Mark Scheme (Results)

October 2018

Pearson Edexcel International
Advanced Subsidiary Level
In Chemistry (WCH01)
Paper 01 Core Principles in Chemistry

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

October 2018
Publications Code WCH01_01_1810_MS*

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Correct Answer	Mark
1	**The only correct answer is B** ***A*** *is not correct because 6HF and* $2H_2O$ *are needed to balance the equation.* ***C*** *is not correct because 6HF and* $2H_2O$ *are needed to balance the equation.* ***D*** *is not correct because 6HF and* $2H_2O$ *are needed to balance the equation.*	**(1)**

Question Number	Correct Answer	Mark
2	**The only correct answer is B** ***A*** *is not correct because the 0.06 g* kg^{-1} *is 60 ppm and this can be safely exceeded* ***C*** *is not correct because this equals 6000 ppm* ***D*** *is not correct because this equals 60 000 ppm*	**(1)**

Question Number	Correct Answer	Mark
3	**The only correct answer is B** ***A*** *is not correct because mol chloride =* $3 \times 10^{-4} < 6 \times 10^{-4}$ ***C*** *is not correct because mol chloride =* $4.5 \times 10^{-4} < 6 \times 10^{-4}$ ***D*** *is not correct because mol chloride =* $5 \times 10^{-4} < 6 \times 10^{-4}$	**(1)**

Question Number	Correct Answer	Mark
4	**The only correct answer is D** ***A*** *is not correct because the lighter ion is deflected more* ***B*** *is not correct because the* Fe^{2+} *ion has one more electron* ***C*** *is not correct because the* Fe^{2+} *ion has an extra proton*	**(1)**

Question Number	Correct Answer	Mark
5	**The only correct answer is C** (*To make solution 1/20 as concentrated, total volume would be 200 cm^3 produced by adding 190 cm^3 to 10 cm^3*) ***A** is not correct because this is the dilution factor* ***B** is not correct because this is just based on 5-fold increase in volume* ***D** is not correct because the final volume would be 210 cm^3*	**(1)**

Question Number	Correct Answer	Mark
6	**The only correct answer is B** (*There is 0.5 mol NO and each molecule contains 2 atoms so answer is 0.5 x 2 x L*) ***A** is not correct because this is 0.5 x L* ***C** is not correct because this is (2/0.5) x L* ***D** is not correct because this is 15 x L*	**(1)**

Question Number	Correct Answer	Mark
7	**The only correct answer is C** ***A** is not correct because this ignores excess oxygen* ***B** is not correct because this assumes all NO and O_2 are used up* ***D** is not correct because this assumes O_2 is not used up*	**(1)**

Question Number	Correct Answer	Mark
8	**The only correct answer is A** ***B** is not correct because X is in Group 4 and this is a Group 6 oxide formula* ***C** is not correct because X is in Group 4 and this is a Group 1 oxide formula* ***D** is not correct because X is in Group 4 and this is a Group 3 oxide formula*	**(1)**

Question Number	Correct Answer	Mark
9	**The only correct answer is B** ***A*** *is not correct because it counts sub-shells not orbitals* ***C*** *is not correct because it includes* $3p_z$ ***D*** *is not correct because it treats the subshells as single orbitals*	**(1)**

Question Number	Correct Answer	Mark
10	**The only correct answer is A** ***B*** *is not correct because ionic radii decrease across the series* ***C*** *is not correct because first ionisation energy decreases down the group* ***D*** *is not correct because this is only true for the first 4 elements in the period.*	**(1)**

Question Number	Correct Answer	Mark
11	**The only correct answer is B** ***A*** *is not correct because it is less easy to polarise bromide than iodide ions.* ***C*** *is not correct because potassium ions polarise anions less than lithium.* ***D*** *is not correct because potassium ions polarise anions less than lithium.*	**(1)**

Question Number	Correct Answer	Mark
12	**The only correct answer is D** ***A*** *is not correct because it is the mass of* $4H_3PO_4$ *divided by the mass of* $P_4 + 5O_2 + P_4O_{10} + 6H_2O$ *(x100)* ***B*** *is not correct because it is the mass of* $4H_3PO_4$ *divided by the mass of* $P_4 + 5O_2 + P_4O_{10}$ *(x100)* ***C*** *is not correct because it is the mass of* $P_4 + 5O_2$ *divided by the mass of* $4H_3PO_4$ *(x100)*	**(1)**

Question Number	Correct Answer	Mark
13(a)	**The only correct answer is A** ***B*** *is not correct because carbonate ions are not spectators* ***C*** *is not correct because carbonate ions are not spectators* ***D*** *is not correct because HCl is fully ionised*	**(1)**

Question Number	Correct Answer	Mark
13(b)	**The only correct answer is C** ***A*** *is not correct because this uses 1/20 instead of 0.2* ***B*** *is not correct because it is based on a 2:1 ratio* ***D*** *is not correct because it is based on 0.4 mol gas forming*	**(1)**

Question Number	Correct Answer	Mark
13(c)	**The only correct answer is C** ***A*** *is not correct because this based on ratio 4.0 : 0.2* ***B*** *is not correct because ratio 1 : 2 for* $NiCO_3$ *:HCl not used* ***D*** *is not correct because it is twice the amount needed*	**(1)**

Question Number	Correct Answer	Mark
14	**The only correct answer is C** ***A*** *is not correct because mol reacting = 0.2 not 0.4* ***B*** *is not correct because mass of solution = 200* cm^3 *and mol reacting = 0.2 and energy transferred should be divided by number of mol* ***D*** *is not correct because mass of solution = 200* cm^3 *and energy transferred should be divided by number of mol*	**(1)**

Question Number	Correct Answer	Mark
15	**The only correct answer is B** ***A*** *is not correct because this is 90% of 30 tonnes of hydrogen* ***C*** *is not correct because this is 160 x 6/16 (ie mass* $3H_2$*/mass* CH_4*)* ***D*** *is not correct because this is 60(the mass of hydrogen) /0.9*	**(1)**

Question Number	Correct Answer	Mark
16	**The only correct answer is D** ***A*** *is not correct because the name is not based on the longest carbon chain in the monomer* ***B*** *is not correct because the name is not based on the longest carbon chain in the monomer* ***C*** *is not correct because this monomer has 7C atoms*	**(1)**

Question Number	Correct Answer	Mark
17	**The only correct answer is A** ***B*** *is not correct because the Ca:C ratio is inverted* ***C*** *is not correct because this is related to mass, not mol* ***D*** *is not correct because Ca:C ratio is incorrect*	**(1)**

Question Number	Correct Answer	Mark
18	**The only correct answer is D** ***A*** *is not correct because only acidified* $KMnO_4$ *gives this product* ***B*** *is not correct because only acidified* $KMnO_4$ *gives this product* ***C*** *is not correct because only acidified* $KMnO_4$ *gives this product*	**(1)**

(Total for Section A = 20 marks)

Question Number	Acceptable Answers	Reject	Mark
19(a)(i)	**M1** % of fourth isotope = 18.60 ALLOW 18.6(0) or 0.186(0) used in the calculation, even if not explicitly stated (1) **M2** $\frac{((64 \times 49.00) + (66 \times 27.90) + (67 \times 4.50)) + 18.6x}{100}$ **=** 65.44 **OR** $\frac{((64 \times 49.00) + (66 \times 27.90) + (67 \times 4.50))}{100}$ = 52.79 $\frac{(65.44 - 52.789) \times 100}{18.60}$ = 68.016 **OR** $\frac{((64 \times 49.00) + (66 \times 27.90) + (67 \times 4.50))}{100}$ = 52.79 (65.44 – 52.79) = 12.65 $\frac{18.6x}{100}$ =12.65 (1) **M3** (x = 68.016) Isotopic mass = 68 (1) Final answers of 68.0 / 68.01/68.02 / 68.016 score 2 Correct answer with no working scores max 2	((64 x 49.00) +(66 x27.90) +(67 x 4.50)) +x =65.44 Isotopic mass to more than 2SF	(3)

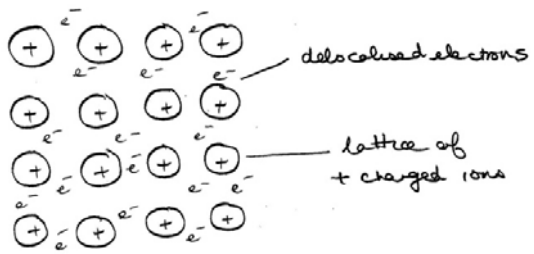
Question Number	Acceptable Answers	Reject	Mark
19(a)(ii)	No difference **And** chemical properties depend on electron(ic) configuration/ electron(ic) structure/ same outer shell electrons ALLOW On number of electrons (which is the same) IGNORE Number of protons is same number of neutrons differs		(1)

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	**M1** To accelerate ions / To make ions travel at same speed / ALLOW Just "acceleration" IGNORE To control velocity (1) **M2** To select ions travelling in same direction / In one direction / on same path ALLOW In a straight line OR To produce a (fine) beam (of ions) OR To focus ions (1) IGNORE To form ions / to deflect ions / to detect ions / to deviate ions / to concentrate ions Description of other parts of mass spectrometer	To change direction (of ions)	(2)

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	Using a magnetic field / an electromagnet field / a magnet / an electromagnet IGNORE By deflection By their mass By their charge		(1)

Question Number	Acceptable Answers	Reject	Mark
19(b)(iii)	Mass/ charge (ratio) ALLOW Mass number for mass Mass to charge ratio / value Mass:charge Mass over charge Mass per (unit) charge Mass divided by charge Mass relative to charge IGNORE *m/e* *m/z* Charge density	 Mass per electron Mass of charge Mass and charge Mass compared to charge	(1)

Question Number	Acceptable Answers	Reject	Mark
19(c)	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$ OR $(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$ OR For 2p and/or 3p: $p_x^2\ p_y^2\ p_z^2$		(1)

Question Number	Acceptable Answers	Reject	Mark
19(d)	 **M1** Diagram of regular lattice of positively charged ions with electrons **between** them and at least 2 rows and 2 columns of ions. ALLOW touching circles. Ions may be shown as particles with +, 2+, or as Zn^{2+} ALLOW Zn^{+} Electrons may be shown as e, e^{-}, — or circle with — charge. Number of electrons should be approximately equal to number of + charges shown (1) IGNORE Lines joining nuclei **M2** Electrons are delocalised (stated or on label of diagram) ALLOW Are mobile/ free/ sea of electrons (1) **M3** Held together by electrostatic forces OR attraction of opposite charges OR forces between + and — charges OR force between positive nuclei/ions and electrons ALLOW Just "forces between charges" if + and — are shown in diagram. (1) IGNORE The attractions are metallic bonds	Electrons just **around** the edge of lattice Circles that overlap Ions labelled protons Electrons double number of + Attractions between atoms and electrons London forces	(3)

(Total for Question 19 = 12 marks)

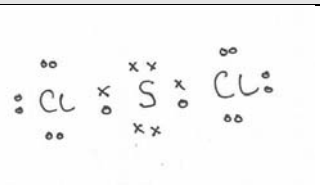
Question Number	Acceptable Answers	Reject	Mark
20(a)(i)	Cross shown above level of P (vertically above 16) (actual value = 2251) ALLOW 2100 – 2400 IGNORE A solid line or dotted line joining the crosses		(1)

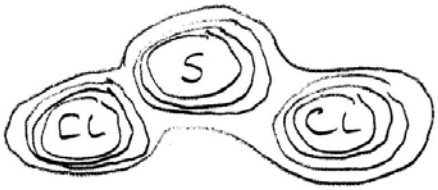
Question Number	Acceptable Answers	Reject	Mark
20(a)(ii)	$Al^{+}(g) \rightarrow Al^{2+}(g) + e^{(-)}$ ALLOW $Al^{+}(g) - e^{(-)} \rightarrow Al^{2+}(g)$ $Al^{+}(g) + e^{(-)} \rightarrow Al^{2+}(g) + 2e^{(-)}$ Equation (1) State symbols ALLOW as long as a reasonable attempt to write the equation e.g. correct third ionisation energy Or $Al^{+}(g) + e^{(-)} \rightarrow Al^{2+}(g)$ (1) IGNORE (g) on electron	Equations with Al^{-}	(2)

Question Number	Acceptable Answers	Reject	Mark
***20(a)(iii)**	**M1** In Mg and Al the second electron removed is from 3s / from the same orbital / from the same sub shell OR In Mg and Al the second electron has the same amount of shielding ALLOW Electron configurations of the Mg^+ **and** Al^+ **ions** (1) **M2** Al has more protons than Mg OR Al has higher nuclear attraction than Mg ALLOW Al has greater nuclear charge (1) **M3** The second electron in Si is removed from a (3)p orbital/sub-shell (1) **M4** (3)p higher (energy) than (3)s OR (3)p needs less energy to remove OR (3)p is more shielded than (3)s (1) IGNORE Atomic radius/ distance from nucleus Comments on full versus half full orbitals	Reference to the charge on the ions	(4)

Question Number	Acceptable Answers	Reject	Mark
20(a)(iv)	Na **And** because electron is removed from a lower quantum shell / lower energy level / shell closer to the nucleus/ full p shell / full outer shell / level 2(p) ALLOW Na^+ has inert gas configuration (so is stable) The + ion with smallest (ionic) radius is Na^+ Less shielding	K with correct explanation Different shell	(1)

Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	ONE clear difference needed Magnesium chloride conducts when molten OR when liquid OR in (aqueous) solution **and** Sulfur dichloride does not conduct (when solid, liquid or gas)	 If no state mentioned	(1)

Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	 Two single bonds each with one shared pair of electrons (1) Rest of diagram (remaining electrons) (1) ALLOW circles for dots reversed symbols for electrons Shared pair beside each other Non bonded electrons not shown in pairs IGNORE Inner electrons even if incorrect Bond angles	All electrons shown the same	(2)

Question number	Acceptable Answers	Reject	Mark
20(b)(iii)	 Diagram with **at least one** contour line going round all three atoms ALLOW diagrams showing three unlabelled atoms diagram with **at least one** contour line going round one S and both Cl diagrams without inner contour lines round individual atoms diagrams without indentations IGNORE Orientation/ bond angles of the three atoms	Ions in diagram round just 2 nuclei round S and Cl_2	(1)

Question Number	Acceptable Answers	Reject	Mark
20(b)(iv)	There is no overlap of the (contour) lines around each ion OR there are separated circles / each ion has discrete contour lines/ contour line **do not** go around more than one nucleus there are gaps between ions/ electron density is zero between ions ALLOW Contour lines do not join Information on diagram Separate circles round Mg^{2+} and $2Cl^-$  	No overlap of orbitals Mg^{2+} and Cl_2	(1)

Question Number	Acceptable Answers	Reject	Mark
20(c)(i)	$Mg^{2+}(g) + 2Cl(g) (+2e^{-})$ ↑ **and** $Mg^{+}(g) + 2Cl(g) (+e^{-})$ (1) ↑ $Mg(g) + 2Cl(g)$ (1) ↑ $Mg(g) + Cl_2 (g)$ (1) ↑ $(Mg(s) + Cl_2 (g))$ ↓ $MgCl_2 (s)$ (1) ALLOW Atomisation of Mg and Cl_2 in either order Ionisation of Mg before atomisation of Cl_2 IGNORE Number of electrons shown Missing state symbol for chlorine Values added beside arrows	$2Cl^{-}(g)$ on top line	(4)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>20(c)(ii)</td><td>Lattice energy =
-641.3 –(147.7 + 738 + 1451 + 2(121.7) + 2(-348.8))

= -2523.8 (kJ mol^{-1})

Correct method (1)

Final answer with sign (1)

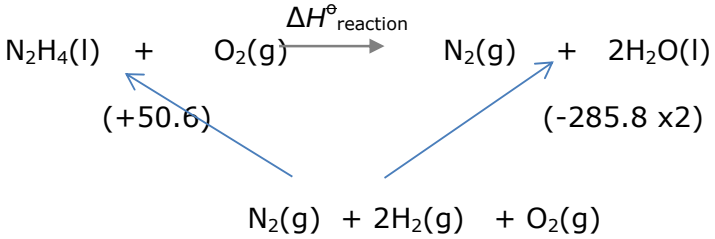
ALLOW
kJ/mol, kJ mol^{-}
Final answer with no working scores (2)

IGNORE
SF except 1 or 2 SF

COMMON ERRORS

<table><tr><td>-2872.6</td><td>Omission of 2x EA of Cl</td><td>(1)</td></tr><tr><td>-2402.1</td><td>Omission of 2x atomisation of Cl</td><td>(1)</td></tr><tr><td>-2750.9</td><td>Omission of 2x EA of Cl and 2x atomisation of Cl</td><td>(1)</td></tr><tr><td>+2523.8</td><td>Incorrect use of Hess</td><td>(1)</td></tr><tr><td>-3919</td><td>Incorrect sign with atomisation of 2Cl</td><td>(1)</td></tr></table></td><td>Incorrect unit</td><td>(2)</td></tr>
</table>

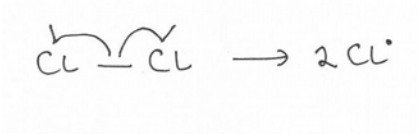
(Total for Question 20 = 19 marks)

Question Number	Acceptable Answers	Reject	Mark
21(a)	 **M1** For correct species with state symbols in the lower box **and** linked to top line by arrows ALLOW Unlabelled arrows / arrows labelled ΔH Addition of $O_2(g)$ shown on both arrows (1) IGNORE Direction of arrows **M2** $\Delta H^{\ominus}_{reaction}$ = (−(285.8 x2) – 50.6) = **−622.2** (kJ mol^{-1}) (1)		(2)

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	**The total enthalpy changes for breaking and making bonds need not be shown if the method of calculating them is shown or if M3 is correct.** **Correct answer with no working scores (3)** **M1** Energy to break bonds: N−N 158 4 x N−H (4x391=)1564 O=O 498 Total: (+)2220 (kJ mol^{-1}) (1) **M2** Energy from making bonds: N ≡ N 945 4 x O−H (4x464=)1856 Total: (−)2801 (kJ mol^{-1}) (1) ΔH = 158 + 4x391 + 498 – 945-4x464 scores M1 and M2 **M3** Value for M1-value for M2 If both correct ΔH (= 2220 – 2801) = **− 581** (kJ mol^{-1}) ALLOW TE for M3 on **two** wrong energy totals (1) Ignore SF except 1 SF	Incorrect sign	(3)

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	**M1** Bond energies are based on substances in the gaseous state OR the Hess cycle is using values for liquid(s) ALLOW Energy is released as water turns from gas to liquid / vaporisation of water is not included (1) IGNORE The reaction is not done under standard conditions **M2** Bond enthalpies (of N-H and O-H) are average / mean for the bond in different compounds OR Bond energies vary with the environment ALLOW Bond energies are different in different substances Mean bond energies do not equal real values (1)	Substances aren't pure Incomplete reaction Heat loss	(2)

(Total for Question 21= 7 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	 Balanced equation including dot for radical(s) and 2Cl• / Cl• + Cl• in products (1) Curly half arrows ending on or close to Cl (1) IGNORE UV above arrow	Use of full arrows	(2)

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	$C_{10}H_{22} + Cl^{\bullet} \rightarrow C_{10}H_{21}^{\bullet} + HCl$ (1) $C_{10}H_{21}^{\bullet} + Cl_2 \rightarrow C_{10}H_{21}Cl + Cl^{\bullet}$ (1) ALLOW equations in either order max(1) for use of wrong alkane IGNORE Curly arrows even if incorrect Non-subscript numbers		(2)

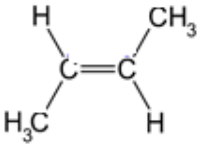
Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	$C_{10}H_{21}^{\bullet} + Cl^{\bullet} \rightarrow C_{10}H_{21}Cl$ (1) $C_{10}H_{21}^{\bullet} + C_{10}H_{21}^{\bullet} \rightarrow C_{20}H_{42}$ (1) ALLOW equations in either order product written $C_{10}H_{21}C_{10}H_{21}$ Termination steps in which a second Cl has been substituted eg $C_{10}H_{20}Cl^{\bullet} + Cl^{\bullet} \rightarrow C_{10}H_{20}Cl_2$ $C_{10}H_{20}Cl^{\bullet} + C_{10}H_{20}Cl^{\bullet} \rightarrow C_{20}H_{40}Cl_2$ Radicals from incorrect alkanes combining IGNORE Curly arrows even if incorrect $2Cl\bullet \rightarrow Cl_2$		(2)

Question Number	Acceptable Answers	Reject	Mark
22(b)	2,2,4-trimethylheptane ALLOW 4,2,2-trimethylheptane 2,2-dimethyl,4-methylheptane	4,6,6-trimethylheptane 2-dimethyl,4-methylheptane 2,2,4-trimethylseptane 2-dimethyl,4-methylheptane	(1)

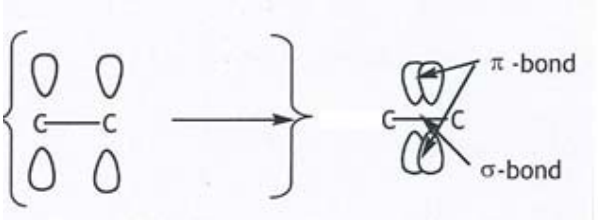
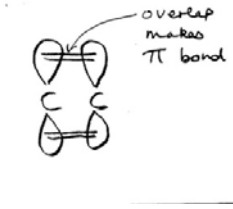
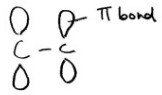
Question Number	Acceptable Answers	Reject	Mark
22(c)	$C_{10}H_{22} + 10½\,O_2 \rightarrow 10CO + 11H_2O$ ALLOW Multiples, 21/2 for $10½\,O_2$, 10.5 O_2 IGNORE State symbols even if incorrect		(1)

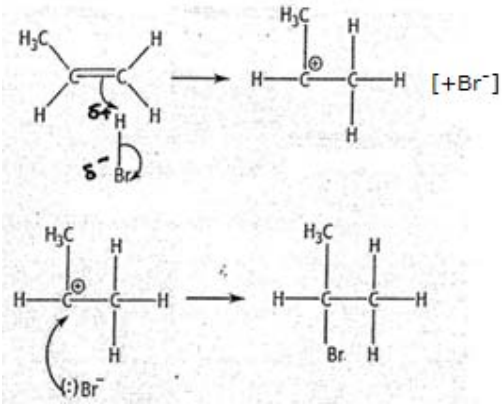
Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	$C_{10}H_{22} \rightarrow C_4H_{10} + C_2H_4 + C_4H_8$ ALLOW structural formulae IGNORE State symbols even if incorrect		(1)

Question Number	Acceptable Answers	Reject	Mark
***22d(ii)**	Any **TWO** of the following: There is no free rotation/ there is restricted rotation (around a C=C bond / pi bond/ in alkenes) (1) There are geometric isomers only if there are (two) different groups on each C at the end of the C=C bond (and some of the products do not meet this requirement) OR reverse argument (1) Ethene/ but-1-ene/ 2-methylprop-1-ene have 2 H atoms at one end of the double bond so would not have different (geometric) isomers ALLOW Answer even if it is not clear which alkene it refers to (1)	Alkenes lack rotation "can't be flipped" Different "molecules" attached.	(2)

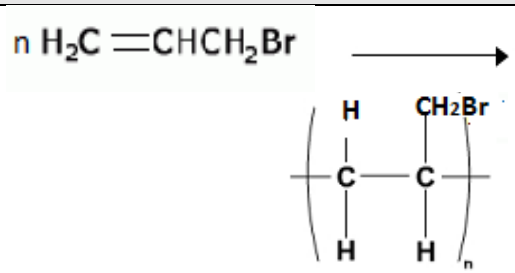
Question Number	Acceptable Answers	Reject	Mark
22(d)(iii)	Diagram of *trans* (*E*) but-2-ene  ALLOW Fully displayed or skeletal formula		(1)

(Total for Question 22 = 12 marks)

Question Number	Acceptable Answers	Reject	Mark
***23(a)**	**M1**: (In C=C) there is good/ "head-on" overlap of orbitals in the sigma bond (1) **M2:** Sideways/ parallel overlap the p orbitals OR The p orbitals are parallel (so overlap is limited) in the pi bond (1) ALLOW Information given on labelled diagram for both M1 and M2 can score (2) eg  OR  **M3:** pi bond breaks more easily/ is weaker (so the alkene is reactive) **OR** Region of high electron density between the carbon nuclei / above and below the C-C bond allows attack by electrophiles (1)	Just 'C=C' consists of 1 sigma and 1 pi bond  	(3)

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	 **M1:** Correct dipole on HBr (1) **M2:** Curly arrow from C=C double bond to $H^{\delta+}$ **and** curly arrow from H-Br bond to $Br^{\delta-}$ (1) **M3:** Structure of intermediate (secondary carbocation) (1) **M4:** Arrow from anywhere on Br^- to C^+ **and** formation of product (1) Mechanism showing primary carbocation does not score MP3, but can score MP4 as a TE if final product is 1-bromobutane. (Giving max 3) Penalise missing bonds and missing H atoms once only	Curly arrow from C atom	(4)

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	A secondary carbocation (intermediate) is more stable OR a primary carbocation is less stable ALLOW $CH_3CH^+CH_3$ is more stable than $CH_2{}^+CH_2\,CH_3$	Just 'the intermediate is more stable' 2-bromopropane is more stable than 1-bromopropane	(1)

Question Number	Acceptable Answers	Reject	Mark
23(c)	 **M1** Structure of polymer **and** extension bonds ALLOW 2 monomer units inside the bracket Absence of brackets if n is correctly positioned IGNORE Structure of monomer (1) **M2** Balancing with n monomers and n after repeat unit ALLOW If dimer is shown 2n monomers and n after repeat unit OR n monomers and n/2 in polymer M2 does not depend on M1 Balancing mark can be awarded if there is an error in drawing the polymer (1)	Bond from C to Br	(2)

(Total for Question 23 = 10 marks)
(Total for Section B = 60marks)

Total for Paper = 80 marks

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom