SCOTTISH QUALIFICATIONS AUTHORITY

2003 Chemistry

Advanced Higher

Finalised Marking Instructions

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:

$$C_2H_2 + 2HCl \longrightarrow CH_2ClCH_2Cl$$

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

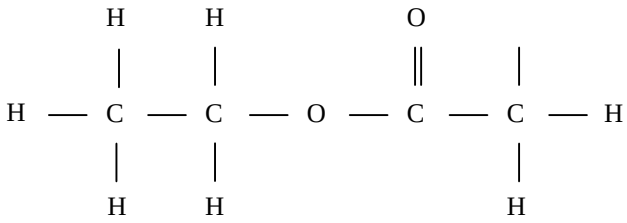
Using $\Delta S^o = \sum S^o_{\text{reactions}} - \sum S^o_{\text{products}}$ would gain zero marks.

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.

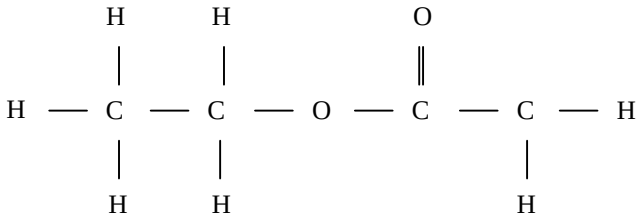
Examples:



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

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

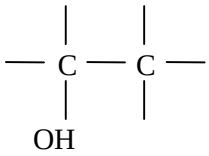
Example:



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, i.e. $OH–CH_2$ 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 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.

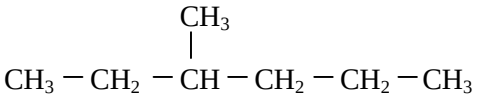
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

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.

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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

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Section B

✓ = acceptable for 1 mark

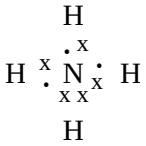
✗ = not acceptable (zero marks)

Question 1

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

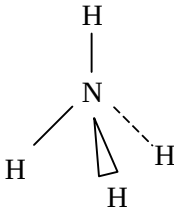
Lone pair from N forms the bond ✓
Bonding electrons from one/same atom ✓
Bonding electrons from one/same substance ✗
Bonding electrons from one/same molecule ✗
} Must be "atom"
Both unpaired electrons from same atom ✗
A bond in which all the electrons come from one/the same atom ✓
When a lone pair is "donated" ✗
When a lone pair is "shared" ✓ 1

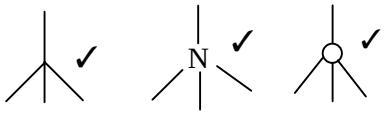
(b)



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
= 0.0009
1 mark for
or

Therefore moles of acid left = 0.000891 (0.0009)

or
moles of acid at start = 0.16 x 0.04
= 0.0064

moles of acid reacted = 0.0064 – 0.000891
= 0.005509 (0.0055)
1 mark

2

(b) (i) $2HCl + MgCO_3 \longrightarrow MgCl_2 + CO_2 + H_2O$ (**not H_2CO_3**) 1

(ii) 2 mole 1 mole

0.005509 (0.0055) 0.0027545 (0.00275) 1 mark

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) $A1_2O_3$ 1

(c)

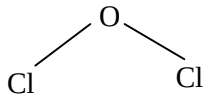
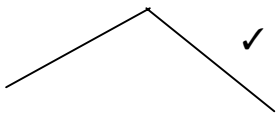


Diagram showing obviously bent molecule

Bond angle approx 100 - 150º

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 $K_3[Fe(C_2O_4)_3]$ is formed) 1

(d) GFM of $(NH_4)_2Fe(SO_4)_2.6H_2O$ = 392.0 g
GFM of $K_3[Fe(C_2O_4)_3].3H_2O$ = 491.1 (1 mark for both GFMs) } Deduct 1 if either or both are wrong

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

% yield = $\frac{1.2}{6.3} \times 100 = 19\%$ (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
Condensation ✗ 1

(ii) Oxidation or dehydration ✓ 1

(c) 1- bromobutane 1

(Must be given)

(d) Benedict's solution OR Fehling's solution OR Tollen's reagent (spelling should be correct)
OR 1
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 C=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

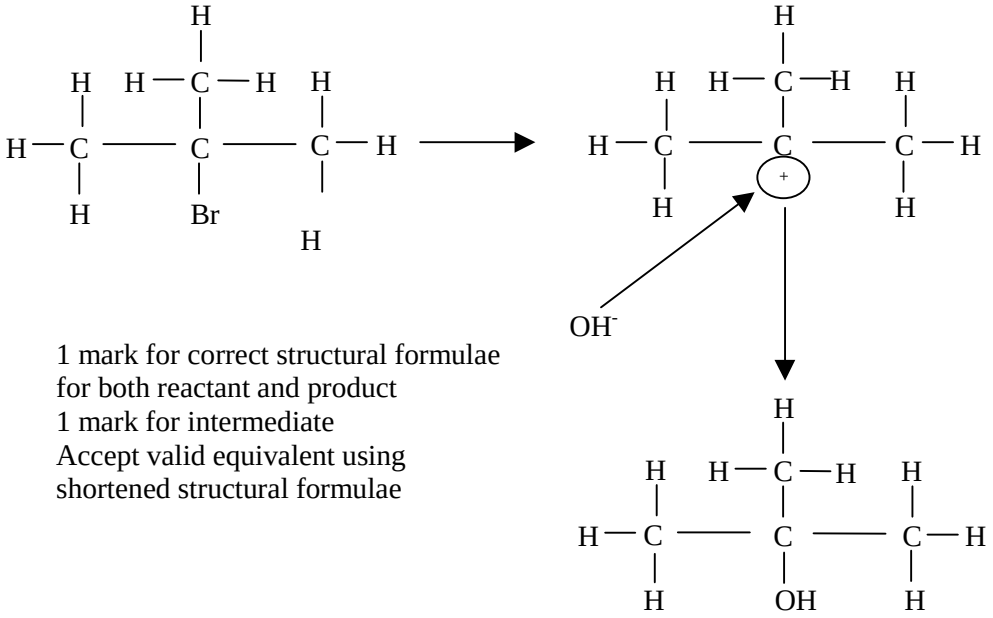
(a) (i) Nucleophilic substitution (both needed) ✓ 1

One molecule/species/entity/particle involved in rate-determining step ✓

One substance/reactant/atom/reagent involved in rate-determining step ✗

1st order ✓ 1

(ii)



1 mark for correct structural formulae for both reactant and product

1 mark for intermediate

Accept valid equivalent using shortened structural formulae

2

(b) Carbocation/ion/intermediate formed is not stable (enough to exist) 1

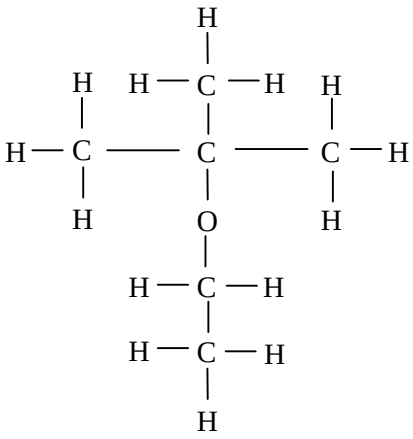
S_N1 for tertiary ✗

S_N2 for primary ✗

2 molecules in r.d.s ✗

Attack by OH^- not hindered ✗

(c)



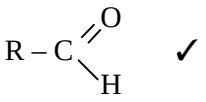
Shortened structural formula ✓

1

(6)

Question 7

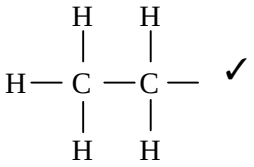
(a) Carbonyl (✓) group or C = 0 (✓)
RCHO ✓



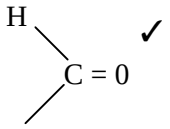
✓

Aldehyde ✓
Ketone ✗
Carboxylic acid ✗
Aromatic ester ✗ 1
Cancelling errors rule applies

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



✓

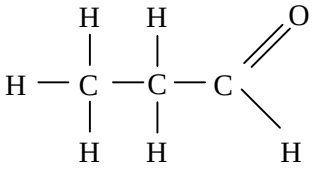


✓

1

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

(d)



or CH_3CH_2CHO

2

Accept CH_3CH_2COOH 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 1
Take the melting point 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 pharmacaphore 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 pharmacaphore to bind to it
or area where pharmacaphore binds (but this depends on answer given to pharmachaphore)
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 = $k[H_2O_2]\,[I^-]$ 1

Rate = $k\,[H_2O_2]\,[I^-]\,[H^+]^o$ ✓

0 marks if capital K is used

Rate α k $[H_2O_2][I]$ 0 marks
But can get 3/3 for (b)

(b) $k = \dfrac{\text{Rate}}{[H_2O_2]\,x\,[I^-]}$ } 1 mark

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

$= \underline{2.3 \times 10^{-2}}\ mol^{-1}\ l\ s^{-1}$ 1 for correct units } 3

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) $\Delta G^o = \Delta H^o - T\Delta S^o$]1 mark for this if nothing else given

$\Delta G^o = -727000 - 298 \times (-81.2)$ (1 mark for formula with correct substitutions) } 1

$\Delta G^o = (-702884 \text{ J mol}^{-1})$ or $\underline{-702.9 \text{ kJ mol}^{-1}}$ (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) $^3/_2O_2(g) + 6H^+(aq) + 6e^- \rightarrow 3H_2O(l)$

OR

$^1/_2O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O(l)$

OR

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

States not needed

1

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

(5)

Question 11

(a) pH = ½ pK_a – ½ log c (1 mark) — If equation wrong then zero marks as wrong principle

= ½ x 4.9 – ½ x (-0.699)

= 2.45 + 0.3495

= 2.7995

= 2.8 (1 mark)

OR

$K_a = \frac{[H^+][Oct^-]}{[HOct]}$

$K_a[HOct] = [H^+]^2$

$[H^+] = \sqrt{K_a \text{ x } c}$

$= \sqrt{1.27 \text{ x } 10^{-5} \text{ x } 0.2}$

= 0.001593737 (0.0016)

} 1 mark

pH = -log $[H^+]$

= -log 0.001593737 (0.0016)

= 2.797583 (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 (1mark) (No need to mention 'buffer')

2

(4)

Question 12

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

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

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

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

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

OR

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

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

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

$= 5.523$ (1 mark)

$K_{In} = 2.99 \text{ x } 10^{-6}$ (1 mark) 3

Ignore any units given in the final answer.

(b) Yellow 1

(4)

[END OF MARKING INSTRUCTIONS]