

# Mark Scheme (Results)

## Summer 2008

GCE

### GCE Chemistry Nuffield (6252/01)

## 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 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)(i)        | AgI<br>Or AgI(s)/(ppt) | Ag <sup>+</sup> I <sup>-</sup><br>ie any correct answers with <b>both</b> charges | Silver Iodide<br>Ag <sup>+</sup> I, AgI <sup>+</sup> , AgI <sup>-</sup> | 1    |

| Question Number | Correct Answer   | Acceptable Answers  | Reject  | Mark |
|-----------------|--|---|---|------|
| 1 (a)(ii)       | Ag <sup>+</sup> (aq) + I <sup>-</sup> (aq) → AgI(s)<br><br>Mark independently of (i), unless acceptable answer<br>TE | TE of Cl, Br, X from (i)<br><br>TE Ag <sup>2+</sup> (aq) + 2I <sup>-</sup> (aq) → AgI <sub>2</sub> (s) from AgI <sub>2</sub> in (i) | TE from AgI <sub>3</sub> , Ag <sub>2</sub> I etc<br><br>Ag <sup>+</sup> (aq) + I <sup>-</sup> (aq) → AgI(ppt) | 1    |

| Question Number | Correct Answer  | Acceptable Answers  | Reject | Mark |
|-----------------|---|---|--------|------|
| 1 (b)(i)        | C <sub>4</sub> H <sub>9</sub> I + H <sub>2</sub> O → C <sub>4</sub> H <sub>9</sub> OH / C <sub>4</sub> H <sub>10</sub> O + HI / IH<br><br>IGNORE states | "H <sup>+</sup> + I <sup>-</sup> " for "HI"<br>Accept Cl, Br, or X instead of I<br><br>Allow combination of X on the left with I, Br, or Cl on the right<br><br>or X on the right with I, Br, or Cl on the left |        | 1    |

| Question Number | Correct Answer   | Acceptable Answers | Reject   | Mark |
|-----------------|--|--------------------|--|------|
| 1 (b)(ii)       | Substitution<br><br>IGNORE nucleophilic (but note this may get 1 <sup>st</sup> mark for (iii)) | hydrolysis         | Displacement/<br>replacement/<br>electrophilic/free radical substitution | 1    |

| Question Number | Correct Answer   | Acceptable Answers | Reject   | Mark |
|-----------------|--|--------------------|--|------|
| 1 (b)(iii)      | Nucleophile - can be awarded from (ii) (1)<br><br>Because of non-bonding/unbonded / lone/unshared <b>pair</b> of electrons (on oxygen/water) (1) |                    | Just "pair of electrons"<br><br>'spare' pair of electrons<br><br>unshared pair of electrons on the hydroxide ion/OH <sup>-</sup> | 2    |

| Question Number | Correct Answer   | Acceptable Answers  | Reject                                      | Mark |
|-----------------|--|---|---|------|
| 1 (c)(i)        | <p>ceramic fibre in horizontal tube (1)</p> <p>soaked in reagents /reactants/halogenoalkane and (alcoholic) KOH with heat/Bunsen (1)</p> <p>collection over water (1)</p>  <p>Penalties (cumulative)<br/>poor diagram -1<br/>e.g. delivery tube through side of trough/no water in trough.</p> <p>Use of pumice/aluminium oxide/<math>\text{Al}_2\text{O}_3</math> in test tube -1</p> | <p>Mineral/glass/cotton wool</p> <p>Vertical flask/side arm test tube/boiling tube and reagents with heat for 2<sup>nd</sup> mark</p> <p>Heat indicated anywhere along the test tube</p> <p>syringe (with three-way tap)</p> <p>IGNORE diagram and position of Bunsen valve</p> | <p>Steel wool</p> <p>Arrow without heat</p> | 3    |

| Question Number | Correct Answer  | Acceptable Answers  | Reject   | Mark |
|-----------------|---|---|--|------|
| 1 (c)(ii)       | $  \begin{array}{ccccccc}  & & \text{H} & & & & \\  & &   & & & & \\  & \text{H} & \text{H}-\text{C}-\text{H} & \text{H} & & & \\  &   &   &   & & & \\  \text{H}-\text{C} & - & \text{C} & - & \text{C}-\text{H} & & \\  &   &   & &   & & \\  & \text{H} & \text{I} & & \text{H} & &   \end{array}  $ <p>(1)</p> <p>Must be fully displayed</p> <p>2-iodo(-2-)methylpropane / (-2-)methyl-2-iodopropane (1)</p> | <p>X, Cl or Br for 1<sup>st</sup> mark</p> <p>Chloro/bromo compounds if TE from diagram</p> <p>Fully correct formula for 2-methyl-1-iodopropane with correct name gains 1 max again allow Br/Cl</p> | <p>All other structures for 1<sup>st</sup> mark</p> <p>All other names for 2<sup>nd</sup> mark</p> | 2    |

| Question Number | Correct Answer  | Acceptable Answers   | Reject | Mark |
|-----------------|---|--|--------|------|
| 1 (d)           | Three attached methyl groups /tertiary (1)<br><br>Weaken/weaker/weak C-I/C-X/C-halogen/C-Cl/C-Br bond<br>Or<br>Carbocation stabilised (1) | two attached methyl groups /secondary (1)<br><br>the iodine /halogen/ chlorine/ bromine/X bond is weak |        | 2    |

| Question Number | Correct Answer  | Acceptable Answers   | Reject                                    | Mark |
|-----------------|---|--|---|------|
| 1 (e)(i)        | $  \begin{array}{cccc}  \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} \\    &   &   &   \\  -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\    &   &   &   \\  \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H}  \end{array}  $<br>CH <sub>3</sub> groups on positions 1,1,3,3, <u>or</u> 2,2,4,4 <u>or</u> 1,1,4,4 <u>or</u> 2,2,3,3<br><br>Ignore brackets and n's | Part/fully displayed<br>Part/fully structural<br>Allow -CH <sub>2</sub> -<br>Allow CH <sub>3</sub><br> <br>Allow more than two units | Skeletal formulae (missing out hydrogens) | 1    |

| Question Number | Correct Answer   | Acceptable Answers | Reject                             | Mark |
|-----------------|--|--------------------|------------------------------------|------|
| 1 (e)(ii)       | Reaction goes to favour lowest number of/no gaseous/gas molecules<br>OR gas to solid |                    | Just "by Le Chatelier's Principle" | 1    |

| Question Number | Correct Answer  | Acceptable Answers | Reject   | Mark |
|-----------------|---|--------------------|--|------|
| 1 (e)(iii)      | A catalyst provides an alternative route/mechanism for a reaction... (1)<br><br>...with a lower activation energy (1)<br><br>Mark independently |                    | Additional totally incorrect comment negates 2 <sup>nd</sup> mark e.g. "...and provides energy for the reaction" | 2    |

| Question Number | Correct Answer  | Acceptable Answers                                       | Reject | Mark |
|-----------------|-----------------|--|--------|------|
| 2 (a)(i)        | van der Waal(s) | Reasonable phonetic spelling<br>London/dispersion forces | vdw    | 1    |

| Question Number | Correct Answer  | Acceptable Answers                                       | Reject                          | Mark |
|-----------------|---|--|---------------------------------|------|
| 2 (a)(ii)       | Same/similar/about the same number of electrons<br>IGNORE numbers of electrons even if incorrect<br><br>BUT allow<br>"Both have 34 electrons" without any other comment | Allow additional comments like 'both are straight chain' | "Similar molar mass" on its own | 1    |

| Question Number | Correct Answer  | Acceptable Answers   | Reject            | Mark |
|-----------------|---|----------------------|-------------------|------|
| 2 (b)(i)        | <pre>       H H H       .x .x .x xx H : C : C : C : O : H       .x .x .x xx       H H H </pre> <p>Check non bonding electrons on oxygen (which can be ".x")</p> | All dots and crosses | Four carbon chain | 1    |

| Question Number | Correct Answer     | Acceptable Answers | Reject                | Mark |
|-----------------|--------------------|--------------------|-----------------------|------|
| 2 (b)(ii)       | Hydrogen bond(ing) | H bonding          | 'Hydrogen' on its own | 1    |

| Question Number | Correct Answer  | Acceptable Answers                                | Reject  | Mark |
|-----------------|---|---|---|------|
| 2 (b)(iii)      | <pre>       H H H H           H H H                               H - C - C - C - O - - - H - O - C - C - C - H                                   H H H           H H H </pre> <p style="text-align: right;">(1)</p> <p>The hydrogen bond can be represented by any number of dots/dashes but not a continuous straight line</p> <p><u>Bond angles</u><br/>COH 103-106.5° (1)<br/>Between molecules 180° (1)</p> <p>Mark independently throughout</p> | O---H-O do not have to be in straight line but... | ...reject two hydrogen bonds between two molecules<br><br>Chain not fully displayed | 3    |

| Question Number | Correct Answer  | Acceptable Answers  | Reject   | Mark |
|-----------------|---|---|--|------|
| 2 (b)(iv)       | <p>An electric kettle/heater of <b>known power rating</b></p> <p>Or</p> <p>Measure rate of heating by Bunsen burner (1)</p> <p>Mass/volume of liquid <b>boiled off /evaporated (1)</b></p> <p>IGNORE additional references to temperature changes</p> <p>In measured (boiling) time (1)</p> <p>Other methods considered on their merits</p> | <p>This could be an electric heater connected to a Joulemeter</p> <p>Allow heating method (no power), balance and stopwatch for 1 max (i.e. no indication of what they are measuring but correct apparatus)</p> | Any reference to finding enthalpy change of combustion scores zero | 3    |

| Question Number | Correct Answer  | Acceptable Answers                 | Reject  | Mark |
|-----------------|---|------------------------------------|---|------|
| 2 (b)(v)        | (14.8 - 6.9 $\Rightarrow$ ) 7.9 (kJ mol <sup>-1</sup> ) | <p>No units</p> <p>kJ for unit</p> | <p>-7.9</p> <p>J for unit or other wrong unit</p> | 1    |

| Question Number | Correct Answer  | Acceptable Answers       | Reject         | Mark |
|-----------------|---|--------------------------|----------------|------|
| 2 (c)(i)        | (Permanent) dipole - (permanent) dipole (forces/ interactions/ attractions) | Permanent dipole (alone) | 'Dipole' alone | 1    |

| Question Number | Correct Answer  | Acceptable Answers  | Reject                   | Mark |
|-----------------|---|---|--------------------------|------|
| 2 (c)(ii)       | <p>Propan-1-ol can form hydrogen bonds to propanone... (1)</p> <p>...using the oxygen of the carbonyl group/propanone (and the hydrogen of the OH group)</p> <p>Or</p> <p>Interactions/bonds made are of a similar strength to those broken (1)</p> | <p>Can be shown by a diagram labelling "hydrogen bond"</p> <p>Can be shown as a diagram</p> | Answers based on dipoles | 2    |

| Question Number | Correct Answer               | Acceptable Answers | Reject | Mark |
|-----------------|------------------------------|--------------------|--------|------|
| 2 (d)(i)        | (thermal/catalytic) cracking | pyrolysis          |        | 1    |

| Question Number | Correct Answer   | Acceptable Answers   | Reject  | Mark |
|-----------------|--|--|---|------|
| 2 (d)(ii)       | <p>Type: Substitution (1)</p> <p>Mechanism: Free radical/radicle (1)</p> <p>2<sup>nd</sup> mark is <u>not</u> conditional on the 1<sup>st</sup></p> <p>The answers can be given on either line, providing there is no contradictory information.</p> | <p>"Free radical substitution" on either line with other line blank gets 2 marks</p> | <p>More than one name of mechanism in either answer loses 2<sup>nd</sup> mark e.g. 'nucleophilic substitution' and 'free radical' (1 max)</p> | 2    |



| Question Number | Correct Answer                                  | Acceptable Answers                       | Reject  | Mark |
|-----------------|---|--|---|------|
| 3 (b)(i)        | Potassium iodide<br><br>(Dilute) Sulphuric acid | KI / any soluble iodide<br><br>$H_2SO_4$ | "I <sup>-</sup> " on its own<br><br>For 2 <sup>nd</sup> mark:<br>Sulphuric acid <b>and</b><br>sodium/potassium<br>hydroxide<br><br>Concentrated sulphuric<br>acid/concentrated<br>$H_2SO_4$<br><br>"H <sup>+</sup> " instead of<br>"sulphuric acid" | 2    |

| Question Number | Correct Answer                                | Acceptable Answers         | Reject | Mark |
|-----------------|---|----------------------------|--------|------|
| 3 (b)(ii)       | (Sodium) <b>thiosulphate</b><br>(solution/aq) | $Na_2S_2O_3$ (solution/aq) |        | 1    |

| Question Number | Correct Answer   | Acceptable Answers   | Reject                                       | Mark |
|-----------------|--|--|--|------|
| 3 (b)(iii)      | Indicator: Starch (1)<br><br>From: Blue/black/blue-<br>black/dark blue/deep blue<br>To: colourless (1)<br><br>2 <sup>nd</sup> mark is dependent on<br>starch | 'no indicator used'<br><b>with</b> (pale) yellow/<br>straw coloured to<br>colourless (2) | Purple/grey in any<br>combination of colours | 2    |

| Question Number | Correct Answer   | Acceptable Answers | Reject | Mark |
|-----------------|--|--------------------|--------|------|
| 4 (a)           | H-C≡C-H<br>Bond angle: 180 °<br><br>Both needed with HCCH in a straight line |                    |        | 1    |

| Question Number | Correct Answer  | Acceptable Answers | Reject | Mark |
|-----------------|---|--------------------|--------|------|
| 4 (b)           | It also contains<br>phosphine/PH <sub>3</sub><br>hydrogen sulphide/H <sub>2</sub> S<br>ammonia/NH <sub>3</sub><br><b>all 3 required</b> |                    |        | 1    |

| Question Number | Correct Answer   | Acceptable Answers              | Reject  | Mark |
|-----------------|--|---------------------------------|---|------|
| 4 (c)           | This method does not require crude oil (which may become too expensive)<br><br>Or<br>This method is more efficient (no tar deposition)<br><br>Or<br>Lime <b>and</b> coke are cheap/readily available | Second method is less efficient | 1,2-dibromoethane is expensive [i.e. not an industrial method]<br><br>No heat required for cracking<br><br>Calcium carbide is cheaper | 1    |

| Question Number | Correct Answer  | Acceptable Answers  | Reject | Mark |
|-----------------|---|---|--------|------|
| 4 (d)           | Ethyne reacts only <b>slowly</b><br><br>Or<br>product still unsaturated/is an alkene/contains C=C/1,2-dibromoethene forms | Answers in terms of ethene<br>e.g. ethene reacts more quickly etc |        | 1    |

| Question Number | Correct Answer  | Acceptable Answers | Reject  | Mark |
|-----------------|---|--------------------|---|------|
| 4 (e)           | Any two from:<br><br>Reaction with copper(I)<br>Reaction with silver ion<br><b>If neither</b> of above given then "Acidity of ethyne" counts as one difference<br><br>Decomposition under pressure<br><br>Addition of water/reaction with dilute sulphuric acid to form ethanal |                    | Reaction with halogen/hydrogen/polymerisation (any reaction from second to last paragraph) <b>but</b> if given with two correct answers is neutral. | 1    |

| Question Number | Correct Answer             | Acceptable Answers                | Reject           | Mark |
|-----------------|----------------------------|-----------------------------------|------------------|------|
| 4 (f)(i)        | Ethene and bromine (water) | Ethene and bromine water formulae | Ethene liquid... | 1    |

| Question Number | Correct Answer   | Acceptable Answers  | Reject | Mark |
|-----------------|--|---------------------|--------|------|
| 4 (f)(ii)       | Side arm flask/or equivalent with dropping funnel attached/stopper and teat pipette and heat indicated | Any workable set up |        | 1    |

| Question Number | Correct Answer  | Acceptable Answers | Reject | Mark |
|-----------------|---|--------------------|--------|------|
| 4 (g)           | <p>Examiners will need to consider each answer for (i) key points and (ii) style and use of English. Candidates should have recorded their word total at the end of their answer, and this should be checked.</p> <p>up to 105 words: no penalty<br/> 106 - 115 words: -1<br/> 116 - 125 words: -2<br/> 126 - 135 words: -3<br/> and at a rate of -1 penalty for every 5 words excess thereafter, up to a maximum penalty equal to the number of key points included by the answer.</p> <p>Note that words appearing in the title to the summary do not count in the word total. Normally hyphenated words, numbers and chemical formulae count as one word. The question does not ask for equations in the summary, but if included they should be counted in the word total.</p> <p>Sub-headings do not count in the word total.</p> <p>2300 K, 1500 K each count as two words (number and unit)<br/> rmm/M<sub>r</sub> one word<br/> water-quenched one word</p> <p><b>Marking for key points</b><br/> One mark should be awarded for every key point clearly identified in an answer.</p> <p><b>Key points minus word penalty = maximum 6 marks</b></p> <p>To gain the mark for a key point the wording used by the candidate must make clear the essential chemistry of the point.</p> <p>The detail of each point is needed, even if it is not all in <b>bold</b> type.</p> |                    |        | 8    |

| Question Number | Correct Answer   | Acceptable Answers   | Reject   | Mark |
|-----------------|--|--|--|------|
|                 | <p><b>Key Points</b></p> <p>1 Lime/calcium oxide is heated with coke at 2300 K to form calcium carbide.</p> <p>2 This/calcium carbide is fed (from a hopper) into (a tank containing) water and ethyne is collected in a gas holder</p> <p>3 Cold water is flushed/pumped through/added (to the generating tank) to cool the mixture/remove sludge waste/remove calcium hydroxide</p> <p>4 Ethyne is purified, dried and compressed</p> <p>5 Low (relative) molecular mass/molar mass/rmm/M<sub>r</sub> alkanes are cracked at 1500 K (in an endothermic process)</p> <p>Or<br/>short chain alkanes are cracked at 1500 K (in an endothermic process)</p> <p>6 A mixture including ethyne/alkynes is produced which is water-quenched...</p> <p>7 ...before separation by selective absorption</p> <p>Or<br/>by solvents under low temperature and high pressure</p> <p>8 On heating ethyne is released/produced from the solvent<br/>Note: solvent must be mentioned here, it cannot be implied</p> <p>Any six key points</p> | <p>Calcium carbide can be implied by next sentence</p> <p>Ethyne can be implied by a subsequent sentence</p> <p>"the gas" instead of "ethyne" if clearly implied</p> | <p>"High temperature and low pressure" on its own or in addition to selective absorption</p> |      |

| Question Number | Correct Answer  | Acceptable Answers | Reject | Mark |
|-----------------|---|--------------------|--------|------|
|                 | <p><b>Quality of written communication</b></p> <p>This should be impression marked on a scale 2 - 1 - 0, and the mark out of 2 should be recorded in the body of the script at the end of the answer. This mark can not be lost as a result of a word penalty.</p> <p>Candidates are expected to:</p> <ul style="list-style-type: none"> <li>• show clarity of expression;</li> <li>• construct and present coherent argument;</li> <li>• demonstrate effective use of grammar, punctuation and spelling.</li> </ul> <p>The aspects to be considered are:</p> <ul style="list-style-type: none"> <li>• use of technical terms; the answer should convey a correct understanding by the writer of the technical terms used in the passage which are involved in the key points.</li> <li>• articulate expression; the answer should be well-organised in clear, concise English, without ambiguity. It should read fluently, with the links between key points in the original maintained.</li> <li>• legible handwriting; the reader should be able to read the answer without difficulty at normal reading pace, with only the occasional difficulty with a word.</li> <li>• points must be in a logical order.</li> </ul> <p>Good style and use of English, with only infrequent minor faults, no use of formulae (2)<br/> Frequent minor or a few major faults in style and use of English (1)<br/> Very poor style and use of English (0)</p> <p>NB: The quality of written communication mark cannot be lost through word penalties.</p> |                    |        |      |

**Note to the examiner:**

This passage lends itself to a simple structure: there are two industrial methods. The first is.... The second is.... This structure will often be seen in a response worthy of 2 for QWC.