

# Mark Scheme (Results) Summer 2008

GCE

## GCE Chemistry (6242/01)

## 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 OWTTE means or words to that effect
- 6 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.

### Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	anode: titanium (1) cathode: steel/Nickel/Ni (1) If both correct but in wrong place max 1		graphite	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	Anode $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^{(-)}$ $2\text{Cl}^- - 2\text{e}^{(-)} \rightarrow \text{Cl}_2$  Cathode $2\text{H}_2\text{O} + 2\text{e}^{(-)} \rightarrow \text{H}_2 + 2\text{OH}^{(-)} (1)$  If both correct but in wrong place max 1	Multiples  $2\text{H}^+ + 2\text{e}^{(-)} \rightarrow \text{H}_2$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	$2\text{H}_2\text{O} + 2\text{Cl}^- \rightarrow \text{H}_2 + \text{Cl}_2 + 2\text{OH}^-$	multiples	$2\text{H}^+ + 2\text{Cl}^- \rightarrow \text{H}_2 + \text{Cl}_2$ Equation with $2\text{e}^{(-)}$ on both sides	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iv)	treatment of (drinking) water Or to kill bacteria in water/swimming pools Or sterilisation of water Or as a disinfectant Or in production/manufacture/making of any one of: PVC bleaches herbicides insecticides/pesticides HCl/hydrochloric acid/hydrogen chloride named chlorinated solvents bromine titanium paper chloroethene poly(chloroethene) CFCs/HCFs Silicon	as a bleach Or in bleach Or bleach	water purification Or swimming pools Or cleaning anything Or anything else	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	<p><u>species oxidised</u> chlorine/Cl<sub>2</sub> <u>oxidation product</u> sodium chlorate(I) / NaOCl / OCl<sup>-</sup> /chlorate(I) (ions) (1)</p> <p>both required for mark</p> <p><u>species reduced</u> chlorine / Cl<sub>2</sub></p> <p><u>reduction product</u> (sodium) chloride / NaCl / chloride ion/Cl<sup>-</sup> (1)</p> <p>both required for mark</p>	<p>Species oxidised Cl (in Cl<sub>2</sub>) ox. prod. sodium hypochlorite</p> <p>Species reduced Cl (in Cl<sub>2</sub>)</p>	Just "chlorate" and "sodium chlorate"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	<p>IGNORE SF unless rounded to 1SF</p> <p>moles NaOCl = <math>\frac{100}{74.5} =</math> 1.342 (1) (= moles Cl<sub>2</sub>)</p> <p>volume Cl<sub>2</sub> = 1.342 x 24 = 32.2 dm<sup>3</sup> - unit essential (1)</p> <p>2<sup>nd</sup> mark consequential on moles</p> <p>To get the 2<sup>nd</sup> mark, must show attempt to calculate moles ie 100 ÷ x</p> <p>Correct answer with no working (2)</p>	<p>Method using mass: volume ratio 74.5 (g) gives 24 (dm<sup>3</sup>) (1) ∴ 100 (g) gives 32.2 dm<sup>3</sup> (1)</p> <p><u>Some common</u> acceptable answers are: 32.16/32/31.2/31 dm<sup>3</sup></p>		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a) QWC	<p>enthalpy/heat/energy change when 1 mole (of a substance) (1)</p> <p>is completely burned in oxygen / burned in excess oxygen (1)</p> <p>(all species) at 1 atm/100 kPa/10<sup>5</sup>Pa/ 1 Bar and “a specified temperature” (1)</p>	<p>“evolved” instead of “change”</p> <p>“sulphur” or “element” or “species” instead of “substance”</p> <p>....298 K/ 25 °C /101 kPa Or “.....a specified temperature e.g. any value”</p>	<p>Heat/energy required</p> <p>“compound” instead of “substance”</p> <p>reacts completely with oxygen</p> <p>Any mention of specific products or specific amounts of products, other than SO<sub>2</sub>, negates 2<sup>nd</sup> mark</p> <p>Just “273 K”</p> <p>Any mention of concentration negates third mark</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	<p><u>Temperature</u> 400 to 500 (°C) or any value or range within this range inclusive (1)</p> <p><u>Pressure</u> &gt;1 to 5 atm or any value or range within this range inclusive (1)</p> <p><u>Catalyst</u> Vanadium(V) oxide / V<sub>2</sub>O<sub>5</sub> (1)</p>	<p>673 - 773 K or any value or range within this range</p> <p>vanadium pentoxide</p>	<p>1 atm or any range that includes 1 atm</p> <p>Just “vanadium oxide”</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii) QWC	<p><u>Temperature</u></p> <p>More molecules/collisions/ particles have <math>E \geq E_{act}</math> /sufficient energy to react (1)</p> <p><math>\therefore</math> a greater proportion of collisions are successful Or More of the collisions are successful (1)</p> <p>IGNORE greater frequency of collision</p> <p>2<sup>nd</sup> mark dependent on 1<sup>st</sup> mark UNLESS 1<sup>st</sup> mark is not awarded through use of “atoms”</p> <p><u>Catalyst</u></p> <p>EITHER: provides alternative route of lower activation energy (1)</p> <p>more molecules have <math>E &gt; E_{cat}</math> / a greater proportion of collisions are successful (1)</p> <p>2<sup>nd</sup> mark dependent on mention of lowered activation energy Do not penalise use of “atoms” again</p> <p>OR: provides (active) sites (1)</p> <p>where reactant molecules can bond/be adsorbed (1)</p>	<p><math>E &gt; E_{act}</math> “energy barrier” instead of “<math>E_{act}</math>/activation energy”</p> <p>Collisions more likely to be successful</p> <p>Greater chance of successful...</p> <p>More successful collisions per second</p> <p>“energy barrier” instead of “<math>E_{act}</math>/activation energy”</p> <p>Collisions more likely to be successful</p> <p>Greater chance of successful...</p> <p>More successful collisions per second</p>	<p>More atoms....</p> <p>just “more successful collisions”</p> <p>“..fruitful collisions”</p> <p>just “more successful collisions” N.B. Penalise “more collisions are successful” only once</p> <p>“..fruitful collisions”</p> <p>Where reaction can take place</p>	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii) QWC	<p>reaction exothermic (1)</p> <p>equilibrium shifts to the left decreasing the yield (1)</p> <p>2<sup>nd</sup> mark is dependent on the 1<sup>st</sup> and is not consequential.</p> <p>IGNORE Le Chatelier explanations</p>	$\Delta H$ negative/reverse reaction is endothermic	<p>Just “equilibrium shifts to the left”</p> <p>Just “yield decreases”</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv) QWC	<p>fewer (gaseous) molecules /particles/moles on the right (1)</p> <p>equilibrium shifts to the right increasing the yield (1)</p> <p>2<sup>nd</sup> mark is dependent on the 1<sup>st</sup> and is not consequential.</p> <p>IGNORE Le Chatelier explanations</p> <p>N.B do not penalise omission of either ‘equilibrium shifts’ or change of yield if already penalised in (iii)</p>		<p>Just “equilibrium shifts to the right”</p> <p>Just “yield increases”</p> <p>Arguments based on volume</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	<p><math>\Delta H = \Delta H_f</math> (products) – <math>\Delta H_f</math> (reactants) Or <math>(-814 \times 2) - (-286 \times 2)</math> (1)</p> <p><math>= -1056</math> (kJ mol<sup>-1</sup>) (1) IGNORE units</p> <p>Correct answer with no working (2)</p> <p>Omission of either or both of <math>\times 2</math> max 1. Hence -242 with some working (1) -1342 with some working (1) -528 with some working (1)</p> <p>(+)1056 with some working (1)</p>		<p><math>\Delta H_f</math> vaues added scores zero overall</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	any one of:  making fertiliser/ detergents/ paint/ pigment inc TiO <sub>2</sub> / dyes/ fibres/ plastics/ pharmaceuticals/ explosives  OR (in) car batteries OR pickling iron OR anodising Al OR electrolytic refining of copper		Making soap	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	Any two of <ul style="list-style-type: none"> <li>• (same) general formula</li> <li>• (successive) members differ by CH<sub>2</sub></li> <li>• (same) functional group/ (similar/same) chemical properties/reactions</li> <li>• regular trend in physical properties</li> </ul> IGNORE "same properties"	(Same) general molecular formula	(Same) molecular formula          Same physical properties   Reference to a specific reaction e.g. same reaction with chlorine	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	alkene(s)		C=C alkane	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	<p>electrophilic addition (1) both needed</p> <p>IGNORE heterolytic and penalise homolytic</p> <p>hydrogen chloride/HCl (1)</p>		(Dilute) hydrochloric acid/dilute HCl /HCl(aq)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	<p><u>Classification</u> nucleophilic substitution (1)</p> <p><u>Reagent</u> potassium cyanide/KCN Or sodium cyanide/NaCN (1)</p> <p><u>Condition</u> (Heat under reflux in) aqueous ethanol/ethanol / alcohol (solvent) (1)</p> <p>3<sup>rd</sup> mark dependent on (a ) cyanide as reagent</p> <p>3<sup>rd</sup> mark can be awarded in reagent line</p>	Cyanide ions/CN <sup>-</sup>	<p>Cyanide</p> <p>Aqueous alone</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	<p>same molecular formula (1)</p> <p>different structural formulae/ displayed formulae/ arrangement of atoms (1)</p>	<p>Same numbers of each atom</p> <p>different structure</p>	different arrangement in space	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	<p>There are many possibilities e.g.</p> <pre>       H             H-C-H             H-C-C≡N             H-C-H               H           </pre> <p>Or structures including rings / multiple bonds / isonitriles</p>	<p>Accept CH<sub>3</sub> and/or CN e.g.</p> <pre>       CH<sub>3</sub>             H-C-CN               CH<sub>3</sub>           </pre>		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	<p>1-bromopropane faster (1) Stand alone</p> <p>because C-Br bond weaker (than C-Cl) (1)</p> <p>IGNORE attempted explanations of why C-Br bond weaker</p> <p>therefore lower activation energy/<math>E_{act}</math> (1) [Lower <math>E_{act}</math> must be related to C-X bond]</p>	<p>Reverse statement</p> <p>Reverse argument</p> <p>Reverse argument</p>	<p>Any answer which gives 1-chloropropane as faster scores zero overall</p> <p>If no reference to carbon-halogen bond</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	<pre>       H   H                 —C—C—                 CH<sub>3</sub> Cl           </pre> <p>2 carbon chain with continuation bonds in repeat unit (1)</p> <p>All other atoms correct (1)</p> <p>IGNORE subscript n</p> <p>IGNORE where the bond to the CH<sub>3</sub> goes e.g.</p> <pre>             CH<sub>3</sub>           </pre> <p>CH<sub>3</sub> is fine</p>	<p>If more than one repeat unit given and number of repeat units stated or the repeat unit identified (2)</p> <p>If repeat unit not stated or identified can score 2<sup>nd</sup> mark only</p>	<p>3 carbon chain</p> <p>Or</p> <p>Any repeat unit containing a double bond scores zero</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)	Restricted rotation around double bond (1)  1-chloropropene has two different groups on both carbons/each carbon (in the double bond)(but propene does not) (1)	No rotation/double bond cannot rotate (at room temperature)  Propene has two identical groups on one carbon (of the double bond) (but 1-chloropropene does not)		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	KMnO <sub>4</sub> /potassium manganate(VII) / potassium permanganate  IGNORE any acid or alkali	Sodium analogues  Or O <sub>2</sub> followed by aqueous acid	Just "Potassium manganate"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	1,2(-)dibromoethane			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	EITHER: sodium bromide/NaBr /potassium bromide/KBr (1)  (50 %) sulphuric acid/H <sub>2</sub> SO <sub>4</sub> / phosphoric acid/H <sub>3</sub> PO <sub>4</sub> (1)  OR: (Moist) red phosphorus/P (1)  Bromine/Br <sub>2</sub> (1)  2 <sup>nd</sup> mark is conditional on the 1 <sup>st</sup>	HBr with concentrated/50 % sulphuric (1 only)  concentrated H <sub>2</sub> SO <sub>4</sub>  PBr <sub>3</sub> alone (1 only)	Dilute/aqueous sulphuric acid/H <sub>2</sub> SO <sub>4</sub>  PBr <sub>3</sub> plus any other reagent (0)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iv)	<p><u>Colour change</u></p> <p>from orange to green/blue (1)</p> <p><u>Oxidation products</u> (2)</p> <p>any 2 of:</p> $\begin{array}{c} \text{O}-\text{H} \\   \\ \text{H}-\text{C}-\text{C}=\text{O} \\   \quad \quad   \\ \text{H} \quad \quad \text{H} \end{array}$ $\begin{array}{c} \text{O} \quad \quad \text{O} \\ // \quad \quad // \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad   \\ \quad \quad \quad \text{H} \end{array}$ $\begin{array}{c} \text{O}-\text{H} \quad \quad \text{O} \\   \quad \quad \quad // \\ \text{H}-\text{C}-\text{C} \\   \quad \quad \quad   \\ \text{H} \quad \quad \quad \text{O}-\text{H} \end{array}$ $\begin{array}{c} \text{O} \quad \quad \text{O} \\ // \quad \quad // \\ \text{H}-\text{C}-\text{C} \\ \quad \quad \quad   \\ \quad \quad \quad \text{O}-\text{H} \end{array}$ $\begin{array}{c} \text{O} \quad \quad \text{O} \\ // \quad \quad // \\ \text{H}-\text{O}-\text{C}-\text{C} \\ \quad \quad \quad   \quad \quad   \\ \quad \quad \quad \text{O}-\text{H} \quad \quad \text{O}-\text{H} \end{array}$ <p>Bonding from C must be to O of OH groups - penalise once only</p> <p>IGNORE any names</p>	<p>OH instead of O-H</p> <p>If any two of the following given (1 out 2)</p> <p>CH<sub>2</sub>OHCHO</p> <p>CH<sub>2</sub>OHCOOH</p> <p>CHOCHO Or OHCCHO</p> <p>CHOCOOH Or OHCCOOH</p> <p>COOHCOOH Or (COOH)<sub>2</sub> Or HOCCOOH</p> <p>Allow CO<sub>2</sub>H for COOH in the above</p>	<p>...to brown</p> <p>CH<sub>2</sub>OHCOH</p> <p>CHOCOH Or OHCCOH</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(v)	<p>C<sub>2</sub>H<sub>2</sub>/CH≡CH/ethyne</p> <p>Or</p> <p>CH<sub>2</sub>=CHBr /CH<sub>2</sub>CHBr/bromoethene</p>	<p>1-bromoethene</p> <p>2-bromoethene</p>	<p>CH<sub>2</sub>BrCH</p> <p>C<sub>2</sub>H<sub>3</sub>Br</p>	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	<p><math>C_2H_5Br</math>/bromoethane (1)</p> <p>(only) monosubstitution occurs (1)</p> <p>Or</p> <p>1,1-dibromoethane/<math>CH_3CHBr_2</math> (1)</p> <p>isomer of B / substitutes onto same carbon/Br (radical) can remove H from either carbon (1)</p> <p>Or</p> <p>1,1,2-tribromoethane etc. (1)</p> <p>substitution continues/ polysubstitution/reaction continues (1)</p> <p>Or</p> <p>Butane/<math>C_4H_{10}</math> (1)</p> <p>Combination of two <math>C_2H_5</math> radicals (1)</p> <p>The 1<sup>st</sup> mark is stand alone in each case.</p>		<p>Side reactions</p> <p>Reaction reaches equilibrium</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	<p><math>C_2H_6 + 3\frac{1}{2} O_2 \rightarrow 2CO_2 + 3H_2O</math></p> <p>Species (1)</p> <p>Balancing (1)</p> <p>IGNORE state symbols</p>	<p>Multiples</p> <p><math>CH_3CH_3</math> instead of <math>C_2H_6</math></p>	If incorrect hydrocarbon e.g. ethene scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	simplest (whole number) ratio of the different atoms in a compound/molecule	.....ratio of moles of atoms....	“elements” for “atoms”	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iv)	$CH_3$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(v)	<p>Any alkane formula with odd no. of C atoms other than <math>CH_4</math></p> <p>This can be a structural, full structural or molecular formula</p> <p>IGNORE names even if incorrect</p>			1