

Mark Scheme (Final) 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/Cl₂ <u>oxidation product</u> sodium chlorate(I) / NaOCl / OCl⁻ /chlorate(I) (ions) (1)</p> <p>both required for mark</p> <p><u>species reduced</u> chlorine / Cl₂</p> <p><u>reduction product</u> (sodium) chloride / NaCl / chloride ion/Cl⁻ (1)</p> <p>both required for mark</p>	<p>Species oxidised Cl (in Cl₂) ox. prod. sodium hypochlorite</p> <p>Species reduced Cl (in Cl₂)</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 = $\frac{100}{74.5} =$ 1.342 (1) (= moles Cl₂)</p> <p>volume Cl₂ = 1.342 x 24 = 32.2 dm³ - unit essential (1)</p> <p>2nd mark consequential on moles</p> <p>To get the 2nd 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 (dm³) (1) ∴ 100 (g) gives 32.2 dm³ (1)</p> <p><u>Some common</u> acceptable answers are: 32.16/32/31.2/31 dm³</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/10⁵Pa/ 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 SO₂, negates 2nd 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> >1 to 5 atm or any value or range within this range inclusive (1)</p> <p><u>Catalyst</u> Vanadium(V) oxide / V₂O₅ (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 $E \geq E_{act}$ /sufficient energy to react (1)</p> <p>\therefore a greater proportion of collisions are successful Or More of the collisions are successful (1)</p> <p>IGNORE greater frequency of collision</p> <p>2nd mark dependent on 1st mark UNLESS 1st 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 $E > E_{cat}$ / a greater proportion of collisions are successful (1)</p> <p>2nd 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>$E > E_{act}$ “energy barrier” instead of “E_{act}/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 “E_{act}/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>2nd mark is dependent on the 1st and is not consequential.</p> <p>IGNORE Le Chatelier explanations</p>	ΔH 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>2nd mark is dependent on the 1st 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>$\Delta H = \Delta H_f$ (products) – ΔH_f (reactants) Or $(-814 \times 2) - (-286 \times 2)$ (1)</p> <p>$= -1056$ (kJ mol⁻¹) (1) IGNORE units</p> <p>Correct answer with no working (2)</p> <p>Omission of either or both of $\times 2$ 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>ΔH_f 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 ₂ / 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"> • (same) general formula • (successive) members differ by CH₂ • (same) functional group/ (similar/same) chemical properties/reactions • regular trend in physical properties 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>3rd mark dependent on (a) cyanide as reagent</p> <p>3rd mark can be awarded in reagent line</p>	Cyanide ions/CN ⁻	<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 CH₃ and/or CN e.g.</p> <pre> CH₃ H-C-CN CH₃ </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/E_{act} (1) [Lower E_{act} 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

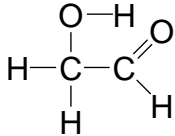
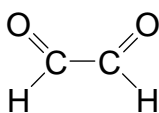
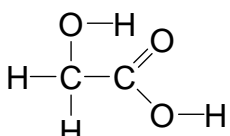
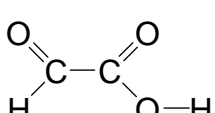
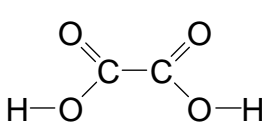
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	<pre> H H —C—C— CH₃ Cl </pre> <p>2 carbon chain with continuation bonds in repeat unit (1)</p> <p>All other atoms correct (1)</p> <p>IGNORE subscript n</p> <p>IGNORE where the bond to the CH₃ goes e.g.</p> <pre> CH₃ </pre> <p>CH₃ is 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 2nd mark only</p>	<p>3 carbon chain Or 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 ₄ /potassium manganate(VII) / potassium permanganate IGNORE any acid or alkali	Sodium analogues Or O ₂ 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 ₂ SO ₄ / phosphoric acid/H ₃ PO ₄ (1) OR: (Moist) red phosphorus/P (1) Bromine/Br ₂ (1) 2 nd mark is conditional on the 1 st	HBr with concentrated/50 % sulphuric (1 only) concentrated H ₂ SO ₄ PBr ₃ alone (1 only)	Dilute/aqueous sulphuric acid/H ₂ SO ₄ PBr ₃ 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>      <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>CH₂OHCHO</p> <p>CH₂OHCOOH</p> <p>CHOCHO Or OHCCHO</p> <p>CHOCOOH Or OHCCOOH</p> <p>COOHCOOH Or (COOH)₂ Or HOCCOOH</p> <p>Allow CO₂H for COOH in the above</p>	<p>...to brown</p> <p>CH₂OHCOH</p> <p>CHOCOH Or OHCCOH</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(v)	<p>C₂H₂/CH≡CH/ethyne</p> <p>Or</p> <p>CH₂=CHBr /CH₂CHBr/bromoethene</p>	<p>1-bromoethene</p> <p>2-bromoethene</p>	<p>CH₂BrCH</p> <p>C₂H₃Br</p>	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	<p>C_2H_5Br/bromoethane (1)</p> <p>(only) monosubstitution occurs (1)</p> <p>Or</p> <p>1,1-dibromoethane/CH_3CHBr_2 (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/C_4H_{10} (1)</p> <p>Combination of two C_2H_5 radicals (1)</p> <p>The 1st 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>$C_2H_6 + 3\frac{1}{2} O_2 \rightarrow 2CO_2 + 3H_2O$</p> <p>Species (1)</p> <p>Balancing (1)</p> <p>IGNORE state symbols</p>	<p>Multiples</p> <p>CH_3CH_3 instead of C_2H_6</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/moleculeratio 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 CH_4</p> <p>This can be a structural, full structural or molecular formula</p> <p>IGNORE names even if incorrect</p>			1