SCOTTISH QUALIFICATIONS AUTHORITY

2004 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 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.

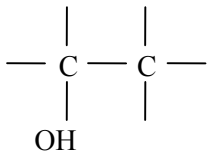
6 A half mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

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, i.e. $OH–CH_2$ 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 has 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.

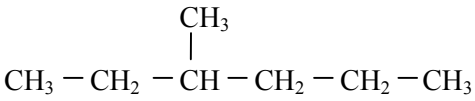
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

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.



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.

2004 Chemistry Higher

Marking scheme

Section A

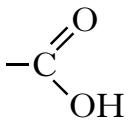
1.	B	21.	D
2.	C	22.	A
3.	A	23.	D
4.	A	24.	D
5.	D	25.	A
6.	C	26.	A
7.	B	27.	B
8.	D	28.	C
9.	C	29.	D
10.	A	30.	B
11.	D	31.	D
12.	C	32.	C
13.	A	33.	C
14.	B	34.	A
15.	D	35.	C
16.	A	36.	B
17.	B	37.	D
18.	B	38.	C
19.	B	39.	B
20.	A	40.	C

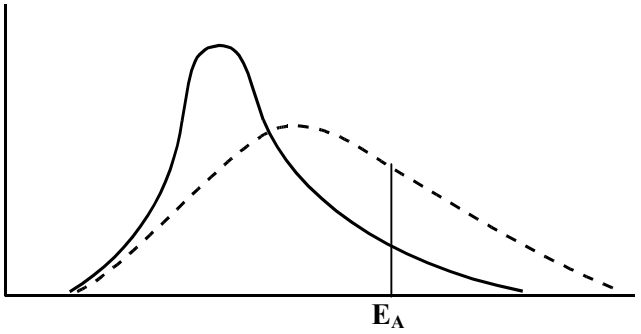
Section B

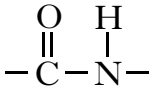
Mark Scheme			Worth ½	Worth 0
1.	**(a)**	<table><tr><td></td><td>Name of Element</td></tr><tr><td></td><td></td></tr><tr><td></td><td>helium or neon or argon</td></tr><tr><td></td><td>carbon or silicon or boron</td></tr><tr><td></td><td>nitrogen or oxygen or fluorine or chlorine or hydrogen</td></tr><tr><td></td><td>phosphorus or sulphur or fullerene</td></tr></table> Accept diamond and graphite in place of carbon	**2**	4 x ½	elements outwith 1 to 20 in the periodic table
	(b)	Any mention of delocalised electrons or electrons able to move or free electrons or sea of electrons	**1**		

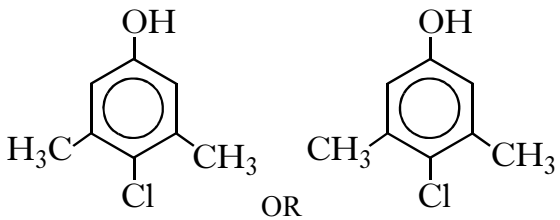
Mark Scheme				Worth ½	Worth 0
2.	**(a)**	$^{32}_{15}P \longrightarrow {}^{32}_{16}S + \beta$ or $^{0}_{-1}e$	**1**	use of e or e^- or atomic numbers on RHS	
		Accept correct equation without atomic numbers or correct symbol above arrow			
	(b) **(i)**	32g ⟶ 1 mol		correct use of phosphorus -31	6×10^{23} on its own
		32g ⟶ 6×10^{23} atoms	½		
		8g ⟶ $0.25 \times 6 \times 10^{23}$			
		$= 1.5 \times 10^{23}$ (atoms)	½		
	(ii)	8g ⟶ (t = 1) 4g ⟶ (t = 2) 2g ⟶ (t = 3) 1g		3 x t	using any other number of half-lives
		total time = 3 x 14.3 = 42.9 days	**1**		
		(-½ for no or incorrect units)			

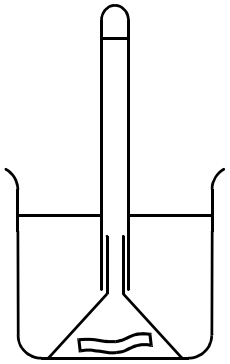
Mark Scheme				Worth ½	Worth 0
3.	**(a)**	sulphur dioxide or sulphur trioxide or sulphur monoxide	**1**		sulphur gas or sulphurous oxide
	(b)	displacement or redox	**1**		oxidation or reduction on their own
	(c)	arrow going from sulphuric acid to neutraliser	**1**		
	(d)	Q = It			Q = It
		= 2000 x (24 x 60 x 60)			
		= 172 800 000 C	**½**		
		(no units required; no penalty for incorrect units)			
		193 000C → 65.4g	**1**		
		172 800 000C → $\frac{172\,800\,000C \times 65.4}{193{,}000}$			
		= 58.555 kg	**½**		
		(no units required; - ½ for incorrect units) **(Accept correct answer in grams)**			

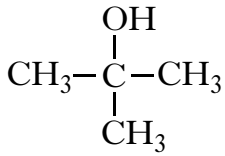
Mark Scheme					Worth ½	Worth 0
4.	**(a)**		starch	**1**		
	(b)	**(i)**	silver mirror (screen, precipitate) Ignore mention of starting colour	**1**		
		(ii)	 or –COOH or CO_2H	**1**		
	(c)		Biogas is renewable or reproduced easily or carbon neutral or produced in a shorter timescale or natural gas is finite etc	**1**		Less/not polluting or less/no carbon dioxide produced or cheaper or methane is finite or biogas lasts for a long time etc
5.	**(a)**		<table><tr><td></td><td>same</td></tr><tr><td></td><td>usually different</td></tr></table>	**1**	2 x ½	
	(b)	**(i)**	It is exothermic or it is negative	**1**		
		(ii)	no effect	**1**		

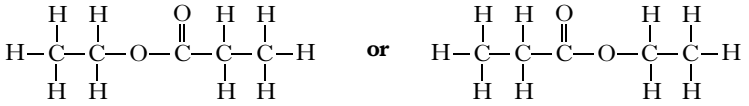
Mark Scheme				Worth ½	Worth 0
6.	**(a)**		purple to colourless **1**	goes colourless	goes clear or colourless to purple
	(b)	**(i)**	40˚C → 0.012		0.012 on its own
			$t = \frac{1}{0.012}$ ½		
			= 83.3 s ½		
			(no units required; - ½ for incorrect units)		
		(ii)	Reaction is too slow or change of colour is difficult to see **1**		too cold/cool or does not react or room temperature fluctuates or room temperature not on graph
	(c)				
			Curve needs to be to the right of initial curve ½		
			Diagram needs to have activation energy point marked ½		

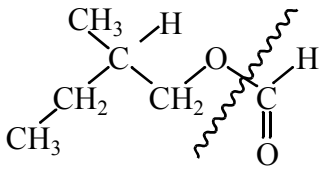
Mark Scheme				Worth ½	Worth 0
7.	**(a)**		**1**	 or CONH	
	(b)	curve with maximum at 37 °C	**1**		
	(c)	Enzyme is denatured or changes shape/structure or is deformed/distorted or loses its active site	**1**		Enzyme is killed or destroyed or broken down or disintegrates etc
8.	**(a)**	$\Delta t = \frac{(18 + 20)}{2} - (25.5) = -6.5\ ^{o}C$	½		
		$\Delta H = cm\,\Delta t = 4.18 \times 40 \times -6.5$			
		$= -1086.8$ J	½		
		(no units required; no penalty for incorrect units or for incorrect or no sign)			
		$\Delta H = \frac{1}{0.02} \times -1068.8$	½	0.02 (mol)	
		$= -54.34$ kJ mol^{-1}	½		
		(no units required; -½ for incorrect units; accept kJ, -½ for incorrect or no sign)			
	(b)	1 mol l^{-1} HCl (aq) $[H^+] = 1 \times 10°$	½	$[H^+]\,[OH^-] = 10^{-14}$	
		$[OH^-] = \frac{10^{-14}}{1} = 10^{-14}$ mol l^{-1}	½		
		(-½ for no or incorrect units)			

Mark Scheme					Worth ½	Worth 0
9.	**(a)**		P^{3-} has an extra layer of electrons/energy level	**1**	Al^{3+} has lost a layer but P^{3-} has gained a layer	P^{3-} has bigger outer shell or Al^{3+} has smaller outer shell
	(b)		Ca^{2+} had a greater nuclear charge/number of protons/ atomic number	**1**		
10.	**(a)**	**(i)**	(ring of) delocalised electrons or electrons able to move around	**1**	ring of electrons	electrons able to move or free moving electrons or ring structure
		(ii)	$C_6H_2Cl_3OH$ or $C_6H_3Cl_3O$	**1**		C(OH)CClCHCClCHCCl
		(iii)	 OR	**1**		no 'circle' in benzere ring
	(b)		petrol	**1**	to make fuel	in car engines

Mark Scheme			Worth ½	Worth 0
11.	**(a)**	 (labels are not required; accept diagram with funnel that does not reach bottom of the beaker) **1**		funnel on top of beaker
	(b)	Measure volume of gas collected (Y) ½ Measure mass of magnesium (used up) ½ X g of Mg → Y cm^3 of gas ½ (assumes 1 mol Mg → 1 mol H_2) Therefore 24.3 g → $\frac{24.3}{X}$ x Y cm^3 of gas = molar volume of gas ½	Find volume of gas produced by 24.3 g Mg	

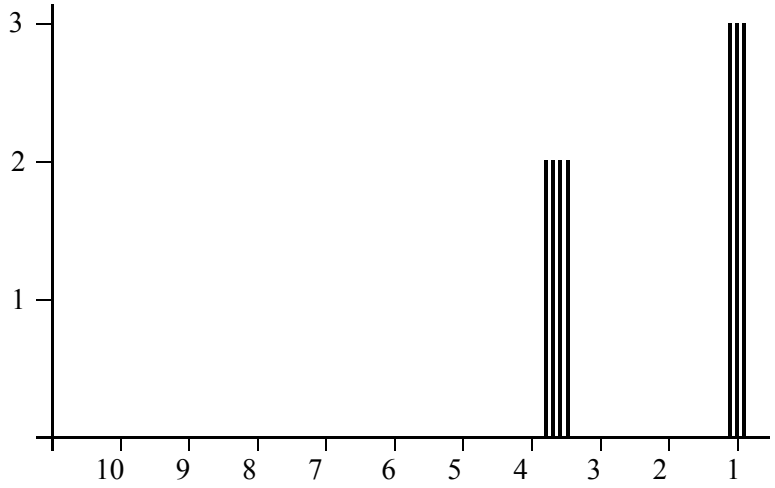
		Mark Scheme		Worth ½	Worth 0
12.	**(a)**	moles of Vitamin C = 0.05 x 0.1 = 0.005 mol	½		
		moles of iodine = $\frac{0.54}{253.8}$ = 0.002 mol	½		
		Therefore Vitamin C is in excess.	½		
		(not needed if next answer is correct)			
		Iodine would have been decolourised.	½		Iodine would have been decolourised (as only answer).
	(b)	$C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-$	**1**		
		(state symbols not required)			
13.	**(a)**	butan-2-ol	**1**		butanol
	(b)	 or full structural formula	**1**		
	(c)	but-2-ene	**1**	butene or but-l-ene	

Mark Scheme				Worth ½	Worth 0
14.	**(a)**	**(i)**	 **or** **1**		
			or correct shortened structural formula		
		(ii)	test tube in beaker of water with the following labels:		
			warm water or water bath or boiling water	4 x ½	
			ethanol/alcohol/propanoic acid/alkanoic acid or reaction mixture or ester mixture		
			wet paper towel (condenser) or other condenser		
			(a few drops of) conc. sulphuric acid **2**		catalyst
		(iii)	ethanol: hydrogen of the water bonded to the oxygen of the hydroxyl group or oxygen of the water bonded to the hydrogen of the hydroxyl group	2x½	solid line to show bond between water molecule and ethanol or propanoic acid
			propanoic acid: hydrogen of the water bonded to either oxygen of the carboxyl group or oxygen of the water bonded to the hydrogen of the carboxyl group **1**		

Mark Scheme		Worth ½	Worth 0
14. **(b)** 	**1**	2 x ½	
15. **(a)** $2C(s) + 2H_2(g) + O_2(g) \rightarrow CH_3COOH$  $2CO_2 + 2H_2O$			
2 x ΔH combustion (C) = 2 x (-394)	½		
2 x ΔH combustion (H_2) = 2 x (- 286)	½		
-ΔH combustion (CH_3COOH) = 876	½		
ΔH formation = - 788 - 572 + 876 = - 484 kJ mol^{-1}	½		
(no units required; - ½ for incorrect units; accept kJ)			

Mark Scheme			Worth ½	Worth 0
15. **(b)**	Sodium ethanoate is the salt of a strong base and a weak acid	**1**	Ethanoic acid is a weak acid. ½	excess hydroxide ions (on its own)
	Ethanoic acid exists in an equilibrium: $CH_3COOH\ (aq) \rightleftharpoons CH_3COO^-\ (aq) + H^+\ (aq)$	½	Sodium hydroxide is a strong base. ½	Sodium is a strong base
	(or suitable words)			
	Water exists in an equilibrium $H_2O\ (l) \rightleftharpoons H^+\ (aq) + OH^-\ (aq)$ (or suitable words)	½		
	Some of the CH_3COO^- ions will combine with the H^+ to form CH_3COOH (as in reverse of top equilibrium).	½		
	This leads to excess hydroxide ions. or $[H^+] < [OH^-]$ or $[H^+] < 10^{-7}$ mol l^{-1})	½		

Mark Scheme				Worth ½	Worth 0
16.	**(a)**		$2\ KMnO_4 \rightarrow K_2O + 2\ MnO_2 + 3/2\ O_2$ Accept multiples	**1**	
	(b)	**(i)**	Flask should be swirled Read at eye level White tile under flask/beaker Paper on burette for easier reading Titrate slowly Add solution dropwise (at end) Take funnel out Keep washing flask down (any two)	**1**	2 x ½ Repeat filtration Ignore rough reading Take average Rinse with water Wash/clean apparatus
		(ii)	moles of MnO_4^- = $25 \times 10^{-3} \times 0.2 = 5 \times 10^{-3}$	**½**	
			therefore moles of Fe^{2+} = $5 \times 5 \times 10^{-3} = 2.5 \times 10^{-2}$	**1**	
			therefore concentration of $FeSO_4$ = $\frac{2.5 \times 10^{-2}}{16.7 \times 10^{-3}} = 1.5\ mol\ l^{-1}$	**½**	
			(no units required; - ½ for incorrect units)		

Mark Scheme				Worth ½	Worth 0
17.	**(a)**	5.5 – 4.5	**1**		range of 1 or average 5
	(b)	propyne or prop-l-yne or prop-2-yne	**1**	methyl ethyne $-CH_3$ and $-C\equiv CH$	
	(c)				
		3 lines around **1** on x axis, line(s) at **3** on y axis	½	3 lines around 1 on x axis ½	single line around 1 on x axis and 3 on y axis
		4 lines at **3.7** on x axis, line(s) at **2** on y axis (Lines need not all be at 'top' height.)	½	4 lines around 3.7 on y axis ½	single line around 3.7 on x axis and 2 on y axis

[END OF MARKING INSTRUCTIONS]