Question 1 (a) (i)

Question	Candidate	Max Mark	Mark awarded	Commentary
1 (a) (i)	A	1	0	The candidate has not completed the definition by stating ‘in a bond’.
	B	1	0	The candidate has mentioned the attraction ‘a bond’ has for electrons and not the attraction an ‘atom’ or a ‘nucleus’ has for the electrons in a bond.
	C	1	1	The candidate has clearly described the attraction an atom has for electrons in a bond.
	D	1	1	In the first sentence, the candidate does not mention the attraction either atom has for the bonding /shared electrons. However, the diagram shows a shared pair of electrons in a bond and so the mark was awarded.

Question 1 (a) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
1 (a) (ii)	A	1	0	The candidate mentions ‘more electron shells’ and shielding, but does not link more shells to more shielding.
	B	1	1	The candidate has linked increased ‘number of energy levels’ to decreased attraction of the nucleus for outer electrons.

Question 1 (b)

Question	Candidate	Max Mark	Mark awarded	Commentary
1 (b)	A	3	2	The candidate has stated 'Going down group 7 …more/stronger intermolecular forces (are) present', and correctly identified the intermolecular forces as London dispersion forces (LDF). There is no mention of more electrons linked to stronger LDFs.
	B	3	3	The candidate has started the answer with 'they increase as …', which links the answer to the question, and indicates the trend described is down the group. The candidate has also identified the type of intermolecular force as London dispersion forces and mentioned an increase in the number of electrons.

Question 2 (c) (i)

Question	Candidate	Max Mark	Mark awarded	Commentary
2 (c) (i)	A	2	0	The candidate stated 'silicon' and not silicon nitride exists as a covalent network, and did not mention which type of bond 'between atoms …requires more energy to break'. Mention of the triple bond within nitrogen is not relevant.
	B	2	1	The candidate has stated 'silicon' and not silicon nitride is a covalent network. However, the candidate has mentioned 'covalent bonds' and that 'more energy is needed to break these bonds' which implies covalent bonds are broken, which was awarded one mark.
	C	2	2	The candidate correctly stated 'silicon nitride must be a covalent network' and also that 'covalent bonds must be broken', so both marks were awarded.
	D	2	1	The candidate was correct in stating 'silicon nitride exists as a covalent network' so one mark was awarded. Although the candidate states 'a covalent network requires a great amount of energy for its bonds to be broken', there is no mention of what type of bonds these are, so the second mark was not awarded.
	E	2	0	The candidate has stated 'silicon' and not silicon nitride is a covalent network. Although the candidate stated there are 'strong covalent bonds, which require great amounts of energy', it is not clear what the 'great amounts of energy' were required to do.

Question 2 (c) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
2 (c) (ii)	A	2	0	The candidate has calculated an incorrect final answer therefore only a partial mark can be considered. The candidate has added the total mass of reactants without applying the mole ratio (170.1 + 17 = 187·1) and used this in the atom economy relationship. If the candidate's answer had been correct for the working shown, one mark would have been awarded, however the final answer has been incorrectly rounded.
	B	2	0	The candidate has calculated an incorrect final answer therefore only a partial mark can be considered. The relationship for atom economy has not been used correctly as there is no working to show where 622·3 has come from, so no mark could be awarded.
	C	2	2	The candidate has given a correct final answer.

Question 2 (d) (i)

Question	Candidate	Max Mark	Mark awarded	Commentary
2 (d) (i)	A	2	1	A workable first diagram is given with the hot aluminium foil labelled. The second mark is not awarded as the collection flask is stoppered and this would prevent chlorine escaping.
	B	2	2	A workable first diagram is given showing the aluminium foil being heated on a hot plate. The second mark is awarded for the open collection flask, which would allow chlorine gas to escape and leave aluminium chloride in the flask.
	C	2	1	A workable first diagram is given showing the aluminium foil being heated by a Bunsen burner. The second mark is not awarded, as the aluminium chloride cannot be collected as a solid.
	D	2	0	No workable method is given to ensure contact (and a reaction) between the chlorine gas generated and the hot aluminium foil. The second mark cannot be awarded, as there is no connection between the delivery tube and the collection flask.

Question 2 (d) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
2 (d) (ii)	A	1	0	The candidate has made an incorrect statement.
	B	1	0	The candidate has made an incorrect statement.
	C	1	0	The candidate has made an incorrect statement.
	D	1	1	The candidate has correctly stated 'the activation energy needs …to be overcome'.

Question 3 (c) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
3 (c) (ii)	A	2	2	The candidate has correctly calculated the number of moles of benzoic acid (0·04) and methanol (0·08), and then stated that methanol is in excess by 0·04 moles. The supporting statement links the fact that as methanol is in excess, the benzoic acid is the limiting reagent.
	B	2	1	The candidate correctly calculated the number of moles of 'benzoic acid' as 0·04 but has incorrectly calculated the moles of methanol to be 0.07 moles (incorrect rounding). Stating 'there is not enough benzoic acid to fully react with methanol' demonstrates an understanding that the limiting reactant is correct for their calculated values, and so one mark was awarded.
	C	2	2	The candidate has correctly calculated 9·53g of benzoic acid is required to react with 2·5g of methanol, and then explained that as 'there is only 5·0g present (of benzoic acid) so …benzoic acid is the limiting reactant'.
	D	2	1	The candidate has correctly calculated the number of moles of benzoic acid (0·041) and methanol (0·078). Although the candidate is correct in stating 'Benzoic acid is the limiting reagent' there is no explanation of how the candidate got to this conclusion, and so the second mark was not awarded.

Question 3 (c) (iii)

Question	Candidate	Max Mark	Mark awarded	Commentary
3 (c) (iii)	**A**	**2**	**2**	The candidate has displayed all working clearly. The working demonstrates the route used to calculate the mass of benzoic acid required and then uses this value (161g, correctly rounded from 161·3g) to calculate the cost. As both processes are clearly shown, the candidate was awarded both marks.
	B	**2**	**0**	The candidate has calculated an incorrect final answer so only a partial mark can be considered. There is no evidence of a calculated mass of benzoic acid nor has the candidate used a calculated mass to calculate the cost of benzoic acid required to make 100g of methyl benzoate.
	C	**2**	**1**	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate incorrectly calculated the mass of benzoic acid required to make 100g of methyl benzoate. The calculated mass was then correctly multiplied by £0·0796 to give a cost of £4·94, so one mark was awarded for this final answer.

Question 6 (c) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
6 (c) (ii)	**A**	**1**	**0**	An incorrect structural formula is given. The structure is missing a bond and a hydrogen atom.
	B	**1**	**0**	An incorrect structural formula is given. The structure given is for threonine.
	C	**1**	**0**	An incorrect structural formula is given. The structure shows the oxygen of the hydroxyl group attached to H_2.

Question 7 (b) (i)

Question	Candidate	Max Mark	Mark awarded	Commentary
7 (b) (i)	A	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has successfully calculated the mass of squalene (5345000mg) but then incorrectly converted this mass to kg.
	B	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has successfully calculated the mass of squalene (5345000mg) but then incorrectly converted this mass to kg.
	C	2	2	The candidate has calculated the correct mass of squalene.
	D	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has incorrectly scaled 10·69mg to 0·01069kg, but then correctly multiplied this value by 500000 (doses) to give a final answer in kg.

Question 8 (a)

Question	Candidate	Max Mark	Mark awarded	Commentary
8 (a)	A	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. Evidence of multiples of all 4 correct bond enthalpies is shown for bond making and bond breaking, so one mark was awarded.
	B	2	2	The calculated final answer is correct.
	C	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has only retrieved three values from the data book (the C-C bond is missing) but in the final calculation, they recognise bond breaking is endothermic and bond making is exothermic, and correctly manipulate their bond enthalpy values to give their answer.

Question 8 (c) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
8 (c) (ii)	A	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate calculated an incorrect mass of oxygen (4 x 32 = 128) and multiplied this by 4·3 to obtain a value of 550·4g. This value was awarded one mark.
	B	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate correctly calculated the mass of oxygen required but did not use this in any further calculation, so only one mark was awarded.
	C	2	0	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has not obtained either of the values which were awarded a mark in the marking instruction.

Question 9 (c)

Question	Candidate	Max Mark	Mark awarded	Commentary
9 (c)	A	1	0	An incorrect structural formula is given. The structure is missing a bond and a hydrogen atom.
	B	1	0	An incorrect structural formula is given. The connectivity of the -OH on the left hand side of molecule is incorrectly represented.
	C	1	1	A correct structure is given.
	D	1	0	An incorrect structural formula is given. The drawing shows the left-hand carbon with a bond connected to the hydrogen of the hydroxyl functional group.

Question 9 (d) (iii) (B)

Question	Candidate	Max Mark	Mark awarded	Commentary
9 (d) (iii) (B)	A	1	0	An incorrect full structural formula is given. A covalent bond is shown between O^- and Na^+.
	B	1	1	The correct shortened structural formula is given.
	C	1	0	An incorrect molecular formula is given.
	D	1	1	The correct full structural formula is given.

Question 11 (c) (ii)

Question	Candidate	Max Mark	Mark awarded	Commentary
11 (c) (ii)	A	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has incorrectly calculated the number of moles of thiosulfate using $50cm^3$ instead of $9{\cdot}5cm^3$. The mole ratio was then correctly applied to this value so one mark was awarded.
	B	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The answer underlined by the candidate is not the number of moles of iodine but the concentration of iodine. As part of their working the candidate has correctly calculated the number of moles of iodine ($4{\cdot}75 \times 10^{-6}$), so one mark was awarded.

Question 12 (b) (i)

Question	Candidate	Max Mark	Mark awarded	Commentary
12 (b)	A	2	2	The candidate has calculated a correct mass of phenol.
	B	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has calculated a theoretical yield of 141 kg so one mark was awarded
	C	2	1	The candidate has given an incorrect final answer so only a partial mark can be considered. The candidate has incorrectly calculated the theoretical yield (0·141 kg). However, they have correctly calculated 90% of this calculated value so one mark was awarded.