

MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers

9701 CHEMISTRY

9701/21

Paper 2 (AS Structured Questions), maximum raw mark 60

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	21

1 (a)

Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₂	Cl ₂ O ₇
alkaline	basic	amphoteric	acidic	acidic	acidic	acidic

Na₂O is alkaline – allow basic (1)

MgO is basic – allow alkaline (1)

Al₂O₃ is amphoteric (1)

SiO₂, P₄O₁₀, and SO₂ are **all** acidic (1) [4]

(b) any **two** from:
sodium, phosphorus, sulfur and chlorine
two names required (1) [1]

(c) (i) any **three** from:
floats
vigorous/violent reaction occurs
melts/forms a sphere
moves
disappears – allow dissolves
effervescence/gas produced (any 3)

(ii) Na + H₂O → NaOH + ½H₂
or
2Na + 2H₂O → 2NaOH + H₂ (1) [4]

(d) (i) combustion of fossil fuels – e.g. from car engines
from car exhausts **or**
during the extraction of metals from sulfide ores or
volcanic eruptions/burning sulfur from volcanoes or
burning biomass (1)

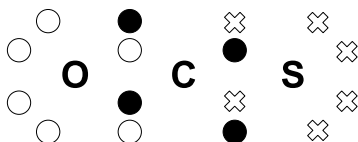
(ii) H₂SO₄
or
SO₃ allow H₂SO₃ **formula required** (1)

(iii) acid rain
or
its consequences e.g. damage to buildings,
damage to crops, plants, marine life
deforestation
or
SO₃ is toxic (1) [3]

(e) it is a reducing agent/antioxidant
or
it kills bacteria (1) [1]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	21

(f) (i)

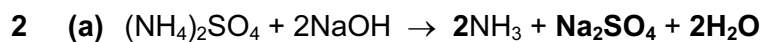


(1)

(ii) 180°

(1) [2]

[Total: 15]



correct products

(1)

correctly balanced equation

(1) [2]



(1)

(ii) $n(\text{HCl}) = \frac{31.2}{1000} \times 1.00 = 0.0312 = 0.03$

(1)

(iii) $n(\text{NaOH}) = \frac{50.0}{1000} \times 2.00 = 0.10$

(1)

(iv) $n(\text{NaOH}) \text{ used up} = 0.10 - 0.0312 = 0.0688 = 0.07$

(1)

(v) $n[(\text{NH}_4)_2\text{SO}_4] = \frac{0.0688}{2} = 0.0344 = 0.03$

(1)

(vi) $\text{mass of } (\text{NH}_4)_2\text{SO}_4 = 0.0344 \times 132 = 4.5408 = 4.54$

(1)

(vii) $\text{percentage purity} = \frac{4.5408 \times 100}{5.00} = 90.816 = 90.8$

(1) [7]

[Total: 9]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	21

- 3 (a) $\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$ (1)
the enthalpy change/energy change/heat change when
one mole of a compound/ CO_2 (1)
is formed from its elements in their standard states (1) [3]
- (b) (i)
$$\begin{array}{ccccccc} \Delta H_f^\circ/\text{kJ mol}^{-1} & \text{CO}_2\text{(g)} & + & 3\text{H}_2\text{(g)} & \rightleftharpoons & \text{CH}_3\text{OH(g)} & + & \text{H}_2\text{O(g)} \\ & -394 & & 0 & & -201 & & -242 \end{array}$$
- $\Delta H^\circ_{\text{reaction}} = -201 + (-242) - (-394)$ (1)
 -49 kJ mol^{-1} (1)
correct sign (1)
- (ii) removal of CO_2 from the atmosphere (1)
 CO_2 is a greenhouse gas/causes global warming (1) [5]
- (c) In this part, in each case, the 'effect' must be correctly stated
in order to gain the explanation mark.
- higher temperature**
yield is reduced/equilibrium goes to LHS (1)
because forward reaction is exothermic/reverse reaction is endothermic (1)
- higher pressure**
yield is increased **or** equilibrium goes to RHS (1)
fewer moles/molecules on RHS **or** more moles/molecules on LHS (1)
- use of catalyst**
yield does not change (1)
forward and backward rates speeded up by same amount (1) [6]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	21

- 4 (a) (i) $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$ (1)
- (ii) elimination **or** dehydration (1)
- (iii) phosphoric acid **or** concentrated sulfuric acid
sulfuric acid must be 'concentrated'
allow aluminium oxide (1) [3]

(b)

	with HBr	with MnO_4^-
colour at start	colourless	purple or pink
colour after reaction	colourless	colourless or decolourised
structural formula of product	$\text{CH}_3\text{CH}_2\text{Br}$	$\text{HOCH}_2\text{CH}_2\text{OH}$

with hydrogen bromide

from colourless **to** colourless **both** colours required

do not allow 'clear' instead of colourless (1)

$\text{CH}_3\text{CH}_2\text{Br}$ (1)

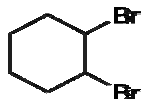
with potassium manganate(VII)

from purple/pink **to** colourless/decolourised **both** colours required (1)

$\text{HOCH}_2\text{CH}_2\text{OH}$ (1) [4]

- (c) (i) C_6H_{10} (1)

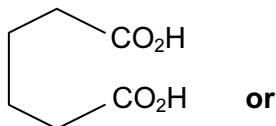
(ii)



accept answers which have $-\text{CH}_2-$ in the ring (1)

- (iii) electrophilic addition (1)
addition (1)

(iv)



$\text{HO}_2\text{C}(\text{CH}_2)_4\text{CO}_2\text{H}$ **or**

$\text{HO}_2\text{CCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ (1)

accept answers which have $-\text{CH}_2-$ in the ring [5]

[Total: 12]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	21

5 (a) carboxylic acid **or** $\text{--CO}_2\text{H}$ **or** --COOH (1) [1]

(b) (i) alcohol (1)

(ii) $n(\text{H}_2) = \frac{160}{24000} = 6.67 \times 10^{-3} \text{ mol}$ (1)

$n(\text{H atoms}) = 2 \times 6.67 \times 10^{-3} \text{ mol} = 1.33 \times 10^{-2} \text{ mol}$ (1)

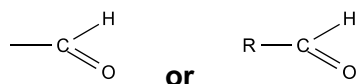
(iii) $n(\text{X}) = \frac{0.600}{90} = 6.67 \times 10^{-3} \text{ mol}$

$n(\text{X}) : n(\text{H atoms}) = 6.67 \times 10^{-3} : 1.33 \times 10^{-2}$
 $= 1 : 2$

since each --OH group produces one H atom
there are two --OH groups

(1) [4]

(c) (i)



(1)

(ii) $\text{HOCH}_2\text{CH}(\text{OH})\text{CHO}$ as the minimum
allow the *gem* diols $(\text{HO})_2\text{CHCH}_2\text{CHO}$ **or** $\text{CH}_3\text{C}(\text{OH})_2\text{CHO}$

(1)

(iii) $\text{HOCH}_2\text{CH}(\text{OH})\text{CO}_2\text{H}$ **or** $\text{HOCH}_2\text{CH}(\text{OH})\text{CO}_2^-$

(1) [3]

(d) (i) $\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$

(1)

(ii) $\text{HO}_2\text{CCOCO}_2\text{H}$

(1) [2]

[Total: 10]