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Mark Scheme (Results)
January 2011

GCE

GCE Chemistry (6CH01/01)

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Section A (multiple choice)

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

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

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

Question Number	Correct Answer	Mark
4 (a)	B	**1**

Question Number	Correct Answer	Mark
4 (b)	C	**1**

Question Number	Correct Answer	Mark
5	B	**1**

Question Number	Correct Answer	Mark
6 (a)	B	**1**

Question Number	Correct Answer	Mark
6 (b)	A	**1**

Question Number	Correct Answer	Mark
7 (a)	D	**1**

Question Number	Correct Answer	Mark
7 (b)	A	**1**

Question Number	Correct Answer	Mark
7 (c)	C	**1**

Question Number	Correct Answer	Mark
8 (a)	A	**1**

Question Number	Correct Answer	Mark
8 (b)	A	**1**

Question Number	Correct Answer	Mark
8 (c)	D	**1**

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

Question Number	Correct Answer	Mark
10	D	**1**

Question Number	Correct Answer	Mark
11	C	**1**

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

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

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

TOTAL FOR SECTION A = 20 MARKS

Section B

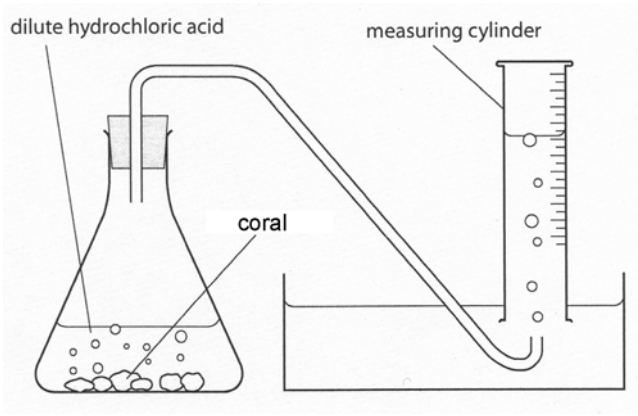
Question Number	Acceptable Answers	Reject	Mark
15 (a)	**Average/mean mass** of an atom/isotopes **(1)** (1/12 mass of an atom of) carbon–12 **(1)** **First mark:** mention of mean or average mass of either an atom/isotope**s** *IGNORE* "weighted" before average or mean *IGNORE* any mention of "moles" in definition **Second mark: any mention** of carbon-12 *IGNORE* any reference to "moles" or "1 mole" at any stage *IGNORE* 12 g with reference to carbon-12 **Mark the two points independently**	"weight" instead of mass mean or average mass **of an element**… without prior mention of either an atom or isotopes	**2**

Question Number	Acceptable Answers	Reject	Mark
15 (b) (i)	(Rubidium/it has) two **isotopes** *ALLOW* (Rubidium/it has) "different **isotopes**" *ALLOW* abbreviations such as formulae of rubidium atoms or cations with isotopic masses		**1**

Question Number	Acceptable Answers	Reject	Mark
15 (b) (ii)	$\frac{85 \times 72 + 87 \times 28}{100}$ **(1)** = 85.56 or 85.6 **(1)** Correct answer with no working **(2)** **NOTE**: Rounding error giving answer 85.5 scores **(1)** *IGNORE* **any** units (for example, g/g mol^{-1}/%) **NOTE:** If 71% abundance used for ^{85}Rb and 29% for ^{87}Rb, answer = 85.58 or 85.6 scores **(1)** Second mark awarded if answer CQ correct on wrong abundances and /or wrong isotopic masses.	Calculation of simple arithmetic mean of 85 + 87 = 86 scores zero	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (a) (i)	$H_2O + CO_2 \rightarrow H_2CO_3$ (Allow atoms in H_2CO_3 in any order) Or $H_2O + CO_2 \rightarrow H^+ + HCO_3^-$ Or $H_2O + CO_2 \rightarrow 2H^+ + CO_3^{2-}$ Or H_3O^+ in place of H^+ *IGNORE STATE SYMBOLS EVEN IF INCORRECT*		**1**

Question Number	Acceptable Answers	Reject	Mark
16 (a) (ii)	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ LHS **(1)** RHS **(1)** **OR** $2H_3O^+ + CO_3^{2-} \rightarrow 3H_2O + CO_2$ LHS **(1)** RHS **(1)** *IGNORE STATE SYMBOLS, EVEN IF INCORRECT* *IGNORE* ⇌ arrows	H_2CO_3 as a product $H^+ + CO_3^{2-} \rightarrow HCO_3^-$ Any other ions including spectator ions (e.g. Ca^{2+}, Cl^-) in the equation scores zero	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (i)	 Conical flask **and** a delivery tube leaving the conical flask **(1)** *IGNORE* "heat" beneath conical flask Inverted measuring cylinder with collection over water shown and cylinder above mouth of delivery tube **(1)** *ALLOW* collection over water to be shown/implied in the diagram without labels or other annotation	If collection **over water** is not somehow evident	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (ii)	Any method which is likely to bring the reactants into contact **after the apparatus is sealed**	Method suggesting mixing the reactants and then putting bung in flask very quickly	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (iii)	(224 ÷ 24000 =) 0.009333/9.333 x 10^{-3} (mol) **Ignore SF except 1 SF** **Ignore any incorrect units**	"0.009" as answer	**1**

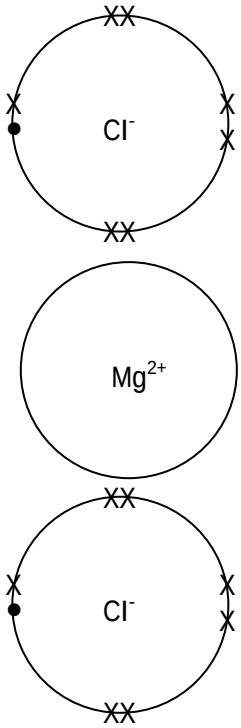
Question Number	Acceptable Answers	Reject	Mark
16 (b) (iv)	$CaCO_3$(**s**) + 2HCl(**aq**) → $CaCl_2$(**aq**) + H_2O(**l**) + CO_2 (**g/aq**) **ALL FOUR** state symbols must be correct for this mark		**1**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (v)	(Mass of 1 mol $CaCO_3$ = 40 + 12 + 3 x 16) = **100** g *ALLOW* just "100" *ALLOW* any incorrect units *ALLOW* "100.1 g " *OR* just "100.1" (Reason: this uses the Periodic Table value of A_r = 40.1 for Ca)		**1**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (vi)	(Mass of $CaCO_3$ = 100 x 0.009333) = 0.9333 (g) **(1)** *IGNORE* sig figs including 1 sf here **NOTE:** Moles of $CaCO_3$ consequential on answers to (b)(iii) and (b)(v) [**NOTE**: if A_r = 40.1 used for Ca, then the answer = 0.9339 (g)] Percentage of $CaCO_3$ in the coral = 100 x 0.9333 /1.13 = 82.6% **(1)** **NOTE:** If mass $CaCO_3$ used is 0.93, final answer is 82.3% [**NOTE***:* if A_r = 40.1 used for Ca, then the answers = 0.9339 (g) and **82.7**%]	Final **%** answer is **not given to 3 sf**	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (b) (vii)	(Different samples of) coral have different amounts of **$CaCO_3$** /different proportions of **$CaCO_3$** / different "levels" of **$CaCO_3$** *ALLOW* "calcium carbonate" for **$CaCO_3$** OR Only one sample of coral (was) used	Answers that do not include any mention of $CaCO_3$ References to solubility of CO_2 in water References to repeating the experiment at a different temperature	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)	$(1s^2\ 2s^2)\ 2p^6\ 3s^2\ 3p^5$ (ignore repetition of $1s^2\ 2s^2$) *ALLOW* subscripts, correct use of p_x, p_y and p_z orbitals or normal font for electrons	2 8 7	**1**

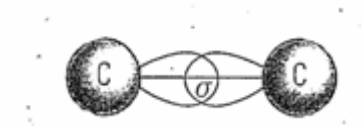
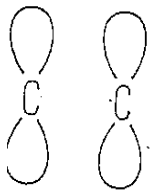
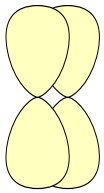
Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	 Correct number of outer electrons (ignore whether dots and / or crosses) drawn **and also** ratio of magnesium : chloride ions is 1:2 **(1)** Correct formulae and charges of the ions shown somewhere **(1)** **NOTE***:* Diagram for Mg^{2+} showing the outermost shell with $8e^-$ (dots and/or crosses) and/or Cl^- shown with a 2 in front or 2 as a subscript would also score both marks **Mark the two points independently**	Covalent bonding (0) Incorrect numbers of electrons in inner shells if drawn for first mark "MG^{2+}" and/or "CL^-" for second mark	**2**

Question Number	Acceptable Answers	Reject	Mark
17 (b) (ii)	4 shared pairs of electrons around the carbon labelled C **(1)** ALL outer electrons, including lone pairs, are correctly shown on each of the four chlorine atoms labelled Cl **(1)** *ALLOW* versions without circles *IGNORE* lines between the shared electrons **Mark two points independently**	Ionic bonding (0)	**2**

Question Number	Acceptable Answers	Reject	Mark
17 (b) (iii)	(Comparison of) charges: O^{2-} ions whereas Cl^- ions OR Statement to the effect that oxide ion has a greater (negative) charge / greater charge density than the chloride ion **(1)** (so the force of) attraction between **ions** is stronger in MgO (than $MgCl_2$) / stronger **ionic** bonding in MgO (than $MgCl_2$) **(1)** More **energy** is required to separate the ions in MgO (than $MgCl_2$) / more **energy** is required to break (ionic) bonds in MgO (than $MgCl_2$) / **(1)** **Mark the above three points independently** *NOTE ALTERNATIVE ANSWER WITH A MAXIMUM OF TWO MARKS:-* **O^{2-}** (ions) **smaller** (than Cl^- ions) **(1)** so (force of) attraction between **ions** is stronger in MgO (than $MgCl_2$) /stronger **ionic** bonding in MgO (than $MgCl_2$) **(1)** Ignore *ANY* references to polarization of ions / covalent character / degree of covalency. **Mark the above two points independently**	Use of term chlorine and/or oxygen "atoms" or "molecules" **(0) for answer overall** "More bonds need to be broken" **(0) for answer overall** if mentions "intermolecular forces"	**3**

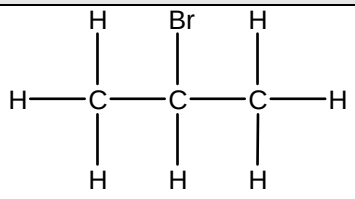
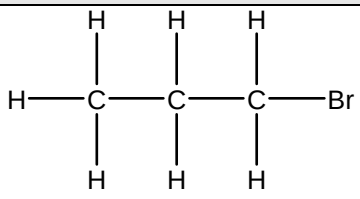
Question Number	Acceptable Answers	Reject	Mark
17 (c)	**First Mark:** *EITHER* Magnesium reacts with chlorine to form only magnesium chloride/ magnesium reacts with chlorine to form only one product / magnesium reacts with hydrochloric acid to form hydrogen (as well as magnesium chloride) / magnesium reacts with hydrochloric acid to form more than one product / magnesium reacts with hydrochloric acid to form a waste product *OR* **Both** equations $Mg + Cl_2 \rightarrow MgCl_2$ **and** $Mg + 2HCl \rightarrow MgCl_2 + H_2$ *IGNORE* state symbols, even if incorrect **(1)** **Second Mark:** *EITHER* The reaction with chlorine has an atom economy which is higher /100% ALLOW "high" *OR* Any mention of numbers comparing 100 % v. 97.9% **(1)** *IGNORE* any comments about **yield** **Mark the two points independently**		**2**

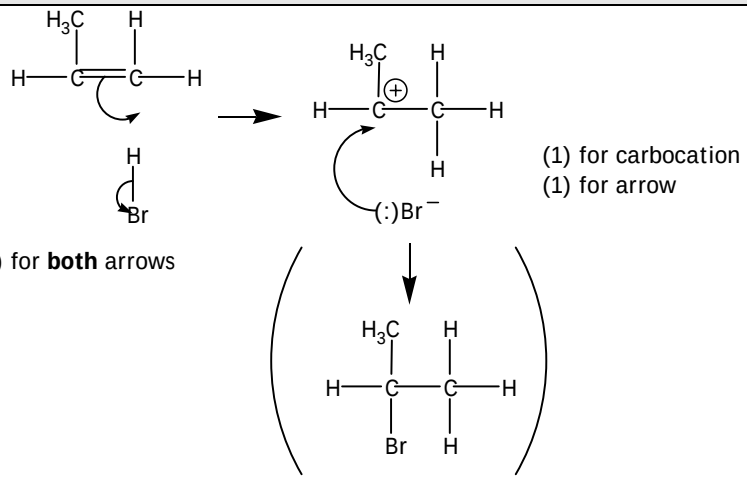
Question Number	Acceptable Answers	Reject	Mark
18 (a)	$C_{10}H_{22} \rightarrow C_7H_{16} + C_3H_6$ *ALLOW* structural or displayed formulae instead of molecular formulae *IGNORE* any state symbols, even if incorrect		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (b) (i)	**diagram for the σ-bond** e.g.  **First Mark:** *EITHER* Diagram shows **overlap** of **any-shaped orbitals** along the line between the two nuclei *OR* Mentions/implies rotation around a sigma/single bond **(1)** **Second Mark:** Any written mention, or clear evidence from the diagram (e.g. shading), of the resultant (high) electron density (along the line) **between** the two nuclei **(1)** **diagram for the π-bond** e.g. *EITHER*  *OR*  **Third Mark:** *EITHER* Diagram shows two dumb-bell shaped (p-) orbitals(these can be separate dumb-bells or the diagram can show the p-orbitals overlapping sideways) *OR* Restricted /lack of /no rotation about a pi/double bond **(1)** **Fourth Mark:** Any written mention, or clear evidence from the diagram (e.g. shading), of the resultant (high) electron density **above and below (**the line between) the two nuclei **(1)**	Just a line between the two nuclei Just curved lines above and below the two nuclei	**4**

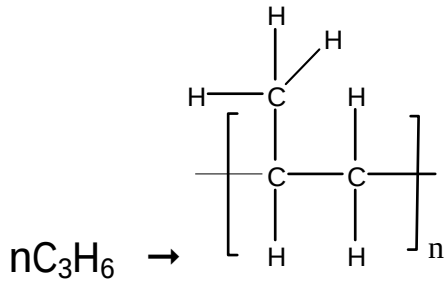
Question Number	Acceptable Answers	Reject	Mark
18 (b) (ii)	Electrophilic addition *BOTH words needed* *ALLOW* "heterolytic" before electrophilic addition		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (b) (iii)	π bond weaker than σ (bond) / less energy needed to break π bond *ALLOW* π bond weak(er) / π bond easy to break **(1)** π – electrons / π bonds (more) accessible (to electrophilic attack) *ALLOW* high/higher/more electron density in π bond (so alkenes more susceptible to electrophilic attack) **(1)** **Mark the two points independently**		**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (i)	 **and**  (main product) both DISPLAYED structures, with ALL bonds and atoms shown **(1)** major product identified or shown as product in (c)(ii) if NOT identified in (c)(i) **(1)** **NOTE**: if only one isomer of C_3H_7Br is named, assume this is the required "labelling" of the major product **Mark the two points independently**	CH_3 not fully displayed Incorrect name of isomer for 2nd mark	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (ii)	 **1st mark:** Curly arrows must start from the bonds NOT the atoms **3rd mark**: Bromide ion must clearly have a 1^- charge to get this mark **NOTE***:* The arrow from the bromide ion can start from anywhere on the Br^- ion (including the minus sign) or from a lone pair on Br^- if shown Curly arrow can go to the C or the + sign on the intermediate TE for mechanism on the isomer identified in (c)(i) or either mechanism if no major product has been identified in (c)(i) **Mark the three points independently**	**half** arrow-heads $Br^{\delta-}$	**3**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (iii)	Secondary carbocation (named or described or drawn) **(1)** more stable (than primary) **(1)** **Mark the two points independently** **NOTE:** Zero awarded if primary carbocation thought to be more stable	Answers just in terms of Markownikoff's rule	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (d) (i)	 $nC_3H_6 \rightarrow$ **Two** "*n*'s" in the equation **and** a correct formula (molecular or structural) for propene on left hand side of the equation **(1)** Correct repeating unit, with a methyl branch shown **(1)** A*LLOW* CH_3 fully displayed or just as CH_3 Continuation bond at each end (with or without bracket shown in equation) **(1)** Unsaturated polymer scores max **(1)** **Mark the three points independently**	"x" instead of "n"	**3**

Question Number	Acceptable Answers	Reject	Mark
18 (d) (ii)	**(Advantage)**: polypropene will decompose (naturally) *ALLOW* "rot" or "break down" *OR* polypropene will not require landfill (as it can decompose in sunlight) *OR* no need to incinerate /burn *IGNORE* "good for environment" / "no pollution" **(1)** **(Disadvantage)**: poly(propene) cannot be used when exposed to (bright) sunlight / UV / outdoors *OR* cannot be recycled / cannot be reused **(1)** **Mark the two points independently**	"Can be recycled" (0) for first scoring point Biodegradable for 1st mark Answers which do not imply exposure to UV/sunlight Biodegradable for 2nd mark	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (a) (i)	(q = 250 x (31.5 – 21.0) x 4.18 =) **10972.5** (J) *IGNORE* sf except 1 sf *IGNORE* units even if incorrect *IGNORE* any sign at this stage *ALLOW* 10.97 (kJ)	10000 (J)	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (a) (ii)	(M_r ethanol) = 46 **(1)** (Mass ethanol burned = 63.21 – 62.47 =) 0.74 (g) *ALLOW* 63.21 – 62.47 as alternative to 0.74 **(1)** (Amount of ethanol = 0.74 ÷ 46 =) 0.0161 (mol) **(1)** **NOTE***:* Moles of ethanol are CQ on molar mass and /or mass of ethanol burned *IGNORE* sf except 1 sf **NOTE***:* Correct answer with no working /limited working scores **(3)** **Mark the three points independently**	0.02 (mol) ethanol	**3**

Question Number	Acceptable Answers	Reject	Mark
19 (a) (iii)	Answer (i) ÷ (1000 x answer (ii)) **(1)** **NOTE***:* Be aware of numbers held in calculator not corresponding to what is written in answer Value and negative sign **(1)** *IGNORE* sf except 1 sf **NOTE***:* Answer consistent with (a)(i) and (a)(ii) with no working scores **(2)** **E.g.** 10.9725 ÷ (0.74 ÷ 46) = – 682 (kJ mol^{-1}) *ALLOW* Just kJ as the units **NOTE***:* If correct answer is given in J mol^{-1}, the units of J mol^{-1} must be clearly given for the second mark to be awarded.	Correct answer in J instead of J mol^{-1}	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (b) (i)	100 x (1370 – Answer to (iii)) ÷ 1370 = value e.g. 100 x (1370 – 682) ÷ 1370 = 50.2 %	Incorrect rounding of final answer **(0)**	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (b) (ii)	Any **three** from: Heat loss (from the beaker)/beaker not insulated/heat loss as no lid on beaker (containing the water) /no stirring **(1)** Incomplete combustion (of the alcohol)/formation of soot (on beaker) **(1)** Not all of the energy from the flame is used to heat the beaker and/or the water OR Too large a distance between flame and beaker / no draught excluder **(1)** Heat capacity of the beaker is neglected/beaker absorbs heat/glass absorbs heat **(1)** Evaporation of the (hot) alcohol **(1)** Evaporation of the (hot) water **(1)**	More accurate thermometer **Just** "experimental /human error" Experiment carried out at a different (laboratory) temperature	**3**

Question Number	Acceptable Answers	Reject	Mark
19 (b) (iii)	$2\ C(s) + 3H_2(g) + ½\ O_2(g) \rightarrow C_2H_5OH(l)$ $\downarrow \qquad\qquad \downarrow$ $2CO_2 + 3H_2O$ $\triangle H_f = 2 \times (-394) + 3 \times (-286) - (-1370)$ $= -276\ (kJ\ mol^{-1})$ Correct expression or cycle **(1)** Evidence for **both** doubling ΔH^{θ}_c [C] **and** trebling ΔH^{θ}_c [H_2] **(1)** Correct sign and answer **(1)** Correct answer with no working scores **(3)** Correct answer with an incorrect cycle **(3)** *IGNORE* units even if incorrect **Alternatively the following answers score as shown even with incorrect cycle or incorrect units** **NOTE***:* (+)276 with or without working scores **(2)** (+)690 with or without working scores **(2)** −690 with or without working scores **(1)** −552 with or without working scores **(2)** −1134 with or without working scores **(2)** (+)1134 with or without working scores **(1)** (+)10 with or without working scores **(2)** **REMINDER IF ANY OTHER ANSWER IS GIVEN: ALL WORKING MUST BE CHECKED TO SEE IF ANY MARKS CAN BE AWARDED**		**3**

TOTAL FOR SECTION B = 60 MARKS

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