

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

**MARK SCHEME for the October/November 2010 question paper  
for the guidance of teachers**

**9701 CHEMISTRY**

**9701/23**

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.

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- 1 (a) atoms of the same element / with same proton (atomic) number / same number of protons (1)  
different numbers of neutrons / nucleon number / mass number (1) [2]

(b)

isotope	no. of protons	no. of neutrons	no. of electrons
$^{24}\text{Mg}$	12	12	12
$^{26}\text{Mg}$	12	14	12

each correct row (1) [2]

(c)  $A_r = \frac{24 \times 78.60 + 25 \times 10.11 + 26 \times 11.29}{100}$  (1)

$$= \frac{1886.40 + 252.75 + 293.54}{100}$$

gives 24.33 to 4 sig fig (same as data in question)

do not credit wrong number of sig figs **or** incorrect rounding up/down (1) [2]



(e) (i)  $n(\text{Sb}) = \frac{2.45}{122} = 0.020$  (1)

(ii) mass of Cl in **A** =  $4.57 - 2.45 = 2.12$  g (1)

$$n(\text{Cl}) = \frac{4.57 - 2.45}{35.5} = \frac{2.12}{35.5} = 0.06$$

allow ecf as appropriate (1)

(iii)  $\text{Sb} : \text{Cl} = 0.02 : 0.06 = 1:3$   
empirical formula of **A** is  $\text{SbCl}_3$  (1)



(f) (i) ionic (1)

(ii) covalent (1)  
**not** van der Waals' forces [2]

[Total: 14]

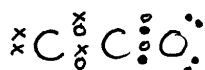
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- 2 (a) 1  $S + O_2 \rightarrow SO_2$  (1)
- 2  $2SO_2 + O_2 \rightleftharpoons 2SO_3$  equation (1)  
equilibrium sign (1)
- 3  $SO_3 + H_2O \rightarrow H_2SO_4$  or  
 $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$  (1) [4]
- (b) condition 1 400 – 600 °C (650 – 900K) (1)  
condition 2 1–10 atm/just above atmospheric pressure  
allow equivalent pressure units (1)  
condition 3 vanadium pentoxide/vanadium(V) oxide/ $V_2O_5$  (1) [3]
- (c) fertilisers/phosphates/ammonium sulfate or  
lead/acid batteries or paints/pigments or dyestuffs or  
steel pickling or metal treatment or detergents or explosives (1) [1]
- (d) (i)  $2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$  (1)
- (ii)  $H_2S$  –2  $SO_2$  +4 S 0 all three (1)  
 $SO_2$  because the oxidation number of S is reduced (1) [3]
- (e) (i)  $2NO + O_2 \rightarrow 2NO_2$  (1)  
 $SO_2 + NO_2 \rightarrow SO_3 + NO$  (1)  
 $SO_3 + H_2O \rightarrow H_2SO_4$   
final product must be  $H_2SO_4$  (1)
- (ii) corrosion of buildings or  
dissolving of  $Al^{3+}$  ions from soil or  
pollution of rivers/killing aquatic life or  
making soil acidic/killing trees/corrosion of metals (1) [4]
- (f) it is a reducing agent/inhibits oxidation (1) [1]

[Total: 16]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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- 3 (a) (i) order of atoms **must** be C-C-O



(1)

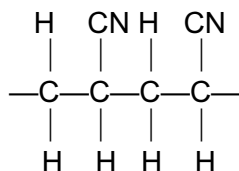
linear (1)

- (ii) a molecule or atom with an unpaired electron **or**  
a species formed by the homolytic fission of a covalent bond (1)

- (iii) molecule has 2 bond pairs and one lone pair (1)  
and one unpaired electron (1)  
these may be shown in a diagram

[5]

- (b) (i)



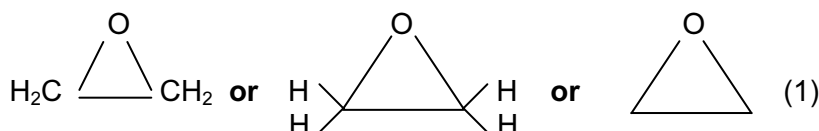
allow the structural formula  $-\text{CH}_2\text{CH}(\text{CN})\text{CH}_2\text{CH}(\text{CN})-$  (1)

- (ii) addition (1)

[2]

- (c) (i)  $\text{CH}_3\text{CHO}$  (1)

- (ii)



[2]

- (d)

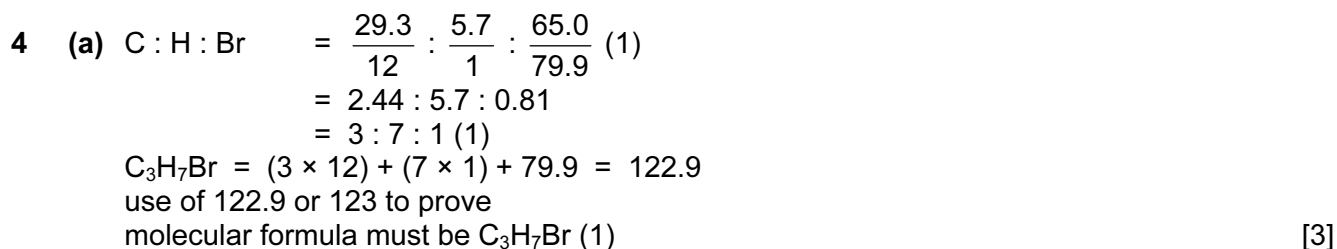
reagent	product
$\text{Br}_2$ in an inert solvent	$\text{BrCH}_2\text{CHBrCHO}$
$\text{NaCN} + \text{dil. H}_2\text{SO}_4$	$\text{CH}_2=\text{CHCH}(\text{OH})\text{CN}$ allow $\text{CH}_2=\text{CHCH}(\text{OH})\text{CO}_2\text{H}$
Tollens' reagent	$\text{CH}_2=\text{CHCO}_2\text{H}$ <b>or</b> $\text{CH}_2=\text{CHCO}_2^-$
$\text{NaBH}_4$	$\text{CH}_2=\text{CHCH}_2\text{OH}$

(4 × 1)

[4]

[Total: 13]

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(b) (i) mechanism must be  $S_N2$

dipole on C-Br bond **or**  
 central C atom shown with  $\delta+$  (1)

attack on C atom by lone pair of  $OH^-$   
**not** from negative charge (1)

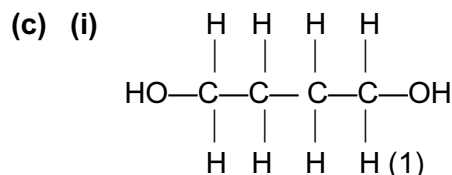
transition state formed **with** negative charge shown (1)

$Br^-$  leaves/ $NaBr$  formed (1)

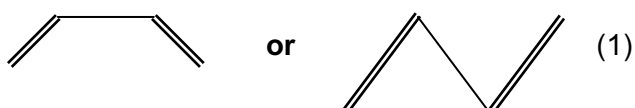
(ii)  $C_2H_4$ /ethane (1)

(iii) ethanol/ $C_2H_5OH$  (1)

(iv) elimination (1) [7]



(ii) **must** be skeletal



[2]

[Total: 12]

5 (a)  $AgCl$ /silver chloride (1) [1]

(b) white (1) [1]

(c) 1-iodobutane (1) [1]

(d) C-I bond is weaker/longer than the other C-halogen bonds (1)

C-I bond energy is  $240 \text{ kJ mol}^{-1}$   
**or** covalent radius of I is  $0.133 \text{ nm}$  (1)

[2]

[Total: 5]