[Cl]_2^-$

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Tell me the answer

e) In another experiment, a student attempts to make a solution of strontium chloride by adding chlorine water to aqueous strontium bromide.

i) Describe what the student would observe. (1)

ii) Write the ionic equation for the reaction which takes place. (1)

iii) Chlorine is more reactive than bromine. Explain why. (4)

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Explain this to me

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e) In another experiment, a student attempts to make a solution of strontium chloride by adding chlorine water to aqueous strontium bromide.

i) Describe what the student would observe. (1)

The mixture would turn orange ✓

ii) Write the ionic equation for the reaction which takes place. (1)

$Cl_2 + 2Br^- \longrightarrow Br_2 + 2Cl^-$ ✓

iii) Chlorine is more reactive than bromine. Explain why. (4)

The electron GAIN mark

Chlorine will form a negative ion more easily than bromine OR chlorine will gain an electron more easily than bromine ✓

Atomic size mark

(An atom of) chlorine is smaller (than bromine) ✓

Shielding mark

(Outermost shell of) chlorine is less shielded (than bromine) ✓

Stronger nuclear attraction mark

Nuclear attraction (on the electron to be gained) by chlorine is greater than bromine) OR the electron (to be gained) is attracted more strongly (to the nucleus) in chlorine ✓

Back to Question

(e)	(i)	The mixture would turn orange ✓	1	**ALLOW** shades and colours containing (eg dark orange, yellow-orange) **ALLOW** the following: yellow, yellow-brown, brown, brown-red BUT **DO NOT ALLOW** red alone **IGNORE** initial colours **DO NOT ALLOW** any response that includes 'precipitate' **OR** solid
	(ii)	$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓	1	**ALLOW** multiples **IGNORE** state symbols

Question			Answer	Marks	Guidance
4	e	(iii)	*The electron* GAIN *mark* Chlorine will form a negative ion more easily than bromine **OR** Chlorine will gain an electron more easily than bromine ✓ *Atomic size mark* (An atom of) chlorine is smaller (than bromine) ✓ *Shielding mark* (Outermost shell of) chlorine is less shielded (than bromine) ✓ *Stronger nuclear attraction mark* Nuclear attraction (on the electron to be gained) by chlorine is greater (than bromine) **OR** the electron (to be gained) is attracted more strongly (to the nucleus) in chlorine ✓	4	**Use annotations ie ticks crosses ECF ^ etc for this part** Look for ORA from perspective of Br throughout. **ALLOW** all four marks applied to 'as you go up **OR** as you down the group' **ALLOW** C*l* for chlorine **AND** Br for bromine **ALLOW** ORA **DO NOT ALLOW** the use of 'ide' BUT **ALLOW** use of 'ide' as an ECF **ALLOW** chlorine is better at electron capture **ALLOW** chlorine has greater electron affinity **IGNORE** chlorine is more electronegative **IGNORE** chlorine has more oxidising power than bromine **IGNORE** explanations given in terms of displacement **ALLOW** chlorine has fewer shells **ALLOW** the electron is added to the (outer) shell closer to the nucleus **IGNORE** 'easily' for 'greater' or for 'stronger' **ALLOW** 'chlorine has greater nuclear attraction (on its outermost electrons)' **OR** '(the outermost) electrons in chlorine are more attracted (to the nucleus)'
			Total	**18**	

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Tell me the answer

5 Hydrogen chloride is a colourless gas which forms white fumes in moist air.

a) Molecules of hydrogen chloride, HCl, and molecules of fluorine, F_2, contain the same number of electrons. Hydrogen chloride boils at -85°C and fluorine boils at -188°C.

Explain why there is a difference in boiling points of HCl and F_2.

In your answer you should refer to the types of force acting between molecules and the relative strength of the forces between the molecules.

In your answer, you should use appropriate technical terms, spelled correctly. (4)

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Explain this to me

5 Hydrogen chloride is a colourless gas which forms white fumes in moist air.

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In your answer, you should use appropriate technical terms, spelled correctly. (4)

F_2 forces mark – F_2 has van der Waals' (forces) **OR** F_2 has induced dipole attractions **OR** F_2 has temporary **OR** instantaneous dipole(-dipole) attraction **OR** interactions

HCl forces mark – HCl has permanent dipole(-dipole) attractions **OR** interactions (dipole(s) spelt correctly for this mark)

Comparison of strength of forces between molecules mark – intermolecular forces in HCl is stronger than that in F_2 **OR** permanent dipoles are stronger (than induced dipoles)

Back to Question

Boiling point mark – more energy required to break stronger (intermolecular) forces

Question			Answer	Marks	Guidance
5	(a)		*F_2 forces mark* F_2 has van der Waals' (forces) **OR** F_2 has induced dipole attractions **OR** interactions **OR** F_2 has temporary **OR** instantaneous dipole(–dipole) attraction **OR** interactions ✓ *HCl forces mark* HCl has **permanent** dipole(–dipole) attractions **OR** interactions ✓ *Comparison of strength of forces between molecules mark* intermolecular force in HCl is stronger than that in F_2 **OR** permanent dipoles are stronger (than induced dipoles) ✓ *Boiling point mark* more energy is required to break stronger (intermolecular) forces ✓	4	**Use annotations ie ticks crosses ECF ^ etc for this part** **ALLOW** vdWs for van der Waals' **IGNORE** F_2 has covalent bond for this mark **IGNORE** F_2 has 'intermolecular forces' *Quality of written communication:* 'dipole(s)' spelled correctly and used in context for the **second** marking point **IGNORE** HCl has 'intermolecular forces' **IGNORE** van der Waals' forces in HCl **DO NOT ALLOW** hydrogen bonding **DO NOT ALLOW** ionic bonding Look for strength of force comparison anywhere in the answer **ALLOW** ECF for hydrogen bonding in HCl being stronger than the stated intermolecular forces in F_2 BUT **DO NOT ALLOW** this mark if HCl or F_2 has covalent bonds broken **OR** if HCl has ionic bonds broken (the question asks for forces between molecules) **IGNORE** HCl has stronger van der Waals' (forces) than F_2 (as they both have the same number of electrons) **DO NOT ALLOW** fourth mark if covalent bonds are broken in HCl or F_2 **OR** if ionic bonds are broken in HCl **IGNORE** 'heat' but **ALLOW** 'heat energy'

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Tell me the answer

b) Hydrogen chloride reacts with water to produce an ion with the formula H_3O^+. An H_3O^+ ion has one dative covalent bond.
Draw a 'dot-and-cross' diagram to show the bonding in H_3O^+.
Show **outer** electrons only.

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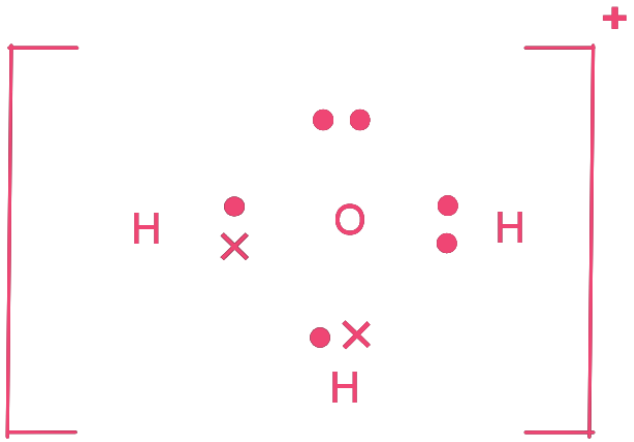
Forward

Click here for full mark scheme

Explain this to me

b) Hydrogen chloride reacts with water to produce an ion with the formula H_3O^+. An H_3O^+ ion has one dative covalent bond.
Draw a 'dot-and-cross' diagram to show the bonding in H_3O^+.
Show **outer** electrons only. (2)



Two '*dot-and-cross*' bonding pairs of electrons and one dative covalent bond pair of electrons consisting of either two dots or two crosses ✓

One non-bonding pair of electrons **AND** which match the dative covalent pair of electrons ✓

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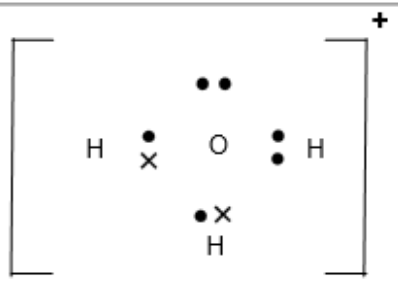
Question			Answer	Marks	Guidance
5	(b)	(i)	 Two *dot-and-cross* bonding pairs of electrons and one dative covalent bond pair of electrons consisting of either two dots or two crosses ✓ **One** non-bonding pair of electrons **AND** which match the dative covalent bond pair of electrons ✓	2	Must be '*dot-and-cross*' Must be H_3O for either mark Circles for shells **not** needed **IGNORE** inner shells **IGNORE** lack of positive charge and square brackets **DO NOT ALLOW** second marking point if negative charge is shown on the ion Non-bonding electrons do **not** have to be seen as a pair **ALLOW** second mark for one non-bonding pair of electrons and three *dot-and-cross* bonding pairs of electrons

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Tell me the answer

c) Borax, $Na_2B_4O_7.10H_2O$, can be used to determine the concentration of acids such as dilute hydrochloric acid.

A student prepares 250cm^3 of a 0.0800 mol dm^{-3} solution of borax in water in a volumetric flask.

Calculate the mass of borax crystals, $Na_2B_4O_7.10H_2O$, needed to make up 250 cm^3 of 0.0800 mol dm^{-3} solution. (3)

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Answer = ...g

Click here for full mark scheme

Explain this to me

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Calculate the mass of borax crystals, $Na_2B_4O_7.10H_2O$, needed to make up 250 cm^3 of 0.0800 mol dm^{-3} solution. (3)

If answer on answer line = 7.624 **OR** 7.62 (g) award 3 marks

Molar mass of borax = 381.2 (g mol^{-1}) ✓

Correctly calculates the mass of borax in 1000 cm^3 = 0.0800 x 381.2

= 30.496 g **OR** 30.50 g OR 30.5 g ✓

Correctly calculates the mass of borax in 250cm^3 = 30.496/4

= 7.624g OR 7.62 ✓

OR

Molar mass of borax = 381.2 (g mol^{-1}) ✓

Amount of borax in 250 cm^3 of solution = 0.0800 x 250/1000 = 0.02(00) mol ✓

Mass of borax = 0.02(00) x 381.2 of borax

Back to Question

= 7.624 g **OR** 7.62 g ✓

Answer = ...g

Question			Answer	Marks	Guidance
5	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 7.624 OR 7.62 (g) award 3 marks Molar mass of borax = 381.2 (g mol^{-1}) ✓ Correctly calculates the mass of borax in 1000 cm^3 = 0.0800 x 381.2 = 30.496 g **OR** 30.50 g **OR** 30.5g ✓ Correctly calculates the mass of borax in 250 cm^3 = 30.496/4 = 7.624 g **OR** 7.62 g ✓ **OR** Molar mass of borax = 381.2 (g mol^{-1}) ✓ Amount of borax in 250 cm^3 of solution = 0.0800 x 250 /1000 = 0.02(00) mol ✓ Mass of borax = 0.02(00) x 381.2 of borax = 7.624 g **OR** 7.62 g ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** 381 **DO NOT ALLOW** 380 **ALLOW** 0.0800 x [molar mass of borax] correctly calculated for 2nd mark (ie mass of borax in 1000 cm^3) **ALLOW** [mass of borax in 1000 cm^3] / 4 correctly calculated for 3rd mark **ALLOW** calculator value or rounding to **three** significant figures or more **IGNORE** (if seen) a second rounding error **ALLOW** 381 **DO NOT ALLOW** 380 **ALLOW** [incorrect amount of borax] x 381.2 **OR** [incorrect amount of borax] x [incorrect molar mass of borax] **OR** 0.02(00) x [incorrect molar mass of borax] correctly calculated for this mark **ALLOW** calculator value or rounding to **three** significant figures or more **IGNORE** (if seen) a second rounding error

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Tell me the answer

d) The student found that 22.50 cm^3 of 0.0800 mol dm^{-3} $Na_2B_4O_7$ reacted with 25.00cm^3 of dilute hydrochloric acid.

$$Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3$$

amount = ...mol (1)

ii) Calculate the amount, in mol, of HCl used.

amount = ...mol (1)

iii) Calculate the concentration, in mol dm^{-3}, of the HCl

concentration = ... mol dm^{-3}

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Explain this to me

d) The student found that 22.50 cm^3 of 0.0800 mol dm^{-3} $Na_2B_4O_7$ reacted with 25.00cm^3 of dilute hydrochloric acid.

$$Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3$$

i) Calculate the amount, in mol, of $Na_2B_4O_7$ used.

Correctly calculates the amount of borax used = 0.0800 x 22.5/1000
= 1.8(0) x 10^{-3} mole OR 0.0018(0) mol ✓

amount = ...mol (1)

ii) Calculate the amount, in mol, of HCl used.

Correctly calculates the amount of HCl used = 1.8(0) x 10^{-3} x 2 mol
= 3.6(0) x 10^{-3} mol OR 0.0036(0) mol ✓

amount = ...mol (1)

iii) Calculate the concentration, in mol dm^{-3}, of the HCl

Correctly calculates the concentration of HCl used = 3.6(0) x 10^{-3}/ (25 / 1000)
= 0.144 (mol dm^{-3}) ✓

concentration = ... mol dm^{-3}

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Question			Answer	Marks	Guidance
5	(d)	(i)	Correctly calculates the amount of borax used = 0.0800 x 22.5/1000 = 1.8(0) x 10^{-3} mol **OR** 0.0018(0) mol ✓	1	
		(ii)	Correctly calculates the amount of HC*l* used = 1.8(0) x 10^{-3} x 2 mol = 3.6(0) x 10^{-3} mol **OR** 0.0036(0) mol ✓	1	**ALLOW** [incorrect amount of borax] x 2 correctly calculated for the 2nd mark. **ALLOW** calculator value or rounding to 3 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2
		(iii)	Correctly calculates the concentration of HC*l* = 3.6(0) x 10^{-3} / (25 / 1000) = 0.144 (mol dm^{-3}) ✓	1	**ALLOW** [incorrect amount of HC*l*] / (25/1000) correctly calculated for the 3rd mark given to 3 SF
			Total	**12**	

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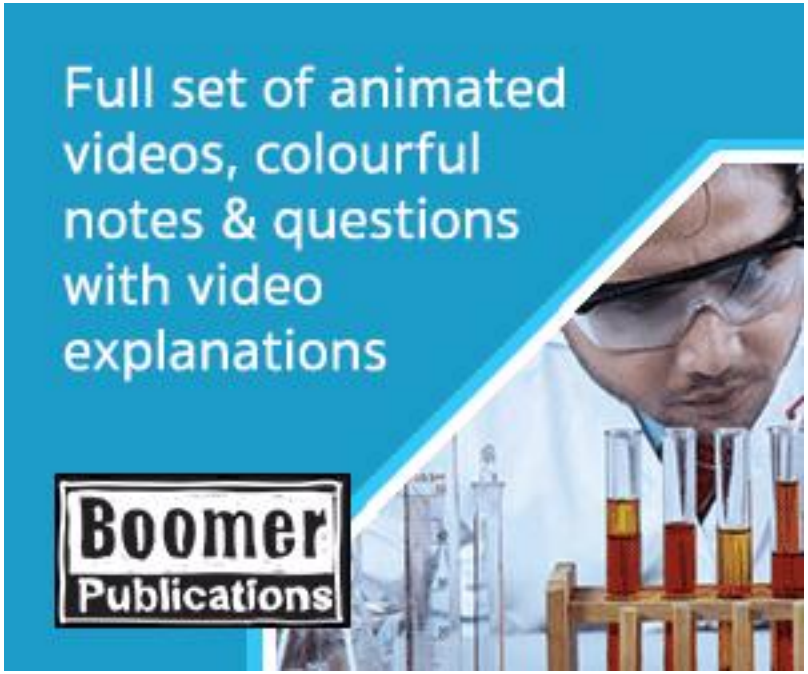

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