Mark Scheme (Results)

Summer 2017

Pearson Edexcel IAL
In Chemistry (WCH02) Paper 1
Application of Core Principles of Chemistry

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

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	Answer	Mark
1	**The only correct answer is A** ***B*** *is not correct because nitrogen is an element from period 2 and so is larger than hydrogen from period 1* ***C*** *is not correct because sulfur is an element from period 3 and so is larger than hydrogen from period 1* ***D*** *is not correct because bromine is an element from period 4 and so is larger than hydrogen from period 1*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is B** ***A*** *is not correct because nitrogen less electronegative than fluorine and so creates a smaller bond polarity* ***C*** *is not correct because carbon is less electronegative than fluorine and so creates a smaller bond polarity* ***D*** *is not correct because oxygen is less electronegative than fluorine and so creates a smaller bond polarity*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** ***A*** *is not correct because a diatomic molecule of two atoms with different electronegativity will never be non-polar* ***B*** *is not correct because hydrogen sulfide is not symmetrical due to the lone pairs of electrons on the sulfur creating a v-shaped molecule* ***C*** *is not correct because phosphorus(III) chloride is not symmetrical due to the lone pair of electrons on the phosphorus creating a pyramidal molecular shape*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is D** ***A*** *is not correct because sodium chloride is an ionic substance and thus will not be very soluble in a non-polar liquid* ***B*** *is not correct because the non-polar nature of cyclohexane means that it will be a non-conductor of electricity* ***C*** *is not correct because the non-polar nature of cyclohexane means that there are no dipoles to respond to the charged rod*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is A** ***B*** *is not correct because in this reaction calcium ions are reduced* ***C*** *is not correct because there is no change to the oxidation state of the calcium ions in this reaction* ***D*** *is not correct because there is no change to the oxidation state of the calcium ions in this reaction*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is D** ***A*** *is not correct because this combination of half equations does not balance for electron transfer* ***B*** *is not correct because electrons are never included in an ionic equation and their numbers do not balance* ***C*** *is not correct because the charges either side of the equation do not balance and this is because the electron transfer does not balance*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is B** ***A*** *is not correct because barium ions give a green and not a red flame colour* ***C*** *is not correct because potassium ions give a lilac and not a red flame colour* ***D*** *is not correct because sodium ions give a yellow and not a red flame colour*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is D** ***A*** *is not correct because this is the wrong trend for both carbonate and nitrate decomposition* ***B*** *is not correct because is the wrong trend for carbonate decomposition* ***C*** *is not correct because is the wrong trend for nitrate decomposition*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is C** ***A*** *is not correct because magnesium hydroxide is not the more soluble hydroxide* ***B*** *is not correct because magnesium hydroxide is not the more soluble hydroxide nor is strontium sulfate the more soluble sulfate* ***D*** *is not correct because strontium sulfate is not the more soluble sulfate*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** ***A*** *is not correct because the measurement uncertainty of a burette has to be doubled because there are two readings taken and so the percentage uncertainty is not the lowest* ***B*** *is not correct because although the measurement uncertainty of the measuring cylinder is only for one reading it is larger than that of the pipette* ***D*** *is not correct because although the measurement uncertainty of the volumetric flask is only for one reading it is larger than that of the pipette*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is C** ***A*** *is not correct because chlorine would displace the bromide ions to form bromine which is coloured* ***B*** *is not correct because this is the colour of chlorine water but a displacement reaction will occur to form bromine* ***D*** *is not correct because this is the colour of iodine in an organic non-polar solvent and iodine is not involved here*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is C** ***A*** *is not correct because application of the silver halide solubility trend to silver fluoride means that it would be soluble in both dilute and concentrated ammonia* ***B*** *is not correct because silver chloride is soluble in dilute ammonia* ***D*** *is not correct because silver iodide is not soluble in dilute ammonia*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is B** ***A*** *is not correct because the height of the peak for T_2 should be lower than that for T_1 so that the area under the curve remains the same* ***C*** *is not correct because the height of the peak for T_2 should be lower than that for T_1 and not higher so that the area under the curve remains the same* ***D*** *is not correct because the peak for T_2 should be to the right of that for T_1 so that the distribution of energies of the particles reflects an increase in energy due to the higher temperature*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is A** ***B*** *is not correct because the change to a different strong monobasic acid has no effect on the reaction rate* ***C*** *is not correct because the change to a strong dibasic acid of half the concentration has no overall effect to reaction rate* ***D*** *is not correct because pressure does not affect the reaction between a solid and a liquid*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is D** ***A*** *is not correct because the trend in electronegativity differences is opposite to the reactivity trend and thus is not the most significant factor in reaction rate* ***B*** *is not correct because the trend in bond enthalpy between carbon and the halogen is the most significant factor and not the ionisation energy which is of the unbonded element* ***C*** *is not correct because the trend in bond enthalpy between carbon and the halogen is the most significant factor and not the oxidising ability of the halogen*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** ***A*** *is not correct because ultraviolet radiation does break up an oxygen molecule regardless of the fact that it does not have a dipole* ***B*** *is not correct because it is infrared radiation and not ultraviolet radiation that results in bond vibration* ***D*** *is not correct because ultraviolet radiation produces oxygen free radicals and not oxygen ions*	**(1)**

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Question Number	Answer	Mark
17	**The only correct answer is C** ***A*** *is not correct because both propanal and propanone mass spectra will have a peak for the molecular ion, m/e=58* ***B*** *is not correct because both propanal and propanone will lose one hydrogen atom in a mass spectrometer to give a fragment ion peak with an m/e=57* ***D*** *is not correct because both propanal and propanone will give a methyl fragment ion peak with an m/e=15*	**(1)**

Question Number	Answer	Mark
18	**The only correct answer is A** ***B*** *is not correct because butan-2-ol would be oxidised to butanone which would not have an infrared spectrum peak for O−H bonds* ***C*** *is not correct because butan-2-ol would be oxidised to butanone which would have an infrared spectrum peak for C=O but not O−H bonds* ***D*** *is not correct because butan-2-ol would be oxidised to butanone which would have an infrared spectrum peak for C=O bonds but not C−O nor O−H bonds*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is B** ***A*** *is not correct because carbon dioxide is produced naturally by all living creatures and so is not just the result of mankind's activity* ***C*** *is not correct because methane is produced naturally by, for example flatulence from cows, and so is not just the result of mankind's activity* ***D*** *is not correct because water vapour in the atmosphere as a result of the water cycle and not due to mankind's activity*	**(1)**

Question Number	Answer	Mark
20	**The only correct answer is D** ***A*** *is not correct because an increase in the number of protons would result in an increase and not a decrease in the magnitude of the ionisation energy* ***B*** *is not correct because the neutrons would have zero effect, but an increase in the number of protons would result in an increase and not a decrease in the magnitude of the ionisation energy* ***C*** *is not correct because the number of electrons in the outer shell is not the best explanation for a less endothermic ionisation energy value*	**(1)**

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)	The titres (for titration 1 and 2) are concordant/ within ±0.20 (cm^3) or any other value less than 0.2 e.g. 0.05. IGNORE Close/near/similar	The mean titre doesn't change Any reference to the third titre	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	(From) blue-black / blue / black (to) colourless Both required. IGNORE clear/shades of colours		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	Iodine/I_2	I Iodide/I^-	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	(Thiosulfate n=0.0600 x 0.01985=) 1.191×10^{-3} /0.001191 (mol) IGNORE SF except 1SF		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	(Iodine n=$1.191 \times 10^{-3} \div 2$=) 5.955×10^{-4} /0.0005955 (mol) TE ans to (a)(i) ÷2 IGNORE SF		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	**Marking point 1** **Division by 3** $n=5.955 \times 10^{-4} \div 3 = 1.985 \times 10^{-4}$ **(1)** **Marking point 2** **Multiplication by 214** Potassium iodate $n= 1.985 \times 10^{-4} \times 214$ **(1)** 4.2479×10^{-2} /0.042479 (g) **Marking point 3** **Multiplication by 1000** $(4.2479 \times 10^{-2} \times 1000=42.479)$ **and** **Answer to3sf** 42.5 (mg) **(1)** Answer without working scores (3)		**(1)**

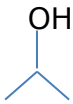
Question Number	Acceptable Answers	Reject	Mark
21(c)(iv)	NOTE If the calculated mass of KIO_3 in the tablet is more than 85 mg then max (1) for sensible comment on suitability of use including overdose, splitting tablets Any **two** of the following four points the content is less than that stated/lower than 85 mg/ lower than the daily dose/lower than 170 mg/ insufficient/only 42.5 mg or value in (iii) **(1)** there could be decomposition **(1)** there could be toxic products **(1)** four tablets (per day) could be taken (to give the stated dose of 170 mg) which could be shown in a calculation OR If mass calculated is not 42.5 (mg) but less than 85 mg then need calculated number/fraction of tablets to give 170 mg **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(v)	(Number of moles of H^+ =2.15 x 10^{-4} x 6 =) 1.29 x 10^{-3}/0.00129 (mol) **(1)** (volume of HCl = 1.29 x 10^{-3} ÷ 0.1=) 0.0129 dm^3/12.9 cm^3 /0.0129 dm^3 /1.29 x 10^{-2} dm^3 ALLOW If value is not multiplied by 6 M2 = 2.15 cm^3/0.00215 dm^3 **(1)** (appropriate volume) 25 cm^3/ 0.025 dm^3 / 2.5 x 10^{-2} dm^3 ALLOW any within the range of 14-25 cm^3/ 0.014-0.025 dm^3 **(1)**	<14	**(3)**

Question Number	Acceptable Answers	Reject	Mark
21(d)i	($6KOH + 3I_2 \rightarrow 5KI + KIO_3 + 3H_2O$ Ox.No.) 0 −1 (+)5 **(1)** (Type of reaction) Disproportionation **(1)** Ignore redox		**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(d)(ii)	Hot (concentrated KOH) COMMENT ALLOW Any indication of heating, including warm, reflux IGNORE reference to NaOH/alkali/dilute	Other conditions and reagents eg pressure, catalyst	**(1)**

(TOTAL FOR QUESTION 21 = 16 MARKS)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>22(a)</td><td>
<table>
<tr><th>Skeletal Formula</th><th>Name</th><th>Classification</th></tr>
<tr><td>  </td><td>Propan-1-ol
ALLOW
Propane-1-ol
1-propanol</td><td>Primary/1°</td></tr>
<tr><td>  </td><td>Propan-2-ol
ALLOW
Propane-2-ol
2-propanol</td><td>Secondary/2°</td></tr>
</table>
Accept rows in any order
One mark for each column correct
NOTE
Classification is dependent on correct name or formulae or near miss

IGNORE
angles, length and punctuation

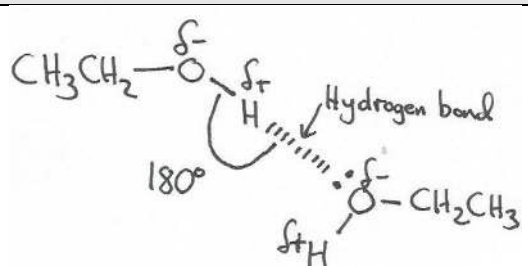
ALLOW
One mark for one correct row if no other marks awarded
</td><td>Horizontal --HO

Prop-1-ol

Prop-2-ol</td><td>(3)</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ Species **(1)** Balancing **(1)** IGNORE state symbols even if incorrect M2 depends on correct species		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	Any ethanal (that evaporates) is condensed (back into the flask to be further oxidised to ethanoic acid) ALLOW Just condensation or change of state from gas to liquid OR Prevents (ethanal) vapour escaping OR Any indication that a liquid is returning to the flask e.g. (Ethanal) drips back into the flask IGNORE Any reference to ethanol		**(1)**

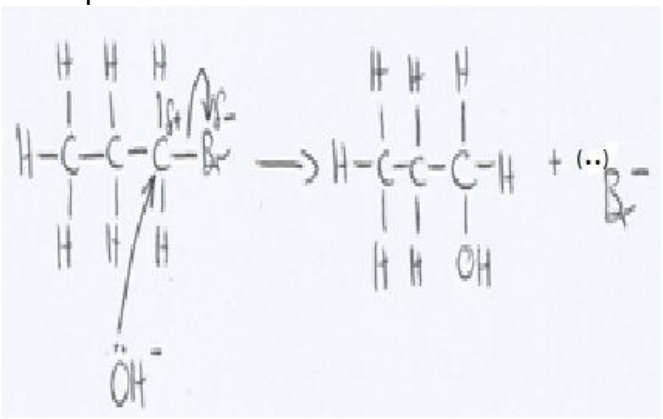
Question Number	Acceptable Answers	Reject	Mark
22(b)(iii)	 Correct dipoles on at least one O-H/O----H **(1)** hydrogen bond must come from a H attached to O and go to a lone pair on O **(1)** Linear shape for O----H-O **and** 180° angle correctly indicated with semi-circle **(1)** If 2 H bonds are shown both must be correct.	+/−	**(3)**

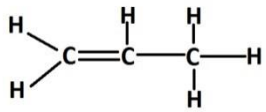
Question Number	Acceptable Answers	Reject	Mark
22(b)(iv)	None of the hydrogens in ethanal are bonded to an oxygen atom (or another highly electronegative atom) OR There is no OH bond in ethanal OR Hydrogen bonds only form if H is bonded to F,O or N	Hydroxide	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	$CH_3OH + PCl_5 \rightarrow CH_3Cl + POCl_3 + HCl$ ALLOW Multiples $POCl_3$ in any order e.g. PCl_3O IGNORE state symbols even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	Steamy / white / misty fumes IGNORE Effervescence / gets hot / PCl_5 dissolves	White smoke Additional observations	**(1)**

Question Number	Acceptable Answers	Reject	Mark
***22(c)(iii)**	ANY 3 OF 4 Potassium chloride and sulfuric acid produce hydrogen chloride/ $KCl + H_2SO_4 \rightarrow HCl + KHSO_4$ ALLOW $2KCl + H_2SO_4 \rightarrow 2HCl + K_2SO_4$ OR Chloride ions are not easily oxidised/poor reducing agents **(1)** Hydrogen chloride reacts with ethanol to produce chloroethane/ $C_2H_5OH + HCl \rightarrow C_2H_5Cl + H_2O$ **(1)** (Hydrogen iodide is not made because) the iodide ions are oxidised (to iodine)/ Iodide ions (powerful) reducing agents/ Hydrogen iodide is a reducing agent/ $2I^- \rightarrow I_2 + 2e^-$ **(1)** Sulfuric acid reduced to $S/SO_2/H_2S$ **(1)** IGNORE State symbols even if incorrect		**(3)**

Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	Dipole on 1-bromopropane **and** the lone pair on the oxygen and the charge on the hydroxide ion **(1)** Curly arrow from hydroxide ion to carbon and curly arrow from C-Br **bond** to Br (or just beyond) **(1)** Products of propan-1-ol **and** bromide ion/sodium bromide/potassium bromide **(1)** Ignore any transition state drawn If S_N1 all three marks can be awarded as M2 can be given for curly arrow to carbocation Exemplar mechanism  If the wrong halogenoalkane is used then only M1 and M2 can be awarded for suitable dipoles and curly arrows.	Lone pair on H	3

Question Number	Acceptable Answers	Reject	Mark
22(d)(ii)	(Name of reaction) Elimination **(1)** (Displayed formula of product)  ALLOW Undisplayed CH_3 **(1)** IGNORE Any structural/skeletal formulae Any other product even if incorrect	Electrophilic	2

Question Number	Acceptable Answers	Reject	Mark
22(e)	Either of the matching pairs of response Addition of sodium / Na **(1)** Effervescence/Fizzing/Bubbles IGNORE H_2/hydrogen evolved Allow If evaporated to dryness then a white solid is seen **(1)** IGNORE Sodium dissolves Just 'white solid' OR Addition of named carboxylic acid and strong acid **(1)** Sweet/fruity 'ester' smell **(1)** No TE on incorrect reagent	PCl_3 $Na_2Cr_2O_7/H^+$ Scores (0) Physical techniques incorrect gas	2

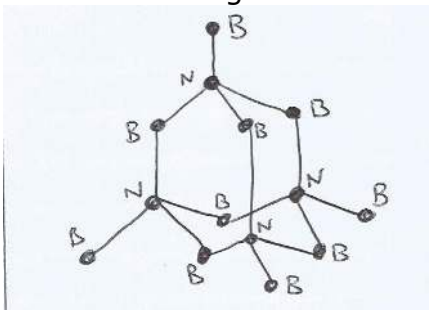
TOTAL FOR QUESTION 22 = 22 MARKS

(TOTAL FOR SECTION B = 38 MARKS)

Section C

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	$H_3BO_3 + NH_3 \rightarrow BN + 3H_2O$ ALLOW multiples IGNORE state symbols even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	Nitrogen is an unreactive gas/ to prevent (nitrogen) oxides from forming / to prevent oxidation (of ammonia) ALLOW inert / won't react with other things/ no oxygen present/prevent combustion IGNORE stable		**(1)**

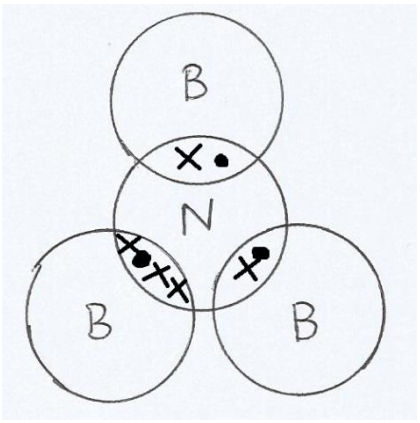
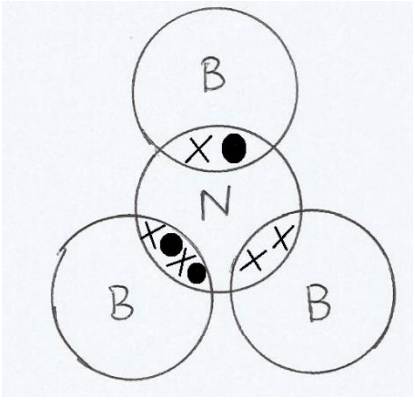
Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	Diagram where the boron and nitrogen atoms alternate throughout the structure, e.g.  Accept use of alternative ways of labelling e.g key		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	(Bond angle) 109.5° **(1)** (shape) Tetrahedral **(1)** Four bonded electron pairs/ Four areas of electron density (around each carbon) **(1)** Repulsion between electron pairs to give minimum repulsion (that results in tetrahedral shape) ALLOW Repulsion to give maximum separation of electron pairs/get as far away from each other as possible **(1)**	Atom repulsion	**(4)**

Question Number	Acceptable Answers	Reject	Mark
***23(c)(i)**	**Marking point 1** Equilibrium shifts to the right/ Equilibrium favours the formation of diamond IGNORE just yield **(1)** **Marking point 2** Because the reaction is endothermic (high temperature favours the formation of diamond) **(1)** M2 depends on M1 or near miss, but these points can be in any order **Marking point 3** (High) pressure favours the formation of higher density diamond ALLOW smaller volume for higher density **(1)** **Marking point 4** There are (many) strong covalent bonds to break (and the rate is slow) ALLOW High temperature and pressure needed because activation energy is high **(1)**	Any reference to moles or molecules Intermolecular forces	**(4)**

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	A catalyst lowers the activation energy for the reaction **(1)** By providing an alternative pathway for the reaction **(1)** So the same number of particles can react at a lower temperature /more particles have sufficient energy to react/more particles exceed E_A ALLOW Molecules/atoms for particles **(1)**		**(3)**

Question Number	Acceptable Answers	Reject	Mark
23(d)	Carbon dioxide/carbon monoxide OR CO_2/CO	Soot Carbon C	**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	Single dot and cross in overlap between top and right-hand boron atoms and the nitrogen atom **and** Three crosses and one dot in the overlap area between left-hand boron atom and the nitrogen atom  IGNORE Other electrons around the boron atoms. ALLOW  The single bond and the dative bonds can be reversed	Any additional electrons around the N	**(1)**

Question Number	Acceptable Answers	Reject	Mark
***23(e)(ii)**	In graphite each carbon atom has **three** (covalent) bonds (to carbon atoms) **(1)** With (one) electron **delocalised** (between the layers of hexagonal rings which can move and carry charge) ALLOW JUST **delocalised** electrons **(1)** The electrons in hexagonal boron nitride are all fixed in position / localised / not delocalised / not free moving / not mobile **(1)**	Just 'free electrons'	**(3)**

Question Number	Acceptable Answers	Reject	Mark
23(e)(iii)	London forces / dispersion forces ALLOW van der Waals' forces **(1)** Instantaneous dipole due to (asymmetric) electron distribution/movement **(1)** Induced dipoles (in adjacent layers) ALLOW In molecules/atoms **(1)**	Permanent dipole/ Polar bonds	**(3)**

TOTAL FOR SECTION C (QUESTION 23) = 22 MARKS

TOTAL FOR PAPER = 80 MARKS

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