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Mark Scheme (Results)
Summer 2008

GCE

GCE Chemistry (6244/01)

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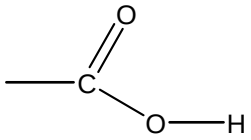
General Marking Guidance

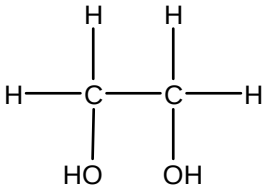
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should 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.

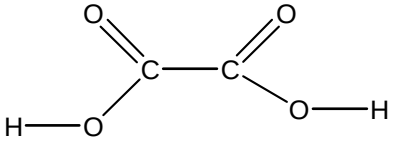
Using the mark scheme

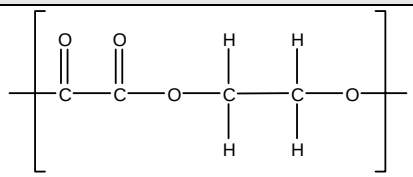
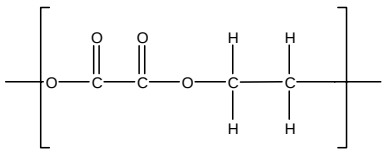
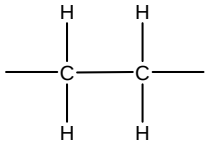
1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
3 [ ] words inside square brackets are instructions or guidance for examiners.
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)	**Can be given in either order** **1st functional group** alkene or C=C or carbon-carbon double bond **(1)** bromine water/Br_2 turns (from orange/brown etc. to) colourless/decolorised **(1)** *INITIAL COLOUR NOT REQUIRED* **2nd functional group** carboxylic (acid)  **(1)** on addition of Na_2CO_3 or $NaHCO_3$ or $CaCO_3$ or Mg , fizzing occurs **(1)** **OR** (warm with) a **named** alcohol plus **conc. acid** (as catalyst), pleasant/fruity smell Ignore references to testing with PCl_5	 $KMnO_4$ Acidified decolorised Alkaline green carboxyl gas evolved which turns limewater milky OR or universal indicator/ blue litmus turns red	 **Just** 'double bond' or just 'carbon double bond' 'clear' instead of 'colourless' "carbonyl" Just "a gas/CO_2/H_2 evolved" for fizzing	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	**W** as it contains an aldehyde group / -CHO group OR **W** can be oxidised (whereas **X** cannot) OR **X** cannot be oxidised OR **W** as **X** is a ketone (which cannot be oxidised)		W with no reason or an incorrect reason **(0)** Contains C=O	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	CH_2OHCH_2OH **OR**  **OR** Ethan(e)-1-2-diol	$(CH_2OH)_2$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	 **OR** HOOCCOOH **OR** Ethanedioic acid/oxalic acid	$(COOH)_2$ ethan(e)-1,2-dioic acid or ethandioic acid	Any other name	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	 **OR**  **(2)** for a correct structure *IF STRUCTURE IS INCORRECT, BUT A CORRECT ESTER LINKAGE IS FULLY DRAWN* **(1)** the correct repeat unit **must contain** only 4 carbon and 4 oxygen atoms	CQ polyester on basis of monomers in 1(b)(ii) and (iii) $-CH_2CH_2-$ instead of  in relevant part of structure **only (1)** if STRUCTURE IS CORRECT, BUT the ester linkage has been written as COO/CO_2		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	Condensation			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Na_2O **(1)** P_4O_{10} or P_2O_5 or P_4O_6 or P_2O_3 **(1)** SO_2 or SO_3 **(1)**	Na_2O_2 **(1)**		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$Na_2O + H_2O \rightarrow 2NaOH$ Ignore state symbols	..... $2Na^+OH^-$ **OR** ..... $2Na^+ + 2OH^-$ **OR** $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$ **OR** $Na_2O_2 + H_2O = 2NaOH$ **+ ½O_2**		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$P_4O_6 + 6H_2O \rightarrow 4H_3PO_3$ **OR** $P_2O_3 + 3H_2O \rightarrow 2H_3PO_3$ **OR** $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ **OR** $P_2O_5 + 3H_2O \rightarrow 2H_3PO_4$ Ignore state symbols		$P(OH)_3$ **instead of** H_3PO_3	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	$SO_2 + H_2O \rightarrow H_2SO_3$ **OR** $SO_3 + H_2O \rightarrow H_2SO_4$ Ignore state symbols			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	**First mark:-** **EITHER** Tin more stable at +4 (than at +2) whereas lead more stable at +2 (than at +4) **OR** +2 (oxidation state) becomes more stable **relative to +4** down the group (OWTTE) **(1)** **Second mark:-** (so) Fe^{3+} reduced to Fe^{2+} (by Sn^{2+}) **OR** (2) $Fe^{3+} + Sn^{2+} \rightarrow Sn^{4+} + (2)\ Fe^{2+}$ **OR** tin(II) stronger reducing agent (than lead(II)) **OR** redox reaction between Sn^{2+} and Fe^{3+} **OR** Sn^{2+} oxidised to Sn^{4+} / $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$ **OR** tin(II) acts as a (strong) reducing agent **OR** tin(II) reduces Fe^{3+} **(1)**		"Sn^{2+} less stable than Pb^{2+} ions" **OR** "Pb(II) is more stable than Sn(II)"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ Species **(1)** Balancing **(1)** Ignore state symbols	...$\rightarrow SiO_2.xH_2O$ **OR** ...$\rightarrow SiO_2.2H_2O$ **OR... + $4H_2O$** ...$\rightarrow Si(OH)_4 + 4HCl$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	$K_p = \frac{p_{NO_2}^2}{p_{N_2O_4}}$ *IGNORE UNITS HERE*		**[ ]**	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$p_{NO_2} = 0.8 \times 1.1$ $= 0.88(atm)$ **and** $p_{N_2O_4} = 0.2 \times 1.1$ $= 0.22(atm)$ **(1)** $K_p = \frac{(0.88)^2}{(0.22)}$ $K_p = 3.52$ **(1)** *atm* **(1)** *SECOND MARK IS CQ ON PARTIAL PRESSURES AS CALCULATED*			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	**First mark:** $X_{N_2O_4} = 0.10$ $X_{NO_2} = 0.90$ **(1)** **Second mark:** K_p constant or use of K_p = 3.52 or use of K_p calculated in 3(b)(i) **(1)** **Third mark:** Value of P_T with some working e.g. $3.52 = \frac{(X_{NO_2} \times P_T)^2}{X_{N_2O_4} \times P_T}$ $3.52 = \frac{0.81}{0.10} \times P_T$ P_T = 0.435(atm) **(1)** *THIRD MARK NOT AVAILABLE IF K_p EXPRESSION DOES NOT CONTAIN A p^2 TERM*	Mark CQ on first and second answers to 3(b)(ii) in range 0.43 to 0.44	B	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Increases / gets larger/ gets bigger/ goes up/greater		more	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**First mark:** Fraction/quotient/ $\frac{p_{NO_2}^2}{p_{N_2O_4}}$ /numerator has to increase (to equal new K_p) **(1)** **Second mark (can only be awarded for an answer that refers to the fraction/quotient above):** **EITHER** so shifts to **RIGHT** hand side (as $p_{NO_2} \uparrow$ and $p_{N_2O_4} \downarrow$) / goes in forward direction (as $p_{NO_2} \uparrow$ and $p_{N_2O_4} \downarrow$) **OR** so (more) N_2O_4 changes to NO_2 **OR** so (equilibrium) yield of NO_2 increases **(1)**	Mark consequentially on "decreases" in (i)	Le Chatelier argument **scores (0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	**BOX A** $Ag_{(g)}$ **(1)** **BOX B** $F_{(g)}$ **(1)** **C**: enthalpy (change) of formation (of AgF) / ΔH_f / $\Delta H_{formation}$ **(1)** IGNORE reference to 'standard'	 'heat of formation'		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	**EITHER** $-205 = (+285) + (+731) + (+79) + EA + (-958)$ **OR** EA = (-205) – (+285) – (+731) – (+79) – (-958) **(1)** $= -342$ (kJ mol^{-1}) **(1)** *CORRECT ANSWER ALONE* **(2)**		Any algebraic expression for EA that would give an incorrect value **(0).** Any algebraic expression for EA that would give a **+ve** value for EA scores **(0).**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	**EITHER** **FIRST MARK:** **EITHER** iodide (ion) larger than fluoride (ion) **OR** Sum of ionic radii in AgI larger (than in AgF) **OR** halide ion or X^- or anion increases in size down group **(1)** **SECOND MARK:** Charges (on anions) same **(1)** **THIRD MARK:** (so) weaker (forces of) **attraction** between **ions** (in AgI) **(1)** *CORRECT REVERSE ARGUMENTS CAN SCORE ALL THE MARKS* **OR** **First and second marks combined by stating** I^- (ion) larger than F^- **(2)** **THIRD MARK:** (so) weaker (forces of) **attraction** between **ions** (in AgI) **(1)** *IGNORE ANY REFERENCES TO POLARISATION OF IONS ANYWHERE IN (b)(i)*	**Just '**iodide has smaller charge density than fluoride' scores first mark "atomic radius of halide ion/X^- /anion increases (down group)" "weaker ionic bonding" **(1)** **Just** iodide has smaller charge density than fluoride scores only one mark "weaker ionic bonding" **(1)**	Reference to "atoms" or "molecules" or "F_2" or "I_2" scores **(0)** overall Ag—X scores **(0)** overall **Just** "weaker bonding (in AgI)" **Just** "weaker bonding (in AgI)"	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Theoretical value (assumes) 100% ionic OR no covalent character **(1)** (Experimental value is different) due to covalency **OR** covalent character **OR** polarisation **of anion(1)**		Mention of "Ag—X" OR "molecules" scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	(as) **size of anion increases** (down group) **(1)** (anions) **more easily polarised** (down group) **OR** more distortion **of anion** (down group) **(1)** *MARK THESE POINTS INDEPENDENTLY*	"atomic radius of halide ion/X^- /anion increases (down group)" "more covalent character"/ "more covalent" for second mark	Mention of "Ag—X" OR "molecules" scores **(0) unless already penalised in 4 (b)(ii)** "more covalent **bonding**" **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	$\Delta H_{SOLN} = -\Delta H_{LATT} + \Delta H_{HYD}$ **OR** $= -(-958) + (-464) + (-506)$ **(1)** $= -12$ (kJ mol^{-1}) **(1)** *CORRECT ANSWER ALONE SCORES 2*	 —12 kJ	+12 scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	AgF soluble / AgF slightly soluble **(1)** as ΔH_{SOLN} exothermic / negative **(1)** *MARK INDEPENDENTLY* Mark CQ on sign and magnitude of answer in (c)(i)	If +12 (kJ mol^{-1}) in (c)(i), AgF insoluble **(1)** because endothermic / positive **(1)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$ **OR** $2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$ *IGNORE STATE SYMBOLS*		if a **full** arrow is shown in the equation	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	$K_W = [H^+_{(aq)}][OH^-_{(aq)}]$ **OR** $K_W = [H_3O^+_{(aq)}][OH^-_{(aq)}]$ *IGNORE STATE SYMBOLS*		If $[H_2O]$ included **(0).** $K_w = [H^+]^2$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iii)	$pH = -\log_{10}[H^+]$ **OR** $pH = -\log_{10}[H_3O^+]$ **OR** in words	pH = lg 1/$[H^+]$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iv)	$K_w = [H^+][OH^-]$ $5.48\times10^{-14} = [H^+]^2$ **(1)** $[H^+] = \sqrt{5.48\times10^{-14}}$ $[H^+] = 2.34\times10^{-7}$ (mol dm^{-3}) $pH = 6.6(3)$ **(1)** correct answer with no working **(2)**		pH = 13.3 /13.6 scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(v)	(In pure water) $[H^+] = [OH^-]$ **OR** equal **concentrations** of H^+ and OH^-			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	12.5			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	4.8 / 4.9 [no consequential marking from (i)]		5 or 5.0	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ **OR** $K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$		expressions containing $[H_2O]$ OR "HA" generic equations	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iv)	(at half-neutralised point so) pK_a = 4.8 OR pH = pK_a **(1)** Ka = antilog$_{10}$ (-4.8) Ka = 1.6 x 10^{-5} (mol dm^{-3}) **(1)** **Must be to two sig figs** *CORRECT ANSWER WITH OR WITHOUT WORKING* (2)	Mark CQ on (ii) Mark CQ on pKa If pKa = 4.9, Ka = 1.3 x 10^{-5}	**Just** pH = 4.8 as already credited in 5 (b)(ii) Answers to other than 2 s.f. 2.5 x 10^{-9} scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)	**Phenolphthalein:** changes colour (OWTTE) in vertical part of the graph **OR** changes colour within a stated range anywhere from 7 to 11 **(1)** **Methyl orange** changes colour at a low(er) pH **OR** has already changed colour **OR** changes colour before the vertical (section) **(1)** **[NB** There must be a statement about methyl orange for second mark]	Allow range for methyl orange of 3 to 6 or colour change takes place below pH = 7	If colour change "pink to colourless" **Just** 'methyl orange changes colour outside the vertical range'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(i)	$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ for **both** (acids) **OR** $H_3O^+_{(aq)} + OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$ for **both** (acids) **OR** Both (acids) fully ionised/fully dissociated **(1)**	State symbols not essential.	Equations shown as equilibria	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(ii)	**EITHER** HCN weak (acid) **OR** HCN ionises to (only) a small extent **OR** HCN equilibrium lies to the left **(1)** Energy taken in OR energy required for dissociation / ionisation (of HCN) **(1)** *MARK INDEPENDENTLY*	"HCN not fully ionised" or "HCN partially dissociates / ionises" "endothermic dissociation of HCN"	Any idea that only partial **neutralisation** occurs negates first mark	2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>6 (a)(i)</td><td>
First two marks:

For correct reagent (ignore all state symbols) (1)
For correct condition(s), but only if with matching reagent (1)

<table>
<tr><th>Reagent</th><th>Condition</th></tr>
<tr><td>HCN</td><td>Catalyst of CN^-</td></tr>
<tr><td>HCN</td><td>KCN</td></tr>
<tr><td>KCN</td><td>HCN</td></tr>
<tr><td>HCN or KCN</td><td>any stated pH or pH range between 5 and 9</td></tr>
<tr><td>KCN</td><td>+ (named) acid / H^+</td></tr>
<tr><td>HCN</td><td>+ (named) base / OH^-</td></tr>
</table>
[Note: The intermediate compound $CH_3CH(OH)CN$ does not have to be identified.]

Hydrolysis of –CN group to –COOH group:

IGNORE MENTION OF “HEAT / REFLUX”

Second two marks (only available if correct reagent has previously been given):

EITHER
Name or formula of a mineral acid (1)
Boil or heat (1)
Second mark dependent on first mark being awarded

IGNORE MENTION OF “REFLUX”

OR
Name or formula of correct alkali AND boil/heat (1)
“Acidify” / H^+ or name/formula of any acid (1)

IGNORE MENTION OF “REFLUX”
</td><td>“H^+”
“warm”

OH^- AND boil /heat/warm (1)</td><td>conc H_2SO_4 (0)</td><td>4</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(ii)	$CH_3CH(OH)CH_2CH_3$ **OR** $CH_3CH(OH)C_2H_5$ **OR** Full structural formula of the above	$CH_3CHOHCH_2CH_3$ **OR** $CH_3CHOHC_2H_5$ -O-H can be represented as -OH		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	W: ethanamide **(1)** X: methylamine **(1)** Y: ethanenitrile **(1)**	acetamide (1-)aminomethane 'methyl cyanide'	Formulae methanamine 'ethanitrile'	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	**Reaction 1** Bromine/Br_2 **and** sodium hydroxide/NaOH/potassium hydroxide/KOH **(1)** *IGNORE CONC OR DILUTE OR AQUEOUS BEFORE NaOH / KOH* **Reaction 2** phosphorus(V) oxide **OR** phosphorus pentoxide **OR** P_4O_{10} **(1)** **Reaction 3** lithium aluminium hydride (in dry ethoxyethane) **OR** $LiAlH_4$ (in dry ethoxyethane) **OR** lithium tetrahydridoaluminate((III)) (in dry ethoxyethane) **(1)** *MARK INDEPENDENTLY*	 P_2O_5 $LiAlH_4$ **followed by** water or acid **OR** H_2 **and** Ni/Pt/Pd (catalyst) **OR** Na **and** C_2H_5OH	 'bromine water' OR 'aqueous bromine' phosphorus oxide $LiAlH_4$ in water **(0)** $NaBH_4$	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(iii)	**Reaction 2** dehydration **(1)** **Reaction 3** reduction/redox **(1)**	 'hydrogenation'	'elimination (of water)'	2