

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 '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, 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.**

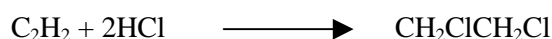
- 5 A mark should be deducted in a calculation for each arithmetic slip **unless stated otherwise in the marking scheme.** No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

- 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:

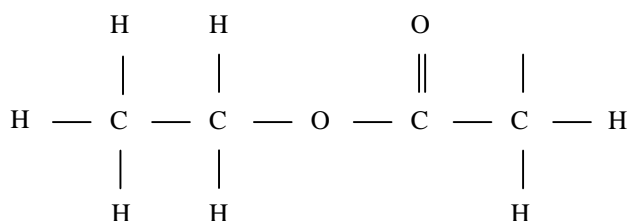


Compound	$S^\circ/\text{J K}^{-1} \text{mol}^{-1}$
C_2H_2	201
HCl	187
$\text{CH}_2\text{ClCH}_2\text{Cl}$	208

Using $\Delta S^\circ = \sum S^\circ_{\text{reactions}} - \sum S^\circ_{\text{products}}$ 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.

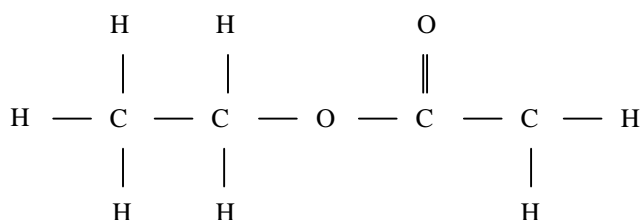
Examples:



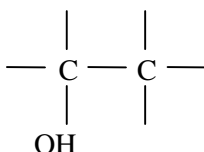
Would not be penalised as the structural formula for ethyl ethanoate.

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

Example:

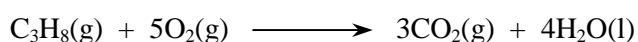


- 12 If a structural formula is asked for, CH_3- and CH_3CH_2- are acceptable as methyl and ethyl groups respectively.
- 13 With structures involving an $-\text{OH}$ or an $-\text{NH}_2$ group, no mark should be awarded if the 'O' or 'N' are not bonded to a carbon, i.e. $\text{OH}-\text{CH}_2$ and NH_2-CH_2 .
- 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 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.
- 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.

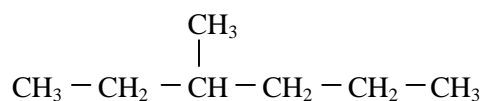


Name the kind of enthalpy change which the student measured.

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 ₃ COOH	1.65
CH ₂ ClCOOH	1.27
CHCl ₂ COOH	0.90
CCl ₃ COOH	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 Cl₂, 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.

2003 Chemistry Advanced Higher

Marking scheme

Section A

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

2003 Chemistry Advanced Higher

Section B

✓ = acceptable for 1 mark

✗ = not acceptable (zero marks)

Question 1

- (a) One atom of the bond provides both of the electrons for the bonding pair ✓

Lone pair from N forms the bond ✓

Bonding electrons from one/same atom ✓

Bonding electrons from one/same substance ✗

Bonding electrons from one/same molecule ✗

Both unpaired electrons from same atom ✗

} Must be "atom"

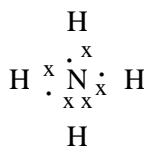
A bond in which all the electrons come from one/the same atom ✓

When a lone pair is "donated" ✗

When a lone pair is "shared" ✓

1

- (b)



All dots or all crosses ✓

+ ve charge present ✓

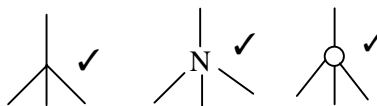
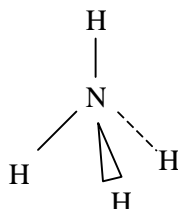
- ve charge present ✗

· x for every bond ✗

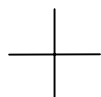
dative bond using arrow only ✗

1

- (c)



OK with charge, but not – ve (unless already penalised in (b))



unacceptable even if "tetrahedral" stated

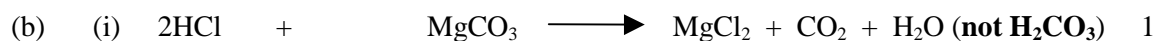
1

(3)

Question 2

(a)

moles of NaOH	= conc x vol		
	= 0.11 x 0.0081		
	= 0.000891	← or	1 mark for
	= 0.0009		
Therefore moles of acid left	= 0.000891 (0.0009)	← or	2
moles of acid at start	= 0.16 x 0.04		
	= 0.0064		
moles of acid reacted	= 0.0064 – 0.000891	1 mark	
	= 0.005509 (0.0055)		



(ii)

2 mole	1 mole	1 mark
0.005509 (0.0055)	0.0027545 (0.00275)	
g.f.m. MgCO_3	= 84.3	

Mass of MgCO_3	= 0.0027545 x 84.3	= 0.2322 (0.232) (0.23)
	(0.00275 x 84.3)	= 0.231825 (0.232) (0.23)

Percentage = $\frac{0.2322 (0.232)}{0.25}$ = 92.88% (92.8%) 1

(Using 0.23 gives 92.0%)

Accept 91.6 – 93.0 ✓✓ for 2 marks

Allow follow through – but should be clear

If calculated using 1:1 mol ratio, get ~185% = 0 marks

If more than 100% = 0 marks

Can do calculation correctly using other methods.

(5)

Question 3

(a) SiO_2 only 1

(b) (i) An amphoteric substance is one which can react as a base or an acid ✓

Reacts with acids and bases ✓

Reacts with acids/alkalis ✓

Can be both an acid and an alkali ✗

Acts as an acid and/or base ✓

Proton donor and acceptor ✓

Acidic/basic properties ✓

H^+ donor and acceptor ✓

H donor and acceptor ✗

1

(ii) Al_2O_3 1

(c)

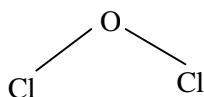
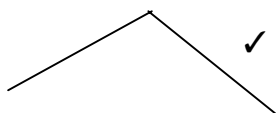


Diagram showing obviously bent molecule

Bond angle approx $100 - 150^\circ$

Must be more than a right angle

No need to show electrons



1

(4)

Question 4

- (a) Co-ordination number 6 1
- (b) The hydrogen peroxide acts as an oxidising agent/oxidises Fe^{2+} to Fe^{3+} / changes Fe^{2+} to Fe^{3+} 1
- (c) One (mole of $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ is formed) 1
- (d) GFM of $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O} = 392.0 \text{ g}$
GFM of $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3] \cdot 3\text{H}_2\text{O} = 491.1$ (1 mark for both GFMs) } Deduct 1 if either or both are wrong

$$\text{Theoretical yield} = 5.0 \times \frac{491.1}{392.0} = 6.3 \text{ g (1 mark)}$$

$$\% \text{ yield} = \frac{1.2}{6.3} \times 100 = 19\% \text{ (1 mark)}$$

18.75 – 19.2 ✓

Allow follow on from incorrect answer for (c) and from wrong GFM(s) 3

(6)

Question 5

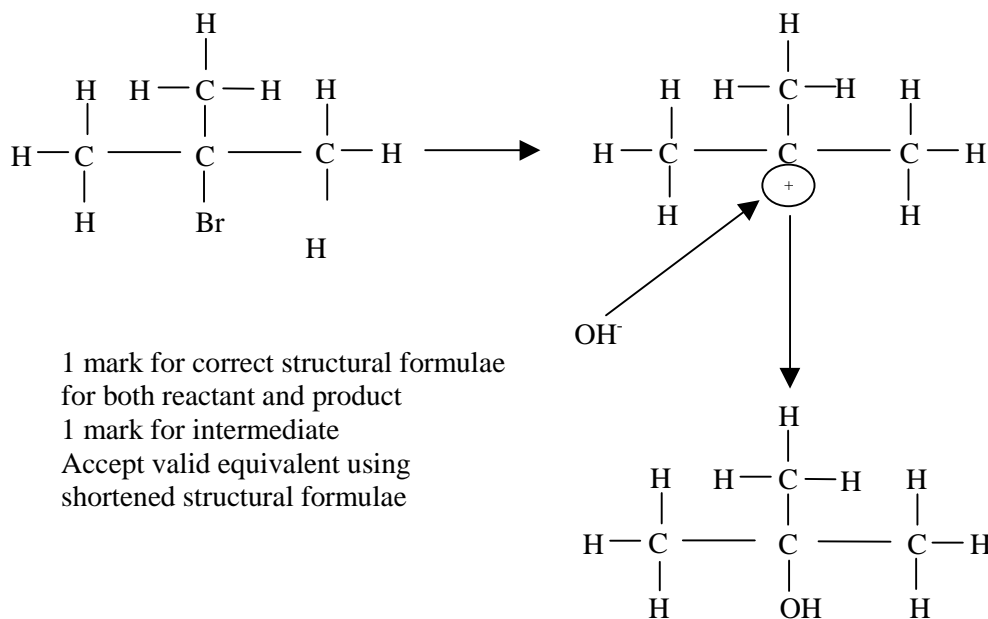
- (a) (i) LiAlH_4 1
Name ✓ LiAlH ✗ NaBH_4 ✓
- (ii) HBr or hydrogen bromide ✓ 1
hydrobromic acid ✗
 H^+Br^- ✗
 HBr (aq) ✗
- (b) (i) Dehydration or Elimination 1
Condensation ✗
- (ii) Oxidation or dehydration ✓ 1
- (c) 1- bromobutane 1
↑
(Must be given)
- (d) Benedict's solution OR Fehling's solution OR Tollen's reagent 1
(spelling should be correct)
OR
acidified dichromate OR acidified permanganate OR (hot) copper
oxide
 Ag NO_3 ✗
- (e) (i) Only one of the atoms on the double bond is different so only one
arrangement of atoms. ✓
One of the C atoms has 2Hs ✓
Both atoms on one side of the double bond are the same ✓
One type of atom joined to C ✗
Double bond at end of chain ✗
Only got H's ✗
(only) 3 Hs bonded to $\text{C}=\text{C}$ ✓ 1
- (ii) (D) and (E)
1 mark for each correct answer
-1 mark for each extra wrong answer to a maximum of -2 2

(9)

Question 6

- (a) (i) Nucleophilic substitution (both needed) ✓ 1
 One molecule/species/entity/particle involved in rate-determining step ✓
 One substance/reactant/atom/reagent involved in rate-determining step ✗
 1st order ✓ 1

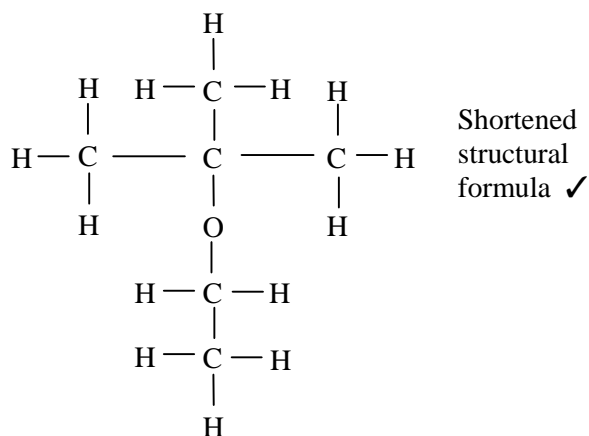
(ii)



2

- (b) Carbocation/ion/intermediate formed is not stable (enough to exist) 1
 S_N1 for tertiary ✗
 S_N2 for primary ✗
 2 molecules in r.d.s ✗
 Attack by OH^- not hindered ✗

(c)

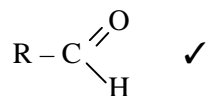


1

(6)

Question 7

- (a) Carbonyl (✓) group or C = O (✓)
RCHO ✓



Aldehyde ✓

Ketone ✗

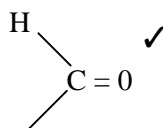
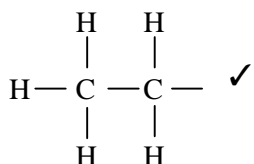
Carboxylic acid ✗

Aromatic ester ✗

Cancelling errors rule applies

1

- (b) C_2H_5^+ or CHO^+ + charge may be omitted
but zero marks for -ve charge

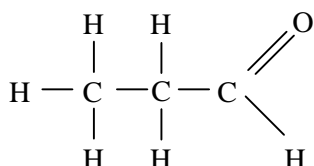


1

- (c) X : Y : Z = 3 : 2 : 1 (1: 2: 3: = 0 marks)

1

- (d)



or $\text{CH}_3\text{CH}_2\text{CHO}$

2

Accept $\text{CH}_3\text{CH}_2\text{COOH}$ for **1 mark** only
(Using some of the information but not all of it)

Propanone = 0

Ethanoic acid = 0

Pentanal = 0

- (e) Brady's reagent forms a solid/derivative/crystal
Take the melting point

1

1

(7)

Question 8

- (a) An agonist produces a response like the body's (natural active compound)
An antagonist prevents the action of the body's (natural active compound)
or
An agonist promotes natural/chemical reaction
An antagonist prevents natural/chemical reaction
or
An agonist stimulates receptors
An antagonist blocks receptors
or
An agonist mimics natural active compound
An antagonist blocks natural active compound

Definition of both agonist and antagonist must be correct for 1 mark 1

- (b) The pharmacophore is the structural fragment/part of molecule which:
makes it of use as a drug.
or has the right/desired effect (on the body)
or fits/binds to receptor/active site
or is pharmacologically active
or is common to all drugs of that type 1

A receptor is:

- the molecule/area where functional groups are correctly positioned for a pharmacophore to bind to it
- or area where pharmacophore binds (but this depends on answer given to pharmacophore)
- or active site within protein molecule
- or active site within enzyme molecule
- or site where reaction take place
- or (part of) protein molecule that interacts with biologically active molecule
- or part of cell where chemicals bind to stimulate a (chemical) reaction
- or enzyme which catalyses a chemical reaction 1

Fully labelled diagrams = 2/2 but must fit in with acceptable answers given above.

(3)

Question 9

(a) Rate = $k[\text{H}_2\text{O}_2] [\text{I}^-]$ 1
 Rate = $k [\text{H}_2\text{O}_2] [\text{I}^-] [\text{H}^+]^0$ ✓

0 marks if capital K is used

Rate $\propto k [\text{H}_2\text{O}_2][\text{I}^-]$ 0 marks

But can get 3/3 for (b)

(b) k = $\frac{\text{Rate}}{[\text{H}_2\text{O}_2] \times [\text{I}^-]}$ $\left. \begin{array}{l} \\ \\ \end{array} \right\} \begin{array}{l} \\ 1 \text{ mark} \\ \end{array}$ $\left. \begin{array}{l} \\ \\ \end{array} \right\} 3$

 = $\frac{2.07 \times 10^{-3}}{0.3 \times 0.3}$

 = $2.3 \times 10^{-2} \text{ mol}^{-1} \text{ l s}^{-1}$ 1 for correct units

Following on correctly from wrong answers in (a) ✓

(4)

Question 10

- (a) $\Delta S = (213.8 + 2 \times 69.9) - (127.0 + 1.5 \times 205.2) = -81.2 \text{ J K}^{-1} \text{ mol}^{-1}$ (units not required) 1
- Only acceptable answer for (a)

- (b) $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$] 1 mark for this if nothing else given }
- $\Delta G^\circ = -727000 - 298 \times (-81.2)$ (1 mark for formula with correct substitutions) 1

- $\Delta G^\circ = (-702884 \text{ J mol}^{-1})$ or $-702.9 \text{ kJ mol}^{-1}$ (1 mark, units not required) 2
- Accept -702.8 or -703
- Only 1 for this as wrong units

Allow correct follow on from wrong answer in (a).

- (c) $\frac{3}{2}\text{O}_2(\text{g}) + 6\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 3\text{H}_2\text{O}(\text{l})$ }
- OR
- $\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{O}(\text{l})$ }
- OR
- $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$ }
- States not needed
- 1

- (d) H^+ ions ✓
- H^+ ✓
- Hydrogen ✓
- H_2 ✗
- H ✗ 1
- (5)

Question 11

(a) pH = $\frac{1}{2} \text{pK}_a - \frac{1}{2} \log c$ (1 mark) ↙ If equation wrong then zero marks as wrong principle
 = $\frac{1}{2} \times 4.9 - \frac{1}{2} \times (-0.699)$
 = $2.45 + 0.3495$
 = 2.7995
 = 2.8 (1 mark)

OR

$$\left. \begin{array}{lcl} \text{K}_a & = & \frac{[\text{H}^+][\text{Oct}^-]}{[\text{HOct}]} \\ \text{K}_a[\text{HOct}] & = & [\text{H}^+]^2 \\ [\text{H}^+] & = & \sqrt{\text{K}_a \times c} \\ & = & \sqrt{1.27 \times 10^{-5} \times 0.2} \\ & = & 0.001593737 \text{ (0.0016)} \end{array} \right\} \text{ 1 mark}$$

pH = $-\log [\text{H}^+]$
 = $-\log 0.001593737 \text{ (0.0016)}$
 = $2.797583 \text{ (2.79588)}$
 = 2.8 (1 mark)

Accept 2.79

2.7 for 1 only as arithmetic error

2

- (b) A buffer solution is formed or a weak acid and salt of weak acid produced (1 mark)
 There is a large reservoir of Oct^- ions to mop up the added H^+ ions (1 mark)
 Or
 An explanation in terms of correct equations but must be clear that H^+ ions react with Oct^- ions from the salt produced to get the 2nd mark. (no need to mention buffer)
 Or
 H^+ ions react with Oct^- ions/conjugate base (1 mark)
 from the salt (1 mark) (No need to mention 'buffer')

2

(4)

Question 12

(a) $[H^+] = 10^{-pH} = 10^{-7}$ (1 mark)

$$K_{In} = \frac{[H^+][In^-]}{[HIn]} \quad (1 \text{ mark})$$

$$K_{In} = \frac{10^{-7} \times (3.9 \times 10^{-4})}{1.3 \times 10^{-5}} = 3 \times 10^{-6} \text{ or } 0.000003 \quad (1 \text{ mark})$$

If $[H^+]$ taken as $3.9 \times 10^{-4} \text{ mol l}^{-1}$
 $K_{In} = 0.0117 \text{ or } 1.17 \times 10^{-2}$ (then 2 marks out of 3)

If $K_{In} = \frac{[In^-]}{[HIn]}$ (then 0 marks out of 3 (wrong principle))

OR

$$pH = pK_{In} + \log \frac{[In^-]}{[HIn]} \quad (1 \text{ mark}) \text{ or } pH = pK_{In} - \log \frac{[HIn]}{[In^-]} \quad (1 \text{ mark})$$

$$7 = pK_{In} + \log \frac{3.9 \times 10^{-4}}{1.3 \times 10^{-5}}$$

$$pK_{In} = 7 - \log 30 = 7 - 1.477$$

$$= 5.523 \quad (1 \text{ mark})$$

$$K_{In} = 2.99 \times 10^{-6} \quad (1 \text{ mark})$$

3

Ignore any units given in the final answer.

(b) Yellow

1

(4)

[END OF MARKING INSTRUCTIONS]