Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE
In Chemistry (8CH0) Paper 01
Core Inorganic and Physical Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is essential to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

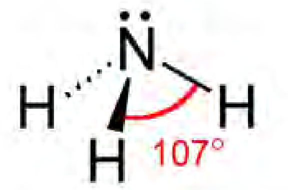
Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

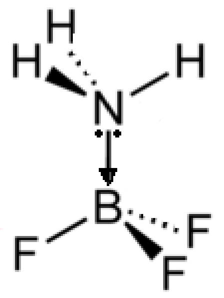
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

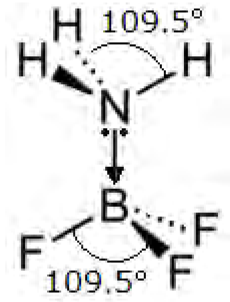
Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Acceptable Answer	Additional Guidance	Mark
1(a)	An answer that makes reference to the following points: • (strong electrostatic) attraction (1) • between two nuclei and the shared /bonding pair of electrons (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
1(b)	• diagram showing 3-D shape of ammonia, including two bonds with one 'wedge' and one 'hatch' and one N-H bond 'in plane' (1) • lone pair of electrons on nitrogen atom and • bond angle of 107° labelled (1)	Example of diagram:  Allow any direction of the wedge and/or hatch This mark can be scored on a dot and cross diagram Allow any angle between 106 and 108° inclusive. Do not award M2 if the 107° bond angle is shown as that between the lone pair and a bonding pair Ignore name of shape even if incorrect	(2)

Question Number	Answer	Mark
1(c)	The only correct answer is D *A is not correct because this is approximately the angle given in the diagram* *B is not correct because this is the angle for three bonds when there is also a lone pair on the central atom* *C is not correct because this is the angle when there are four pairs of bonding electrons around the central atom*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
1(d)(i)	An answer that makes reference to the following points: • donation of lone pair (of electrons) from nitrogen / lone pair from ammonia (1) • to the boron (atom) which is electron deficient / has only 6 electrons in outer shell / has 6 valence electrons / can accept two electrons to complete octet /can accept two electrons to get a full (outer) shell (1)	Allow 'non-bonding pair' for lone pair Allow 'sharing' for donation Do not penalise donation to F atoms, but can only score M1 in this case Allow just 'boron has an incomplete outer shell' Allow boron has an empty (p-)orbital Do not award M2 for just 'nitrogen shares lone pair with boron atom' or similar M1 may be scored from a diagram here OR a diagram in (d)(ii) e.g.  scores only M1	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
1(d)(ii)	• HNH angle is (approximately) 109.5° (1) • FBF angle is (approximately) 109.5° (1)	May be shown on a diagram, including on a diagram in 3(d)(i) e.g  Allow 1 for just 109.5° if it has not been made clear that this angle applies to BOTH bond angles <u>Both angles</u> change to 109.5° scores 2 Allow 109-110°	(2)

(Total for Question 1 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)(i)	($^{1}_{1}H$) protons 1, neutrons 0 ($^{2}_{1}H$) protons 1, neutrons 1	All four correct needed	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)(ii)	An explanation that makes reference to the following points: • (atoms that) have the same number of protons (1) • but a different number of neutrons (1)	Ignore any references to electrons	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to following: • both isotopes have an isotopic mass of greater than 1 / 1.0 / one OR • there are no isotopes with an isotopic mass of less than one	Award mark if it is stated that the (only) other isotope is ^{2}H Ignore calculation of value, even if incorrect.	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)(ii)	• calculation to find A_r (1) • value of A_r to 4 DP (1)	Example of calculation $A_r = \frac{(1.007825 \times 99.9885) + (2.014101 \times 0.0115)}{100}$ (= 1.0079407) = 1.0079 Correct answer with no working scores (2) Allow TE for M2 for incorrect transfer of data or for one incorrect % abundance (e.g. 1.15%), provided that the final A_r value is between 1 and 2 Ignore units even if incorrect	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following: • equation (1) • state symbol, (g), on both H and H^+ (1)	$H(g) \rightarrow H^+(g) + e^{(-)}$ or $H(g) - e^{(-)} \rightarrow H^+(g)$ Ignore state symbol for electron $H_2(g) \rightarrow H_2^+(g) + e^{(-)}$ scores only M2 $H_2(g) - e^{(-)} \rightarrow H_2^+(g)$ scores only M2 $H_2(g) \rightarrow 2H^+(g) + 2e^{(-)}$ scores 0 $X(g) \rightarrow X^+(g) + e^{(-)}$ scores only M2	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(c)(ii)	An explanation that makes reference to the following points: H < He: • He more protons than H / He greater nuclear charge than H (1) • in helium the outer electron is in the same shell as hydrogen (1) H > Li: • in lithium the outer electron is in a higher energy level / a new shell / further from the nucleus / in a 2s orbital (1) • (and) is shielded by inner electrons / $1s^2$ electrons (1)	 Ignore references to shielding for H and He Ignore references to atomic radius or electrons being closer to or the same distance from the nucleus in helium Allow lithium has more shells of electrons Allow (outer electron of) lithium has more shielding than hydrogen / is shielded	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(d)	An answer that makes reference to the following: (in favour) • electronic structure of hydrogen is s^1 / $1s^1$ / has one electron in s orbital / form 1+ ions (1)	Allow 1 electron in outer shell / has 1 valence electron Do not award 'last electron is in s orbital' unless it is clear there is only one Do not award just 'single unpaired electron'	(3)
	(against) any two from • the rest of Group 1 are (alkali) metals / metallic (hydrogen is not) (1)	Allow hydrogen is not a metal Ignore hydrogen is a gas but Group 1 elements are solid	
	• hydrogen does not react in the same way as / has different reactivity to the rest of Group 1 / has different chemical properties (1)	Do not award just 'different properties' or 'different behaviour' Allow hydrogen forms covalent bonds as a chemically different property Ignore trends in physical properties	
	• forms a H^- ion (1)	Allow hydrogen can gain one electron to form a stable ion / become stable / fill its outer shell	

(Total for Question 2 = 15 marks)

Question Number	Acceptable Answer	Mark

3(a)	The only correct answer is C *A is not correct because a burette is used to measure varied volumes* *B is not correct because a measuring cylinder is less precise* *D is not correct because a volumetric flask is less precise*	(1)

Question Number	Acceptable Answer	Mark
3(b)	The only correct answer is C *A is not correct because this is the appearance of the solution before the potassium hydroxide is added* *B is not correct because this is the colour that methyl orange would be in neutral solution* *D is not correct because this is a colour sometimes given for the end-point which is incorrect, and it is the colour of phenolphthalein in acidic solution*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(i)	• two correct readings to nearest 0.05 (1) • correct subtraction of two values to 2 d.p. (1)	<u>Example of answer</u> 32.35 and 4.60 27.75 Allow TE for M2 on their burette readings	(2)

Question Number	Acceptable Answer	Mark
3(c)(ii)	The only correct answer is A *B is not correct because this is the mean of the three values given without the rough value* *C is not correct because this is the mean of the last two values* *D is not correct because this is the mean of all four including the rough value*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(iii)	• calculates moles of H_2SO_4 (1) • calculates moles of KOH (1) • calculates concentration of KOH to 2/3 SF (1)	<u>Example of calculation</u> $= 0.0800 \times \frac{25}{1000} = 0.00200$ (mol) $= 0.00200 \times 2 = 0.00400$ (mol) $= \frac{0.00400}{27.00} \times 1000$ (= 0.148148148...) (mol dm^{-3}) = 0.148/0.15 (mol dm^{-3}) to 2 or 3 SF Allow TE on all stages of the calculation Correct answer with no working scores (3)	(3)

(Total for Question 3 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(i)	An answer that makes reference to two of the following: • sulfate / sulfate(VI) / SO_4^{2-} • sulfite / sulfate(IV) / SO_3^{2-} • carbonate / CO_3^{2-}	Penalise lack of charge	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(ii)	SO_4^{2-}	Ignore sulfate (ion) Only penalise lack of charge if not penalised in 4(a)(i)	(1)

Question Number	Acceptable Answer	Mark
4(a)(iii)	The only correct answer is C *A is not correct because the ratio is one-to-one* *B is not correct because cations are positive* *D is not correct because cations are positive*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(b)	Cation is Mg^{2+} / magnesium (ion)	Do not award use of symbol just "Mg" Award Be^{2+}/ beryllium (ion)	(1)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>4(c)</td>
<td>Method 1
Calculates M_r of $MgSO_4$ (1)

Divides percentage by relative formula mass (1)

Divides ratio by smallest (1)

x = 7 (1)

For Alternative

Calculates M_r of $CoCl_2$ (1)

Divides percentage by relative formula mass (1)

Divides ratio by smallest (1)

y = 6 (1)</td>
<td>In all cases correct answer with some correct working scores (4)

<u>Example of calculation:</u>
M_r of $MgSO_4$ = 24.3 + 32.1 + (4 x 16) = 120.4
<table>
<tr><th></th><th>$MgSO_4$</th><th>H_2O</th></tr>
<tr><td>%</td><td>48.9</td><td>51.1</td></tr>
<tr><td>Moles
(÷ RFM)</td><td>48.9 / 120.4 =
0.406146170...</td><td>51.1 / 18 =
2.838888889...</td></tr>
<tr><td>Ratio
(÷ smallest)</td><td>1</td><td>6.98982049</td></tr>
</table>
Allow $MgSO_4.7H_2O$

M_r of $CoCl_2$ = 58.9 + 2 x 35.5 = 129.9
<table>
<tr><th></th><th>$CoCl_2$</th><th>H_2O</th></tr>
<tr><td>%</td><td>54.6</td><td>45.4</td></tr>
<tr><td>Moles
(÷ RFM)</td><td>54.6 / 129.9 =
0.42032</td><td>45.4 / 18 =
2.5222</td></tr>
<tr><td>Ratio
(÷ smallest)</td><td>1</td><td>6.0007</td></tr>
</table>
Allow $CoCl_2.6H_2O$</td>
<td>(4)</td>
</tr>
</table>

	Method 2 Calculates M_r of $MgSO_4$ (1) Forms algebraic equation for M_r of $MgSO_4.xH_2O$ (1) Finds algebraic expression for ratio of $MgSO_4$ to hydrated $MgSO_4$ (1) Solves for x (1) For Alternative Calculates M_r of $CoCl_2$ (1) Forms algebraic equation for M_r of $CoCl_2.xH_2O$ (1) Finds algebraic expression for ratio of $CoCl_2$ to hydrated $CoCl_2.xH_2O$ (1) Solves for x (1) Method 3 Calculates M_r of $MgSO_4$ (1) Calculates M_r of $MgSO_4.xH_2O$ (1) Calculates mass of water in one mol (1) Finds moles of water (1)	Example of calculation: M_r of $MgSO_4$ = 24.3 + 32.1 + (4 x 16) = 120.4 M_r of $MgSO_4.xH_2O$ = 120.4 + 18x $\frac{120.4}{120.4 + 18x}$ = 48.9 % x = 7 M_r of $CoCl_2$ = 58.9 + 2 x 35.5 = 129.9 M_r of $CoCl_2.xH_2O$ = 129.9 + 18x $\frac{129.9}{129.9 + 18x}$ = 54.6 % x = 6 M_r of $MgSO_4$ = 24.3 + 32.1 + (4 x 16.0) = 120.4 M_r of $MgSO_4.xH_2O$ = $\frac{120.4 \times 100}{48.9}$ = 246.2 246.2 − 120.4 = 125.8 $\frac{125.8}{18}$ = 7	

	<u>Method 3 for $CoCl_2.yH_2O$</u> Calculates M_r of for $CoCl_2$. (1) Calculates M_r of $CoCl_2.yH_2O$ (1) Calculates mass of water in one mol (1) Finds moles of water (1)	M_r of $CoCl_2$ = 58.9 + (2 x 35.5) = 129.9 M_r of $CoCl_2.yH_2O = \frac{129.9 \times 100}{54.6} = 237.9$ 237.9 − 129.9 = 108.0 $\frac{108.0}{18} = 6$ Use of Beryllium Calculates M_r of $BeSO_4$ = 105.1 Moles in 48.9% of 100g = 0.46527117 Ratio of $BeSO_4$:H_2O = 1:6.102 x=6	

(Total for Question 4 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)(i)	A description making reference to the following points: • fizzing / effervescence stops (1) • (all) metal carbonate / solid disappears (1)	Allow stops frothing / no more bubbles Allow metal carbonate / solid "dissolved" OR just 'a clear solution forms' for M2 Ignore colourless	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)(ii)	• remove excess / unreacted metal carbonate	Allow to remove excess / unreacted solid Allow "removes insoluble solid" Ignore just "to remove impurities"	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)(iii)	An explanation that makes reference to the following points: • so as little product dissolves as possible (1) • to remove any soluble impurities (1)	Allow product might dissolve in large volumes / warm water Ignore rinse / wash / clean the crystals Ignore hydration of crystals	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)	• M1 calculate moles of acid (1) • M2 finds moles of JCl_2 / $6H_2O$ (1) Either • M3 finds M_r of JCl_2 (1) • M4 finds A_r of J (1) Or • M3 finds mass of water and finds mass of JCl_2 by subtraction (1) • M4 finds mass and A_r of J (1) • M5 identifies J (1)	<u>Example of calculation:</u> 150/1000 x 0.800 = 0.12(0) (mol) 0.12 / 2 = 0.06(00) (mol) M_r = 14.26 / 0.0600 = 237.7 (g mol^{-1}) A_r = 237.7 - (71 + 108) = 58.7 (g mol^{-1}) J is Ni Allow TE for M5 on the A_r calculated Mass of water = 0.06 x 6 x 18 = 6.48 (g) Mass of JCl_2 = 14.26 − 6.48 = 7.78 (g) Mass of J = 7.78 − (0.06 x 71) = 3.52 (g) A_r of J = $\frac{3.52}{0.06}$ = 58.66667 / 58.7 (g mol^{-1}) Or Mr of JCl_2 = $\frac{7.78}{0.06}$ = 129.6667 / 129.7 A_r = 129.7 - 71 = 58.7 (g mol^{-1}) J is Ni Allow TE for M5 on the A_r calculated Ignore SF except 1SF	(5)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(c)(i)	An explanation which makes the following points: M1 • transition metals form coloured compounds / are not normally white or • crystals are white suggesting (compound of) an s-block element / group 2 element (1) M2 • flame test to identify cation / metal ion (1)	Allow any stated colour as long as the presence of a transition metal (in the compound) is stated Do not award compound of a group 1 element	(2)

Question Number	Answer	Mark
5(c)(ii)	The only correct answer is D *A is not correct because barium gives a green flame colour* *B is not correct because calcium gives an orange-red flame colour* *C is not correct because lithium is not in Group 2*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(c)(iii)	Method 1 calculate molar mass of $SrCl_2.6H_2O$ (1) EITHER calculates the percentage yield (1) or calculates maximum mass of $SrCl_2.6H_2O$ and hence percentage yield (1) or finds moles of $SrCl_2.6H_2O$ and hence percentage yield (1)	Example of Calculation Correct answer with no working scores (2) 266.6 237.7 / 266.6 x 100 = 89.16% = 89% (to 2 S.F.) Maximum mass = 0.0600 x 266.6 = 15.996 (g) Percentage yield $= \frac{14.26}{15.996} \times 100 = 89.147\ \%$ = 89% (to 2 S.F.) $\frac{14.26}{266.6}$ = 0.0534883 / 0.0535 (mol) Moles of $SrCO_3$ / $SrCl_2$ (calculated in 5(b)) = 0.06 (mol) Percentage yield $= \frac{0.0534883}{0.0600} \times 100 = 89.147\ \%$ = 89% (to 2 S.F.) Allow TE on an incorrect choice of metal only	(2)

(Total for Question 5 = 15 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(i)	$(1s^2)2s^22p^63s^23p^5$	Ignore repeat of $1s^2$ Allow 1s2 2s2……. 1S2 2S2…….. For $3p^5$ accept $3p_x^2$, $3p_y^2$, $3p_z^1$	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(ii)	An explanation that makes reference to the following points: • iodine (also) has 7 electrons in the outer shell / is $5s^25p^5$ / is (also) np^5 (1) • electronic configurations / number of electrons in the outer shell govern their chemical reactions (1)	 Allow has the same number of electrons in the outer shell / valence electrons for M1 M2 is dependent on M1 being scored	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(i)	Any two correct (1) Third also correct (1)	see table below Allow any equivalent fractions e.g. 5/2+ Penalise missing + once only	(2)

Ion	Oxidation number of sulfur
$S_2O_3^{2-}$	+2 / 2+ / +II / II+
SO_4^{2-}	+6 / 6+ / +VI / VI+
$S_4O_6^{2-}$	+2.5 / 2.5+ / $+\frac{10}{4}$ / $\frac{10}{4}+$

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(ii)	An answer that makes reference to: • gain of electrons (by iodine / I_2)	Allow thiosulfate ion has lost electrons / sulfur has lost electrons Ignore reference to oxidation numbers	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(iii)	An answer that makes reference to: • chlorine oxidises sulfur (from +2) to +6 whereas iodine only oxidises sulfur (from +2) to +2.5	Allow chlorine causes a greater increase in oxidation number (than iodine) OR chlorine causes loss of more electrons (from sulfur than iodine) Do not award chlorine gains more electrons Award mark for a greater increase in oxidation number, even if the stated oxidation numbers are incorrect	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(iv)	• correct species (1) • balancing of correct species (1)	<u>Example of equation</u> $S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{2-} + 10H^+ + 8e^-$ Allow for one mark: $S_2O_3^{2-} + 10OH^- \rightarrow 2SO_4^{2-} + 5H_2O + 8e^-$ Ignore state symbols even if incorrect	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(v)	• correct equation	<u>Example of equation</u> $4Cl_2 + S_2O_3^{2-} + 5H_2O \rightarrow 8Cl^- + 2SO_4^{2-} + 10H^+$ Allow HCl in place of H^+ and Cl^- as long as balanced ($8HCl + 2H^+$) Allow $4Cl_2 + S_2O_3^{2-} + 10OH^- \rightarrow 8Cl^- + 2SO_4^{2-} + 5H_2O$ From $S_2O_3^{2-} + 10OH^- \rightarrow 2SO_4^{2-} + 5H_2O + 8e^-$ in (b)(iv) Do not award equations with electrons not cancelled Ignore state symbols even if incorrect	(1)

(Total for Question 6 = 10 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*7</td>
<td>
This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5–4</td><td>3</td></tr>
<tr><td>3–2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
</td>
<td>
Guidance on how the mark scheme should be applied:
The mark for indicative content should be added to the mark for lines of reasoning.
For example, an answer with five indicative marking points, which is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).
If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).
</td>
<td>(6)</td>
</tr>
</table>

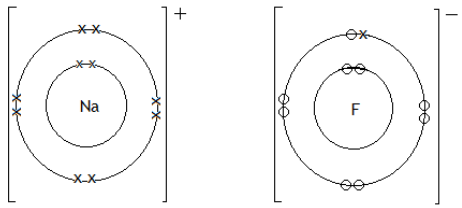
<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*7 contd</td><td>The following table shows how the marks should be awarded for structure and lines of reasoning.
<table><tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr></table></td><td>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).</td><td></td></tr>
</table>

	Indicative content: • <u>IP1 Electrons</u> Same number of electrons so similar / the same London forces / van der Waals' forces / dispersion forces • <u>IP2 Electronegativity</u> Large electronegativity differences in HF and H_2O and small in CH_4 / quoting all electronegativity values of differences / combination of previous three alternatives covering all three bonds • <u>IP3 Intermolecular forces in methane</u> Only (weak) London forces / van der Waals' forces / dispersion forces in CH_4 • <u>IP4 Intermolecular forces in water and hydrogen fluoride</u> Hydrogen bonding in both HF and H_2O (but not CH_4) • <u>IP5 Relative numbers of hydrogen bonds</u> More hydrogen bonds / (average of) twice as many hydrogen bonds in H_2O than in HF • <u>IP6 Energy</u> More energy needed to break stronger intermolecular forces / less needed to break weaker intermolecular forces.	Read all of the answer first as IPs can be found anywhere in the answer Allow high electronegativity of F and O (compared to H) Allow HF and H_2O (highly) polar and CH_4 non polar Allow IP2 for any three of: F=4.0, O=3.5, H=2.1, C=2.5 Allow IP2 for any two of: HF=1.9, HO=1.4, HC=0.4 These values may be seen anywhere Allow no dipole-dipole forces / no hydrogen bonds in CH_4 Award IP3 if London forces are the only intermolecular forces mentioned in CH_4 May be shown in a diagram Do not award IP6 for any clear indication of covalent bond breaking or ionic bond breaking	

(Total for Question 7 = 6 marks)

Question Number	Answer	Mark
8(a)(i)	The only correct answer is B *A is not correct because fluorine is diatomic* *C is not correct because sodium is 1^+ ion* *D is not correct because fluorine is diatomic*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)(ii)	A diagram which shows the first two points: • electronic configuration for Na is 2.8 <u>and</u> +1 charge (1) • electronic configuration for F is 2.8 <u>and</u> -1 charge (1) • isoelectronic ions have the same electronic configuration (1)	<u>Example of diagram</u>  Allow one mark if both ions have eight electrons in their outer shell if M1 and M2 not scored OR Both with correct charge if M1 and M2 not scored. Do not award either mark for a covalent bond Ignore balancing numbers Allow same number of electrons	(3)

Question Number	Answer	Mark
8(a)(iii)	The only correct answer is A *B is not correct because diagram has cations larger than anions* *C is not correct because diagram has cations larger than anions* *D is not correct because trends in wrong direction*	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)(iv)	• increase in number of protons (in the nucleus) (1) • increases the attraction for the electrons (bringing them closer to the nucleus) (1)	Allow increasing nuclear charge For explanations of graph B allow max (1) for a correct explanation for any downward trend for three ions Allow max (1) for an explanation of the smallest or largest ion without an explanation of the trend e.g. Al^{3+} has the most protons so electrons most attracted to nucleus so smallest scores (1) Discussion of atomic radius max (1)	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)	An explanation that makes reference to the following points: • the higher the charge on the cation the stronger the attraction between ions and mention of a 2+ cation in CaF_2 compared to a 1+ cation in LiF / KF (1) • the smaller the radius of the cation the stronger the attraction between ions and mention of Li^+ being smaller than K^+ (1)	Allow "stronger bonding" for stronger attraction between ions Both charges should be stated Allow calcium ions have twice the charge of potassium / lithium ions. Do not award 'lithium has a smaller radius than potassium' unless it is clear ions are being considered, for example the use of Li^+ and K^+ in the answer. If no other marks awarded, allow a discussion of charge density without reference to charge or radius of one pair of ions for (1) If no other mark awarded, allow a correct statement about the effect of charge and ionic radius without justification from table of data for (1)	(2)

(Total for Question 8 = 9 marks)

TOTAL FOR PAPER = 80 MARKS