Question number	Answer	Accept	Reject	Marks
1 (a)	covalent			1
(b) (i)	**M1** – giant covalent / giant structure/lattice/network **M2** – strong (covalent) bonds/many (covalent) bonds **M3** – lot of (thermal/heat) energy required **M4** – to <u>break</u> bonds	macromolecular giant molecular	Max 1 if bonding stated to be intermolecular/ionic/metallic	1 1 1 1
(ii)	**M1** –intermolecular forces(of attraction) / forces (of attraction) between molecules **M2** – are weak / little (thermal/heat) energy required (to overcome the forces) M2 DEP on M1 Weak bonds on its own = 0	intermolecular bonds in place of intermolecular forces	any indication that covalent/ionic/metallic bonds are broken scores 0	1 1
(c)	<u>theory B</u> AND since there are no/fewer gas molecules in space OR there is no/less gas in space OR space is a vacuum	fewer gas molecules at high altitude/less gas at high altitude air/specified gas in place of gas ORA		1

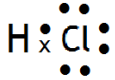
(d)	high temperature AND since (forward) reaction is endothermic/absorbs heat IGNORE references to le Chatelier's principle			1

(Total marks for Question 1 = 9 marks)

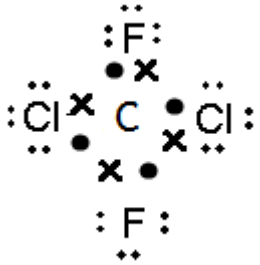
Question number	Answer	Notes	Marks
2 a	4 electrons shared between 2 (carbon) atoms	Ignore inner electrons even if wrong Ignore number of hydrogen atoms	1
	4 electron pairs between 2C and 4H atoms	Accept all permutations of dots and crosses Ignore intersecting circles Accept H atoms at all angles At least one C or one H atom must be labelled – max 1 if not Max 1 if more than 2 C atoms Max 1 if wrong number of electrons in outer shell of any atom	1

Question number	Answer	Notes	Marks
2 b i	setting out correct division of each % by A_r OR 3.2, 9.7 and 3.2	Award 0/3 if division by any atomic numbers / wrong way up / multiplication used Do not penalise roundings and minor misreads of % values, eg 38 or 39 for carbon If molecular masses used for H and/or O, no M1, but can award M2 and M3 but no CQ in ii Using 2 and 32 gives C_2H_3O Using 1 and 32 gives C_2H_6O Using 2 and 16 gives $C_2H_3O_2$ Working required for these answers	1
	division by smallest /ratio of 1 : 3 : 1	M2 subsumes M1	1
	CH_3O	Accept elements in any order Award 3 for correct final answer with no working No ECF from M2	1
		Accept use of 62 from ii, i.e. 62 × 0.387 = 24 etc scores M1 ratio scores M2, answer scores M3	
ii	$C_2H_6O_2$	Accept elements in any order No other answer acceptable	1
		Total	**6**

Question number	Answer	Notes	Marks
3 a	covalent	Ignore references to polar bonding and electron sharing	1
b	M1 weak forces (of attraction) between molecules / weak intermolecular forces M2 (therefore) little (thermal/heat) <u>energy</u> required to overcome the forces / separate the molecules	Accept bonds for forces for both M1 and M2 Reject atoms for both M1 and M2 Accept particles for molecules Accept correctly named IMF eg van der Waals' Ignore more easily separated / easier to break if any reference to/implication of breaking covalent or ionic bonds scores 0/2 M1 and M2 indep	2
c	M1 (strong) attraction between bonding/shared pair of electrons M2 (and) nuclei of (both atoms) **OR** M1 bonding/shared pair of electrons M2 (strongly) attracted to nuclei (of both atoms)	Do not award M2 if reference to only one nucleus Do not award M2 if reference to only one nucleus	2

d		M1 for 2 electrons shared between one H and one Cl M2 rest of molecule fully correct M2 DEP on M1 Accept any combination of dots and crosses Ignore inner shells of electrons in chlorine if overlapping touching/circles are used both electrons must be within the overlapping/touching area symbols do not need to be shown if overlapping touching /circles are used	2
e	M1 (effervescence) due to hydrogen (gas) M2 solution A is acidic / contains H^+ / contains hydrochloric acid M3 solution B is not acidic / does not contain H^+ / does not contain hydrochloric acid	Accept hydrogen chloride/HCl does not ionise/ dissociate If only reference to HCl ionises/dissociates allow max one mark for M2 and M3, ie reference to either H^+ or acid(ic) needed to score both marks Ignore the bonds between H and Cl are not broken (when HCl dissolved) in methylbenzene Do not award M3 if any reference to methylbenzene reacting or dissociating	3

Question number	Answer	Notes	Marks
4 (a) (i)	**M1** – (covalent) bonds have to be broken	any mention of ions / metallic bonding / molecules / intermolecular forces scores 0/2	1
	M2 – large amount of energy required / bonds are strong	Accept large number of bonds to be broken Accept forces (of attraction) between <u>atoms</u> in place of bonds	1
(ii)	the (covalent) bonding in silicon dioxide is stronger (than the (ionic) bonding in sodium chloride)	Accept the covalent bonds (in silicon dioxide) are stronger than the ionic bonds (in sodium chloride) Accept more energy is required to break the (covalent) bonds in silicon dioxide (than is required to break the (ionic) bonds in sodium chloride) Accept forces (of attraction) between <u>atoms</u> in place of bonds	1
(b)	<u>ions</u> flow/move (to the electrodes)	Accept ions are mobile/can move reject electrons	1
(c)	weak forces (of attraction) between <u>molecules</u> / weak <u>intermolecular</u> forces (of attraction) / little energy is required to separate <u>molecules</u>	Accept boiling point is below room temperature reject any mention of covalent bonds broken	1

Question number	Answer	Accept	Reject	Marks
5 (a) (i)	**M1** – divide all the masses by respective A_r **M2** – to give 0.02 : 0.02 : 0.04 **M3** – (mole) ratio is 1 : 1 : 2 Correct ratio or empirical formula with no working scores 0/3		division by atomic number/division upside down for all marks	1 1 1
(ii)	**M1** – 204 ÷ 102 = 2 OR 102 x 2 = 204 **M2** – $C_2F_2Cl_4$ Correct answer with no working scores 2 marks	(2 x 12) + (2 x 19) + (4 x 35.5) = 204 symbols in any order	 Fl for F	1 1
(b)	 **M1** – all four bonding pairs correct **M2** – rest of diagram correct **M2** dep on **M1**	Fl for F any combination of dots and crosses		2

	IGNORE inner shell electrons even if incorrect Award 1 mark for similar molecules, eg CCl_4 and CF_4			

(Total marks for Question 5 = 7 marks)

Question number			Answer	Notes	Marks
6	a	i	gains oxygen	Accept increase in oxidation number/state Ignore reference to loss of electrons	1
		ii	$SO_2 + H_2O \rightarrow H_2SO_3$	Accept $2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$ OR $2SO_2 + O_2 \rightarrow 2SO_3$ AND $SO_3 + H_2O \rightarrow H_2SO_4$	1
	b	i	covalent	Accept sharing electrons Reject sharing 1 electron Reject references to ions Ignore intermolecular forces Ignore simple Reject giant	1
		ii	intermolecular forces (of attraction) / forces (of attraction) between molecules	Accept intermolecular bonds	1
			weak / need little (thermal/heat) energy to overcome	Accept easily overcome M2 DEP on M1 at least partially correct If only answer is weak bonds, then 0/2 If any reference to breaking covalent /ionic / metallic bonds, then 0/2	1
		iii	Mo_2O_6		1

Question number			Answer	Notes	Marks
9	c	i	(giant structure of) positive ions	Accept cations but not just ions Reject references to negative ions and molecules	1
			(surrounded by) delocalised electrons	Accept sea of electrons Mark independently	1
		ii	(delocalised / sea of) electrons	Ignore free electrons Ignore references to carrying charge/current	1
			move / flow (through structure) / are mobile (when voltage/potential difference applied)	M2 DEP on M1 No penalty for references to molybdenum atoms or ions / nuclei / protons, but any mention of these moving = 0/2	1
		iii	layers/sheets/planes/rows AND (positive) ions/atoms/particles	If any reference to molecules/protons/electrons/nuclei, then 0/2	1
			slide (over each other)	Allow slip/flow/shift/move/OWTTE in place of slide M2 DEP on mention of either layers etc OR ions etc	1

(Total for Question 6 = 12 marks)

Question number				Answer	Notes	Marks
7	a	i	M1	H—O—H with both bonds represented by 2 shared electrons	Accept 2 dots, 2 crosses or 1 of each Atoms do not have to be labelled with H or O If wrongly labelled, only M1 can be awarded	1
			M2	8 electrons in outer shell of O AND 2 electrons in outer shell of both H	Ignore inner shell of O Reject if H has 2 shells M2 dependent on M1	1
		ii	M1	(strong electrostatic) attraction between bonding/shared pair of electrons	Must refer to pair or two electrons	1
			M2	and nuclei (of hydrogen and oxygen)	Accept word nucleus instead of nuclei if clear reference to 2 atoms 0/2 if any mention of ions / electron transfer M2 dependent on mention of both attraction and electrons in M1	1

Question number				Answer	Notes	Marks
7	b	i	M1	idea of electron transfer / loss and gain of electrons		1
			M2	direction of transfer, eg sodium to oxygen / sodium loses and oxygen gains		1
			M3	correct number of electrons involved, eg (each) sodium loses 1 and oxygen gains 2	Ignore charges on ions Ignore covalent 0/3 if any mention of electron sharing All marks may be scored on diagrams or by reference to electronic configurations Max 2 if molecules mentioned	1
		ii	M1	(sodium) loses electron(s)	Ignore oxygen gains electrons	1

Question number				Answer	Notes	Marks
7	c		M1 M2	attractions between water molecules are weak(er) / easily overcome / need little energy to break attractions between (sodium and oxide) ions are strong(er) / ionic bonds are strong /need a lot of energy to break	Allow (named) intermolecular forces in place of attractions Do not award M2 if any mention of intermolecular forces / metallic bonding Any implication of <u>breaking</u> covalent bonds = 0/2	1 1

Question number				Answer	Notes	Marks
7	d	i	M1 M2 M3	s l aq	All three correct = 2 marks Two correct = 1 mark One/none correct = 0 marks Do not award M1 for g or if not possible to be sure that it is s and not g Do not award marks for abbreviations such as sol / liq	2
		ii	M1 M2	blue / purple OH^- / hydroxide	Allow indigo or violet M1 and M2 independent	1 1

Total 14 marks