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Mark Scheme (Results)
January 2010

GCE

GCE Chemistry (6245/01)

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January 2010

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.

General Guidance on Marking

All candidates must receive the same treatment.

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.

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.

Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the Team Leader must be consulted.

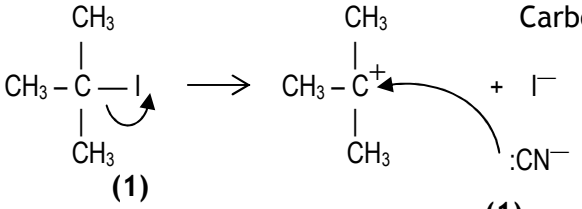
Using the mark scheme

The mark scheme gives:
- 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.

1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) 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.
3 [ ] words inside square brackets are instructions or guidance for examiners.
4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
5 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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	S_N1 $(CH_3)_3CI$**(1)** S_N2 $CH_3CH_2CH_2CH_2I$ Or $CH_3CH(CH_3)CH_2I$ **(1)**	$CH_3CH_2CHICH_3$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Cq on their answer in (a)			**3**

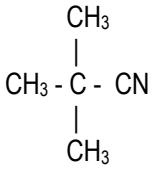


(1)

(1)

Carbocation (1)

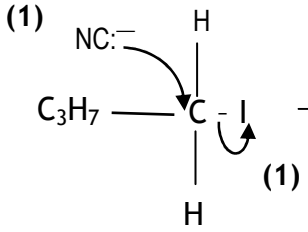
Do not award first mark if curly arrow **clearly** extends beyond I



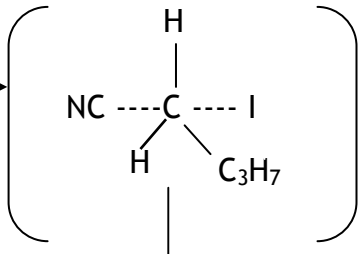
Allow arrow from negative charge provided negative charge on C (penalise once only)
Lone pairs need not be shown
Penalise use of fish hook arrows once only
Penalise curly arrows from N: of CN^- once only

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Cq on their answer in (a) Allow branched chain hydrocarbon			**3**

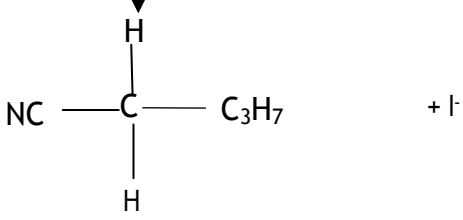
(1)



(1)

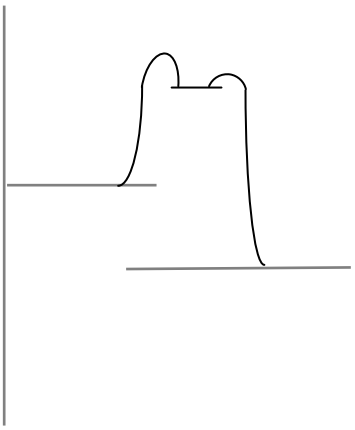
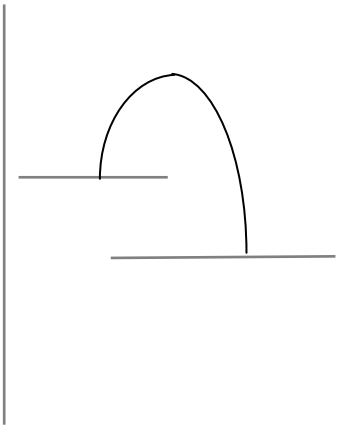


(1)



Both arrows must be in first step
Allow arrow from negative charge
Lone pairs need not be shown
In transition state the dotted bonds are essential but allow if both on same side of central C

If candidate draws a correct S_N1 AND a correct S_N2 mechanism but swapped over then MAX 3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	S_N1  S_N2  **1 mark for each general shape (total 2 marks)** 0 marks if correct profiles swapped over Not Cq on exchanged mechanism in (b)	Energy level of intermediate could be below that of the reactants		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1(d)	The rate would be slower **(1)** The bond energy of the C–Cl bond is higher **(1)** So activation energy higher **(1)** Any answer stating rate will increase scores zero	C-Cl harder to break		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2(a)(i)	Equation B because Hydrogen peroxide is giving away electrons Or As the oxidation number of **oxygen** (in H_2O_2) is going from -1 to 0/ increased			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	$2H_2O_2 \rightarrow 2H_2O + O_2$	Multiples $2H^+$ on both sides	Equations with $2e^-$ on both sides	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	The rate constant /specific reaction rate	Constant of proportionality in the rate equation		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	s^{-1} OR $\frac{1}{s}$ any unit of time $^{-1}$	Words		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	The concentration term / $[H_2O_2]$ (in the rate equation) is raised to the power 1 OR The rate is (directly) proportional to concentration of the hydrogen peroxide	Doubling $[H_2O_2]$ doubles rate Half-life is constant		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i) QWC	(As T increases) the value of E_a/RT gets **smaller (1)** so the value of ln*k* /k increases/less negative /more positive (and so does rate)**(1) stand alone**	Larger T, larger denominator	Any argument in terms of collision	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii) QWC	Catalysts lowers E_a **(1)** $-\frac{E_a}{RT}$ because less negative/increases (hence k increases) **(1)**		Any argument in terms of collision for the 2nd mark	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)(i)	Plotting of points **(1)** Drawing of **straight** line **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)(ii)	Gradient = - 9.68 x 10^3 **(1)** - E_a/R = - 9.68 x 10^3 $\therefore$ E_a = gradient x – 8.31 **(1)** (ignore sf) Value cq on their gradient but must be positive and unit **(1)**	Range -9400 to -10000 Range (+) 78.1 to (+) 83.1 kJ mol^{-1}		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	**Either** The $E^{\ominus}$ value for the reaction between Zn + VO_2^+ is +1.76 The $E^{\ominus}$ value for the reaction between Zn + VO^{2+} is +1.1 The $E^{\ominus}$ value for the reaction between Zn + V^{3+} is +0.49 **(2)** (all three correct 2 marks, two correct 1 mark) All $E^{\ominus}$cell values are positive (so will reduce to V(II)) **(1)** **Or** $E^{\ominus}$ for Zn is **more** negative **(1)** / $E^{\ominus}$ for Zn/Zn^{2+} is **more** positive **than** for each of the reductions of V(V), V(IV) and V(III) **(1)** **NB** $E^{\ominus}$ for zinc is the **most negative** scores first 2 marks All $E^{\ominus}$cell values are positive / So can provide electrons for each of the reductions (so will reduce to V(II)) **(1)**			**3**

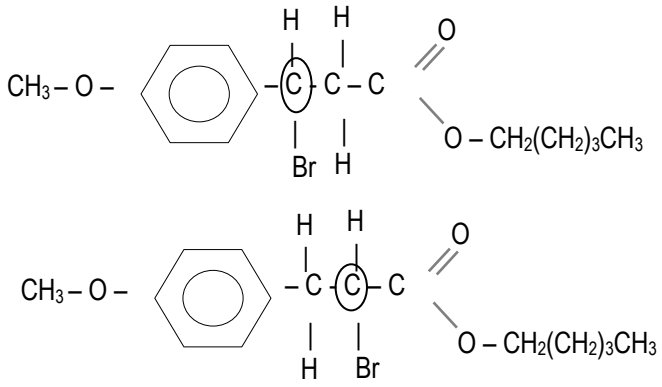
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	VO_2^+ **and** VO^{2+}			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Moles of VO_2^+ = 25.0 x 0.0500 /1000 = 1.25×10^{-3} **(1)** Moles of manganate(VII) = 37.5 x 0.0200/1000 ..... = 7.5×10^{-4} **(1)** If both moles VO^{2+} and moles Mn (VII) correctly calculated but not identified scores 1 of first 2 marks Moles of electrons = 37.5 x 0.0200 x 5/1000 = 3.75×10^{-3} **(1)** Ratio of moles of VO_2^+ to moles of electrons = 1 to 3 **(1)** (So final state = 5 -3 = 2)	Any valid alternative route Ratio V species: Mn(VII) = 5:3 As oxidation number of Mn changes by 5 (therefore V changes by 3) (so final state = 2)		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	EITHER Moles of manganate(VII) = 12.5 x 0.0200/1000 Moles of electrons = 12.5 x 0.0200 x 5/1000 = 1.25×10^{-3} **(1)** Ratio of moles of vanadate to moles of electrons = 1 to 1 So final state = 5 - 1 = 4**(1)** **OR** 37.5 cm^3 causes a change of 3 in oxidation state **(1)** therefore 12.5 cm^3 causes a change of 1 in oxidation state hence vanadium(IV) **(1)**	 Ratio V species: Mn(VII) = 1:5 (1) Therefore +4 (1)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	E_a (too) high (for reduction to V^{3+}) Or $VO^{2+} \rightarrow V^{3+}$ **very** slow	reactants kinetically stable	reaction kinetically stable	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	Bromine (water) decolourised OR Potassium manganate (VII) goes colourless/ brown ppt/green	Names or formulae		**1**

Question Number	Correct Answer	Reject	Mark
4 (b)(i)	 Penalise other error(s) in rest of molecule once only		**2**

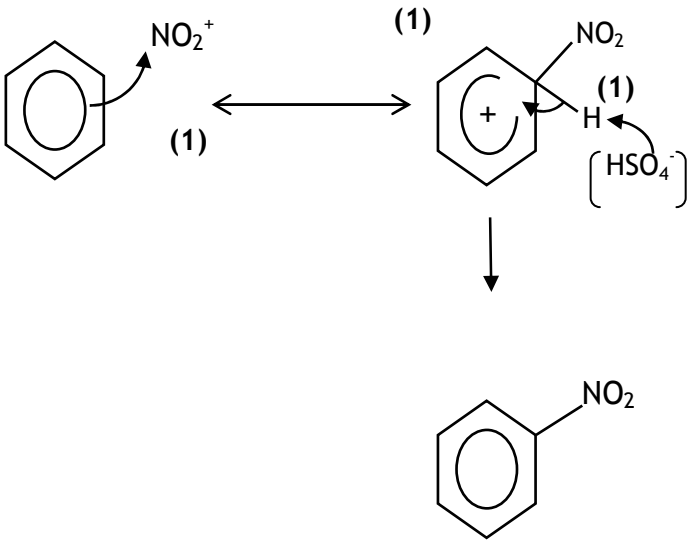
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Chiral centre shown on one of the diagrams in (i) **(1)** The intermediate / carbocation is planar (at reaction site) **(1)** Attack can take place from both sides **(1) Not stand alone**			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	$CH_3OC_6H_4CH{=}CHCOOH$ **(1)** $CH_3(CH_2)_3\ CH_2OH$ **(1)** Full or structural formulae			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)	Boil under reflux / heat with alkaline potassium manganate(VII) **(1)** followed by addition of acid**(1)** **Not stand alone**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)	The alkene / 1650 – 1450 peak absent **(1)** the arene / 1700 – 1650 peak absent **(1)**		Double bond peaks absent	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)	$HNO_3 + H_2SO_4 \rightarrow H_2^+NO_3 + HSO_4^-$ **(1)** $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$ OR $H_2NO_3^+ + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_3O^+$ **(1)** **OR** $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$ **(2)** or $HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$ **(2)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)	 1 mark for arrow from ring on to N of the NO_2^+ 1 mark for intermediate with positive charge shown and delocalisation not extending over carbon attached to NO_2 but covering the other carbons 1 mark for arrow from C – H bond into ring Correct use of Kekule structures scores full marks			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	Type – Reduction / redox **(1)** Reagents Tin/Iron **(1)** concentrated hydrochloric acid /conc. HCl **(1)** conditional on tin or iron			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	Sodium nitrite / sodium nitrate(III) / $NaNO_2$ **(1)** HCl (aq) **/** Dilute hydrochloric acid / dil HCl OR other named dilute acid **(1)**	HNO_2 max 1	Just HCl	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5(c)(iii)	Above 10 ^oC the product decomposes / breaks down **(1)** Below 0 ^oC the reaction is too slow / the reaction does not take place**(1)**	Ion/salt decomposes	It decomposes	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d) **QWC**	Heat on water bath / heating mantle to prevent it catching fire / as it is flammable**(1)** **Stand alone** Dissolve solid in **minimum** amount of hot solvent **(1)** Filter solution (while hot) **(1)** To remove insoluble impurities **(1)** Cool / leave (to crystallize) and filter **(1)** To remove soluble impurities**(1)** Wash with cold solvent(and set aside to dry) **(1)**	Named organic solvent		**7**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)	$CH_3CH_2COOH \longrightarrow$ A $CH_3CH_2CH_2OH$ / propan-1-ol **(1)** B $\longrightarrow$ $CH_3CH_2CH_2Cl$ Reagents for step A Lithium aluminium hydride / $LiAlH_4$ in dry ether **(1)** Reagents for step B PCl_3, PCl_5, $SOCl_2$ or names **(1)**			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b) **QWC**	The height of the CH_3 peak would be **twice** as high in **Y** Or **X** has **one** more peak	X has 4 peaks Y has 3	X has more peaks	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	CH_3^+			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii) **QWC**	**Y** as **X** would have a line due to $C_2H_5^+$ Penalise lack of + once only across (i) and (ii)			**1**

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