

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

## **MARK SCHEME for the May/June 2013 series**

### **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 should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	

- 1 (a) (i)  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$  (1)
- $(\text{NH}_4)_2\text{SO}_4 + 2\text{NaOH} \rightarrow 2\text{NH}_3 + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$  (1)
- allow ionic equations in each case
- (ii)  $n(\text{NaOH}) = n(\text{HCl}) = \frac{39.2 \times 2.00}{1000} = 0.0784$  (1)
- (iii)  $n(\text{NaOH}) = n(\text{HCl}) = \frac{29.5 \times 2.00}{1000} = 0.059$  (1)
- (iv)  $n(\text{NaOH}) = 0.0784 - 0.059 = 0.0194$  (1)
- (v)  $n[(\text{NH}_4)_2\text{SO}_4] = \frac{0.0194}{2} = 9.7 \times 10^{-3}$  (1)
- (vi) mass of  $(\text{NH}_4)_2\text{SO}_4 = 9.7 \times 10^{-3} \times 132.1 = 1.2814 \text{ g}$  (1)
- (vii) % of  $(\text{NH}_4)_2\text{SO}_4 = \frac{1.2814 \times 100}{2.96} = 43.30405405 = 43.3$   
 give one mark for the correct expression (1)  
 give one mark for answer given as 43.3 – i.e. to 3 sig. fig. (1)  
 allow ecf where appropriate [9]
- (b) fertiliser in the river causes  
 excessive growth of aquatic plants/algae **or** algal bloom (1)  
 when plants and algae die  $\text{O}_2$  is used up **or** fish or aquatic life die (1) [2]
- (c) manufacture of  $\text{HNO}_3$  **or** explosives **or** nylon **or**  
 as a cleaning agent **or** as a refrigerant  
**not** detergent (1) [1]

[Total:12]

Page 3	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	

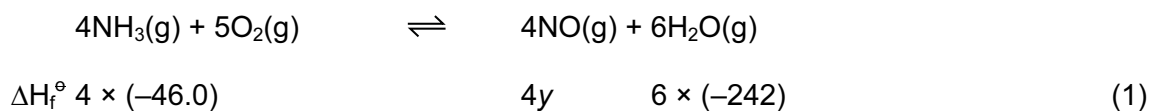
2 (a)  $K_p = \frac{p(\text{NO})^4 p(\text{H}_2\text{O})^6}{p(\text{NH}_3)^4 p(\text{O}_2)^5}$  (1)

atmospheres **or** Pa **or** kPa (1)  
 allow ecf on incorrect powers [2]

(b) (i) **increasing temperature**  
 yield of NO is decreased **or** reaction moves to LHS (1)  
 forward reaction is exothermic (1)

(ii) **decreasing the pressure**  
 yield of NO is increased **or** reaction moves to RHS (1)  
 more moles/molecules of gas on RHS **or**  
 fewer moles/molecules of gas on LHS (1) [4]

(c) let  $\Delta H_f^\ominus$  for NO be  $y \text{ kJ mol}^{-1}$



$$\Delta H_{\text{reaction}}^\ominus = 4y + [6 \times (-242)] - [4 \times (-46.0)]$$

$$= 4y - 1452 + 184$$
 (1)

$\Delta H_{\text{reaction}}^\ominus$  is  $-906 \text{ kJ mol}^{-1}$  so  
 $4y = -906 + 1452 - 184 = 362$  (1)

whence  $y = \Delta H_f^\ominus$  for NO =  $+90.5 \text{ kJ mol}^{-1}$   
 + sign is required (1) [4]

**[Total: 10]**

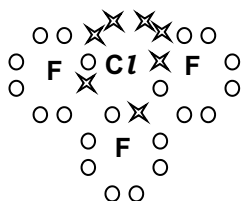
Page 4	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	021Based.com

3 (a) penalise (–1) for names of elements

- (i) Na or K or Li (1)
- (ii) S or C or N or P (1)
- (iii) K (1)
- (iv) C (1)
- (v) Cl (1)
- (vi) Al or Si (1) [6]

- (b) (i)  $Al_2O_3$  or  $SiO_2$  (1)
- (ii)  $Na_2O$  (1)
- (iii)  $P_2O_3$  or  $P_4O_6$  and  $P_2O_5$  or  $P_4O_{10}$  or  $SO_2$  and  $SO_3$  (1+1)
- (iv)  $Al_2O_3$  (1) [5]

(c) (i)



- 3 bonding pairs and  
2 lone pairs around Cl atom (1)  
3 lone pairs on each of the F atoms (1)

(ii) either

referring to van der Waals' forces in  $BrF_3$

- van der Waals' or  
intermolecular forces are greater/stronger (1)  
because there are more electrons in  $BrF_3$  than in  $ClF_3$  (1)

OR referring to permanent dipoles

- permanent dipole or intermolecular forces are stronger/greater in  $BrF_3$  (1)  
because  $BrF_3$  has a larger permanent dipole than  $ClF_3$

- OR because difference in electronegativity is larger between Br and F than  
between Cl and F (1)

part (ii) has a maximum of 2 marks (max 2) [4]

[Total: 15]

Page 5	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	

4 Types of reaction used must come from the list in the question.

organic reaction	type of reaction	reagent(s)
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \rightarrow$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	nucleophilic (1) substitution (1)	$\text{NH}_3$ (1)
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \rightarrow$ $\text{BrCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$	free radical (1) substitution (1)	$\text{Br}_2$ <b>or</b> $\text{Br}_2$ in an organic solvent (1) <b>not</b> $\text{Br}_2(\text{aq})$
$\text{CH}_3\text{COCH}_3 \rightarrow$ $\text{CH}_3\text{C}(\text{OH})(\text{CN})\text{CH}_3$	nucleophilic (1) addition (1)	$\text{HCN}$ <b>or</b> $\text{HCN}$ and $\text{CN}^-$ <b>or</b> $\text{NaCN/KCN} + \text{H}^+$ (1)
$\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$ $\rightarrow \text{CH}_3\text{CH}=\text{CHCH}_3$	elimination (1) <b>not</b> dehydration	conc. $\text{H}_2\text{SO}_4$ <b>or</b> $\text{P}_4\text{O}_{10}$ <b>or</b> $\text{Al}_2\text{O}_3$ <b>or</b> $\text{H}_3\text{PO}_4$ (1)

[Total: 11]

Page 6	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	

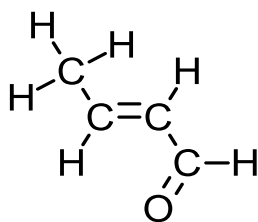
5 (a)

reaction	reagent	product
A	Br <sub>2</sub> in an inert organic solvent	CH <sub>3</sub> CHBrCHBrCHO
B	PCl <sub>3</sub>	NO REACTION
C	H <sub>2</sub> and Ni catalyst	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> OH
D	NaBH <sub>4</sub>	CH <sub>3</sub> CH=CHCH <sub>2</sub> OH
E	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> /H <sup>+</sup>	CH <sub>3</sub> CH=CHCO <sub>2</sub> H

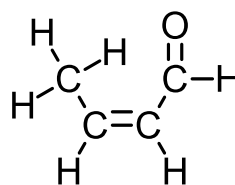
one mark for each correct answer

[5]

(b)



*trans* or E



*cis* or Z

**two** correct structures

(1)

**both** correctly labelled

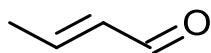
(1)

correctly displayed -CHO group

(1) [3]

Page 7	Mark Scheme	Syllabus	Paper 1
	GCE AS/A LEVEL – May/June 2013	9701	

(c)



(1) [1]

(d) (i)  $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{H}$

(1)

(ii)  $\text{CH}_3\text{CO}_2\text{H}$   
 $\text{HO}_2\text{CCO}_2\text{H}$

(1)

(1) [3]

allow ecf on candidate's answer to E in (a)

[Total: 12]