Mark Scheme (Results)

Summer 2017

Pearson Edexcel IAL
In Chemistry (WCH04) Paper 01
General Principles of Chemistry II -
Transition Metals and Organic Chemistry

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General marking guidance

- This mark scheme provides a list of acceptable answers for this paper. Candidates will receive credit for all correct responses but will be penalised if they give more than one answer where only one is required (e.g. putting an additional cross in a set of boxes). If a candidate produces more written answers than the required number (two instead of one, three instead of two etc), only the first answers will be accepted. Free responses are marked for the effective communication of the correct answer rather than for quality of language but it is possible that, on some occasions, the quality of English or poor presentation can impede communication and loose candidate marks. It is sometimes possible for a candidate to produce a written response that does not feature in the mark scheme but which is nevertheless correct. If this were to occur, an examiner would, of course, give full credit to that answer.
- 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	Answer	Mark
1	**1. The only correct answer is C** ***A*** *is not correct because because the acid forms of 1 and 2 do not correspond to the base forms of 1 and 2* ***B*** *is not correct because because the acid forms of 1 and 2 do not correspond to the base forms of 1 and 2* ***D*** *is not correct because because the acid forms of 1 and 2 do not correspond to the base forms of 1 and 2*	**(1)**

Question Number	Answer	Mark
2	**2. The only correct answer is C** ***A*** *is not correct because it is acidic* ***B*** *is not correct because it is acidic* ***D*** *is not correct because it is acidic*	**(1)**

Question Number	Answer	Mark
3	**3. The only correct answer is A** ***B*** *is not correct because the pH of the substances are not as accurately known* ***C*** *is not correct because the pH of the substances are not as accurately known* ***D*** *is not correct because two solutions ensure the meter is calibrated across a pH range*	**(1)**

Question Number	Answer	Mark
4(a)	**4(a). The only correct answer is D** ***A*** *is not correct because has an incorrect sign* ***B*** *is not correct because are incorrect values* ***C*** *is not correct because are incorrect values*	**(1)**

Question Number	Answer	Mark
4(b)	**4(b). The only correct answer is C** ***A*** *is not correct because the value is incorrect* ***B*** *is not correct because the value is incorrect* ***D*** *is not correct because the value is incorrect*	**(1)**

Question Number	Answer	Mark
4(c)	**4(c). The only correct answer is A** ***B*** *is not correct because the value is incorrect* ***C*** *is not correct because the value is incorrect* ***D*** *is not correct because the value is incorrect*	**(1)**

Question Number	Answer	Mark
4(d)	**4(d). The only correct answer is B** ***A*** *is not correct because the value is incorrect* ***C*** *is not correct because the value is incorrect* ***D*** *is not correct because the value is incorrect*	**(1)**

Question Number	Answer	Mark
5(a)	**5(a). The only correct answer is A** ***B*** *is not correct because raising the pressure increases the rate of a gas reaction* ***C*** *is not correct because there is no change to the equilibrium yield* ***D*** *is not correct because raising the pressure increases the rate of a gas reaction*	**(1)**

Question Number	Answer	Mark
5(b)	**5(b). The only correct answer is D** ***A*** *is not correct because as the ⊿H expressions are wrong* ***B*** *is not correct because* K_c *is wrong* ***C*** *is not correct because as the ⊿H expressions are wrong*	**(1)**

Question Number	Answer	Mark
6	**6. The only correct answer is C** ***A*** *is not correct because the water is still neutral* ***B*** *is not correct because the water is still neutral* ***D*** *is not correct because the two concentrations are equal*	**(1)**

Question Number	Answer	Mark
7	**7. The only correct answer is B** ***A*** *is not correct because an amide forms* ***C*** *is not correct because the solution is strongly acidic* ***D*** *is not correct because the ester is wrong*	**(1)**

Question Number	Answer	Mark
8	**8. The only correct answer is D** ***A*** *is not correct because they do not explain the lack of optical activity* ***B*** *is not correct because they do not explain the lack of optical activity* ***C*** *is not correct because it is incorrect*	**(1)**

Question Number	Answer	Mark
9	**9. The only correct answer is B** ***A*** *is not correct because an excess of water is used* ***C*** *is not correct because the gaseous salt is not used* ***D*** *is not correct because the gaseous salt is not used*	**(1)**

Question Number	Answer	Mark
10	**10. The only correct answer is B** ***A*** *is not correct because lattice energies are always negative* ***C*** *is not correct because the enthalpy change of hydration is not positive* ***D*** *is not correct because the enthalpy change of hydration is not positive*	**(1)**

Question Number	Answer	Mark
11	**11. The only correct answer is A** ***B*** *is not correct because this is not the correct reason for hydrogenating vegetable oils for low-fat spreads* ***C*** *is not correct because this is not the correct reason for hydrogenating vegetable oils for low-fat spreads* ***D*** *is not correct because this is not the correct reason for hydrogenating vegetable oils for low-fat spreads*	**(1)**

Question Number	Answer	Mark
12	**12. The only correct answer is A** ***B*** *is not correct because is not a true statement* ***C*** *is not correct because is not a true statement* ***D*** *is not correct because is not a true statement*	**(1)**

Question Number	Answer	Mark
13	**13. The only correct answer is B** ***A*** *is not correct because this is are all less polar so would take less time* ***C*** *is not correct because this is are all less polar so would take less time* ***D*** *is not correct because this is are all less polar so would take less time*	**(1)**

Question Number	Answer	Mark
14(a)	**14(a). The only correct answer is D** ***A*** *is not correct because the compound is Z* ***B*** *is not correct because the compound is Z* ***C*** *is not correct because the hydroxyl group is not in the 7 position*	**(1)**

Question Number	Answer	Mark
14(b)	**14(b). The only correct answer is B** ***A*** *is not correct because m/e are all wrong* ***C*** *is not correct because m/e are all wrong* ***D*** *is not correct because m/e are all wrong*	**(1)**

Question Number	Answer	Mark
15	**15. The only correct answer is D** ***A*** *is not correct because they are addition polymers* ***B*** *is not correct because they are addition polymers* ***C*** *is not correct because because it is formed from two different monomers*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Correct Answer	Reject	Mark
16(a)(i)	Grind the reactant(s) together (using a pestle and mortar) OR Use powdered reactants OR Stir/mix (the reactants together) OR Add a **few drops** of water ALLOW **dampen** with water IGNORE Increase surface area Make solid particles smaller Add a catalyst	Heating/ raising temperature Change in pressure Addition of product Removal of reactants Dissolve	**(1)**

Question Number	Correct Answer	Reject	Mark
16(a)(ii)	**Moist/damp** red litmus turns blue ALLOW **moist/damp** universal indicator paper turns blue ALLOW UI for universal indicator OR (Glass rod dipped in) **concentrated** HCl gives **white** smoke / (dense) **white** fumes ALLOW (Pass gas into) HCl gas/fumes IGNORE (white) solid / ammonium chloride / NH_4Cl	Steamy /misty fumes/ ppt	**(1)**

Question Number	Correct Answer	Reject	Mark
16(b)(i)	+202.9 + 2 x 192.3 = +587.5 −[(99.7 + 2 x 94.6) (= −288.9)] = +298.6 J K^{-1} mol^{-1} Correct answer with no working 3 **M1** All correct values from Data booklet **(1)** **M2** Both multiples **(1)** **M3** Correct numerical answer with **sign** and **units** **(1)** No multiples gives +200.9 1 x 192.3 gives +106.3 1 x 94.6 gives +393.2 TE at each stage IGNORE SF Use of enthalpies of formation and other strange calculations using standard entropies of elements enables M2 and M3.		**(3)**

Question Number	Correct Answer	Reject	Mark
16(b)(ii)	Sign is positive as expected, as solids react to form a gas (and solid) ALLOW Yes because a gas is formed TE if b(i) is negative, then allow not as expected with **same reason** IGNORE Disorder increases	1 mole of gas forms	**(1)**

Question Number	Correct Answer	Reject	Mark
16(c)(i)	**M1** $\Delta S^{\ominus}_{total} = \Delta S^{\ominus}_{system} + \Delta S^{\ominus}_{surroundings}$ $\Delta S^{\ominus}_{surroundings} = \Delta S^{\ominus}_{total} - \Delta S^{\ominus}_{system}$ $= 227.5 - 298.6$ $= -71.1$ (J K^{-1} mol^{-1}) **(1)** $\Delta S^{\ominus}_{surroundings} = -\frac{\Delta H^{\ominus}}{T}$ $\Delta H^{\ominus} = -T\,\Delta S^{\ominus}_{surroundings}$ $= -(-71.1 \times 298)$ $= +21187.8/21200$ J mol^{-1}/+21.2 kJ mol^{-1} **M2** Final value **(1)** **M3** Final sign and unit **(1)** Fully correct answer with no working 3 Accept all SF except one ALLOW TE from b(i) and internal errors 200.9 gives (+)26.6 gives -7.2968 etc 106.3 gives (+)121.1 gives -36.1176 etc 393.2 gives −165.7 gives + 49.768 etc Using $\Delta H^{\ominus} = -T\,\Delta S^{\ominus}_{total}$ Gives $\Delta H^{\ominus} = -67.795$ kJ mol^{-1} scores (1)		**(3)**

Question Number	Correct Answer	Reject	Mark
16(c)(ii)	The temperature would fall **and** as the reaction is endothermic/energy absorbed from surroundings / $\Delta H^{\ominus}$ is positive ALLOW TE from sign of c(i)		**(1)**

(Total for Question 16 = 10 marks)

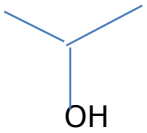
Question Number	Correct Answer	Reject	Mark
17(a)(i)	$CH_3COCH_3 + I_2 \rightarrow CH_3COCH_2I + H^+ + I^-$ OR $CH_3COCH_3 + I_2 \rightarrow CH_3COCH_2I + HI$ OR Organic product may be given as CH_2ICOCH_3 ALLOW Extra H^+ on each side H^+ over the arrow IGNORE di and tri substituted products		**(1)**

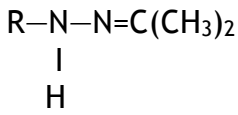
Question Number	Correct Answer	Reject	Mark
17(a)(ii)	H^+ / HI produced / a product **and** catalyses the reaction OR the reaction is self-catalysing / autocatalytic IGNORE References to mechanism	Temperature changes Exothermic reaction	**(1)**

Question Number	Correct Answer	Reject	Mark
17(b)(i)	Triiodomethane/iodoform/CHI_3 **(1)** Sodium ethanoate / $CH_3COO^-Na^+$ / CH_3COONa OR Ethanoate / CH_3COO^- ALLOW Ethanoic acid, CH_3COOH **(1)** IGNORE Inorganic products unless incorrect	CH_3I	**(2)**

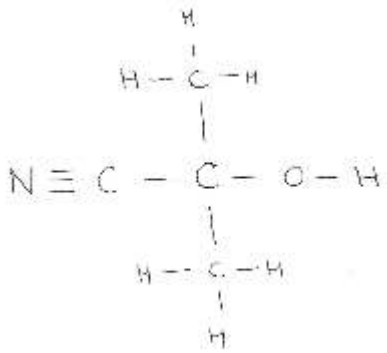
Question Number	Correct Answer	Reject	Mark
17(b)(ii)	A (pale) yellow precipitate **(1)** ALLOW solid / crystals for precipitate Antiseptic smell **(1)** IGNORE Strong smell Specified colour of iodine solution fades etc	Fizzing/ Bubbling fumes	**(2)**

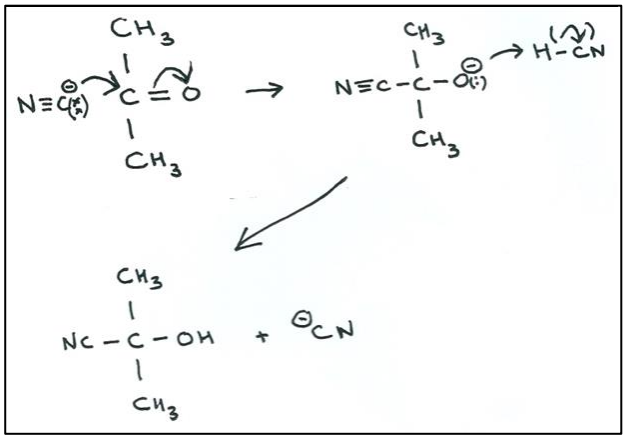
Question Number	Correct Answer	Reject	Mark
17(c)(i)	Lithium tetrahydridoaluminate((III)) reacts with /reduces water / is oxidised by water (to form hydrogen) **(1)** IGNORE solubility arguments (Dry) ethoxyethane/(diethyl) ether should be used ALLOW Any named ether **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
17(c)(ii)	 OR alkoxide ion skeletal formula with charge OH can point up or down, or be on one of three downward bonds IGNORE structural/displayed formulae ALLOW various bond angles and –O–H	–H–O	**(1)**

Question Number	Correct Answer	Reject	Mark
17(d)(i)	 Notice the N=C double bond must be shown ALLOW displayed or part-displayed formulae IGNORE bond angles		**(1)**

Question Number	Correct Answer	Reject	Mark
17(d)(ii)	Test for a **carbonyl** compound OR Test for aldehydes **and** ketones ALLOW **carbonyl** group **(1)** IGNORE Just C=O Identification of a specific carbonyl compound (from melting temperature of derivative and comparison with Data booklet value) ALLOW To form a solid (compound) so that its melting temperature can be measured OR To prepare a derivative **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
17(e)(i)	 All bonds must be shown IGNORE bond angles **(1)** 2-hydroxy-2-methylpropa(n)(e)nitrile ALLOW 2-methyl-2-hydroxypropa(n)(e)nitrile 2,2-hydroxymethylpropa(n)(e)nitrile Hydroxyl and hydroxo are acceptable alternatives to hydroxy **(1)** IGNORE Omitted punctuation		**(2)**

Question Number	Correct Answer	Reject	Mark
17(e)(ii)	Ignore absence of lone pairs in drawn mechanism  **M1** Arrow from any part of the **carbon** of CN^- (including the non-bonding electrons if shown) to the carbon of C=O ALLOW Negative charge on the nitrogen **(1)** **M2** Arrow from C=O double **bond** to oxygen or just beyond **(1)** **M3** Correct intermediate including charge COMMENT Notice if bonds are C-NC to attach the nitrile group this is penalised. Had the M1 arrow gone from nitrogen to the carbon of C=O this attachment would also be penalised effectively for a second time. **(1)** **M4** Arrow from any part of the resulting O^- (including the charge) to hydrogen of HCN **and** formation of CN^- OR Arrow from any part of the resulting O^- (including the charge) to hydrogen of HCN **and** arrow from H-C bond to carbon or nitrogen **(1)** IGNORE Dipoles unless incorrect or shown as full charges	No negative charge e.g. just CN HCN	**(4)**

Question Number	Correct Answer	Reject	Mark
17(e)(iii)	**Method 1** **M1** Initial concentrations 0.05 and 0.1 (mol dm^{-3}) **(1)** At equilibrium **M2** This mark is conditional on some attempt at a calculation of initial concentrations, when TE is allowed from their calculated value. [propanone] = 0.05 – 0.034 = 0.016 **AND** [HCN] = 0.10 – 0.034 = 0.066 **(1)** **M3** $K_c = \frac{0.034}{0.016 \times 0.066}$ M3 consequential on some attempt, that is a clear subtraction, to find equilibrium concentration **(1)** **M4** = 32.197 = 32 $dm^3\,mol^{-1}$ **(1)** **Method 2** $(CH_3)_2CO$ / HCN / $(CH_3)_2C(OH)CN$ Initital amount: 0.01 / 0.02 / 0 Equilibrium amount: 0.0032 / 0.0132 / 0.0068 Equilibrium concentration: 0.016 / 0.066 / 0.034 **M1** First row **(1)** **M2** This mark is conditional on some attempt at a calculation of initial amounts, when TE is allowed from their calculated value. Third row **(1)** **M3** $K_c = \frac{0.034}{0.016 \times 0.066}$ M3 consequential on some attempt, that is a clear subtraction, to find equilibrium concentration **(1)** **M4** = 32.197 = 32 $dm^3\,mol^{-1}$ **(1)** Correct value to 2 SF and units with no working (4) Use of 0.1 and 0.2 mol dm^{-3} concentrations gives 3.1 $dm^3\,mol^{-1}$ (2) Use of 0.034/(0.1 x0.2) = 1.7 $dm^3\,mol^{-1}$ (1)		**(4)**

(Total for Question 17 = 22 marks)

Question Number	Correct Answer	Reject	Mark
18(a)(i)	Observation mark depends on correct test **Any two from** Fehling's/Benedicts solution **(1)** Red **precipitate** forms IGNORE qualifiers e.g. brown, orange. **(1)** Tollens' reagent/ammoniacal silver nitrate **(1)** Silver mirror OR black/grey ppt forms **(1)** Acidified sodium/potassium dichromate(VI) ALLOW $H^+/Cr_2O_7^{2-}$ **(1)** Green/ Blue solution forms **(1)**	Turns red Other qualifiers	**(4)**

Question Number	Correct Answer	Reject	Mark
18(a)(ii)	Oxidation/redox ALLOW Oxydation	Reduction Reduction/redox Displacement Nucleophilic substitution	**(1)**

Question Number	Correct Answer	Reject	Mark
18(b)(i)	CH_3CH_2COOH ALLOW $CH_3CH_2CO_2H$ IGNORE skeletal/displayed formulae unless incorrect	 Incorrect additional skeletal or displayed formulae	**(1)**

Question Number	Correct Answer	Reject	Mark
18(b)(ii)	Step 1 Phosphorus(V) chloride / phosphorus pentachloride / phosphorus(III) chloride / phosphorus trichloride / thionyl chloride ALLOW Recognisable spelling e.g. phosphorous **(1)** IGNORE Correct formulae PCl_5 / $SOCl_2$ Step 2 Propan-1-ol / 1-propanol IGNORE Correct formula **(1)**	Additional incorrect formulae (this could happen twice) Propanol	**(2)**

Question Number	Correct Answer	Reject	Mark
18(b)(iii)	(Both) the reaction(s) in b(ii) go(es) to completion / not an equilibrium OR The one step process is an equilibrium IGNORE Reversible/irreversible Atom economy		**(1)**

Question Number	Correct Answer	Reject	Mark
*18(c)(i)	**M1** $CH_{(A)3}CH_{(B)2}CH_{(C)}O$ Three proton environments identified **(1)** **M2** Relative areas 3(A), 2(B), 1(C) **(1)** **M3** Triplet(A), quintuplet(B), triplet(C) ALLOW non-standard terms e.g. pentuplet / cinquplet / pentet / 5 splits / 5 peaks for quintuplet **(1)** IGNORE Chemical shifts COMMENT If propanoic acid chosen **M2** and **M3** may be awarded		**(3)**

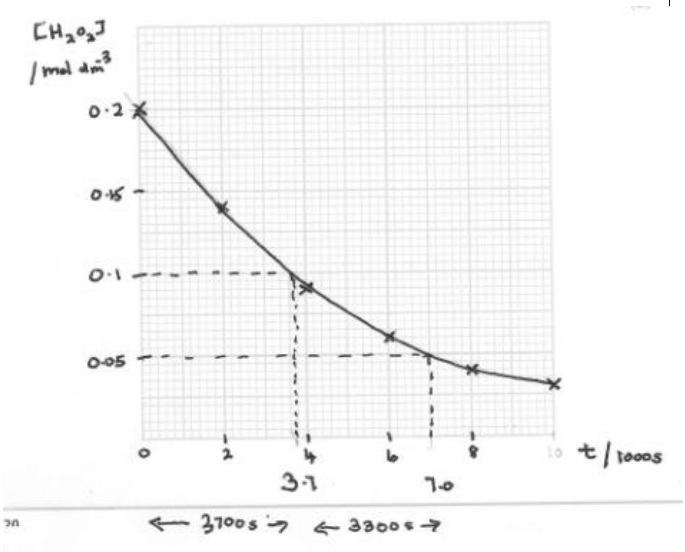
Question Number	Correct Answer	Reject	Mark
*18(c)(ii)	Only one peak ALLOW One singlet peak But not just 'one singlet' (without the word peak) **(1)** All hydrogens / protons in the same environment **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
***18(c)(iii)**	C=O at 1740-1720 (cm^{-1}) aldehyde **(1)** C-H aldehyde at 2775-2700/2900-2820 (cm^{-1}) **(1)** C=O at lower value/1700 – 1680 (cm^{-1}) ketone OR No corresponding C-H (aldehyde) absorption for ketone **(1)** Two or three correct values linked to correct compounds with no bonds mentioned 1 max IGNORE other bonds and peaks		**(3)**

(Total for Question 18 = 17 marks)

TOTAL FOR SECTION B = 49 MARKS

Section C

Question Number	Correct Answer	Reject	Mark
19(a)(i)	 Axes, labels (including units) and graph to cover at least half the paper in each direction [] must be placed around hydrogen peroxide Units should follow a / but may be in brackets instead **(1)** Points and smooth curve Check there are six points plotted Check last point is correctly plotted **(1)** Non-linear scale scores zero		**(2)**

Question Number	Correct Answer	Reject	Mark
19(a)(ii)	**M1** 3400 – 3800 / 3.4 - 3.8 x 10^3 (s) **(1)** **M2** 3200 – 3600 / 3.2 - 3.6 x 10^3 (s) **(1)** Only penalise missing 10^3 once If no working shown on graph, max **(1)** Minimum working is 2 perpendiculars dropped to x axis from graph		**(2)**

Question Number	Correct Answer	Reject	Mark
19(a)(iii)	First order **(1)** Constant / similar / the same half-life ALLOW Phrases like 'literally the same' even if this does not apply to their numbers **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
19(b)(i)	So that the concentration is proportional to volume IGNORE 'If the volume changes the concentration changes' References to fair test and controlling variables.		**(1)**

Question Number	Correct Answer	Reject	Mark
19(b)(ii)	The rate does not alter significantly /is constant during the time of its measurement / during the reaction ALLOW During this time / experiment the graph is approximately linear OR Initial gradient of the concentration time graph is constant OR Initial rate is constant IGNORE Temperature comments Rate proportional to 1/t		**(1)**

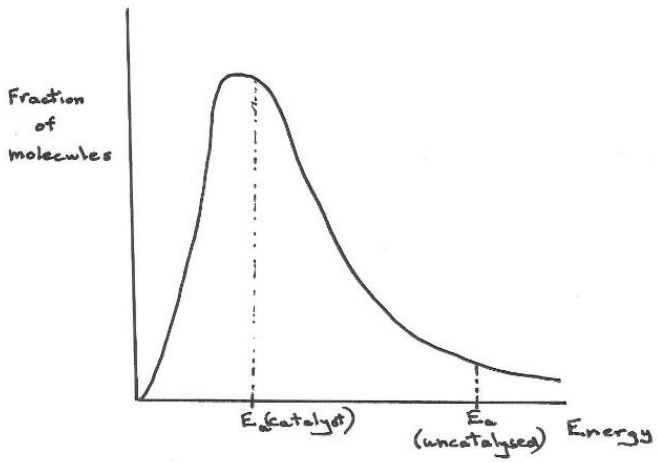
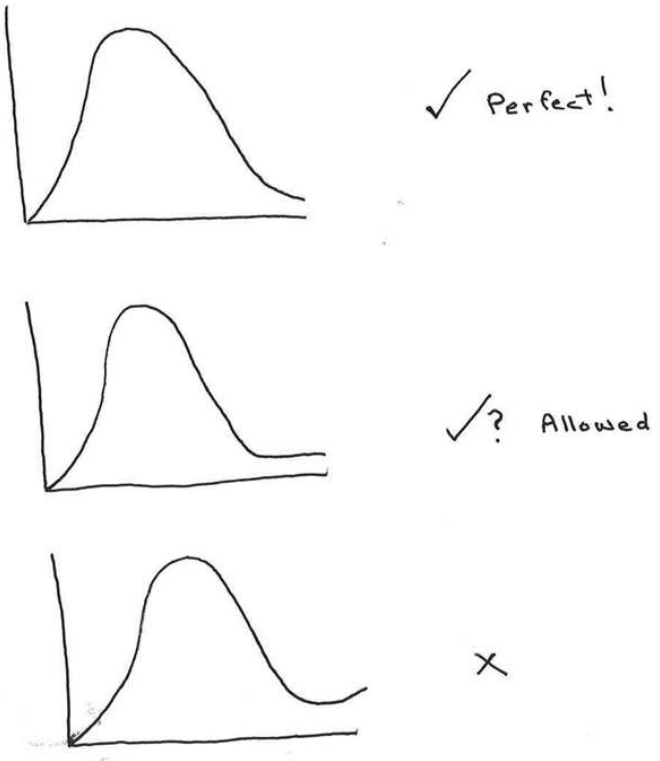
Question Number	Correct Answer	Reject	Mark
19(b)(iii)	**M1** Iodide – order 1 **(1)** **M2** as concentration decreases, rate decreases by the same factor OR (Run 3 → 2) $[I^-]$ doubles, rate doubles **(1)** **M3** Hydrogen ion - order 0 **and** As rate is unaffected by hydrogen ion concentration OR (Run 5 → 4) $[H^+]$ doubles rate is constant **(1)**		**(3)**

Question Number	Correct Answer	Reject	Mark
19(b)(iv)	Rate = $k[H_2O_2][I^-]([H^+]^0)$ ALLOW R for rate [KI] and $[H_2SO_4]$ ALLOW any order wrt $[H_2O_2]$ TE from (b)(iii)		**(1)**

Question Number	Correct Answer	Reject	Mark
19(b)(v)	0.1 x 3/12 = 0.025 (mol dm^{-3}) ALLOW TE on (b)(iv)		**(1)**

Question Number	Correct Answer	Reject	Mark
19(b)(vi)	$\frac{1.06 \times 10^{-4}}{0.025 \times 0.025}$ = 0.1696/0.170/0.17 $dm^3\ mol^{-1}\ s^{-1}$ If 0.03 mol dm-3 in (b)(v) k = 0.1178 $dm^3\ mol^{-1}\ s^{-1}$ Value **(1)** Unit **(1)** ALLOW TE on (b)(iv) and (b)(v) for k value **and** units IGNORE SF except 1		**(2)**

Question Number	Correct Answer	Reject	Mark
19(c)(i)	Gradient = $\frac{-2.25 - (-4.55)}{(3.06 - 3.35) \times 10^{-3}}$ = – 7931… (K) **(1)** Correct value with sign Allow range – 7600 to – 8000 (K) E_a = 8.31 x (–7931…) **(1)** TE on candidate value for gradient **=** – 65.9 kJ mol^{-1} Correct value with + or – sign, and units Ignore SF except 1SF **(1)** ALLOW Values within range 63.0 to 66.5 kJ mol^{-1} providing graph read correctly	No sign	**(3)**

Question Number	Correct Answer	Reject	Mark
*19(c)(ii)	 **M1** *x* axis (kinetic) energy or clearly marked with E_a *y* axis fraction/number of molecules / particles or left blank **(1)** **M2** Shape of graph fully correct, starting at **zero**, approaching *x* axis asymptotically / allow horizontal Please note the following examples:  **(1)**	Curve clearly rising at the end	**(3)**

	M3 A greater proportion of / more molecules have energy greater than the activation energy when catalyst is present A greater proportion of / more molecules have energy sufficient / enough to react when catalyst is present OR This can be shown on the graph, by labels and lines etc. **(1)**		

TOTAL FOR SECTION C = 21 MARKS

TOTAL FOR PAPER = 90 MARKS

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