SCOTTISH QUALIFICATIONS AUTHORITY

2005 Chemistry

Advanced Higher

Finalised Marking Instructions

These Marking Instructions have been prepared by Examination Teams for use by SQA Appointed Markers when marking External Course Assessments.

Advanced 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, and the candidate's answer is 'It has a low melting point and is coloured grey' this would **not** be treated as a cancelling error.

4 Full marks should be awarded for the correct answer to a calculation on its own whether or not the various steps are shown **unless the question is structured or working is specifically asked for.**

5 A mark should be deducted in a calculation for each arithmetic slip **unless stated otherwise in the marking scheme.** No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

6 A mark should be deducted for incorrect or missing units **unless stated otherwise in the marking scheme**. Please note, for example, that KJ mol^{-1} is not acceptable for kJ mol^{-1} and a mark should be deducted.

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 No mark is given for the solution of an equation which is based on a wrong principle.

Example: Use the information in the table to calculate the standard entropy change for the reaction:

$$C_2H_2 + 2HCl \longrightarrow CH_2ClCH_2Cl$$

Compound	**S^o/J K^{-1} mol^{-1}**
C_2H_2	201
HCl	187
CH_2ClCH_2Cl	208

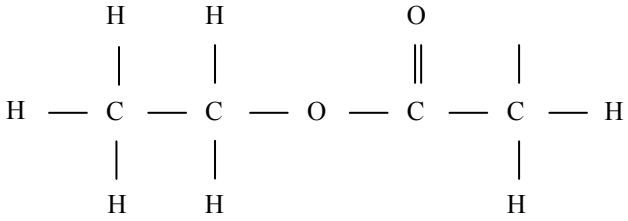
Using $\Delta S^o = S^o_{\text{reactions}} - S^o_{\text{products}}$ would gain zero marks.

9 No marks are given for the description of the wrong experiment.

10 Full marks should be given for correct information conveyed by a sketch or diagram in place of a written description or explanation.

11 In a structural formula, if one hydrogen atom is missing but the bond is shown, no marks are deducted.

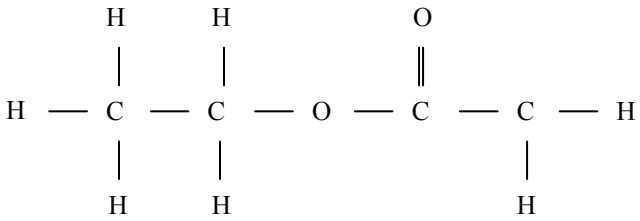
Examples:



Would not be penalised as the structural formula for ethyl ethanoate.

If the bond is also missing, then zero marks should be awarded.

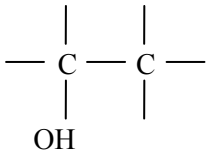
Example:



12 If a structural formula is asked for, CH_3– and CH_3CH_2– are acceptable as methyl and ethyl groups respectively.

13 With structures involving an –OH or an $–NH_2$ group, no mark should be awarded if the 'O' or 'N' are not bonded to a carbon, ie $OH–CH_2$ and $NH_2–CH_2$.

14 When drawing structural formulae, no mark should be awarded if the bond points to the 'wrong' atom, eg



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

16 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.

17 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.

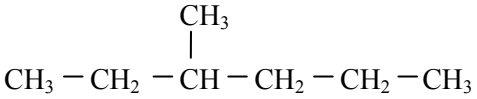
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

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.

18 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 not completely correct, the answer, '3, methyl-hexane' would gain the full mark ie wrong use of commas and dashes.

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?

Again, although not completely correct, an answer like 'the more Cl_2, the stronger the acid' should gain the full mark.

Example 3: Why does the (catalytic) converter have a honeycomb structure?

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

2005 Chemistry Advanced Higher

Marking scheme

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

Section B

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
1 (a) (i)	Superconductor A – conductivity increases. Must specify which.	1	Answer in terms of resistance (but not a cancelling error)	
(ii)	Semiconductor B – conductivity decreases 1 for both increase or both decrease	1		
(b)	n-type, N-type or just n	1	P-type and correct explanation for p-type	
	Must be singular: P has 1 more e^-/spare e^-/1 surplus e^-			
	P contains more <u>outer</u> electrons than Si	1		
	Phosphorus contains 5 <u>outer</u> electrons			
	Phosphorus contains an extra (outer) electron			
	P contains an extra electron in the conductance band			
	P-type and correct explanation for n-type			

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
2 (a)	Amphoteric	**1**		
(b)	Covalent network/lattice/macromolecule Polar covalent network/lattice/macromolecule	**1**	Covalent molecular One part only correct covalent crystals	
(c) (i)	Temperatures below 1750 K or other acceptable values which fit into this range	**1**		º K
(ii)	Change of state/increase in entropy Magnesium boils/changes into a gas/melts Any change of state in which entropy increases (but not (aq)) So s → l ✓ or l → g ✓	**1**	Change of chemical state g → l x l → s x	

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
3 (a)	Both ammonia and water are electron pair donors can form dative (covalent) bonds Their molecules have lone pairs of electrons/free electron pairs or non bonding pairs	**1**	free electrons 2 unpaired electrons	
(b)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ Correct orbital box notation indicating which orbitals are involved [Ne] $3s^2 3p^6 3d^6$ Ignore $4s^0$	**1**	$[Ar]3d^6$	
(c) (i)	$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ (or multiples) States not required Negative sign on electron not required	**1**	Equation reversed	
(ii)	$\Delta G^o = -nFE^o$ $\Delta G = -nFE$	**1**	J mol^{-1} Or correct answer in J mol^{-1}	
	= - 4 x 96500 x 0·58	**1**	ΔG = + nFE deduct 1 only	
	= -223·9 (kJ mol^{-1})	**1**		
	Answer given as +223·9 without working = 2/3 If n = 3, ΔG^o = -167·9 kJ mol^{-1} **(2/3)** n = 2, ΔG^o = -111·9 kJ mol^{-1} **(2/3)** n = 1, ΔG^o = -55·9 kJ mol^{-1} **(2/3)** If given as +ve values, then **(1/3)**			

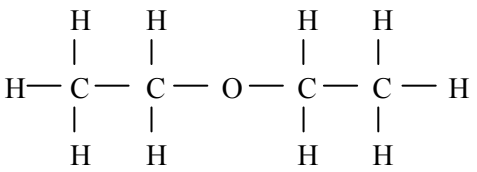
Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
4 (a)	$Ca^{+}(g) + e^{-} + 2H(g)$ (states must be present)	**1**		
(b)	-145·6 kJ or kJ mol^{-1} or -146 kJ	**1**	KJ mol^{-1} no units	
(c)	-2412·4 (kJ mol^{-1}) Units not required. Following on from -72·8 in (b) gives -2458·2 here **(1)** (allow follow through from wrong answer in (b)) but only if -72·8 in (b)	**1**	-3869 even if 1311 kJ given as answer to (b)	
(d)	Calcium hydroxide and hydrogen or $Ca(OH)_2$ and H_2 Correct formulae acceptable in place of names	**1**	CaO No names, wrong formulae	

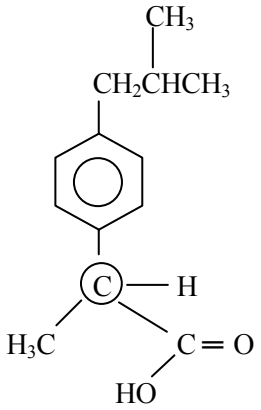
Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
5 (a) (i)	Hexachloroplatinate(IV) Hexachloroplatinumate(IV)	**1**	… ite (IV)	
(ii)	$K = \frac{[PtCl_6]^{2-}(organic)}{[PtCl_6]^{2-}(aq)}$	**1**	No brackets at all Need both states	
(iii)	No effect	**1**		
(b)	Tertiary	**1**		

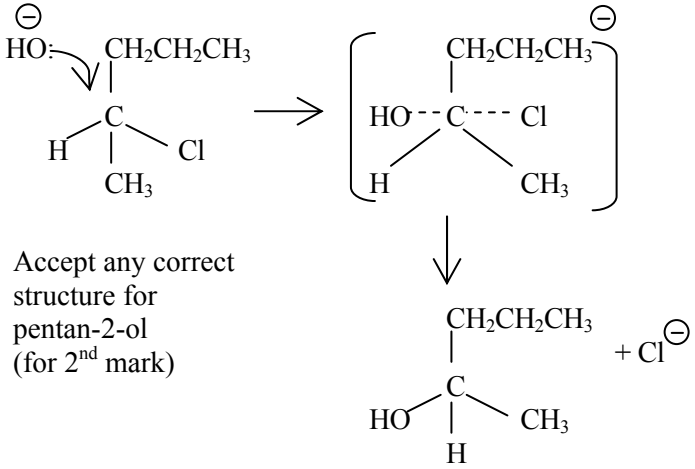
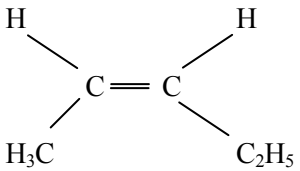
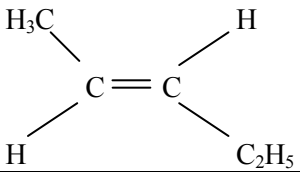
Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
6 (a) (i)	$n = V \times C = 0{\cdot}0152 \times 0{\cdot}05 = 7{\cdot}6 \times 10^{-4}$	**1**		
(ii)	$7{\cdot}6 \times 10^{-4} \times 2 \times 10 = 1{\cdot}52 \times 10^{-2}$ (allow follow through if answer to (i) has been multiplied by 20 correctly) $1{\cdot}5 \times 10^{-2}$	**1**		
Need to follow through from wrong answers to (i) and (ii) **(iii)** Answer to (iii) x 30 gives answer to (iv) **(iv)**	Moles of NaOH started with = V x C = 0·025 x 1 = 0·025 Moles of NaOH reacted with aspirin = 0·025 – 0·0152 = <u>0·0098</u> 0·01 (Allow follow through)	**1**		
	Moles of aspirin = 0·0098/2 = <u>0·0049</u> 0·05	**1**		
	Mass of aspirin = 0·0049 x 180 = <u>0·882g</u> 0·9			
	Average mass of aspirin in each tablet = $\frac{0{\cdot}882}{3}$ = 0·294g = 0·300g	**1**		
(b)	Aspirin is insoluble in water Aspirin is not very soluble in water Aspirin is more soluble in alkaline solution	**1**		
(c)	Check its melting point/mixed MP	**1**	Colorimetry/IR/nmr/spectroscopy/thin layer chromatography Boiling point but not a cancelling error	

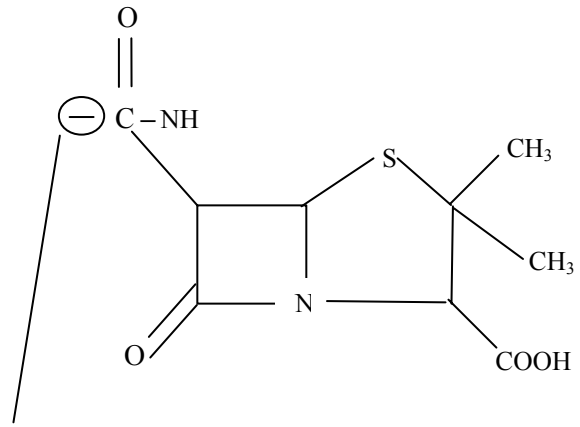
Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
7 (a)	+5/5/$\overline{\underline{V}}$	**1**	Fifth oxidation state	
(b) (i)	1st order wrt $[BrO_3^-]$ 1st order wrt $[Br^-]$ 2nd order wrt $[H^+]$ (all 3 required) Must give order	**1**		
(ii)	Rate = k $[BrO_3^-]$ $[Br^-]$ $[H^+]^2$ k must be lower case allow follow through from (i)	**1**	Rate α 4th order K instead of k	
(iii)	$k = \frac{\text{Rate}}{[BrO_3^-][Br^-][H^+]^2}$ but must follow on from answer to (ii)			
	= 8	**1**		
	Units = $l^3mol^{-3}\ s^{-1}$	**1**		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
8 (a)	ClO^- or $ClO^-(aq)$ hypochlorite	**1**	Chlorine oxide CLO^- C&O	
(b)	$K_a = \frac{[H_3O^+][ClO^-]}{[HClO]}$ H+ instead of H_3O	**1**	$[H_2O]$ in equation no brackets or curved brackets	
(c)	$[H^+] = 3{\cdot}98 \times 10^{-6}$ (from $pH = -\log_{10}[H^+]$) $\frac{[ClO^-]}{[HClO]} = K_a/[H^+] = 3{\cdot}98\times10^{-8}/3{\cdot}98\times10^{-6}$ $= 0{\cdot}01$ (or 1/100) Can also work out from $pH = pK_a + \log \frac{[salt]}{[acid]}$ in which case calculating $pK_a = 7{\cdot}4$ is worth 1 mark	**1** **1**		

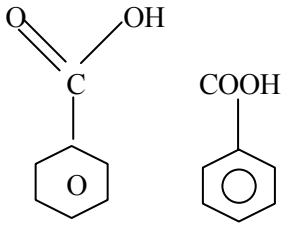
Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
9 (a) (i)	Sodium or any other Group I metal Accept Ba	1		
(ii)	Acidified dichromate/permanganate (Hot) copper oxide/copper (II) oxide any other suitable oxidising agent	1	Tollens', Benedict's, Fehlings' reagents Copper (I) oxide	
(b)	$CH_3CH_2OCH_2CH_3$ or  If full SF drawn then all bonds should be drawn correctly. Allow as a slip 1 H missing as long as bond is given	1	C_2H_5 instead of CH_3CH_2	
(c)	Bonds Broken(ΔH +ve) Bonds made (ΔH -ve) 1 x C = C (+602) 2 x C – Cl (-652) 1 x Cl – Cl (+243) 1 x C – C (-346) Δ H = 602 + 243 – 652 – 346 = <u>-153 kJ mol^{-1}</u> or kJ First mark for values in brackets (ignore signs)	1 1		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
10 (a)	(Electrophilic) Substitution	**1**	Nucleophilic Substitution	
(b)	Dilute acid H^+/H_2O	**1**	H_2O on its own Concentrated acid Acid hydrolysis	
(c)	 Immediate environment around the chiral C atom must be correct	**1**		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
11 (a)	1 mark for intermediate 1 mark for final product Solid lines ok but must have charge on central C or outside the brackets.  Accept any correct structure for pentan-2-ol (for 2nd mark)	**2**	Charge on OH in intermediate OH – C	
(b)	cis pent-2-ene  trans pent-2-ene  	**1** **1**		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
12 (a)	Parts underlined (or equivalent) must be given <u>Antagonists</u> because they <u>inhibit</u> <u>bacterial</u> wall synthesis	**1**	General definition of an antagonist	
(b)	 Can be omitted or joined to another C	**1**	Any errors in the structure	

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
13 (a)	C=O or carbonyl	**1**	Carboxyl Or COOH	
(b)	Element C H O Mass 68·9 4·9 26·2 RAM 12 1 16 N° moles 5·742 4·9 1·638 Mole ratio 3·5 2·99 1 Simplest ratio 7 6 2 Empirical formula = $C_7H_6O_2$ Can work out % composition to show empirical formula eg or can be done as %C = $\frac{84}{122}$ x 100 = 68·9% 68·9% of 122 = 84 $\Rightarrow C_7$ %H = $\frac{6}{122}$ x 100 = 4·9% 4·9% of 122 = 6 $\Rightarrow H_6$ %O = $\frac{32}{122}$ x 100 = 26·2% 26·2% of 122 = 32 $\Rightarrow O_2$	**1**		
(c) (i)	$C_7H_6O_2$	**1**	C_6H_5COOH	
(ii)	$C_6H_5^+$ phenyl	**1**	-ve charge	

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
(d)		**1**		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
13 (e)	$E = Lhc\bar{\nu}$ $= \frac{(6{\cdot}02 \times 10^{23})(6{\cdot}63 \times 10^{-34})(3 \times 10^{8})(1{\cdot}685 \times 10^{5})}{10^{3}}$ $= \underline{20{\cdot}176 \text{ kJ mol}^{-1}}$ $(20{\cdot}2 \text{ kJ mol}^{-1})$ units not required or 20·355 if calculate frequency first If use $E = \frac{Lhc}{\lambda}$ (1) but use 1685 as wavelength then answer will be $7{\cdot}106 \times 10^{-8}$ kJ mol^{-1} (1) only If don't change cm^{-1} to m^{-1}, E = 0·202 kJ mol^{-1} (2/3) or change cm^{-1} to m^{-1} wrongly, E = 0·00202 kJ mol^{-1} (2/3) If don't change J to kJ, E = 20176 kJ mol^{-1} or 20176 J mol^{-1} (2/3 for either) If don't change cm^{-1} to m^{-1} and J to kJ, E = 201·76 kJ mol^{-1} (1/3) If L omitted, then 1 mark for $3{\cdot}35 \times 10^{-23}$ but zero for $3{\cdot}35 \times 10^{-20}$ kJ mol^{-1}	**1** **1** **1**		

[END OF MARKING INSTRUCTIONS]