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.

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

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CIE is publishing the mark schemes for the October/November 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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}Mg	12	12	12
^{26}Mg	12	14	12

each correct row (1) [2]

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

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

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]

(d) $Mg + Cl_2 \rightarrow MgCl_2$ (1) [1]

(e) **(i)** $n(Sb) = \dfrac{2.45}{122} = 0.020$ (1)

(ii) mass of C*l* in **A** = 4.57 – 2.45 = 2.12 g (1)

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

allow ecf as appropriate (1)

(iii) Sb : C*l* = 0.02 : 0.06 = 1:3
empirical formula of **A** is $SbCl_3$ (1)

(iv) $2Sb + 3Cl_2 \rightarrow 2SbCl_3$ (1) [5]

(f) **(i)** ionic (1)

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

[Total: 14]

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]

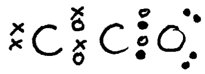
(e) **(i)** $2NO + O_2 \rightarrow 2NO_2$ (1)
$SO_2 + NO_2 \rightarrow SO_3 + NO$ (1)
$SO_3 + H_2O \rightarrow H_2SO_4$
final product must be H_2SO_4 (1)

(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]

3 **(a)** **(i)** order of atoms **must** be C-C-O



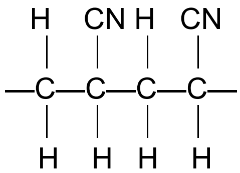
(1)

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]

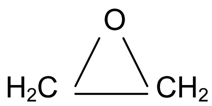
(b) **(i)**

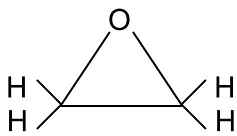


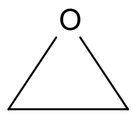
allow the structural formula —$CH_2CH(CN)CH_2CH(CN)$— (1)

(ii) addition (1) [2]

(c) **(i)** CH_3CHO (1)

(ii) 

or 

or 

(1) [2]

(d)

reagent	product
Br_2 in an inert solvent	$BrCH_2CHBrCHO$
NaCN + dil. H_2SO_4	$CH_2{=}CHCH(OH)CN$ allow $CH_2{=}CHCH(OH)CO_2H$
Tollens' reagent	$CH_2{=}CHCO_2H$ **or** $CH_2{=}CHCO_2^-$
$NaBH_4$	$CH_2{=}CHCH_2OH$

(4 × 1) [4]

[Total: 13]

4 **(a)** C : H : Br $= \frac{29.3}{12} : \frac{5.7}{1} : \frac{65.0}{79.9}$ (1)

$= 2.44 : 5.7 : 0.81$

$= 3 : 7 : 1$ (1)

$C_3H_7Br = (3 \times 12) + (7 \times 1) + 79.9 = 122.9$

use of 122.9 or 123 to prove

molecular formula must be C_3H_7Br (1) [3]

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

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

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

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

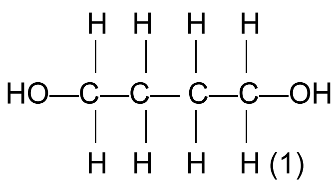
Br^- leaves/NaBr formed (1)

(ii) C_2H_4/ethane (1)

(iii) ethanol/C_2H_5OH (1)

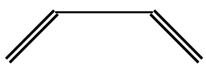
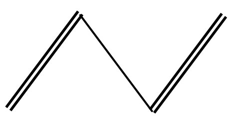
(iv) elimination (1) [7]

(c) **(i)**



(1)

(ii) **must** be skeletal

 **or**  (1) [2]

[Total: 12]

5 **(a)** AgC*l*/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 kJ mol^{-1}
or covalent radius of I is 0.133 nm (1) [2]

[Total: 5]