

Mark Scheme (Results) Summer 2009

GCE

GCE Chemistry (6CH02/01)

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.

6CH02/01

Section A

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 1 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 2 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 3 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 4 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 5 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 6 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 7 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 8 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 9 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 10 (a) | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 10 (b) | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 11 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 12 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 13 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 14 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 15 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 16 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 17 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 18 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|------|
| 19 | B | | 1 |

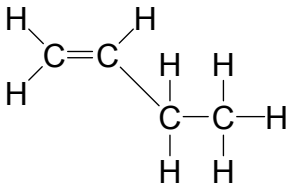
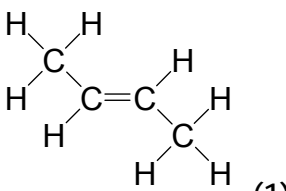
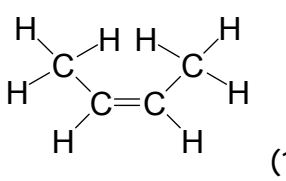
Section B

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 20 (a)(i) | Reaction 1 - (nucleophilic) substitution (1) Reaction 2 - elimination (1) | | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-------------------|--|------------------|------|
| 20 (a)(ii) QWC | Reaction 1 - Water can behave as a nucleophile /water can donate a lone pair (from oxygen)/water has a lone pair/water forms an OH^- ion (1) And attack (positive) carbon (originally attached to Cl)/bonds to the carbon/bonds to the carbocation (1) Reaction 2 - behaves as a base (1) and accepts a hydrogen ion/proton / donates e^- pair to H/removes a proton/removes a hydrogen ion/removes a H^+ (1) In each case a correctly drawn mechanism could get (2) | Removes a H atom | 4 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 20 (b)(i) | Heterolytic (fission) Notes Accept phonetic/incorrect spelling as long as the word is recognisable | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|---------------------------|------|
| 20 (b)(ii) | <p>Butyl group less electron releasing/butyl group has less of a (positive) inductive effect (1)</p> <p>so less stable (positive charge on) carbocation (1)</p> <p>OR</p> <p>1- chlorobutane is a primary halogenoalkane/the carbon only has 1 other C attached (1)</p> <p>So forms a less stable carbocation (1)</p> <p>OR</p> <p>Primary carbocation is less stable than a tertiary carbocation (2)</p> <p>OR</p> <p>Water/OH^- can attack C on 1° chloroalkane more easily (so no need to form cation) OWTTE / 1° chloroalkane reacts via $\text{S}_\text{N}2$ mechanism/C-O bond forms before C-Cl breaks (1)</p> <p>As the carbon attacked is not surrounded by bulky groups OWTTE (1)</p> | Negative inductive effect | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 20 (c) | <p>Hydrogen (ion) can be eliminated from C on either side (of C attached to Cl)/double bond can form between 1st and 2nd or 2nd and 3rd carbon OWTTE (1)</p> <p>OR</p> <p>double bond can't rotate (so methyl group and hydrogens can be fixed in position) to form E and Z isomers / geometric isomers/cis and trans/stereoisomers/or named in diagrams OWTTE (1)</p> <p>allow descriptions in terms of cis and trans</p> <div style="text-align: center;">  <p>(1)</p> </div> <div style="text-align: center;">  <p>(1)</p> </div> <div style="text-align: center;">  <p>(1)</p> </div> <p>Methyl and ethyl groups do not need to be fully displayed</p> <p>Structural formulae/skeletal formulae For all 3 (2) For 2 (1) For 1 (0)</p> <p>For an incorrect haloalkane structure that can form 3 isomers including cis/trans (2 max) (eg 2-chloropentane)</p> | | 4 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|------------------|------|
| 20 (d) | <p>(Slower) as C-F bond is stronger (than C-Cl)/fluorine bonds more strongly/fluorine holds the carbon more strongly</p> <p>OR</p> <p>Slower as F⁻ is a poorer leaving group (than Cl⁻) (1)</p> <p>Use sodium hydroxide /NaOH/ potassium hydroxide /KOH/ hydroxide ions (1)</p> <p>As OH⁻ is a stronger nucleophile / OH⁻ has a full negative charge/ more strongly attracted to C^{δ+} /OH⁻ has more lone pairs (than water)/ OH⁻ is more negative than water (1)</p> | Alkali Hydroxide | 3 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|---|------|
| 21 (a)(i) | <p>Hydrogen bonding Hydrogen bond(s) H bonding H bond(s)</p> <p>Notes Accept phonetic/incorrect spelling as long as the word is recognisable</p> | <p>Not “hydrogen” on its own Dipole-dipole bond Permanent dipole-dipole bond Covalent bond van der Waals’ (forces) Temporary dipole-dipole Induced dipole-dipole London forces</p> <p>Any correct answer in conjunction with an incorrect response, eg hydrogen dipole-dipole bond.</p> | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 21 (a)(ii) | <p>(Fluorine atom) is more electronegative (1)</p> <p>Because it has less shielding / (bonding) electrons closer to the nucleus/ smaller /has less shells (so greater pull from nucleus on bonding electrons) (1)</p> <p>so HF has a (greater) dipole moment/H^{δ+} on HF (greater than on HBr)/HF is (more) polar (1)</p> | | 3 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------|------|
| 21 (a)(iii) | Between 150 - 180 (K) Accept a range within the range e.g. '150-170' | °C | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 21 (b)(i) | Because propanone has both polar and non polar characteristics/can form both London forces and H bonds/can form London forces and dipole-dipole forces OWTTE (1) London forces can be described as Van der Waals VDW Temporary dipole-dipole Instantaneous dipole-induced dipole | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------------|------|
| 21 (b)(ii) | Water: Hydrogen bonds with the (oxygen of the) carbonyl group/H bonds to the oxygen (1) Octane: London forces with methyl groups/carbon chain/CH groups/H atoms (1) Both forces given allow (1) | Carbon atoms | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------|------|
| 22 (a)(i) | Use of heat (1) To break down (a reactant)/one reactant into more than one product (1) | | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------|------|
| 22 (a)(ii) | $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ Allow correct multiples | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--|------|
| 22 (a)(iii) | <p>Group 2 carbonates are more (thermally) stable as you go down the group (1)</p> <p>as the cations get bigger/charge density gets less/cation has more shells (1)</p> <p>So have less of a polarising effect/distortion on the carbonate (ion)/less of a weakening effect on C-O (1)</p> <p>2nd and 3rd marks cq on first</p> | <p>Metal gets bigger/element gets bigger</p> <p>Carbonate molecule</p> | 3 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--|------|
| 22 (b)(i) | orange | <p>Yellow</p> <p>Any colour in conjunction with orange</p> | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------|------|
| 22 (b)(ii) | $(18.0/1000 \times 0.100) = 1.8 \times 10^{-3}$ $/0.0018/2 \times 10^{-3}/0.002$ <i>IGNORE sf and units even if incorrect</i> | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 22 (b)(iii) | $(50/1000 \times 0.100) = 5 \times 10^{-3}$ (1) <p>[If candidate fails to divide by 1000 in both (b)(ii) and b(iii) penalise only once]</p> <p>Moles HCl reacted = 3.2×10^{-3} (can get first mark here if 5×10^{-3} not shown above) So moles CaO = 1.6×10^{-3} (1)</p> <p><i>IGNORE sf</i></p> <p>Allow TE from b (ii)</p> | | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|---|------|
| 22 (b)(iv) | <p>Mass CaO = $(1.6 \times 10^{-3} \times 56.1)$ = 0.0898 g (1)</p> <p>% purity = $0.0898/0.121 \times 100 =$ 74.2% (1)</p> <p>OR</p> <p>Allow % calculated in terms of moles e.g moles of CaO should be $0.121 \times$ $56.1 = 0.0021568$ (mol) (1)</p> <p>% purity = $0.0016/0.0021568 = 74.2\%$ (1)</p> <p>Accept = $(1.6 \times 10^{-3} \times 56)$ = 0.0896 g (1)</p> <p>% purity = $0.0896/0.121 \times 100 =$ 74.0% (1)</p> <p>Allow TE of incorrect moles of CaO from (b)(iii)</p> <p>Allow TE from incorrect mass of CaO if answer is $\leq 100\%$</p> <p>0.09 g and 74.4% is 1 out of 2 (rounding too soon)</p> | Any % purity without 3 sf for second mark | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--|------|
| 22 (c)(i) | <p>(Clean) nichrome/platinum wire/ceramic rod/silica/nickel/chrome rod (1)</p> <p>(In conc.) HCl/HCl(aq)/dilute HCl (1)</p> <p>Heat/place in (blue Bunsen) flame (1)</p> | <p>Metal loop/inoculating loop/glass rod/silver/spatula</p> <p>Place in yellow Bunsen flame/burn</p> | 3 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------------------|--------|------|
| 22 (c)(ii) | Barium/Ba/Ba ²⁺ | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|-----------------------------------|------|
| 23 (a) | <p>H bond between appropriate O and H atom (1) Angle of 180° between molecules (1)</p> <p>2nd mark is dependent on first Compounds other than ethanol showing correct H bond and angle (1 max)</p> | O---H-O if not in a straight line | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--------|------|
| 23 (b) | <p>Incorrect water flow through condenser (1) so takes longer to collect product / lower amount of product collected / inner tube in condenser could crack / backflow of water due to gravity/air bubbles/inefficient cooling/condenser does not fill up with water (1)</p> <p>Thermometer bulb too high (1) so incorrect boiling point reading/product collected at incorrect temp OWTTE (1)</p> <p>Sealed apparatus (1) so risk of explosion/pressure build up (1)</p> <p>2nd mark in each pair dependent on 1st mark 1st mark can be obtained by circling correct point on diagram or by description</p> <p>Circle for 3rd error must cover joint to collection flask and/or delivery adaptor</p> <p>If the whole apparatus is circled to indicate sealed 2 marks could be awarded if the problem of the pressure build up is explained</p> <p>Circling the whole apparatus with no or incorrect explanation = 0 marks</p> | | 6 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|--|--------|------|
| 23 (c) | $(0.005 \times 2)/20.10 \times 100 = 0.05/0.04975 (\%)$ <i>IGNORE sf</i> | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|---|------|
| 23 (d) | Suitable drying agent e.g anhydrous magnesium sulfate/anhydrous sodium sulfate/calcium oxide (1) Accept anhydrous calcium chloride silica (gel) Add to ethanol (leave) and then filter/Add to ethanol (leave) and then decant (1) Mark independently | Concentrated sulfuric acid OR Sodium and potassium hydroxide Anhydrous copper sulfate Anhydrous cobalt chloride | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|---|--|------|
| 23 (e) | Add PCl_5 /phosphorous(v)chloride/ phosphorous pentachloride (1) Misty fumes (of HCl) seen/steamy fumes/fumes that form white smoke with NH_3 /fumes that turn blue litmus red (1) OR Add Na (to dried ethanol) (1) Bubbles (of H_2) seen/fizzing/effervescence (1) OR Add acidified (sodium) dichromate(VI)/ $\text{Cr}_2\text{O}_7^{2-}$ and H^+ (1) Blue/green colour observed (1) OR Add acidified (potassium) manganate(VII)/ MnO_4^- & H^+ (1) Loss of (purple) colour/colour fades/decolourises (1) 2^{nd} mark dependent on sensible attempt at test reagent | PCl_3 White smoke on its own White fumes on its own | 2 |

| Question Number | Correct Answer | Reject | Mark |
|------------------|---|--------|------|
| 23 (f)(i) QWC | <p>A fuel (derived from a plant) that takes in as much CO₂ (as it forms/grows) (1) as is released during its production /combustion/when used (1)</p> <p>OR</p> <p>A fuel (such as hydrogen) that produces no CO₂ when burnt (1) Nor in its production/processing (1)</p> | | 2 |

| Question Number | Correct Answer | Reject | Mark |
|-------------------|--|--------|------|
| 23 (f)(ii) QWC | <p>2 specific reasons e.g</p> <ul style="list-style-type: none"> • energy used to heat/distil (ethanol water mixture after fermentation) may require burning a fuel/energy • energy required to manufacture fertilisers (to grow plants for biofuels in good yield) • energy required to manufacture insecticides (to grow plants for biofuels in good yield) • energy required to transport fuel to the power plant • biofuels less effective at absorbing CO₂ than (rain)forests/trees <p style="text-align: right;">(2)</p> <p>2 well reasoned effects on society e.g</p> <ul style="list-style-type: none"> • use of food crops to produce biofuels reduces food supply • (use of land) for biofuels reduces biodiversity • use of land to grow biofuels leads to reduced food supply • leads to deforestation/leads to habitat loss • new jobs created to grow crops on new farmland • increased price of car/car service due to engine modifications • less CO₂ so less global warming • less SO₂ so less acid rain • less SO₂ so less respiratory illnesses e.g asthma <p style="text-align: right;">(2)</p> <p>Choice of most sustainable biofuel with appropriate reasoning e.g</p> <ul style="list-style-type: none"> • elephant grass as it requires little/no energy to process before it is burnt • elephant grass grows very quickly • elephant grass is a high yield crop • Any of the fuels can be burnt using existing technology <p style="text-align: right;">(1)</p> | | 5 |