

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

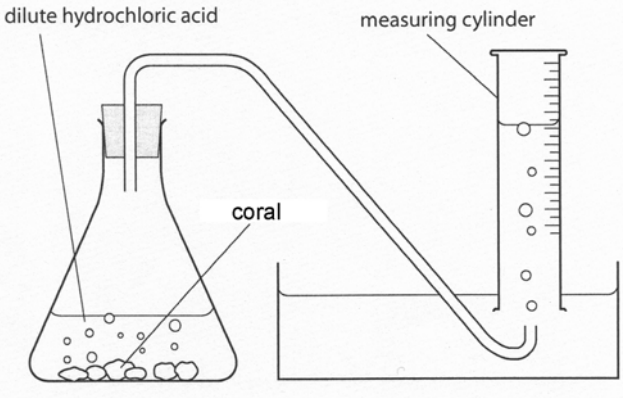
Question Number	Acceptable Answers	Reject	Mark
15 (a)	<p>Average/mean mass of an atom/isotopes (1) (1/12 mass of an atom of) carbon-12 (1)</p> <p>First mark: mention of mean or average mass of either an atom/isotopes <i>IGNORE</i> “weighted” before average or mean <i>IGNORE</i> any mention of “moles” in definition</p> <p>Second mark: any mention of carbon-12</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>Mark the two points independently</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 isotopes</p> <p><i>ALLOW</i> (Rubidium/it has) “different isotopes”</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>$\frac{85 \times 72 + 87 \times 28}{100}$ = 85.56 or 85.6 (1) Correct answer with no working (2)</p> <p>NOTE: Rounding error giving answer 85.5 scores (1)</p> <p><i>IGNORE</i> any units (for example, g/g mol⁻¹/%)</p> <p>NOTE: If 71% abundance used for ⁸⁵Rb and 29% for ⁸⁷Rb, 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 H_2CO_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 H_3O^+ in place of 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) OR $2\text{H}_3\text{O}^+ + \text{CO}_3^{2-} \rightarrow 3\text{H}_2\text{O} + \text{CO}_2$ LHS (1) RHS (1) <i>IGNORE STATE SYMBOLS, EVEN IF INCORRECT</i> <i>IGNORE = arrows</i>	H_2CO_3 as a product $\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{HCO}_3^-$ 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)	 <p>Conical flask and a delivery tube leaving the conical flask (1) <i>IGNORE</i> "heat" beneath conical flask</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 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)	$(224 \div 24000 =) 0.009333/9.333 \times 10^{-3}$ (mol) Ignore SF except 1 SF Ignore any incorrect units	“0.009” as answer	1

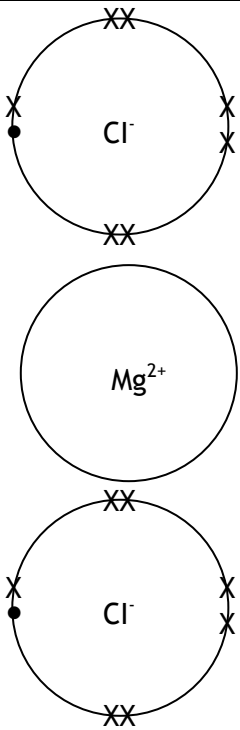
Question Number	Acceptable Answers	Reject	Mark
16 (b) (iv)	$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g/aq})$ ALL FOUR state symbols must be correct for this mark		1

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 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 = $100 \times 0.9333 / 1.13 = 82.6\%$ (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 <i>ALLOW</i> “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 $1s^2 2s^2$) <i>ALLOW</i> subscripts, correct use of p_x , p_y and p_z orbitals or normal font for electrons	2 8 7	1

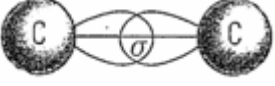
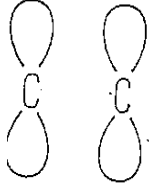
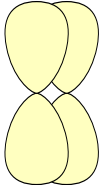
Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	 <p>Correct number of outer electrons (ignore whether dots and / or crosses) drawn and also ratio of magnesium : chloride ions is 1:2 (1)</p> <p>Correct formulae and charges of the ions shown somewhere (1)</p> <p>NOTE: Diagram for Mg^{2+} showing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

Question Number	Acceptable Answers	Reject	Mark
17 (b) (iii)	<p>(Comparison of) charges: O^{2-} ions whereas Cl^{-} 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 ions is stronger in MgO (than $MgCl_2$) / stronger ionic bonding in MgO (than $MgCl_2$) (1)</p> <p>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)</p> <p>Mark the above three points independently</p> <p><i>NOTE ALTERNATIVE ANSWER WITH A MAXIMUM OF TWO MARKS:-</i></p> <p>O^{2-} (ions) smaller (than Cl^{-} ions) (1)</p> <p>so (force of) attraction between ions is stronger in MgO (than $MgCl_2$) / stronger ionic bonding in MgO (than $MgCl_2$) (1)</p> <p>Ignore <i>ANY</i> references to polarization of ions / covalent character / degree of covalency.</p> <p>Mark the above two points independently</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>First Mark:</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>Both equations $\text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2$ and $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$</p> <p><i>IGNORE</i> state symbols, even if incorrect (1)</p> <p>Second Mark:</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 yield</p> <p>Mark the two points independently</p>		2

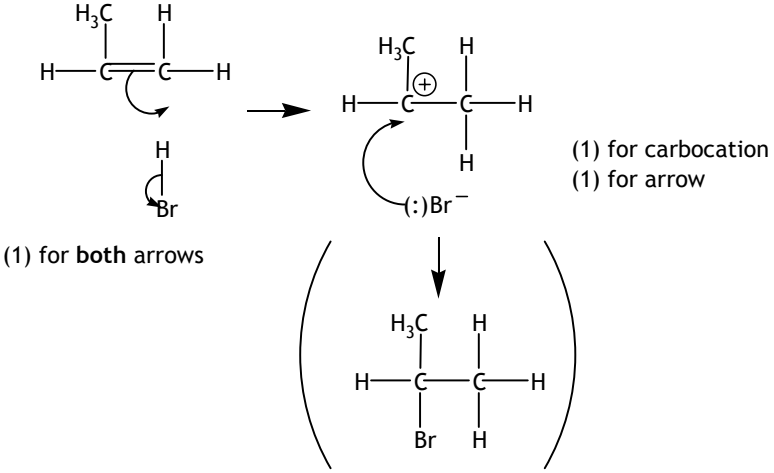
Question Number	Acceptable Answers	Reject	Mark
18 (a)	$C_{10}H_{22} \rightarrow C_7H_{16} + C_3H_6$ <i>ALLOW</i> structural or displayed formulae instead of molecular formulae <i>IGNORE</i> any state symbols, even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
18 (b) (i)	<p style="text-align: center;">diagram for the σ-bond</p> <p>e.g.</p>  <p>First Mark: <i>EITHER</i> Diagram shows overlap of any-shaped orbitals along the line between the two nuclei <i>OR</i> Mentions/implies rotation around a sigma/single bond (1)</p> <p>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)</p> <p style="text-align: center;">diagram for the π-bond</p> <p>e.g.</p> <p><i>EITHER</i></p>  <p><i>OR</i></p>  <p>Third Mark: <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>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)</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)	π bond weaker than σ (bond) / less energy needed to break π bond <i>ALLOW</i> π bond weak(er) / π bond easy to break (1) π - electrons / π bonds (more) accessible (to electrophilic attack) <i>ALLOW</i> 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)	$ \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} \quad \text{and} \quad \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) NOTE: 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 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)	 <p>(1) for both arrows</p> <p>(1) for carbocation (1) for arrow</p> <p>1st mark: Curly arrows must start from the bonds NOT the atoms</p> <p>3rd mark: Bromide ion must clearly have a 1⁻ charge to get this mark</p> <p>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</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>Mark the three points independently</p>	<p>half arrow- heads</p> <p>Br^{δ-}</p>	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)	<div style="text-align: center;"> $n\text{C}_3\text{H}_6 \rightarrow \left[\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C} \\ \\ \text{---}[\text{C}-\text{C}]_n \\ \quad \\ \text{H} \quad \text{H} \end{array} \right.$ </div> <p>Two “n’s” in the equation and 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> CH₃ fully displayed or just as CH₃</p> <p>Continuation bond at each end (with or without bracket shown in equation) (1)</p> <p>Unsaturated polymer scores max (1)</p> <p>Mark the three points independently</p>	“x” instead of “n”	3

Question Number	Acceptable Answers	Reject	Mark
18 (d) (ii)	<p>(Advantage): 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” (1)</p> <p>(Disadvantage): 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 (1)</p> <p>Mark the two points independently</p>	<p>“Can be recycled” (0) for first scoring point</p> <p>Biodegradable for 1st mark</p> <p>Answers which do not imply exposure to UV/sunlight</p> <p>Biodegradable for 2nd mark</p>	2

Question Number	Acceptable Answers	Reject	Mark
19 (a) (i)	$(q = 250 \times (31.5 - 21.0) \times 4.18 =) 10972.5 \text{ (J)}$ 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)	$(M_r \text{ ethanol}) = 46 \quad (1)$ $(\text{Mass ethanol burned} = 63.21 - 62.47 =) 0.74 \text{ (g)}$ ALLOW 63.21 – 62.47 as alternative to 0.74 (1) $(\text{Amount of ethanol} = 0.74 \div 46 =) 0.0161 \text{ (mol)}$ (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)	$\text{Answer (i)} \div (1000 \times \text{answer (ii)}) \quad (1)$ 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) <u>E.g.</u> $10.9725 \div (0.74 \div 46) = - 682 \text{ (kJ mol}^{-1}\text{)}$ 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)	$100 \times (1370 - \text{Answer to (iii)}) \div 1370 = \text{value}$ e.g. $100 \times (1370 - 682) \div 1370 = 50.2 \%$	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 ΔH_c^θ [C] and trebling ΔH_c^θ [H₂] (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>Alternatively the following answers score as shown even with incorrect cycle or incorrect units</p> <p>NOTE:</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>REMINDER IF ANY OTHER ANSWER IS GIVEN: ALL WORKING MUST BE CHECKED TO SEE IF ANY MARKS CAN BE AWARDED</p>		3

TOTAL FOR SECTION B = 60 MARKS

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