2010 Chemistry

Higher

Finalised Marking Instructions

Higher Chemistry

General information for markers

The general comments given below should be considered during all marking.

1 Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

Example: Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

2 A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

Example: What is the colour of universal indicator in acid solution?

The answer 'red, blue' gains no marks.

3 If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

Example: Why can the tube not be made of copper?

If the correct answer is related to a low melting point, 'It has a low melting point and is coloured grey' would **not** be treated as having a cancelling error.

4 Full marks are usually awarded for the correct answer to a calculation on its own; the part marks shown in the marking scheme are for use when working is given. An exception is when candidates are asked to 'Find, by calculation, …..'.

5 A half mark should be deducted in a calculation for each arithmetic slip.

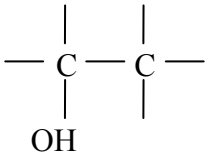
6 A half mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

7 Where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly.

8 Ignore the omission of one H atom from a full structural formula provided the bond is shown.

9 With structures involving an – OH or an – NH_2 group, a half mark should be deducted if the 'O' or 'N' are not bonded to a carbon, ie $OH–CH_2$ and $NH_2–CH_2$.

10 When drawing structural formulae, a half mark should be deducted if the bond points to the 'wrong' atom, eg



11 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

12 When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

13 If an answer comes directly from the text of the question, no marks should be given.

Example: A student found that 0·05 mol of propane, C_3H_8 burned to give 82·4 kJ of energy.

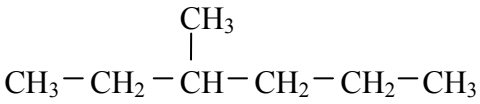
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

14 A guiding principle in marking is to give credit for (partially) correct chemistry rather than to look for reasons not to give marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the full mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	**pH**
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Although not completely correct, an answer such as 'the more Cl_2, the stronger the acid' should gain the full mark.

15 Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemistry, a non-chemical answer gains no marks.

Example: Why does the (catalytic) converter have a honeycomb structure?

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

16 When it is very difficult to make a decision about a partially correct answer, a half mark can be awarded.

17 When marks have been totalled, a half mark should be rounded up.

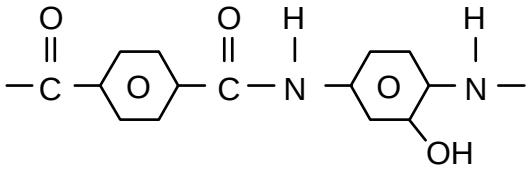
2010 Chemistry Higher

Marking Scheme

Section A

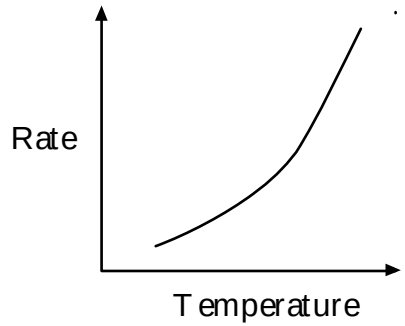
1	B	11	B	21	C	31	B
2	C	12	A	22	C	32	A
3	C	13	B	23	A	33	B
4	B	14	D	24	C	34	C
5	B	15	D	25	A	35	B
6	D	16	C	26	D	36	C
7	C	17	D	27	D	37	B
8	B	18	A	28	C	38	D
9	A	19	A	29	D	39	D
10	D	20	B	30	D	40	A

Mark Scheme				Worth ½	Worth 0
1	lithium	metallic (or metal) **(½)**			
	boron	covalent **(½)**	network or lattice **(½)**		cross-linked or giant structure
	nitrogen	(discrete) molecular (or molecule) or diatomic **(½)**	**2**		discrete

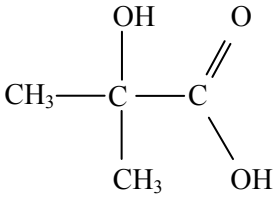
Mark Scheme			Worth ½	Worth 0
2	**(a)**	**(i)** 8 **1**		
		(ii)  **1**	one or both ends (correctly) closed; one or both end bonds missing no –OH on correct structure	linked as ester
		(accept − CONH−)		
	(b)	dissolves (or soluble) in water **1**	reacts with water	disintegrates (or breaks up or is destroyed) in water or soluble in hexane

Mark Scheme					Worth ½	Worth 0
3	**(a)**	**(i)**	rate of forward reaction equals rate of reverse reaction or concentration of reactants and products remain constant	**1**	forward reaction equals backward reaction or volume of products and reactants are constant	concentration of reactants and products are equal or volumes are equal or constant rate of reaction
		(ii)	decreases (or reduces or gets smaller or diminishes or lowers)	**1**	(equilibrium) shifts to left	
	(b)		no. of moles $= \frac{0.010}{32}$ **(½)** $= 3.125 \times 10^{-4} (0.00031)$ **(½)**	**1**	$\frac{0.010}{16} = 6.25 \times 10^{-4}$	

Mark Scheme				Worth ½	Worth 0
4	**(a)**	they react with the oxygen (or are oxidised) or burn or react to form CO_2 or CO	**1**	saturated with oxygen or electrodes absorb oxygen	corrode or wear out or break up or disintegrate, etc or coated with oxide layer
	(b)	$Q = I\,t = 50\,000 \times 20 \times 60$ **(½)** $= 6 \times 10^7$ C **(½)** Al $3 \times 96\,500$ C $\leftrightarrow$ 1 mol **(1)** 6×10^7 C $\leftrightarrow \frac{6 \times 10^7 \times 27}{3 \times 96\,500}$ **(½)** = 5596 g **(½)** (no units required; deduct ½ mark for incorrect units)	**3**		

Mark Scheme					Worth ½	Worth 0
5	**(a)**	**(i)**	concentration of reactants **(½)** (or permanganate or oxalic acid) volume of reactants **(½)** (or permanganate or oxalic acid)	**1**	concentration of permanganate and concentration of acid or volume of permanganate and volume of acid	size of beakers or temperature or dryness of beakers
		(ii)	colour change is too slow (or too gradual or takes a long time) or colour change is indistinct	**1**	reaction is too slow	room temperature fluctuates
	(b)			**1**		straight line (through the origin)

Mark Scheme			Worth ½	Worth 0
6	**(a)**	$^{11}C \rightarrow {}^{11}B + {}^{0}_{1}e$ (atomic numbers not required)	**1**	$^{11}C \rightarrow {}^{11}B$	correct atomic number for product but incorrect symbol
	(b)	3 half-lives **(½)** half-life $= \frac{60}{3} = 20$ minutes **(½)** (no units required; deduct ½ mark for incorrect units)	**1**		
	(c)	^{11}C **(½)** more ^{11}C atoms or more radioactive atoms or greater mass of ^{11}C **(½)**	**1**		more radiation in ^{11}C or glucose is a molecule or concentration of ^{11}C in glucose is less or ^{11}C has no other elements

Mark Scheme			Worth ½	Worth 0
7	**(a)**	intermolecular attractions (or forces) **or** attractions between molecules **(1)** any mention of a difference in electronegativity **(½)** carbon (or hydrogen) has a small positive charge and nitrogen a small negative charge **(½)** (accept diagram with key points, maximum **1½** marks if mention of hydrogen bonding) **2**	mention of polar molecules (or positive and negative ends in a molecule)	attraction between atoms
	(b)	 **1**		stage 1 product

Mark Scheme					Worth ½	Worth 0
8	**(a)**	**(i)**	a reactant from which other chemicals can be made (or synthesised or produced or obtained or derived) or product of one reaction becomes the reactant of another	**1**		a raw material or starting material (or substance) or material (or substance) that can be used to make something else or a material (or substance) in the chemical industry
		(ii)	addition or additional	**1**		
		(iii)	sodium chloride (accept correct formula)	**1**		any incorrect formula
		(iv)	fats and oils are renewable (or will not run out or are unlimited) or propene is obtained from a finite source or reaction has fatty acids as bi-products	**1**		fats and oils are widely available (or more common) or less polluting or less stages required to produce fats and oils or less energy required or useful bi-products, etc
	(b)		$2C_3H_8O_3 \rightarrow 3CO_2 + 3CH_4 + 2H_2$ (accept multiples)	**1**		

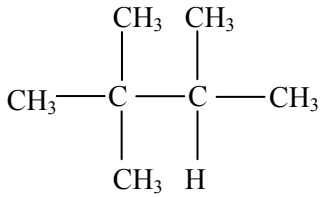
Mark Scheme	Worth ½	Worth 0
(c) $3C + 3O_2 \rightarrow 3CO_2$ $-394 \times 3 = -1182$ kJ **(½)** $4H_2 + 2O_2 \rightarrow 4H_2O$ $-286 \times 4 = -1144$ kJ **(½)** $3CO_2 + 4H_2O \rightarrow C_3H_8O_3 + 7/2\ O_2 = +1654$ kJ **(½)** addition = -672 kJ mol $^{-1}$ **(½)** **2** (3 'sensible' numbers required for ½ mark for addition based on following through; no units required; accept kJ; deduct ½ mark for incorrect units)		

Mark Scheme				Worth ½	Worth 0
9	**(a)**	carbon, oxygen, nitrogen and hydrogen [accept C, O (or O_2), N (or N_2), H (or H_2)]	**1**		
	(b)	count the number of (oxygen or gas) bubbles produced in a given time or measure the volume of gas produced in a given time or measure height of bubbles (or foam) produced in a given time or find rate of gas production (ignore wrong gas named)	**1**	count the bubbles or measure volume of gas or measure height of bubbles (or foam) or collect gas over period of time	measure mass of oxygen
	(c)	increasing temperature can denature the enzyme or idea of optimum temperature	**1**		enzyme is destroyed or disintegrates or breaks down (or up)

Mark Scheme	Worth ½	Worth 0
10 (a) <u>for drying</u>, entry delivery tubes must be below surface of concentrated sulphuric acid and exit tube must be above **(1)** <u>for collection</u>, apparatus must be workable **(½)** and 'cooler' labelled **(½)** eg use of an ice/water bath **2**		
(b) 1 mol SO_2 → 1 mol SO_3 64.1g → 80.1g **(½)** 51.2 tonnes → $\frac{51.2 \times 80.1}{64.1} = 64.0$ tonnes **(½)** % yield = $\frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{43.2}{64.0} \times 100$ **(½)** = 67.5% **(½)** **2** **or** moles of $SO_2 = \frac{51.2}{64.1} = 0.799$ **(½)** moles of $SO_3 = \frac{43.2}{80.1} = 0.539$ **(½)** % yield = $\frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{0.539}{0.799} \times 100$ **(½)** = 67.5% **(½)**		$\frac{43.2 \times 100}{51.2} = 84.38$

Mark Scheme					Worth ½	Worth 0
11	**(a)**	**(i)**	outer electron is further away from the nucleus or greater number of electron shells **(1)** (increased) shielding (or screening) by the inner electrons or decreased nuclear attraction due to inner election shells **(1)**	**2**	bigger atoms decreased nuclear attraction	
		(ii)	$3.94 \times 10^{-21} \times 6 \times 10^{23}$ **(½)** = 2371.9 kJ mol^{-1} **(½)** (no units required; accept kJ)	**1**		2380 (value from data booklet)
	(b)		$Cl(g) + e^- \rightarrow Cl^-(g)$	**1**		no state symbols

Mark Scheme			Worth ½	Worth 0
12	**(a)**	moles of LiOH = $0.1 \times 0.4 = 0.04$ **(½)** moles of $CO_2 = \frac{0.24}{24} = 0.01$ **(½)** 0.02 mol of LiOH reacts with 0.01 mol of CO_2 **(½)** excess LiOH = 0.02 **(½)** **2**		
	(b)	13 **1**	$[H^+(aq)] = 1 \times 10^{-13}$ mol l^{-1} (units not required)	$[OH^-(aq)] = 10^{-13}$ or 1×10^{-13}
	(c)	two points related to the weak acid equilibrium 2 x **(½)** **1** two points related to water equilibrium 2 x **(½)** **1** (accept equations showing the two equilibria) or salt of a weak acid and a strong base **(1)**		

Mark Scheme				Worth ½	Worth 0
13	**(a)**	**(i)**	 **1**	correct structure with one or more hydrogens missing but all bonds shown	structure with bonds missing
		(ii)	all have branched-chains (or branches) **1**	not linear or all have methyl groups attached to chain	chained molecules
	(b)	**(i)**	more complete combustion (or less incomplete combustion or less CO) or higher octane rating or burns more smoothly or prevents knocking (or auto-ignition), or carbon burns more cleanly or reduces the oxygen (or air) required for combustion **1**		burns better (or more efficiently) or less harmful gases
		(ii)	any correct ether isomer **1**	correct structure with one or more hydrogens missing but all bonds shown	structure with bonds missing
	(c)		cyclohexane or any correct cyclic isomer **1**	any correct structure	any molecular formula, eg C_6H_{12}

Mark Scheme					Worth ½	Worth 0
14	**(a)**	**(i)**	2. measure the temperature (of the water) **(½)** 4. measure the <u>highest temperature</u> reached by the solution **(½)**	**1**		measure final (or new) temperature or temperature of solution
		(ii)	to reduce (or prevent) heat loss to the surroundings or to keep heat in or less energy lost (or to conserve energy)	**1**	polystyrene is an insulator	
		(iii)	1 mol KOH = 56.1 g 1.2 g ↔ 1.08 kJ 56.1 ↔ $\frac{1.08 \times 56.1}{1.2} = -50.49$ kJ mol^{-1} **(½)** (accept kJ and (in this case) no units)	**1**	correct answer with incorrect or no sign and/or incorrect units	
	(b)		enthalpy change is for the formation of <u>one</u> mole of water or equivalent	**1**	it's the same for both	two moles of water are formed with sulphuric acid

Mark Scheme				Worth ½	Worth 0
15	**(a)**	**x** is O-H **(½)** **y** is C-H **(½)**	**1**		
	(b) **(i)**	condensation or esterification	**1**		condensation polymerisation
	(ii)	2 peaks only: at 1705-1800 **(½)** and 2800-3000 **(½)** (deduct ½ mark for each additional incorrect peak)	**1**		

Mark Scheme				Worth ½	Worth 0
16	**(a)**	any 2 (½ mark each) from: flask should be swirled read burette at eye level white tile under flask add drop-wise (near end-point) no air bubble in burette use an indicator to give a sharp colour change rinse with solutions being used titrate slowly remove funnel from burette put a piece of white paper behind burette stir constantly, etc.	**1**		rough titre, take average of readings, etc.
	(b)	**(i)** no. of moles of $MnO_4^-(aq) = 21.6 \times 1.50 \times 10^{-5} = 3.24 \times 10^{-4}$ **(½)** mole ratio 2:5 **(½)** no. of moles of $NO_2^- = 8.1 \times 10^{-4}$ **(½)** concentration = $\frac{8.1 \times 10^{-4}}{0.025} = 3.24 \times 10^{-2}$ **(½)** (no units required; deduct ½ mark for incorrect units)	**2**	**Worth 1 mark** $\frac{3.24 \times 10^{-4}}{0.025} = 0.13$	
		(ii) $NO_2^-(aq) + H_2O(\ell) \rightarrow NO_3^-(aq) + 2H^+(aq) + 2e^-$ (state symbols not required)	**1**		

[END OF MARKING INSTRUCTIONS]