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Mark Scheme (Results)
January 2010

GCE

GCE Chemistry (6CH02/01)

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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

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) 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.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
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.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

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	A		**1**

Question Number	Correct Answer	Reject	Mark
3	D		**1**

Question Number	Correct Answer	Reject	Mark
4	D		**1**

Question Number	Correct Answer	Reject	Mark
5	A		**1**

Question Number	Correct Answer	Reject	Mark
6	B		**1**

Question Number	Correct Answer	Reject	Mark
7	C		**1**

Question Number	Correct Answer	Reject	Mark
8	B		**1**

Question Number	Correct Answer	Reject	Mark
9(a)	A		**1**

Question Number	Correct Answer	Reject	Mark
9(b)	C		**1**

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

Question Number	Correct Answer	Reject	Mark
10(b)	D		**1**

Question Number	Correct Answer	Reject	Mark
11	A		**1**

Question Number	Correct Answer	Reject	Mark
12	C		**1**

Question Number	Correct Answer	Reject	Mark
13(a)	D		**1**

Question Number	Correct Answer	Reject	Mark
13(b)	B		**1**

Question Number	Correct Answer	Reject	Mark
13(c)	C		**1**

Question Number	Correct Answer	Reject	Mark
14	B		**1**

Question Number	Correct Answer	Reject	Mark
15 (a)	B		**1**

Question Number	Correct Answer	Reject	Mark
15 (b)	C		**1**

Section B

Question Number	Acceptable Answers	Reject	Mark
16(a)(i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ Correct formulae (1) Balancing (1) **ALLOW** multiples or equation divided by 2 Second mark on correct species only Ignore state symbols even if incorrect **ALLOW** N_2O_4 Extra oxygen molecules on both sides in a balanced equation		**2**

Question Number	Acceptable Answers	Reject	Mark
16(a)(ii)	Stand alone marks Mg^{2+} / Magnesium **ion** smaller or fewer electron **shells** / greater charge density (1) **OR** Magnesium **ion** has same charge (as calcium ion) but is smaller (1) Causes more polarisation /distortion of nitrate / anion (electron clouds) / N—O (bond)(1) **OR** MgO produced has stronger lattice (1) **OR** production of MgO is more exothermic (1) **OR** reverse argument based on Ca^{2+}	Magnesium / calcium / atoms / molecules	**2**

Question Number	Acceptable Answers	Reject	Mark
16(b)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ **ALLOW** multiples or equation divided by 2 Ignore state symbols even if incorrect **ALLOW** Extra oxygen molecules on both sides in a balanced equation		**1**

Question Number	Acceptable Answers	Reject	Mark
16(c)	No as…. double bond would be shorter (than single bond) / shorter than dative (covalent) bond. **ALLOW** Structure has double and single bonds (between N and O) Double and single bonds have different lengths	Implication that the single covalent and dative covalent bonds have different lengths	**1**

Question Number	Acceptable Answers	Reject	Mark
16(d)(i)	Mark independently Goes darker (brown) (1) ALLOW Goes browner Ignore comments on mixture first becoming paler if volume increases Equilibrium moves in the endothermic direction (1) **OR** Equilibrium moves left as forward reaction is exothermic (1) For second mark **ALLOW** Equilibrium moves left to counteract addition of heat / increase in temperature(1) **OR** Reaction removes added heat by moving left (1)	Brown (gas evolved)	**2**

Question Number	Acceptable Answers	Reject	Mark
16(d)(ii)	Equilibrium moves right (ALLOW forwards) (so NO_2 concentration decreases) (1) **OR** Reaction reduces pressure (1) As fewer moles / molecules(ALLOW particles) (of gas) on RHS (1) Stand alone marks		**2**

Question Number	Acceptable Answers	Reject	Mark
16(e)	At T_2 more molecules/collisions have energy greater than (or equal to) E_A (1) This can be shown on the diagram by indicating areas to right of vertical line Energy must be at least E_A for successful collision / for reaction (1) **OR** So more collisions have sufficient energy to react(1) Ignore references to the average energy and speed of the molecules		**2**

Question Number	Acceptable Answers	Reject	Mark
17(a)(i)	A hydrocarbon (solvent) / volasil / named hydrocarbon solvent / tetrachloromethane Formulae	Ethanol Alkenes	**1**

Question Number	Acceptable Answers	Reject	Mark
17(a)(ii)	Red / brown /orange / amber / yellow Or any combination No TE on incorrect / no reagent		**1**

Question Number	Acceptable Answers	Reject	Mark
17(b)(i)	Oxidation number of S in H_2SO_4 =(+)6 Oxidation number of S in SO_2 =(+)4 (1) Oxidation number had decreased (1) ALLOW S has gained electrons for second mark Second mark stands alone provided oxidation numbers have decreased, even if calculated wrongly	Just 'S has gained electrons' without calculating oxidation numbers	**2**

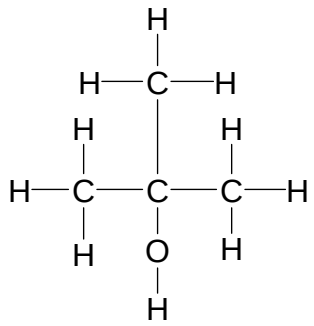
Question Number	Acceptable Answers	Reject	Mark
17(b)(ii)	Black / (shiny) grey solid (1) Purple / violet / pink vapour / fumes (1) Smell of (bad) eggs (1) Yellow solid (1) **ALLOW** Brown liquid (1) Any two	Purple solid	**2**

Question Number	Acceptable Answers	Reject	Mark
17(b)(iii)	Oxidation number of S has reduced more / to –2 (in H_2S) (1) OR Oxidation number of S is lower in H_2S (than in SO_2) If ON of S in H_2S is calculated it must be correct		**1**

Question Number	Acceptable Answers	Reject	Mark
17(c)	People can choose whether to take extra fluoride ALLOW Fluoride is not released into the environment	Fluoride can be monitored	**1**

Question Number	Acceptable Answers	Reject	Mark
18(a)(i)	Effervescence / fizzing / bubbles (of colourless gas) (1) Mixture gets hot (1) White solid (ALLOW ppt) produced / sodium dissolves or disappears (1) Any two Ignore inferences unless incorrect		**2**

Question Number	Acceptable Answers	Reject	Mark
18(a)(ii)	C_4H_9ONa / $C_4H_9O^-Na^+$ /structural or displayed formulae of any of the isomers: $CH_3CH_2CH_2CH_2ONa$ $(CH_3)_2CHCH_2ONa$ $(CH_3)_3CONa$ $CH_3CH(ONa)CH_2CH_3$	Structures showing a covalent bond between O and Na C_4H_9NaO / $C_4H_9Na^+O^-$	**1**

Question Number	Acceptable Answers	Reject	Mark
18(b)	 Do not penalise undisplayed CH_3 or O-H (1) (2-)methylpropan-2-ol(1) Marks are stand alone	Missing hydrogen atoms Skeletal formula	**2**

Question Number	Acceptable Answers	Reject	Mark
18(c)	$(CH_3)_2CHCH_2OH$ OR correct displayed formula OR semi-displayed formula **ALLOW** $CH_3CH(CH_3)CH_2OH$ **ALLOW** missing bracket round CH_3 in this version Ignore names	Missing hydrogen atoms Skeletal formula	**1**

Question Number	Acceptable Answers	Reject	Mark
18(d)(i)	CH_3CH_2 CH(OH)CH_3 (1) OR correct displayed formula OR semi-displayed formula Do not penalise missing bracket round OH Ignore names	Missing hydrogen atoms Skeletal formula	**1**

Question Number	Acceptable Answers	Reject	Mark
18(d)(ii)	O—H absorption / peak in 2-methylpropanoic acid / No O—H absorption / peak in **Q** ALLOW C—O absorption / peak in 2-methylpropanoic acid / No C—O absorption / peak in **Q** Ignore references to broad or sharp peaks and to the fingerprint region		**1**

Question Number	Acceptable Answers	Reject	Mark
18(e)	PCl_5 / PCl_3 / conc HCl / $SOCl_2$ / mixture of NaCl + H_2SO_4 / mixture of KCl + H_2SO_4 Ignore reference to concentration of H_2SO_4 OR Names	Hydrogen chloride Conc hydrogen chloride HCl PCl_5(aq), PCl_3(aq), $SOCl_2$(aq)	**1**

Question Number	Correct Answer	Reject	Mark
18(f)(i)	White precipitate/ white solid		**1**

Question Number	Acceptable Answers	Reject	Mark
18(f)(ii) QWC	Water has 2 hydrogen bonds per molecule (on average) whereas ethanol only has 1 (1) **ALLOW** Water has more hydrogen bonds (per molecule) than ethanol Needs more energy to break H bonds in water (so less soluble) / H bonding (ALLOW intermolecular forces) stronger in water (1) Second mark dependent on first. Ignore references to London, dispersion and van der Waals forces		**2**

Question Number	Acceptable Answers	Reject	Mark
19(a)	Starch (solution)		**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	I_2 at start = 1×10^{-3} / 0.001 (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	1.26×10^{-3} (mol) thiosulfate (1) $6.3(0) \times 10^{-4}$ / 0.00063 (mol) I_2 (1) Correct answer with no working (2) Ignore SF except 1 SF		**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)(iii)	I_2 used = $(1 \times 10^{-3} - 6.30 \times 10^{-4}) = 3.70 \times 10^{-4}$ (mol) (1) Mol SO_2 = mol I_2 = 3.70×10^{-4} / 0.00037 (mol) (1) Correct answer with no working (1) **ALLOW** TE from (i) and (ii) Ignore SF except 1 SF		**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)(iv)	Mass SO_2 in 100 m^3 =$(64.1 \times 3.70 \times 10^{-4})$ (1) Mass SO_2 in 1 m^3 = $64.1 \times 3.70 \times 10^{-4}$ /100 = $237(.2) \times 10^{-6}$ g = 2.37×10^{-4}g (1) (= 237.2 / 237 / 240 μg) units required (∴ within limit) Allow TE from (iii) Ignore SF except 1 SF		**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	Improved because titration may be repeated /averages could be taken **ALLOW** Smaller titration reading so greater (%) error		**1**

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	Larger titration reading (1) So smaller (%)error in titration reading (1) OR Smaller mass of sodium thiosulfate used to make solution (1) So greater %) error in the mass measurement (1) Second mark dependent on correct first or near miss		**2**
Question Number	Acceptable Answers	Reject	Mark
19(c)(iii)	Smaller titration reading as more I_2 reacts/ less I_2 left (1) So greater (%) error in titration reading (1) Second mark dependent on correct first or near miss) OR Smaller (%) error in measuring volume of air (1)		**2**

Section C

Question Number	Acceptable Answers	Reject	Mark
20(a) **QWC**	(Strong) covalent bonds between atoms within the layers / good overlap of electron orbitals in layers (1) (Weak) London / dispersion / induced dipole-induced dipole (ALLOW van der Waals) forces between layers (1)	Intermolecular forces alone	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)	Within a layer, one electron per carbon is (ALLOW electrons are) **delocalized** (so electrons can move easily along layers) (1) Energy gap (ALLOW distance) between layers is too large for (easy) electron transfer (1)	Electrons between layers not delocalized	**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)	N has **one** more (outer shell) electron than C(1) Would increase number of (delocalised) electrons … contributing to the London / dispersion (ALLOW van der Waals) forces (1) OR holding layers together (1)	Just London / dispersion / van der Waals) forces stronger	**2**

Question Number	Acceptable Answers	Reject	Mark
20(d)	No **heat** energy required / low energy requirement / high temperatures not needed / sunlight (which is renewable) could be used Ignore generalisations such as 'greener', 'environmentally friendly' 'smaller carbon footprint' cheaper or fossil fuels not used.		**1**

Question Number	Acceptable Answers	Reject	Mark
20 (e)	$CO + 2H_2 \rightarrow CH_3OH$ OR Structural and displayed formulae ALLOW CH_4O for CH_3OH		**1**

Question Number	Acceptable Answers	Reject	Mark
20 (f) QWC	Score 1 mark for each clearly made point 1. Need energy to make benzene / catalyst / hydrogen 2. High energy / temperature / pressure needed for the reaction (ALLOW stated T or P) 3. Fossil fuel (oil or coal) used as source of energy, benzene or hydrogen 4. Hydrogen has to be manufactured 5. Hydrogen has to be stored 6. Fossil fuels non-renewable 7. Reduces CO_2 in atmosphere / recycles CO_2 8. CO_2, is a greenhouse gas / causes global warming 9. CO toxic 10. Benzene toxic / carcinogenic 11. 100% atom economy in making methanol 12. Beneficial if phenol useful / not beneficial if phenol a waste product Ignore generalisations such as 'greener', 'smaller carbon footprint' or 'environmentally friendly'.	References to the ozone layer	**6**

Question Number	Acceptable Answers	Reject	Mark
20 (g)	Delivering drugs to cells **ALLOW** Delivering drugs to specific / targeted parts of the body Catalyst with big surface area	Just drug delivery	**1**

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