

# Mark Scheme (Results) January 2011

GCE

GCE Chemistry (6CH01/01)

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January 2011

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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

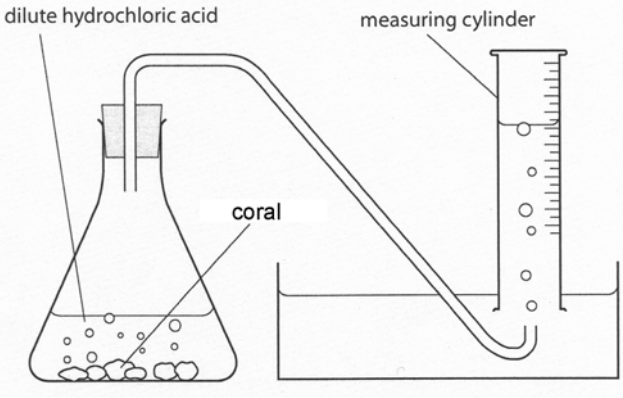
Question Number	Acceptable Answers	Reject	Mark
15 (a)	<p><b>Average/mean mass of an atom/isotopes (1)</b> (1/12 mass of an atom of) carbon-12 (1)</p> <p><b>First mark:</b> mention of mean or average mass of either an atom/isotopes <i>IGNORE</i> “weighted” before average or mean <i>IGNORE</i> any mention of “moles” in definition</p> <p><b>Second mark: any mention of carbon-12</b></p> <p><i>IGNORE</i> any reference to “moles” or “1 mole” at any stage</p> <p><i>IGNORE</i> 12 g with reference to carbon-12</p> <p><b>Mark the two points independently</b></p>	<p>“weight” instead of mass</p> <p>mean or average mass of an element... without prior mention of either an atom or isotopes</p>	2

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

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

Question Number	Acceptable Answers	Reject	Mark
16 (a) (i)	$\text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{H}_2\text{CO}_3$ (Allow atoms in $\text{H}_2\text{CO}_3$ in any order) Or $\text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{H}^+ + \text{HCO}_3^-$ Or $\text{H}_2\text{O} + \text{CO}_2 \rightarrow 2\text{H}^+ + \text{CO}_3^{2-}$ Or $\text{H}_3\text{O}^+$ in place of $\text{H}^+$  <i>IGNORE STATE SYMBOLS EVEN IF INCORRECT</i>		1

Question Number	Acceptable Answers	Reject	Mark
16 (a) (ii)	$2\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{CO}_2$ LHS (1)                  RHS (1) <b>OR</b> $2\text{H}_3\text{O}^+ + \text{CO}_3^{2-} \rightarrow 3\text{H}_2\text{O} + \text{CO}_2$ LHS (1)                  RHS (1)  <i>IGNORE STATE SYMBOLS, EVEN IF INCORRECT</i> <i>IGNORE = arrows</i>	$\text{H}_2\text{CO}_3$ as a product  $\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{HCO}_3^-$  Any other ions including spectator ions (e.g. $\text{Ca}^{2+}$ , $\text{Cl}^-$ ) in the equation scores zero	2

Question Number	Acceptable Answers	Reject	Mark
16 (b) (i)	 <p>Conical flask and a delivery tube leaving the conical flask (1)  <i>IGNORE "heat" beneath conical flask</i></p> <p>Inverted measuring cylinder with collection over water shown and cylinder above mouth of delivery tube (1)</p> <p><i>ALLOW</i> collection over water to be shown/implied in the diagram without labels or other annotation</p>	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 <b>after the apparatus is sealed</b>	Method suggesting mixing the reactants and then putting bung in flask very quickly	1

Question Number	Acceptable Answers	Reject	Mark
16 (b) (iii)	$(224 \div 24000 =) 0.009333/9.333 \times 10^{-3}$ (mol)  <b>Ignore SF except 1 SF</b> <b>Ignore any incorrect units</b>	“0.009” as answer	1

Question Number	Acceptable Answers	Reject	Mark
16 (b) (iv)	$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g/aq})$  <b>ALL FOUR</b> state symbols must be correct for this mark		1

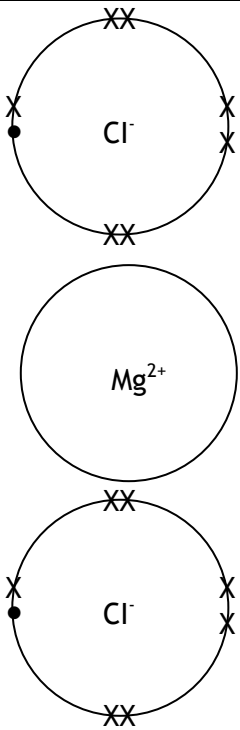
Question Number	Acceptable Answers	Reject	Mark
16 (b) (v)	(Mass of 1 mol $\text{CaCO}_3 = 40 + 12 + 3 \times 16 = 100$ g  <i>ALLOW</i> just “100” <i>ALLOW</i> any incorrect units  <i>ALLOW</i> “100.1 g ” <i>OR</i> just “100.1” (Reason: this uses the Periodic Table value of $A_r = 40.1$ for Ca)		1

Question Number	Acceptable Answers	Reject	Mark
16 (b) (vi)	(Mass of $\text{CaCO}_3 = 100 \times 0.009333 = 0.9333$ (g) (1)  <i>IGNORE</i> sig figs including 1 sf here  <b>NOTE:</b> Moles of $\text{CaCO}_3$ consequential on answers to (b)(iii) and (b)(v)  [ <b>NOTE:</b> if $A_r = 40.1$ used for Ca, then the answer = 0.9339 (g)]  Percentage of $\text{CaCO}_3$ in the coral = $100 \times 0.9333 / 1.13 = 82.6\%$ (1)  <b>NOTE:</b> If mass $\text{CaCO}_3$ used is 0.93, final answer is 82.3%  [ <b>NOTE:</b> if $A_r = 40.1$ used for Ca, then the answers = 0.9339 (g) and <b>82.7%</b> ]	Final % answer is <b>not given to 3 sf</b>	2

Question Number	Acceptable Answers	Reject	Mark
16 (b) (vii)	(Different samples of) coral have different amounts of $\text{CaCO}_3$ / different proportions of $\text{CaCO}_3$ / different “levels” of $\text{CaCO}_3$  <i>ALLOW</i> “calcium carbonate” for $\text{CaCO}_3$  OR  Only one sample of coral (was) used	Answers that do not include any mention of $\text{CaCO}_3$  References to solubility of $\text{CO}_2$ 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 $1s^2 2s^2$ ) <i>ALLOW</i> subscripts, correct use of $p_x$ , $p_y$ and $p_z$ orbitals or normal font for electrons	2 8 7	1

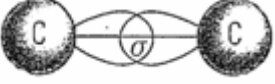
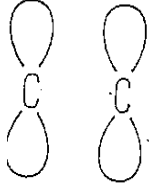
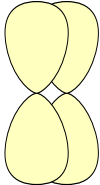
Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	 <p>Correct number of outer electrons (ignore whether dots and / or crosses) drawn <b>and also</b> ratio of magnesium : chloride ions is 1:2 (1)</p> <p>Correct formulae and charges of the ions shown somewhere (1)</p> <p><b>NOTE:</b> Diagram for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

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

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

Question Number	Acceptable Answers	Reject	Mark
17 (c)	<p><b>First Mark:</b></p> <p><i>EITHER</i>  Magnesium reacts with chlorine to form only magnesium chloride /</p> <p>magnesium reacts with chlorine to form only one product /</p> <p>magnesium reacts with hydrochloric acid to form hydrogen (as well as magnesium chloride) /</p> <p>magnesium reacts with hydrochloric acid to form more than one product /</p> <p>magnesium reacts with hydrochloric acid to form a waste product</p> <p><i>OR</i></p> <p><b>Both</b> equations <math>\text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2</math> and <math>\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2</math></p> <p><i>IGNORE</i> state symbols, even if incorrect (1)</p> <p><b>Second Mark:</b></p> <p><i>EITHER</i>  The reaction with chlorine has an atom economy which is higher /100%</p> <p>ALLOW “high”</p> <p><i>OR</i></p> <p>Any mention of numbers comparing 100 % v. 97.9% (1)</p> <p><i>IGNORE</i> any comments about <b>yield</b></p> <p><b>Mark the two points independently</b></p>		2

Question Number	Acceptable Answers	Reject	Mark
<b>18 (a)</b>	$\text{C}_{10}\text{H}_{22} \rightarrow \text{C}_7\text{H}_{16} + \text{C}_3\text{H}_6$ <p><i>ALLOW</i> structural or displayed formulae instead of molecular formulae</p> <p><i>IGNORE</i> any state symbols, even if incorrect</p>		<b>1</b>

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

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

Question Number	Acceptable Answers	Reject	Mark
18 (b) (iii)	$\pi$ bond weaker than $\sigma$ (bond) / less energy needed to break $\pi$ bond  <i>ALLOW</i> $\pi$ bond weak(er) / $\pi$ bond easy to break  (1)  $\pi$ - electrons / $\pi$ bonds (more) accessible (to electrophilic attack)  <i>ALLOW</i> high/higher/more electron density in $\pi$ bond (so alkenes more susceptible to electrophilic attack)  (1)  <b>Mark the two points independently</b>		2

Question Number	Acceptable Answers	Reject	Mark
18 (c) (i)	$  \begin{array}{c}  \text{H} \quad \text{Br} \quad \text{H} \\    \quad   \quad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\    \quad   \quad   \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $ and $  \begin{array}{c}  \text{H} \quad \text{H} \quad \text{H} \\    \quad   \quad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{Br} \\    \quad   \quad   \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $ (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)  <b>NOTE:</b> if only one isomer of $\text{C}_3\text{H}_7\text{Br}$ is named, assume this is the required "labelling" of the major product  <b>Mark the two points independently</b>	CH <sub>3</sub> not fully displayed           Incorrect name of isomer for 2nd mark	2

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

Question Number	Acceptable Answers	Reject	Mark
18 (c) (iii)	Secondary carbocation (named or described or drawn) (1) more stable (than primary) (1) <b>Mark the two points independently</b> <b>NOTE:</b> 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)	<div style="text-align: center;"> </div> <p>Two “n’s” in the equation <b>and</b> a correct formula (molecular or structural) for propene on left hand side of the equation (1)</p> <p>Correct repeating unit, with a methyl branch shown (1)</p> <p><i>ALLOW</i> CH<sub>3</sub> fully displayed or just as CH<sub>3</sub></p> <p>Continuation bond at each end (with or without bracket shown in equation) (1)</p> <p>Unsaturated polymer scores max (1)</p> <p><b>Mark the three points independently</b></p>	“x” instead of “n”	3



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

Question Number	Acceptable Answers	Reject	Mark
19 (a) (i)	$(q = 250 \times (31.5 - 21.0) \times 4.18 =) 10972.5 \text{ (J)}$ <i>IGNORE</i> sf except 1 sf <i>IGNORE</i> units even if incorrect <i>IGNORE</i> any sign at this stage  <i>ALLOW</i> 10.97 (kJ)	10000 (J)	1

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

Question Number	Acceptable Answers	Reject	Mark
19 (a) (iii)	$\text{Answer (i)} \div (1000 \times \text{answer (ii)}) \quad (1)$  <b>NOTE:</b> Be aware of numbers held in calculator not corresponding to what is written in answer  Value and negative sign $(1)$  <i>IGNORE</i> sf except 1 sf  <b>NOTE:</b> Answer consistent with (a)(i) and (a)(ii) with no working scores <b>(2)</b>  <u>E.g.</u> $10.9725 \div (0.74 \div 46) = - 682 \text{ (kJ mol}^{-1}\text{)}$  <i>ALLOW</i> Just kJ as the units  <b>NOTE:</b> If correct answer is given in $\text{J mol}^{-1}$ , the units of $\text{J mol}^{-1}$ must be clearly given for the second mark to be awarded.	Correct answer in J instead of $\text{J mol}^{-1}$	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)	<p>Any three from:</p> <p>Heat loss (from the beaker)/beaker not insulated/heat loss as no lid on beaker (containing the water) /no stirring (1)</p> <p>Incomplete combustion (of the alcohol)/formation of soot (on beaker) (1)</p> <p>Not all of the energy from the flame is used to heat the beaker and/or the water</p> <p>OR</p> <p>Too large a distance between flame and beaker / no draught excluder (1)</p> <p>Heat capacity of the beaker is neglected/beaker absorbs heat/glass absorbs heat (1)</p> <p>Evaporation of the (hot) alcohol (1)</p> <p>Evaporation of the (hot) water (1)</p>	<p>More accurate thermometer</p> <p>Just “experimental /human error”</p> <p>Experiment carried out at a different (laboratory) temperature</p>	3

Question Number	Acceptable Answers	Reject	Mark
19 (b) (iii)	$2 \text{C(s)} + 3\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{C}_2\text{H}_5\text{OH(l)}$ $\begin{array}{ccc} \downarrow & & \downarrow \\ 2\text{CO}_2 + 3\text{H}_2\text{O} & & \end{array}$ $\Delta H_f = 2 \times (-394) + 3 \times (-286) - (-1370)$ $= -276 \text{ (kJ mol}^{-1}\text{)}$ <p>Correct expression or cycle (1)</p> <p>Evidence for both doubling <math>\Delta H_c^\theta</math> [C] and trebling <math>\Delta H_c^\theta</math> [H<sub>2</sub>] (1)</p> <p>Correct sign and answer (1)</p> <p>Correct answer with no working scores (3)</p> <p>Correct answer with an incorrect cycle (3)</p> <p><i>IGNORE</i> units even if incorrect</p> <p><b>Alternatively the following answers score as shown even with incorrect cycle or incorrect units</b></p> <p><b>NOTE:</b></p> <p>(+)276 with or without working scores (2)</p> <p>(+)690 with or without working scores (2)</p> <p>-690 with or without working scores (1)</p> <p>-552 with or without working scores (2)</p> <p>-1134 with or without working scores (2)</p> <p>(+)1134 with or without working scores (1)</p> <p>(+)10 with or without working scores (2)</p> <p><b>REMINDER IF ANY OTHER ANSWER IS GIVEN: ALL WORKING MUST BE CHECKED TO SEE IF ANY MARKS CAN BE AWARDED</b></p>		3

TOTAL FOR SECTION B = 60 MARKS

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