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

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UNIVERSITY of CAMBRIDGE
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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}Mg	12	12	12
^{26}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]

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

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

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

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

allow ecf as appropriate (1)

(iii) Sb : Cl = 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]

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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]

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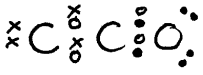
3 (a) (i) order of atoms **must** be C-C-O



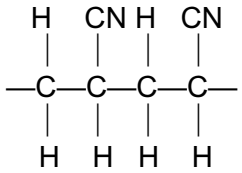
(1)

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)

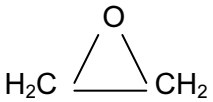


allow the structural formula —$CH_2CH(CN)CH_2CH(CN)$— (1)

(ii) addition (1) [2]

(c) (i) CH_3CHO (1)

(ii)



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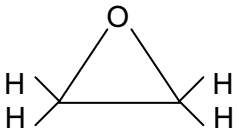

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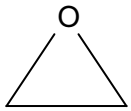

(1) [2]

(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]

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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 $\delta+$ (1)

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

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

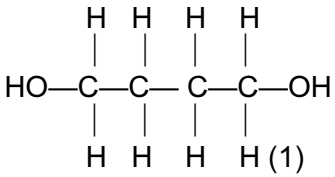
Br^- leaves/NaBr formed (1)

(ii) C_2H_4/ethane (1)

(iii) ethanol/C_2H_5OH (1)

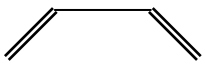
(iv) elimination (1) [7]

(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]

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