2006 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 'distiling' (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 Instructions 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.

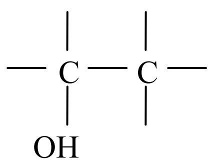
6 A half mark should be deducted for incorrect or missing units **only when stated in the Marking Instructions**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

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 Instructions**.

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.

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

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.

$$\begin{array}{c} CH_3 \\ | \\ CH_3-CH_2-CH-CH_2-CH_2-CH_3 \end{array}$$

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.

2006 Chemistry Higher

Marking Scheme

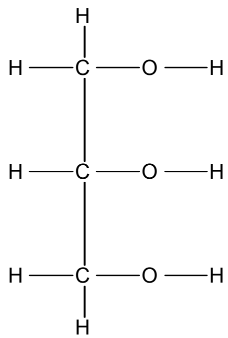
Section A

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

Mark Scheme				Worth ½	Worth 0
1		**A –** covalent molecular solid ½ **D –** covalent network solid ½ **C** – ionic ½ **B –** metallic ½	**2**		
2	**(a)**	number of protons increases **or** increased atomic number **or** greater nuclear charge (pull) **or** greater pull on outer electrons **or** increased nuclear field strength	**1**		increased number of electrons **or** larger nucleus **or** stronger nucleus
	(b)	a fullerene **or** Buckminster fullerene **or** C_{60}, C_{70} etc	**1**		
	(c)	no difference in (electronegativity) values **or** same (electronegativity) values **or** both have a value of 3 **or** same attraction for electrons	**1**	difference in electronegativity is less than 0.5	similar (small difference) in electronegativity values

Mark Scheme	Worth ½	Worth 0
3 **(a)** carbon dioxide (½) and nitrogen (½) **1** (accept correct formulae)		carbon oxide **or** N in place of N_2
(b) molecules absorbed on the surface (active sites) of the catalyst (metal) ½ (covalent) bonds weaken **or** more successful collisions ½ reaction occurs **or** mention of product ½ molecules desorb **or** leave the surface ½ (accept above points on suitable diagram) **2**		lower activation energy

Mark Scheme	Worth ½	Worth 0
4 **(a)** $E = mc\Delta T$ $= 0{\cdot}10 \times 4{\cdot}18 \times 10$ ½ $= 4{\cdot}18$ kJ ½ (unit and sign not required at this stage) mass of 1 mol CH_3OH = 32 g ½ 0·45 g CH_3OH ↔ 4·18 kJ ½ 32 g ↔ $\frac{32 \times (-4 \cdot 18)}{0 \cdot 45}$ kJ mol^{-1} = - 297 kJ mol^{-1} ½ **or** $n = \frac{0 \cdot 45}{32}$ ½ for 32 = 0·014 mol ½ $\Delta H = -\frac{4 \cdot 18}{0 \cdot 014}$ 1 for 4·18 = -298·6 kJ mol^{-1} ½ (correct sign given in answer ½; units not required; deduct ½ for incorrect units, eg kJ mol 1^{-1}, accept kJ) **2**		

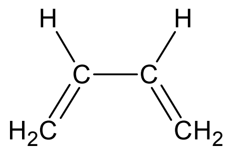
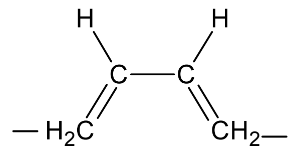
Mark Scheme	Worth ½	Worth 0
(b) incomplete combustion of methanol **or** heat loss (to surroundings, etc) **or** some loss of methanol due to evaporation (any two – **1** mark each) **2**		experiment not repeated **or** human error **or** impure methanol **or** water evaporating
5 **(a)** **(i)**  **or** shortened formula **1** **(ii)** fats **or** oils **or** glycerides **or** triglycerides **1**		
(b) $\mathbf{4}C_3H_5N_3O_9(l) \rightarrow \mathbf{6}N_2(g) + \mathbf{10}H_2O(g) + \mathbf{12}CO_2(g) + O_2(g)$ **or** $\mathbf{2}C_3H_5N_3O_9(l) \rightarrow \mathbf{3}N_2(g) + \mathbf{5}H_2O(g) + \mathbf{6}CO_2(g) + \frac{1}{2}O_2(g)$ **or** $C_3H_5N_3O_9(1) \rightarrow \mathbf{1\frac{1}{2}}N_2(g) + \mathbf{2\frac{1}{2}}H_2O(g) + \mathbf{3}CO_2(g) + \frac{1}{4}O_2(g)$ **1**		

Mark Scheme			Worth ½	Worth 0
6	**(a)**	First mark for valid method of measuring rate, eg count how many bubbles (½) in certain time interval (½) **or** time how long it takes (½) to form a set number of bubbles (½) Second mark for valid method of altering temperature, eg repeat experiment with test-tube in water bath **or** heat solution to different temperatures **or** repeat experiment at different temperatures **or** repeat using a water bath **2**	time how long it takes for reaction **or** count the bubbles use a water bath **or** heat the test tube	 heat water to different temperatures
	(b)	enzyme (protein, catalyst) denatures **or** changes shape **or** active sites altered **1**		enzyme dies **or** doesn't work **or** destroyed **or** damaged

Mark Scheme					Worth ½	Worth 0
7	**(a)**		ethene is produced (made, formed) from other chemicals **or** ethene requires prior processing **or** ethene does not occur naturally **or** made from crude oil	**1**		ethene is a feedstock **or** not easily obtained
	(b)	**(i)**	any response that implies recycling the ethene, eg reused, recirculated	**1**		evaporation **or** fractionating
		(ii)	distillation	**1**		
	(c)	**(i)**	hydration **or** addition	**1**	reversible	equilibrium **or** oxidation
		(ii)	equilibrium moves to the left **or** shifts (moves) to give less ethanol (product) in mixture **or** shifts (moves) to give more reactants in mixture **or** moves in (favours) endothermic direction **or** speeds up right to left reaction	**1**		

Mark Scheme	Worth ½	Worth 0
(iii) 1 mol C_2H_4 ↔ 1 mol C_2H_5OH 28 g ↔ 46 g **½** 10·0 kg ↔ $\frac{10 \cdot 0 \times 46\text{kg}}{28}$ ½ = 16·4 kg ½ % yield = $\frac{1 \cdot 64 \times 100}{16 \cdot 4}$ = 10 % ½ **or** n = $\frac{10000}{28}$ ½ = 357 mol ½ mass = 357 × 46 = 16·4 kg ½ % yield = $\frac{1 \cdot 64 \times 100}{16 \cdot 4}$ = 10 % ½ **2**		

Mark Scheme				Worth ½	Worth 0
8	**(a)**	to ensure the same volume of gas is used each time **or** to give a fair test **or** to ensure sufficient breath has passed through **or** similar	**1**		
	(b)	$H^+(aq)$ ions are needed for the reaction **or** to provide $H^+(aq)$ ions **or** to remove O (as water) **or** to allow the **reduction** to take place **or** so the alcohol can be oxidised **or** to allow chromate to act as oxidising agent	**1**	allow oxidation **or** allow redox reaction	so the reaction works **or** to lower the pH **or** to react with hydroxide ions **or** to speed up the reaction **or** to act as a catalyst
	(c)	ethanal (acetaldehyde) or ethanoic acid (acetic acid) (accept correct structure)	**1**	vinegar **or** alkanal (aldehyde) **or** alkanoic (carboxylic) acid	

Mark Scheme	Worth ½	Worth 0
9 **(a)** **(i)**  **or** full structural formula **1**		
(ii) addition(al) **1**		
(b) hard-wearing **or** more like a thermoset **or** stronger **or** more rigid **or** harder **or** less elastic **or** melts less easily **or** durable **or** longer lasting, etc **1**		

Mark Scheme	Worth ½	Worth 0
10 **(a)** $NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(\ell)$ (state symbols not required) **1**		
(b) 1 mol Cu ↔ 1 mol SO_2 ½ 63·5 g ↔ 24 litre ½ 10·0 g ↔ $\frac{10 \cdot 0 \times 24}{63 \cdot 5}$ ½ = 3·8 litre ½ **or** $n = \frac{10}{63 \cdot 5}$ ½ = 0·16 mol ½ volume = 0·16 × 24 ½ = 3·8 litre ½ (no units required; deduct ½ for incorrect units; accept correct answer in cm^3) **2**		

Mark Scheme				Worth ½	Worth 0
11	(a)	2	1		
	(b)	ethanoic acid: higher sulphuric acid: lower	1 1		
	(c)	hydrogen bonding 1 due to polar O—H bond **or** as a result of relatively high electronegativity difference between oxygen and hydrogen of O—H bond ½ mention of attraction between the H of the O—H bond and the O of the C = O ½ (δ+ and δ– indication would cover the two latter ½ marks)	2	permanent dipole/dipole	ethenoic acid is polar

Mark Scheme		Worth ½	Worth 0
12 **(a)** **(i)** 2 temp. of KOH (aq) 3 temp. of HCl (aq) 4 vol. of HCl (aq) **or** vol. of KCl (aq) 5 final (max) temp. of KCl (aq) (accept average initial temperature and temperature change for 1 mark) **(ii)** 1 reversed 1852 kJ mol^{-1} ½ 2 unchanged -437 kJ mol^{-1} ½ 3 multiplied by 3 -1806 kJ mol^{-1} ½ correct addition -391 kJ mol^{-1} ½ (3 'sensible' numbers with 2 correct required for ½ mark for addition based on following through; no units required; deduct ½ for incorrect units; accept kJ)	**2** **2**		
(b) $2Na(s) + ½\ O_2(g) \rightarrow Na_2O(s)$ (state symbols required)	**1**		$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

Mark Scheme				Worth ½	Worth 0
13	(a)	reaction vessel containing NaOH and CH_3COONa being heated collection by displacement of water using an upturned measuring cylinder (graduated test tube) **or** collection using gas syringe	1 1	reaction vessel without heat use of test tube without graduations	
	(b)	ethane **or** correct formula	1		

Mark Scheme		Worth ½	Worth 0
14 (a) (i) $^{241}_{95}\text{Am} \rightarrow ^{237}_{93}\text{Np} + \alpha$ (accept $^{4}_{2}\text{He}$ or $^{4}_{2}\text{He}^{2+}$ in place of α; accept α above arrow)	**1**	correct equation with mass numbers and atomic numbers to right of symbols	
(ii) alpha-particles not very penetrating **or** absorbed by plastic/paper/air **or** mass of radioisotope very low **or** americium oxide insoluble so not absorbed if ingested	**1**		radiation weak **or** deflected by paper **or** not strong enough
(b) formula mass AmO_2 = 273 ½ mass americium-241 = $\dfrac{241 \times 0 \cdot 00025}{273}$ = 0·00022 g ½ (no units required; deduct ½ for incorrect units)	**1**		

Mark Scheme		Worth ½	Worth 0
15 **(a)** $2Cl^-(aq) + 2H_2O(\ell) \rightarrow Cl_2(g) + H_2(g) + 2OH^-(aq)$ (ignore state symbols; both charges required)	**1**	electrons in equation	
(b) **(i)** sodium hydroxide	**1**	Na^+ sol. **or** OH^- sol	sodium
(ii) use as a fuel **or** not finite (renewable) **or** does not produce CO_2, etc	**1**		
(c) $Q = I \times t = 80\,000 \times 10 \times 60 \times 60$ ½ $= 288 \times 10^7$ C ½ 1 mol Cl_2 $\leftrightarrow$ $2 \times 96\,500$ C ½ $288 \times 10^7 \text{ C} \rightarrow \dfrac{288 \times 10^7}{2 \times 96\,500} = 1.49 \times 10^4$ moles ½ mass of $Cl_2 = 1.49 \times 10^4 \times 71 \times 10^{-3}$ ½ $= 1059$ kg ½ (no units required; deduct ½ for incorrect units; accept correct answer in g)	**3**		

Mark Scheme		Worth ½	Worth 0
16 **(a)** C—O	**1**		
(b) **(i)** S ½ *Q* ½ **or** C ≡ C—H ½ C ≡ C ½	**1**		
(ii) propan-1-ol	**1**	propanol **or** propane-1-ol **or** prop-1-ol	correct structure

[END OF MARKING INSTRUCTIONS]