Pearson Edexcel

Mark Scheme (Results)

January 2025

Pearson Edexcel International Advanced Subsidiary Level In Chemistry (WCH11)
Paper 01 Structure, Bonding and Introduction to Organic Chemistry

Section A

Question Number	Answer	Mark
1	**The only correct answer is B** (3.6×10^{23}) ***A*** *is incorrect because this is the number of molecules of carbon dioxide in 8.8 g* ***C*** *is incorrect because this is the number of molecules of carbon dioxide in 88 g* ***D*** *is incorrect because this is the number of atoms of carbon dioxide in 88 g*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is C** (0.0060 mol) ***A*** *is incorrect because this is the number of moles of magnesium nitrate in the solution* ***B*** *is incorrect because this would be correct if the formula of magnesium nitrate was* $MgNO_3$ ***D*** *is incorrect because this is the number of ions that would be present if there were two magnesium ions and two nitrate ions in each magnesium nitrate*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is C** (1.6605×10^{-24}) ***A*** *is incorrect because this is the mass of a water molecule derived from mass numbers ÷ by the mass in g instead of × mass in g* ***B*** *is incorrect because this is the mass of a water molecule in amu ÷ by the mass in g instead of × mass in g* ***D*** *is incorrect because this is using the mass numbers rather than the relative isotopic masses*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is B** (92) ***A*** *is incorrect because this is the molecular mass of* NO_4 *which has 82.05% oxygen* ***C*** *is incorrect because this is the molecular mass of* N_3O_4 *which has 60.38% oxygen* ***D*** *is incorrect because this is* $69.57 \div 64 \times 100$ *instead of* $64 \div (69.57 \div 100)$	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** (10.0 cm^3 of 0.90 mol dm^{-3} magnesium chloride solution**)** ***A*** *is incorrect because this solution contains 0.012 mol of chloride ions* ***B*** *is incorrect because this solution contains 0.012 mol of chloride ions* ***D*** *is incorrect because this solution contains 0.012 mol of chloride ions*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is C** (0.095 g) ***A*** *is incorrect because this has been divided by 1000 not 1000000* ***B*** *is incorrect because this is ten times too big* ***D*** *is incorrect because this is the mass of the solute in kg instead of g*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is B** ($MgSO_4 \bullet 5H_2O$) ***A*** *is incorrect because this has a percentage by mass of water of 57%* ***C*** *is incorrect because this has a percentage by mass of water of 27%* ***D*** *is incorrect because this has a percentage by mass of water of 16%*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is D** (87%) ***A*** *is incorrect because this is the atom economy of water* ***B*** *is incorrect because this is the economy by moles rather than by mass* ***C*** *is incorrect because this is the value ignoring the stoichiometry (balancing) of the equation for the products*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is B** (579 1979 2963 6200) ***A*** *is incorrect because there is a large jump between 3rd and 4th ionisation energy, so Group 3, but lower first ionisation energy than B so lower in the group* ***C*** *is incorrect because there is not a relatively large jump between the 3rd and 4th ionisation energies* ***D*** *is incorrect because there is not a relatively large jump between the 3rd and 4th ionisation energies*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is D** (sulfur molecules have more electrons than phosphorus molecules) *A is incorrect because there is no electronegativity difference so no dipole in sulfur or phosphorus* ***B** is incorrect because the covalent bonds do not break during melting, only intermolecular forces between simple molecular structures are broken* ***C** is incorrect because sulfur has a simple molecular structure, S_8*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is A** ($K^+ < Ar < Cl^- < Br^-$) ***B** is incorrect because potassium ion is the smallest as it is isoelectronic with Ar and Cl^- and has the most protons* ***C** is incorrect because bromide ion has one more shell of electrons than the others so is the largest* ***D** is incorrect because bromide ion has one more shell of electrons than the others so is the largest*	**(1)**

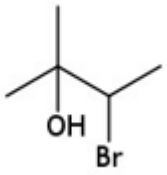
Question Number	Answer	Mark
12	**The only correct answer is A** (small large) ***B** is incorrect because the ion needs a large charge* ***C** is incorrect because the ion needs a small radius and a large charge* ***D** is incorrect because the ion needs a small radius*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is B** (PCl_3F_2) ***A*** *is incorrect because this is not symmetrical so must have a dipole* ***C*** *is incorrect because this is not symmetrical as the central equatorial chlorines are asymmetrical so must have a dipole* ***D*** *is incorrect because this is not symmetrical so must have a dipole*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is A** () ***B*** *is incorrect because hexane is not an oxidising agent* ***C*** *is incorrect because hexane is not corrosive* ***D*** *is incorrect because hexane is not toxic*	**(1)**

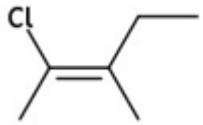
Question Number	Answer	Mark
15	**The only correct answer is B** (3,4-dimethyldecane) ***A*** *is incorrect because the longest chain has 10 carbons so it is a decane* ***C*** *is incorrect because the longest chain has 10 carbons so it is a decane* ***D*** *is incorrect because the numbering of the substituents must give the lowest numbers*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is D** (decreases the average number of carbon atoms per molecule) ***A*** *is incorrect because cracking converts alkanes into smaller alkanes and alkenes* ***B*** *is incorrect because this is fractional distillation* ***C*** *is incorrect because cracking converts alkanes into smaller alkanes and alkenes*	**(1)**

Question Number	Answer	Mark
17	**The only correct answer is A** () ***B*** *is incorrect because this is the minor product of the addition of BrOH to 2-methylbut-2-ene* ***C*** *is incorrect because this is the major product of the addition of BrOH to 2-methylbut-1-ene* ***D*** *is incorrect because this is the minor product of the addition of BrOH to 2-methylbut-1-ene*	**(1)**

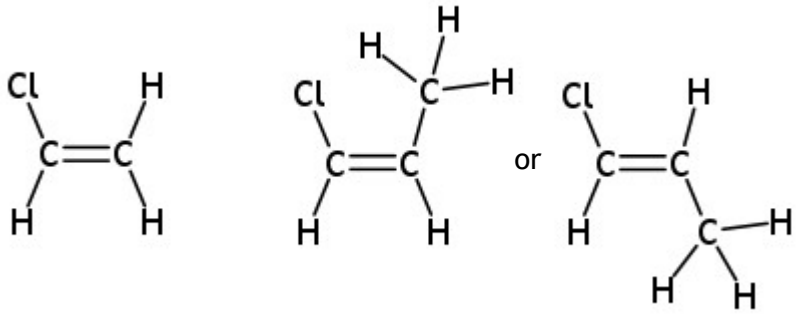
Question Number	Answer	Mark
18	**The only correct answer is D** ((i), (ii) and (iii)) ***A*** *is incorrect because all three are true* ***B*** *is incorrect because all three are true* ***C*** *is incorrect because all three are true*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is B** (4π and 38σ) ***A*** *is incorrect because there are 38* σ *bonds and discounts C–H bonds attached to carbons in the C=C bonds* ***C*** *is incorrect because this counts the double bonds as two* π *bonds* ***D*** *is incorrect because this counts the double bonds as two* π *bonds not one* π *bond and one* σ *bond*	**(1)**

Question Number	Answer	Mark
20	**The only correct answer is D** () ***A*** *is incorrect because the chlorine on C1 and the methyl on C2 are highest priority so E-* ***B*** *is incorrect because the chlorine on C1 and the ethyl on C2 are highest priority so E-* ***C*** *is incorrect because the bromine on C1 and the chlorine on C2 are highest priority so E-*	**(1)**

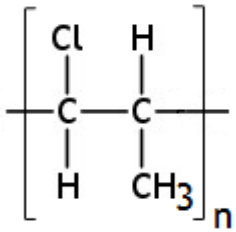
TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	• displayed formula of chloroethene **(1)** • displayed formula of either isomer of 1-chloropropene **(1)**	 chloroethene 1-chloropropene Allow the methyl group to be condensed to CH_3 Ignore incorrect connectivity to CH_3 Ignore labels identifying geometric isomers (*E*-, *Z*-, cis-, trans-) even if incorrect Penalise non-displayed formulae once only	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An explanation that makes reference to two of the following points: (because they) • have the same functional group(s) **(1)** • have similar chemical properties **(1)** • have the same general formula / $C_nH_{2n-1}Cl$ **(1)** • differ from each other by a $–CH_2–$ group **(1)**	**Penalise reference to molecules for atoms / groups once only in (a)(ii) and (a)(iii)** Allow they are both alkenes / chloroalkenes / they both contain C=C / chlorine Allow same chemical properties Do not award same empirical / molecular formula Do not award an incorrect general formula Do not award $–CH_2–$ molecule	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(a)(iii)	An explanation that makes reference to the following points: • (because there is) restricted rotation around the C=C / carbon to carbon double bond (in both molecules) **(1)** • (and) 1-chloropropene has two different groups on each of the carbons (in the double bond) **(1)** • (but) there are two hydrogen (atoms) / same atoms on one carbon of chloroethene **(1)**	Allow no rotation around the C=C Allow 1-chloropropene has a Cl and a H on one carbon and a H and a CH_3 on the other carbon Allow reverse argument e.g. chloroethene does not have different groups (on one carbon) If M2 and M3 are not scored: award (1) for geometric isomers must have 2 different groups on each of the carbons May reference their diagrams in (a)(i)	**(3)**

Question Number	Answer	Additional Guidance	Mark
21(b)(i)	• formula showing $CHCl{-}CH(CH_3)$ **(1)** • brackets **and** extension bonds **and** subscript n on the right **(1)**	Accept correct multiple repeat units Accept Cl and CH_3 on same side of C-C Ignore connectivity to CH_3 Allow any type of bracket Allow N for n <u>Example of formula</u> 	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to two of the following points: • less dense / less weight **(1)** • doesn't corrode / rust / oxidise **(1)** • no metal (ions) get into the water supply **(1)**	Allow lower mass Allow unreactive / does not react Allow long life of the piping means it does not need to be replaced Ignore **non**-biodegradable Do not award reference to "it is biodegradable" Do not award reference to erosion Ignore pollution, keeps water clean Ignore references to cost of energy, recycling, production, insulation properties Ignore comparisons of sustainability / renewable resources even if incorrect	**(2)**

(Total for Question 21 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)	An answer that makes reference to the following point: • to show that the electrons have opposite **spin**	Allow different **spin** Allow **spin** in different / opposite direction Award **spin** +½ and −½ Do not award spin/rotate around the nucleus in opposite direction Do not award references to attraction / positive charges	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(b)	An explanation that makes reference to the following points: • some of the electrons are in an s sub-shell / orbital **and** some electrons are in the p sub-shell / orbital **(1)** • (they don't have the same energy because) electrons in p sub-shell / orbital have higher energy **(1)**	Do not award s / p shell Accept reverse argument Allow mention of singular p orbital Do not award s / p shell Penalise use of s / p shell once only	**(2)**

Question Number	Answer	Additional Guidance	Mark
22(c)	An explanation that makes reference to the following points: • sphere / spherical **(1)**	 Allow ball Do not award just circle / round Ignore diagrams	**(1)**

(Total for Question 22 = 4 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)(i)	• calculation of abundance of 5th isotope **(1)** • expression for relative atomic mass **(1)** • calculation of x given to 2SF **(1)**	Example of calculation 100 – 20.5 – 7.8 – 36.5 – 7.8 = 27.4 (%) $72.6 = \frac{(70 \times 20.5) + (73 \times 7.8) + (74 \times 36.5) + (76 \times 7.8) + (x \times 27.4)}{100}$ OR $72.6 = \frac{1435 + 569.4 + 2701 + 592.8 + (x \times 27.4)}{100}$ OR $72.6 = \frac{5298.2 + (x \times 27.4)}{100}$ Allow TE from M1 $x = \frac{7260 - 5298.2}{27.4} = 1961.8 \div 27.4 = 71.59 = 72$ Allow TE from M2 provided final answer is between 68 – 78 Correct answer with some working scores 3 Correct answer with no working scores 1	**(3)**

Question Number	Answer	Additional Guidance	Mark
23(a)(ii)	An answer that makes reference to the following point: • the number of protons **and** neutrons / nucleons must be an integer / whole number	Ignore the values in the table with the least significant figures have 2 SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)	An answer that makes reference to the following points: Similarity • (the atoms) have the same total / sum of the numbers of protons and of neutrons **(1)** Difference • (an atom of) germanium(-76) has 2 fewer protons / (an atom of) selenium(-76) has 2 more protons • (an atom of) germanium(-76) has 2 more neutrons / (an atom of) selenium(-76) has 2 fewer neutrons **(1)** • (an atom of) germanium(-76) has 2 fewer electrons / (an atom of) selenium(-76) has 2 more electrons **(1)** **(1)**	M2, M3 and M4 must be quantitative Allow the atoms have the same mass number Allow germanium has 32 protons and selenium has 34 protons Allow germanium has 44 neutrons and selenium has 42 neutrons Allow germanium has 32 electrons and selenium has 34 electrons Allow germanium has 4 outer-shell electrons and selenium has 6 outer-shell electrons If none of M2, M3 and M4 have been awarded allow 1 mark for **two** of the following: • germanium has more neutrons • germanium has fewer protons • selenium has more electrons Allow reverse argument(s)	**(4)**

(Total for Question 23 = 8 marks)

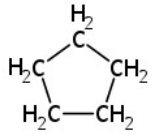
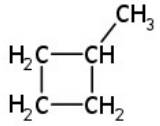
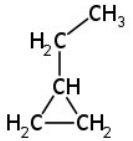
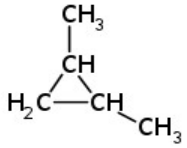
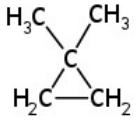
Question Number	Answer	Additional Guidance	Mark
24(a)(i) **Clip all**	• rearrangement of $pV = nRT$ **(1)** • conversion of dm^3 to m^3 **(1)** • substitution in correctly rearranged expression **(1)** • calculation of value of n **(1)**	<u>Example of calculation</u> $n = pV \div RT$ $V = 0.00179 / 1.79 \times 10^{-3}$ $n = (110\,000 \times 0.00179) \div (8.31 \times 473)$ Allow TE in M3 from incorrect conversion from dm^3 to m^3 $n = 0.0501$ (mol) / 5.01×10^{-2} (mol) / 0.050094 (mol) / 5.0094×10^{-2} (mol) / 0.05 (mol) / 5×10^{-2} (mol) Allow TE for M4 from incorrect values shown in a correctly rearranged expression Ignore SF throughout Correct answer with some working scores 4	**(4)**

Question Number	Answer	Additional Guidance	Mark
24(a)(ii)	• calculation of M_r of X	<u>Example of calculation</u> $M_r = 3.5 \div 0.0500 = 70$ Accept 69.869 Allow TE on incorrect moles in (a)(i) provided answer >1	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(a)(iii)	• calculation of moles of carbon **and** moles of hydrogen **(1)** • calculation of ratio **and** gives empirical formula **(1)**	Example of calculation 85.7 ÷ 12 = 7.1417 **and** 14.3 ÷ 1 = 14.3 14.3 ÷ 7.1417 = 2.0023 CH_2 Ignore SF throughout Correct answer with no working scores (2)	**(2)**

Question Number	Answer	Additional Guidance	Mark
24(a)(iv)	• molecular formula	Example of calculation ans(a)(ii) ÷ ans(a)(iii) 70 ÷ 14 = 5 C_5H_{10} Allow TE on (a)(ii) and (a)(iii) Answer with no working scores 1	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(b)	An answer that makes reference to the following point: • no (C=C) double bonds are present / molecule is not unsaturated / molecule is not an alkene / only single bonds are present / molecule is saturated / molecule is an alkane	Allow it is a cycloalkane Ignore it does not contain oxygen	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(c)	An answer that makes reference to the following points: • one possible structural isomer **(1)** • a second structural isomer **(1)**	 OR cyclopentane  OR methylcyclobutane  OR ethylcyclopropane  OR 1,2-dimethylcyclopropane  OR 1,1-dimethylcyclopropane Allow any type of displayed or skeletal formulae Allow 1-methylcyclobutane and 1-ethylcyclopropane If name and formula are given, both must be correct Allow TE on formula from (a)(iv) If answer in (b) is alkene, then allow 1 mark for two correct alkenes using formula in (a)(iv)	**(2)**

(Total for Question 24 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
25(a)(i)	An answer that makes reference to the following point: • (free) radical substitution	 Ignore homolytic fission / homolysis Ignore halogenation	**(1)**

Question Number	Answer	Additional Guidance	Mark
25(a)(ii)	An answer that makes reference to the following point: • ultraviolet / uv (radiation)	 Allow uv light / sunlight Ignore references to temperature and pressure	**(1)**

Question Number	Answer	Additional Guidance	Mark
25(a)(iii)	An answer that makes reference to the following point: • propagation		**(1)**

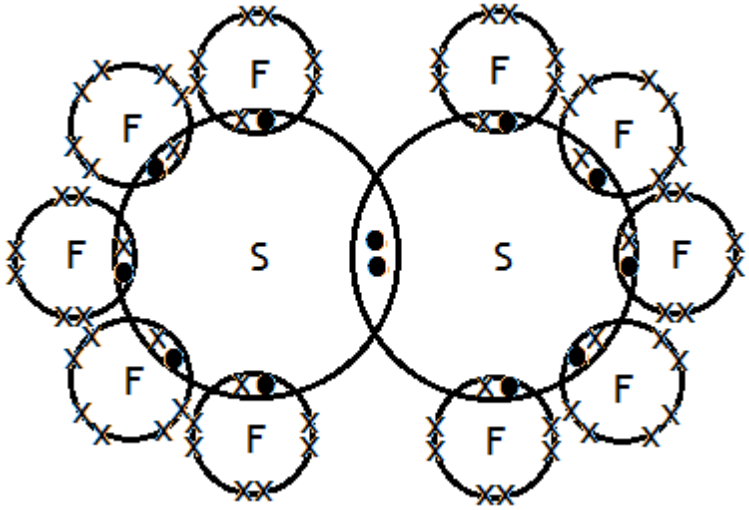
Question Number	Answer	Additional Guidance	Mark
25(a)(iv)	A description that makes reference to the following points: • It is a termination step **(1)** • **two** (free) radicals join together / react (to form a molecule and no other product / with no radical on the product side) **(1)** • one example of a termination step (by words or equation) **(1)** • a second example of a termination step (by words or equation) **(1)**	Possible termination steps include: $CH_3(CH_2)_3\bullet + Cl\bullet \rightarrow CH_3CH_2CH_2CH_2Cl$ $2Cl\bullet \rightarrow Cl_2$ $2CH_3(CH_2)_3\bullet \rightarrow CH_3(CH_2)_6CH_3$ Allow termination steps involving products with more than one chlorine Ignore attempted initiation and propagation steps, overall substitution equation and correct further substitution in M3 and M4 Apply list principle for M3 and M4 only Do not award steps with H• Penalise omission of • once only	**(4)**

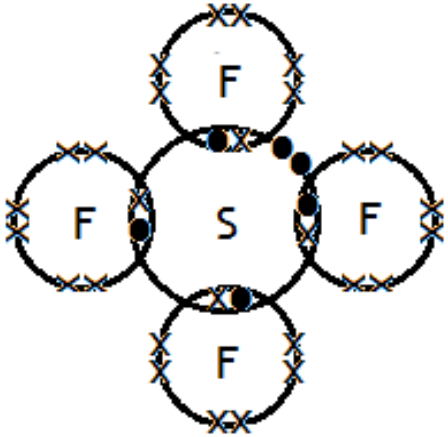
Question Number	Answer	Additional Guidance	Mark
25(b)(i)	An answer that makes reference to the following points: (A polar molecule is one in which) • one end / atom / region which is slightly positive **and** one which is slightly negative OR there is a dipole moment / charge separation OR the electron density / partial charge is concentrated around one end / atom / region / is unsymmetrical OR there is an electronegativity difference (between the atoms) **(1)** • chlorine (is not polar because it) has no electronegativity difference OR chlorine is symmetrical and so no slightly positive and slightly negative end OR no concentration of electron density OR no charge separation OR does not have a dipole moment OR only has one type of atom / element **(1)**	Do not award M1 if any references to ions or intermolecular forces Allow the shared pair (of electrons) is not equally shared Allow the shared pair (of electrons) is equally shared Do not award dipoles cancel / bonds cancel	**(2)**

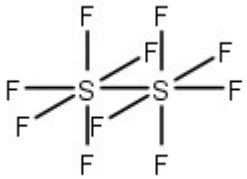
Question Number	Answer	Additional Guidance	Mark
25(b)(ii)	An explanation that makes reference to the following points: • (the electrons in) the double bond / π-bond / C=C (of the alkene) **(1)** • repel electrons / distorts the electron cloud in the chlorine molecule / induces a dipole **(1)**	Allow making one chlorine atom (in the molecule) slightly positive / slightly charged Do not award references to free radicals / nucleophiles	**(2)**

(Total for Question 25 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
26(a)	An answer that makes reference to the following point: • disulfur decafluoride	 Allow disulfur(V) fluoride Ignore sulfur decafluoride Do not award fluorine for fluoride	**(1)**

Question Number	Answer	Additional Guidance	Mark
26(b)	• 2 dots in the S-S overlap **(1)** • 10 pairs of one dot and one cross in the 10 S-F overlaps **(1)**	 Allow bonding electrons to touch / sit on the circles Any extra electron or electrons negates one of the marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
26(c)	• 4 pairs of one dot and one cross in the S-F overlap **(1)** • 1 pair of dots on the outer shell of sulfur **and** 3 pairs of crosses on the outer shell of each fluorine **(1)**	Example of dot-and-cross diagram  Allow two separate electrons for the sulfur lone pair Allow fluorine lone pairs shown as unpaired electrons Allow dots and crosses reversed	**(2)**

Question Number	Answer	Additional Guidance	Mark
26(d)	An answer that makes reference to the following points: • S_2F_{10} shape with bonds as shown **(1)** • S_2F_{10} 90º for Do not award 120° **(1)** • SF_4 shape with at least one dotted or wedged bond **(1)** • SF_4 90º / 180º **and** 120º Allow values 85–90° / 170–180° **and** 100–120° **(1)**	<table><tr><th>Molecule</th><th>Diagram</th><th>F–S–F bond angle</th></tr><tr><td>SF_6</td><td>  </td><td>90º</td></tr><tr><td>S_2F_{10}</td><td>  </td><td>90º (ignore 180º)</td></tr><tr><td>SF_4</td><td>  </td><td>90º / 180 º **and** 120º</td></tr></table> Ignore lack of degree sign Ignore presence of a lone pair on S in SF4	**(4)**

Question Number	Answer	Additional Guidance	Mark
26(e)	An answer that makes reference to the following points: • sulfur in SF_6 has six bonding pairs (of electrons) (and no lone pairs) **(1)** • sulfur in SF_4 has four bonding pairs (of electrons) **and** one lone pair **(1)** • the (electron) pairs repel to be as far away as possible / maximum separation **(1)**	Bonding pairs needs to be seen once only in the response Ignore references to individual shapes and bond angles, e.g., octahedral, tetrahedral, bipyramidal even if incorrect Allow the (electron) pairs move to minimise repulsion Do not award bonds repel Do not award repulsion of atoms	**(3)**

Question Number	Answer	Additional Guidance	Mark
26(f)	An answer that makes reference to the following points: • (SF_4 has) a lone pair of electrons on the **sulfur** (making SF_4 more reactive than SF_6) OR SF_4 is polar (because of its shape) **(1)** • (in S_2F_{10}) the S–S bond is weak compared to the S–F bond OR (in S_2F_{10}) the S–S bond is long compared to the S–F bonds **(1)** • SF_6 has (six) strong / difficult to break (S–F) bonds OR (the sulfur atom is small) so the six fluorine atoms hinder attack on the sulfur **(1)**	Allow the S–S bond requires less energy to break than an S–F bond Do not award S_2F_{10} has lone pair(s) / is polar Allow SF_6 is octahedral **and** non-polar Allow the six fluorine atoms block the sulfur Ignore throughout references to intermolecular forces, free electrons, symmetry, polarity	**(3)**

(Total for Question 26 = 15 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS