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Mark Scheme (Results)
January 2012

GCE Chemistry (6CH02) Paper 01
Application of Core Principles of Chemistry

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

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.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1 (a)	B		**1**
(b)	D		**1**
(c)	A		**1**

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

Question Number	Correct Answer	Reject	Mark
3	B		**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	A		**1**

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

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

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

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

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

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

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

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

Question Number	Correct Answer	Reject	Mark
16 (a)	C		**1**
(b)	D		**1**

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

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
18(a)	London/dispersion forces greater (ALLOW 'more') (in HI) ALLOW van der Waals forces/ temporary dipole (forces)/induced dipole (forces) Just 'Intermolecular (forces)' does not score this mark Stand alone mark **(1)** **Any two from** Because (Iodine/HI) has more electrons/iodine has more electron shells ALLOW bigger surface area **(1)** (So) more energy needed (ALLOW 'harder') to separate molecules / break the (London) forces ALLOW more energy needed to boil compound ALLOW intermolecular (forces) here **(1)** Permanent dipole in HI is weaker than the permanent dipole in HBr **(1)** The increase in London forces (from HCl to HI) outweighs the decrease in permanent dipole **(1)**	Iodide/bromide More electrons in the bond HI has more electron shells Just 'easier to boil compound'	**3**

Question Number	Acceptable Answers	Reject	Mark
18(b)	HF has hydrogen bonding (and HCl does not) Stand alone mark **(1)** **Any two from** Fluorine very electronegative/more electronegative than chlorine **(1)** Hydrogen bonding is (much) stronger (than other/named intermolecular forces) ALLOW Hydrogen bonding is (very) strong **(1)** So more energy needed (ALLOW 'harder') to separate molecules/ break the hydrogen bonds ALLOW more energy needed to boil compound **(1)** HCl has London/dispersion (and (weak) dipole-dipole) forces ALLOW (weak) dipole-dipole forces ALLOW 'Only London/dispersion forces' **(1)** ALLOW van der Waals forces/ temporary or induced dipole forces for London/dispersion	Just 'HF has stronger intermolecular forces (than HCl)' HF/F^- for fluorine Just 'easier to boil compound'	**3**

Question Number	Acceptable Answers	Reject	Mark
18(c)	Water forms (up to) two hydrogen bonds (per molecule but HF only one). IGNORE references to numbers of lone pairs.	More/stronger/ greater than two	**1**

Question Number	Acceptable Answers	Reject	Mark
19(a)(i)	**Time** for the first (permanent) cloudiness to appear in the limewater ALLOW **Time** for the limewater to turn milky/cloudy ALLOW **Time** for the limewater to turn milky/cloudy and (ppt) to dissolve ALLOW how long for time IGNORE references to volume of CO_2	How fast/how quickly	**1**

Question Number	Acceptable Answers	Reject	Mark
19(a)(ii)	**Any three from** Constant Bunsen flame/electrical heater setting Fixed height of test tube above the flame Fixed moles/(ALLOW mass/amount) of carbonate Fixed volume/amount/mass of limewater Penalise use of quantity once only Same surface area/particle size (of solid) Standardise cloudiness of limewater using the disappearance of a cross (or similar) IGNORE repeats & use same measuring instruments /same person	 Constant temp/ heat Water bath Fixed angle Volume/quantity Concentration / quantity	**3**

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	More stable/(thermal stability) increases (as the group is descended)		**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	Ignore an incorrect answer to 19b(i) and mark statements given independently Cation/positive (ALLOW metal) ion becomes larger (charge unchanged) OR cation charge density reduced **(1)** IGNORE references to shielding Polarisation/distortion reduced **(1)** (ALLOW polarising power reduced) of carbonate electron cloud/ carbonate ion/C-O bonds /anion **(1)** OR reverse argument for stability *decreasing* as group *ascended*	Atomic/metal radius/charge density of **atom**/ molecule	**3**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	Throughout 20 (a): IGNORE sf except 1 sf (penalise once) correct answer with no working scores full marks mark consequentially IGNORE units unless incorrect $0.109 \times 27.35 \times 10^{-3}$ **(1)** $= 2.98115 \times 10^{-3}$ (mol) $= 2.98 \times 10^{-3}$ / 0.00298(mol) **(1)** cq only on some concentration x some volume	 0.003	**2**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	Moles I_2 = 0.5 x moles thiosulfate **= 0.5 x answer to (a)(i)** $= 1.490575 \times 10^{-3} = 1.49 \times 10^{-3}$ /0.00149(mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iii)	Moles of Cl_2 = moles of I_2 **= answer to (a)(ii)** $= 1.49 \times 10^{-3}$ /0.00149(mol)		**1**

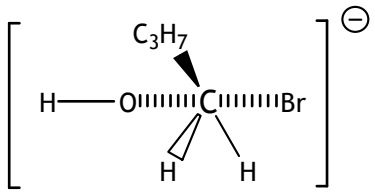
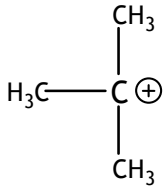
Question Number	Acceptable Answers	Reject	Mark
20 (a)(iv)	**Mark consequentially on answer in (a)(iii)** Amount in volumetric flask = 25 x answer to (a)(iii) (= 25 x 1.490575 x 10^{-3} = 3.72644 x 10^{-2}) OR (25 x 1.49 x 10^{-3} = 3.725 x 10^{-2}) **(1)** (= amount in 10 cm^3 of disinfectant) Concentration = 100 x previous value (= 1000 x 3.73 x 10^{-2} /10 = 3.73 (mol dm^{-3})) **(1)** Concentration = 100 x answer to (a)(iii) scores **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)	(Atoms of) the same element (in the same species) are oxidized and reduced **(1)** ALLOW chlorine for 'element' Chlorine ON 0 oxidized to (+)1 in ClO^- **(1)** and reduced to −1 in Cl^- **(1)** Only penalise once if oxidized and reduced omitted Just 'Chlorine ON 0 oxidized to (+)1 and reduced to −1' or 'Chlorine oxidized to chlorate(I) and reduced to chloride'(1 mark only) Only penalise once if oxidized and reduced reversed	Molecule/substance/ reactant /species Just Cl oxidized & reduced	**3**

Question Number	Acceptable Answers	Reject	Mark
20(c)	Colour just before adding the starch: (very) pale yellow/straw coloured **(1)** Colour after adding the starch: Blue-black (ALLOW black or (dark) blue) Colour at the end point: colourless **(1)** **Both** colours required IGNORE 'Clear'	Just 'yellow', brown, gold purple	**2**

Question Number	Acceptable Answers	Reject	Mark
21(a)	Names OR Formulae A = NaOH/KOH in ethanol /alcohol **(1)** B = NaOH/KOH in water/ aqueous **(1)** IGNORE any reference to ethanol /alcohol /dilute C = NaBr/KBr & (50% or moderately conc) H_2SO_4 / P & Br_2 / PBr_3 /PBr_5 /NaBr /KBr & H_3PO_4 /HBr ALLOW phosphorus bromide **(1)** IGNORE red/white (phosphorus) D = NH_3 (in alcohol /in a sealed tube /at high pressure) **(1)** IGNORE aqueous	Water + ethanol /water + alcohol For A and B OH^-/alkali (penalise once) Dilute H_2SO_4 any mention of alkali any mention of acid	**4**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	A = elimination **(1)** IGNORE 'nucleophilic' D = (nucleophilic) substitution **(1)**	mention of dehydration in A mention of electrophilic in A or D	**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	Mark the diagrams; then mark the explanation sections together Score **(1)** for intermediate/ transition state wrong way round  IGNORE geometry and missing minus sign and δ+/ δ- **(1)**  **(1)** **Any two from** Tertiary carbocation more stable (than primary carbocation) ALLOW Tertiary carbocation very stable/fairly stable/stable **(1)** This mark can be awarded even if structures and other explanations are incorrect or missing Methyl groups stabilise charge (of carbocation) (through positive inductive effect) Steric hindrance (by methyl groups) inhibits formation of (trigonal bipyramid) transition state/attack by nucleophile with tertiary compound Steric hindrance is less with the primary halogenoalkane/more with tertiary halogenoalkane ALLOW a description of steric hindrance e.g. blocking/less space	Full O—C—Br bonds OH—C + sign δ+ Just 'primary carbocation unstable'	**4**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	C−I bond weaker ALLOW C−I bond easier to break ALLOW iodine forms weaker bonds than bromine without mention of carbon ALLOW reverse arguments with C−Br bond stronger IGNORE Explanations in terms of electronegativity or bond polarity or activation energy or shielding even if incorrect	Just C−I bond longer	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (c)(i)	(Boiling) absorbs heat (allow energy)/latent heat (of vaporization)/enthalpy of vaporization from the surroundings/endothermic. If bonds are mentioned they must be intermolecular		**1**

Question Number	Acceptable Answers	Reject	Mark
21 (c)(ii)	**Any two from** Not flammable Not toxic Unreactive/inert/non-corrosive (only one of these can score) (easily) compressible does not harm the ozone layer Boiling temperature below target temperature ALLOW low boiling temperature high heat of vaporization high gas density high critical temperature IGNORE Non-polluting/ environmentally friendly/ cheap/easily manufactured/ easy to store/easy to contain /take up little space/low melting point/endothermic/ harmful	 Does not produce CFCs Gas/solid stable	**2**

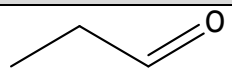
Question Number	Acceptable Answers	Reject	Mark
22 (a)	$N_2 + O_2 \rightarrow 2NO$ or $\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightarrow NO$ Or multiples ALLOW extra oxygen or nitrogen molecules provided equation is balanced IGNORE state symbols even if incorrect ALLOW $\rightleftharpoons$ and 2NO.		**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	Free radical(s) ALLOW recognisable spellings e.g. radicle		**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	Homolytic (fission) ALLOW recognisable spellings e.g. homolitic		**1**

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	(unburnt) fuel/petrol/diesel/ kerosene (aviation fuel) ALLOW Car exhaust fumes/ fossil fuels/oil IGNORE burning/combustion except if stated as complete	Engines/factories/cattle/ methane/ethane/crude oil/ natural gas/coal/pollution	**1**

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	Oxidation ALLOW partial oxidation	Redox Addition oxidation	**1**

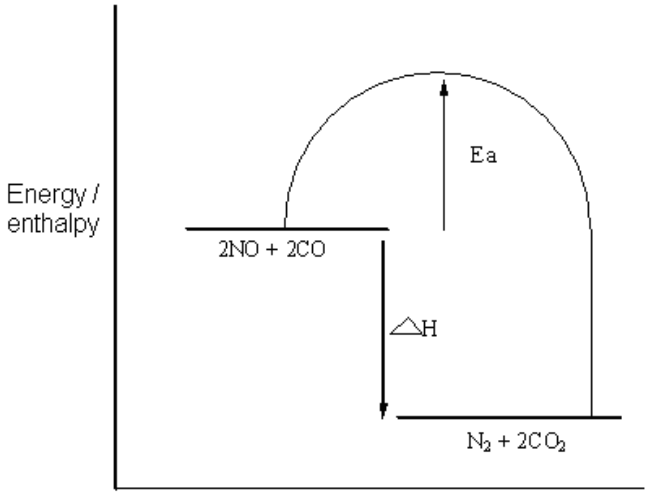
Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	 IGNORE angles provided clearly 3 carbons	displayed or structural or molecular formulae or skeletal showing any H atoms	**1**

Question Number	Acceptable Answers	Reject	Mark
22(c)(iv)	NO removed so less O_3 broken down/NO reacts with hydrocarbon rather than O_3 so less O_3 broken down IGNORE build up of ozone	Just 'less O_3 broken down'	**1**

Question Number	Acceptable Answers	Reject	Mark
22(d)	(At high altitudes) intensity of UV (radiation/light) is greater **(1)** ALLOW more UV So conversion of NO_2 to NO will increase **(1)** ALLOW (At high altitudes) pressure is lower **(1)** So equilibrium $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ shifts to the left **(1)**	NO_2 removed before it gets to high altitudes more sunlight less oxygen	**2**

Question Number	Acceptable Answers	Reject	Mark
22(e)	Ozone absorbs/blocks/filters/ protects against ALLOW removes (all) **UV** radiation **(1)** UV/sunlight is biologically harmful/causes genetic damage/causes (skin) cancer/causes eye cataracts **(1)** Reference to global warming max **(1)**	Sunlight; Infrared; reflects Just 'harmful' Effect of radiation without any mention of UV or sunlight	**2**

Question Number	Acceptable Answers	Reject	Mark
22(f)(i)	$2NO + 2CO \rightarrow N_2 + 2CO_2$ OR $NO + CO \rightarrow \frac{1}{2}N_2 + CO_2$ Or multiples IGNORE state symbols even if incorrect ALLOW $\rightleftharpoons$		**1**

Question Number	Acceptable Answers	Reject	Mark
22(f)(ii)	 ALLOW names or symbols in diagram ALLOW double headed arrows or headless arrows IGNORE Maxwell Boltzmann distributions **First mark** Labelled y axis and reactants and products ALLOW potential energy **(1)** IGNORE units IGNORE formula errors and x axis labels even if incorrect ALLOW 'reactants' and 'products' as labels **Second mark** **Exothermic** reaction **and** △H label **(1)** IGNORE negative sign on △H **Third mark** Activation energy line and label OR a double hump with higher first (smooth curve is not needed) **(1)**	Reversed arrows Energy change or enthalpy change or △H Any other humped diagram	**3**

Question Number	Acceptable Answers	Reject	Mark
22(f)(iii)	Catalyst provides an alternative route/mechanism **(1)** with lower activation energy ALLOW low activation energy **(1)** So a higher proportion (ALLOW more) molecules / collisions (ALLOW reactants) have energy equal to or greater than Ea ALLOW 'so more molecules react' **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
22(g)	Aircraft (release NO) closer to the ozone layer/(atmosphere) at high altitude/in the stratosphere **(1)** IGNORE greenhouse gases at this point So less NO is lost through competing / other reactions **(1)** ALLOW broken down ALLOW NO (released at ground level) dissipated (e.g. by reaction with oxygen or hydrocarbons or by reaction to form ozone (as in the passage))	Just 'atmosphere'	**2**

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS

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