Covalent Bonding

Mark Scheme

Level	A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Bonding & Structure
Sub Topic	Covalent Bonding
Booklet	Mark Scheme
Paper Type	Open-Response

Time Allowed: **45 minutes**

Score: **/37**

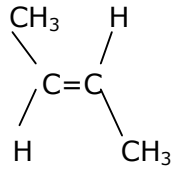
Percentage: **/100**

Grade Boundaries:

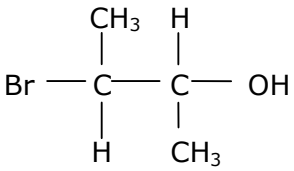
A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

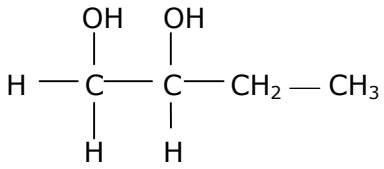
Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	σ bond between C atoms **(1)** π bond above and below σ bond **(1)**  Max (1) if diagram is unlabelled.		2

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	Good overlap of s orbitals in sigma bonds (1) p orbitals are parallel so poor overlap when π bonds form (1) OR Overlap of orbitals in sigma bond is along the line between the two nuclei (1) whereas, in the π bond, there is sideways overlap (1) Can be shown on a diagram		2

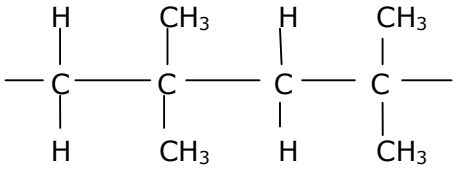
Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	 *E*-but-2-ene Allow angles of 90° between C=C and other bonds. Allow displayed or skeletal formula		1

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	One C on the double bond has two of the same atoms/ two hydrogen atoms attached to it OR C on one end of double bond is not attached to two different atoms or groups Ignore references to restricted rotation about the C=C double bond		1

Question Number	Acceptable Answers	Reject	Mark
1(b)(iii)	(Bromine water goes from brown/ red-brown / yellow/ orange to) colourless OR (Bromine water is) decolorised **(1)**  Accept any orientation Allow addition of two Br atoms Allow un-displayed CH_3 and OH groups Allow skeletal or structural formula **(1)**	To 'clear' Molecular formula	2

Question Number	Acceptable Answers	Reject	Mark
1(c)	(Colour change purple/ purple-pink / pink to) colourless OR ($KMnO_4$ is) decolorised **(1)**  Accept any orientation Allow un-displayed CH_2CH_3 and OH groups, skeletal or structural formula **(1)**	To clear Molecular formula	2

Question Number	Acceptable Answers	Reject	Mark
1(d)(i)	(2-) methylprop(-1)ene	2- methylprop-**2**-ene	

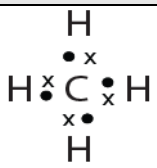
Question Number	Acceptable Answers	Reject	Mark
1(d)(ii)	 Allow methyl groups on C2 and C3 Allow complete polymer formula with square brackets and n		1

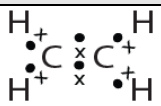
Question Number	Acceptable Answers	Reject	Mark
1(e)	Not sustainable as (polybutene) not made from a renewable resource / Not sustainable as made from non-renewable resource / not sustainable as made from crude oil / Not sustainable as crude oil is not renewable / Not sustainable as crude oil finite resource **IGNORE** References to non-biodegradability / long-lasting in use		1

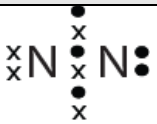
Total = 13 marks

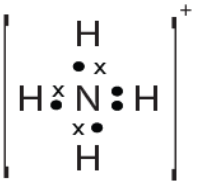
Question Number	Acceptable Answers	Reject	Mark
2(a)	(Electrostatic) attraction between (bonding) electrons and nuclei/protons	**Just** a 'shared pair of electrons'	**1**

- IGNORE ANY INNER SHELL ELECTRONS DRAWN
- ONLY THE TOTAL NUMBERS OF ELECTRONS IN OUTER SHELLS ARE BEING ASSESSED
- ALLOW ELECTRONS TO BE ALL DOTS OR ALL CROSSES OR BOTH

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)			**1**

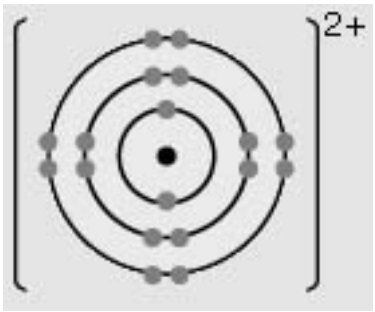
Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)			**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	 NOTE: The lone pair of electrons on each N atom do not have to be shown as a pair		**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)(iv)	 The **+** sign can be shown anywhere Ignore missing brackets Ignore if the **+** is missing		**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)(i)	IGNORE any references to 'molecules' in this part only **First mark: Location of silicon's electrons** Silicon's (outer) electrons are fixed (in covalent bonds)/ silicon's (outer) electrons are in fixed positions (in covalent bonds)/ silicon's (outer) electrons are involved in bonding **(1)** **Second mark: Lack of mobility of silicon's electrons** (therefore) silicon's electrons are not free (to move)/ silicon has no free electrons/ there are no mobile electrons in silicon/ silicon has no delocalized electrons/ silicon's electrons cannot flow **(1)** IGNORE references to **lack of** ions	'Silicon is ionic' scores **(0)** for the question 'silicon's **ions** are not free to move' scores **(0)** for the question	**2**

Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	(The covalent) bonds are **strong** (throughout the lattice) **(1)** (therefore) a lot of **energy** is required to break the bonds / a lot of **energy** is needed to overcome the attractions **(1)** IGNORE any references to 'giant molecular'	'(simple) molecular silicon' **(0)** /'molecules of silicon' **(0)** /'silicon has ions' **(0)** /'intermolecular forces' / 'van der Waals' forces'/ 'London forces' **(0)** ALL THE ABOVE SCORE **(0)** OVERALL	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(i)	 electrons **(1)** charge **(1)** square brackets not essential Mark independently Ignore (labelling of) nucleus unless incorrect		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	$1s^2 2s^2 2p^6 3s^2 3p^6$ Allow electron number as sub script Allow orbitals as capital letters Allow TE from (a) (i) if Ca atom or Ca^+ ion		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(iii)	Smaller Because it has one less (sub) shell of electrons / orbital / energy level / less shielding **(1)** And the ratio of protons : electrons has increased / more protons than electrons / greater net force on remaining electrons (so remainder of electrons held more closely) / greater effective nuclear charge **(1)**	bigger scores zero greater nuclear charge /positive charge	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(iv)	Any two from: Strong (electrostatic) forces / attractions / bonds (between ions) **(1)** (ions) held in giant lattice / **many** (ionic) attractions / forces / bonds **(1)** So large amount of energy needed (to break apart ions) **(1)**	Any mention of covalent or metallic bonds or atoms or molecules scores zero High temperature	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(i)	Because the **ions** are free to move (when a potential difference is applied)	Electrons / particles are free to move	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(ii)	The cations / barium and calcium (ions) are different sizes Ignore any discussion of reasons (could select either the calcium ion because it has more water molecules associated with it OR the barium ion because it has more shells of electrons and so larger)	Atoms are different sizes	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(iii)	Mass of calcium ions in 1 kg = 0.100 x 40 (= 4.0) (g) **(1)** If mass quoted must be correct to score first mark Hence 4.0 g per 1000 g of solution So ppm = (4.0/1000) x 1000000 = 4000 (ppm) **(1)** OR Mass of calcium ions in 1 kg = 0.100 x 40.1 (= 4.01) (g) **(1)** Hence 4.01 g per 1000 g of solution So ppm = (4.01/1000) x 1000000 = 4010 (ppm) **(1)** Correct answer alone = 2 marks Allow TE for second mark from incorrect mass		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (c)	(Sulfur / nitrogen oxides) form when (fossil) fuels are burnt / when petrol or diesel burn in vehicle engines / emissions from vehicle (engines) / volcanoes / lightning **(1)** They (react with water to) form sulfuric / sulfurous acid /nitric acid /acid rain / gases are acidic **(1)** Which **reacts** with limestone (to form soluble compounds) / limestone and acid take part in neutralisation / dissolves building / corrodes building **(1)** Allow correct equation for third mark but Ignore equations if mark already awarded. Ignore comments regarding erosion	from factories alone	**3**

Question Number	Acceptable Answers	Reject	Mark
3 (d)	**Either** Yes, as the values match closely (so little deviation from ionic model) **Or** no, as the values are (slightly) different so a degree of covalency / not fully ionic	100% ionic covalent	**1**