A Level OCR Chemistry

Chapter 4 – answers

Question	Answers	Extra information	Mark	AO Spec reference
1(a)(i)	Strong attraction between oppositely charged ions Large amount of energy needed to overcome attraction	Allow named charges and ions	1 1	AO1 2.2.2
1(a)(ii)	Ions can bond to water/ can be attracted to polar bonds/H bonds with water		1	AO1 2.2.2
1(b)	$K(s) + H_2O(l) \rightarrow K^+(aq) + OH^-(aq) + \frac{1}{2}H_2(g)$	Accept multiples Must include state symbols	1	AO1 2.1.2
1(c)	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6$		1	AO1 2.2.1
1(d)	This question is marked using Levels of Response. Examiners should apply a 'best-fit' approach to the marking. **Level 3 5–6 marks:** All stages are covered and the explanation of each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from stage 1 to stage 2, stage 3 and then stage 4. Coherent communication requires that there is a comparison between the types of bonding and that the bonding is correct for each substance. **Level 2 3–4 marks:** All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete. Answer is mainly coherent and shows some progression from stage 1 to stage 2, stage 3 and stage 4.	'Virtually complete' means 2/3 points in content covered	6	2.2.2 AO3

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td></td><td>
<table>
<tr><td>Level 1
1–2 marks</td><td>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies

OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer shows some progression between two stages</td></tr>
<tr><td>Level 0
0 marks</td><td>Insufficient correct chemistry to gain a mark.</td></tr>
</table>
</td><td>Indicative chemistry content.
Contradictions (eg molecules, IMFs, covalent bonding,) negate statements.

<u>Stage 1 – K</u>
1a) K has metallic bonding
1b) there is attraction/ bonding between the positive nucleus/ ion and the <u>delocalised</u> electrons in K
1c) K has a giant/lattice structure

<u>Stage 2 – KBr</u>
2a) Ionic bonding in KBr
2b) There is attraction/ bonding between the + and – ions in KBr
2c) KBr has a giant/lattice structure

<u>Stage 3 – Br_2</u>
3a) Covalent (molecular) bonding
3b) shared pair of electrons
3c) Van der waals forces of attraction</td><td></td><td></td></tr>
</table>

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<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td></td><td></td><td><u>Stage 4 – comparison of bonding</u>
3a) The ionic bonds are stronger (or wtte) than the metallic bonds and/or vdw forces
3b) there is stronger attraction (or wtte) between the + and – ions in KBr than in K or Br_2
3c) so more energy is needed to overcome the forces increasing the melting point</td><td></td><td></td></tr>
<tr><td>2(a)</td><td>
<table>
<tr><td colspan="2">This question is marked using Levels of Response.
Examiners should apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td>Level 3
5–6 marks</td><td>All stages are covered and the explanation of each stage is generally correct and virtually complete.
Answer is communicated coherently and shows a logical progression from stage 1 to stage 2, stage 3 and then stage 4.
Coherent communication requires that there is a comparison between the types of bonding and that the bonding is correct for each substance.</td></tr>
<tr><td>Level 2
3–4 marks</td><td>All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies
OR two stages are covered and the explanations are generally correct and virtually complete.
Answer is mainly coherent and shows some progression from stage 1 to stage 2, stage 3 and then stage 4.</td></tr>
</table>
</td><td>‘Virtually complete’ means 2/3 points in content covered</td><td>6</td><td>2.2.2
AO3</td></tr>
</table>

Question	Answers	Extra information	Mark	AO Spec reference
	<table><tr><td>Level 1 1–2 marks</td><td>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR only one stage is covered but the explanation is generally correct and virtually complete. Answer shows some progression between two stages</td></tr><tr><td>Level 0 0 marks</td><td>Insufficient correct chemistry to gain a mark.</td></tr></table>	**Indicative chemistry content.** Contradictions (eg molecules, IMFs, covalent bonding,) negate statements. **Stage 1 – Water** 1a) Has hydrogen bonding 1b) Between H atom and lone pair on oxygen 1c) Can form 2 H bonds **Stage 2 – Ammonia** 2a) Has hydrogen bonding 2b) between H atom and lone pair on nitrogen 2c) can form 1 H bond **Stage 3 – CH_4** 3a) Van der waals forces of attraction 3b) caused by temporary dipoles **Stage 4 – comparison of bonding** 3a) The hydrogen bonds are stronger (or wtte) than the vdw forces		

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Question	Answers	Extra information	Mark	AO Spec reference
		3b) Water makes more H bonds than ammonia 3c) so more energy is needed to overcome the forces increasing the boiling point		
2(b)	Ammonia is a polar molecule / can form hydrogen bonds with water molecules		1	AO1 2.2.2
2(c)(i)	Ammonia: 3 bonding pairs + 1 lone pair Pyramidal 107° Boron trihydride: 3 bonding pairs + 0 lone pairs Trigonal planar 120°	Diagrams do not have to be to scale as long as they are able to communicate the basic shape Lone pair on NH_3 must be shown	 1 1 1 1 1 1	AO3 AO1 2.2.2
2(c)(ii)	Dative (covalent) bond Both electrons come from nitrogen/one atom		1 1	2.2.2 AO1
2(d)	Moles ammonium chloride = 25 000/53.5 = 467.3 (467.2897) Mass NH_3 = 467.3 × 17 = 7943.9 g (7944.1) = 7.94 kg		1 1 1 1	2.1.3 MS0.4 AO2

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Question	Answers	Extra information	Mark	AO Spec reference
2(e)	Moles of HCl = 467.3 V = mol/conc = 467.3/2.5 = 186.9 dm^3	For 500 moles 500/25 = 20 dm^3	1 1	2.1.3 MS0.4 AO2
2(f)	Ammonium chloride is ionically bonded Strong attraction between oppositely charged ions Ammonia is molecular covalently bonded Hydrogen bonds between molecules Ionic bonds are stronger so more energy needed to separate ions	Allow names ions Allow 'covalent molecules' Ignore van der waals	1 1 1 1 1	2.2.2 AO3
3(a)	Power/ability of an atom to attract a pair of electrons in a covalent bond.		1	2.2.2 AO1
3(b)	<u>Difference in electronegativity</u> leads to bond polarity (Dipoles don't cancel therefore the molecule has an overall permanent dipole) and there is an attraction between δ+ on one molecule and δ− on another		1 1	2.2.2 AO1
3(c)(i)	$BeCl_2$ Linear shape drawn Angle = 180° CH_3Cl Tetrahedral Angle = 109.5°		1 1 1 1	2.2.2 AO1
3(c)(ii)	$BeCl_2$ is symmetrical		1	2.2.2 AO1
4(a)	Water has hydrogen bonds Dihydrogen sulfide only has van der Waals forces H bonds are much stronger than van der Waals forces		1 1 1	2.2.2 AO3

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Question	Answers	Extra information	Mark	AO Spec reference
4(b)	Both have van der waals forces only Dihydrogen selenide has more electrons so stronger van der waals	 Allow converse	1 1	2.2.2 AO3
4(c)	As the water freezes, the molecules are held in an expanded structure	Allow any reference to larger spaces between molecules caused by hydrogen bonds	1	AO1 2.2.2
4(d)	2 bonding pairs and 2 lone pairs Correct V shape shown bent or non-linear Bond angle of 104.5°		1 1 1	AO1 2.2.2
4(e)(i)	Giant covalent / covalent macromolecule		1	3.1.1 AO1
4(e)(ii)	Diamond has 4 covalent bonds between carbon atoms Graphite has layers that can slide past each other		1 1	3.1.1 AO1
4(e)(iii)	Graphite has <u>delocalised electrons AND diamond does not</u> Which can move/flow to carry charge/current AND can't in diamond owtte		1 1	3.1.1 AO1
4(e)(iv)	Both are giant covalent macromolecules Melting needs the strong covalent bonds to be broken	OWTTE	1 1	3.1.1 AO1
4(e)(v)	Diamond 4 bonding pairs Tetrahedral 109.5° Graphite 3 bonding pairs + 0 lone pairs Trigonal planar 120°		 1 1 1 1 1 1	AO3 AO1 2.2.2

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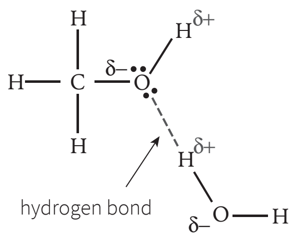
Question	Answers	Extra information	Mark	AO Spec reference
5(a)	Covalent bonds Shared pair of electrons		1 1	2.2.2 AO1
5(b)	Ethanol can form hydrogen bonds Propane has van der Waals H bonds require more energy to break		1 1 1	2.2.2 AO3
5(c)	 1st mark showing correct structures of both molecules 2nd mark δ+ and δ- charges on H and O respectively 3rd mark H bond (dotted or dashed line) from lone pair on O to H		3	2.2.2 AO3
5(d)	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$		1	2.1.2 AO2
5(e)	25/46 = 0.543 $\frac{P}{nRT} = V$ OR $\frac{101000}{(0.543 \times 5 \times 8.31 \times 2000)} = V$ = 2.238 m^3 = 2.24 m^3	Allow e.c.f. If 0.543 used as n in gas equ, max mark is **4**	1 1 1 1 1	2.1.3 AO2 MS0.0, 2.2,2.3,2.4
6(a)	Aluminium ion is a 3+ ion Oxygen is a 2– ion Small highly charged ions form strong bonds	Allow hard to break/separate	1 1 1	2.1.2 AO3

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Question	Answers	Extra information	Mark	AO Spec reference
6(b)	Radii decreases Increasing nuclear charge, same/similar shielding		1 1 1	3.1.1 AO2
6(c)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$	Allow Al_2Cl_6 Allow multiples	1	2.1.2 AO1
6(d)	Dative (Covalent bond) formed with both electrons from one atom	Allow co-ordinate bond	1 1	2.2.2 AO1
6(e)	Aluminium chloride is molecular covalent Weak forces of van der Waals between molecules Aluminium oxide is ionic Strong electrostatic forces between oppositely charged ions More energy needed to separate the ions		1 1 1 1 1	2.2.2 AO1 AO3
6(f)	It is a covalent molecule No free electrons/ions to carry charge/flow		1 1	2.2.2 AO1
7(a)	Iodine has more electrons So stronger van der Waals forces So more energy needed to separate the molecules	Do not accept break bonds unqualified	1 1 1	2.2.2 AO1
7(b)(i)	The (forward) reaction / to the right is <u>endothermic</u> or <u>takes in / absorbs heat</u> <u>The equilibrium shifts / moves left to right to oppose the increase in temperature</u>	Allow converse	1 1	3.2.3 AO3
7(b)(ii)	No effect equal number of gaseous moles both sides		1 1	3.2.3 AO1
7(c)	$\Delta G = \Delta H - T\Delta S$ $= -11 - (300 \times 2.0 \times 10^{-2})$ $= -17\ kJ\ mol^{-1}$ Yes, it is feasible as less than 0		1 1 1 1	5.2.2 AO2 MS 2.2 2.3 2.4

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Question	Answers	Extra information	Mark	AO Spec reference
7(d)	Oxidising agent		1	2.1.5 AO1
7(e)	$HI(g) \rightarrow H^+(aq) + I^-(aq)$		1	2.1.2 AO1
7(f)	$pH = -\log[H^+] = -\log(0.015)$ $= 1.82$	Must be 2 d.p.	1 1	5.1.3 AO1 AO2 MS 0.4 2.5
7(g)	brown solution purple fumes/solution $2I^-(aq) \rightarrow I_2(g) + 2e^-$ $Cl_2 + 2e^- \rightarrow 2Cl^-$ $2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$	 Ignore state symbols	1 1 1 1 1	2.1.5 3.1.3 AO1/3
8(a)	Hydrogen bonding / hydrogen bonds / H-bonding / H-Bonds	Not just hydrogen.	1	2.2.2 AO1

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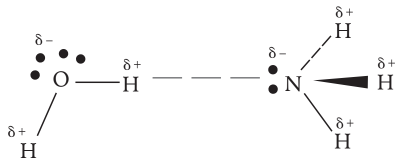
Question	Answers	Extra information	Mark	AO Spec reference
8(b)	 One mark for minimum of 4 correct partial charges shown on the N-H and O-H One mark for the 3 lone pairs. One mark for H bond from the lone pair on O or N to the $H^{\delta+}$ **OR** Allow opposite with bond from oxygen lone pair to hydrogen on ammonia The N-H-O should be linear but can accept if the lone pair on O or N hydrogen bonded to the H		3	2.2.2 AO1
8(c)	No hydrogen bonds	Allow 'H bonds'	1	2.2.2 AO1
8(d)	Trigonal pyramidal structure 3 bonding pairs and 1 lone pair angle = 107°		1 1 1	2.2.2 AO1

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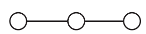
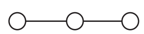
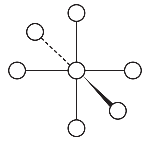
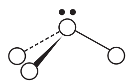
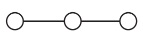
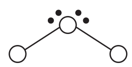
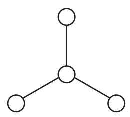
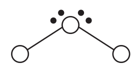
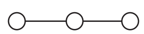
Skills box answers

		$AlCl_4^-$	PCl_4^+	PCl_6^-	IF_5	NH_4^+	OF_2	IF_3	NH_2^-	SO_4^{2-}
Step 1	central atom	3	5	5	7	5	6	7	5	6
Step 2	outer atoms	4×1	4×1	6×1	5×1	4×1	2×1	3×1	2×1	4×2
Step 3	charge?	+ 1	–1	+1	0	–1	0	0	+1	+2
Step 4	total e^-	8	8	12	12	8	8	10	8	16
	e^- pairs	4	4	6	6	4	4	5	4	8
Step 5	double/ triple bond	0	0	0	0	0	0	0	0	–4 (S = O)
Step 6	lone pairs	0	0	0	1	0	2	2	2	0
Answer	a) drawing									
	b) shape	tetrahedral	tetrahedral	octahedral	square pyramidal	tetrahedral	non-linear	trigonal planar	non-linear	tetrahedral
	c) angle / °	109	109	90	82	109	104.5	120	104.5	109