**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

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

# MARK SCHEME for the October/November 2012 series

## 9701 CHEMISTRY

**9701/22** 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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**1 (a)** $ZnCO_3$ $Zn(OH)_2$ ZnO
**not** Zn **or** other compounds of Zn (any 2) [2]

**(b) (i)** to ensure all of the water of crystallisation had been driven off **or** to be at constant mass (1)

**(ii)** mass of $ZnSO_4$ = 76.34 – 74.25 = 2.09 g (1)

$M_r$ $ZnSO_4$ = 65.4 + 32.1 + (4 × 16.0) = 161.5

allow use of Zn = 65 and/or S = 32 to give values between 161 and 161.5 (1)

$n(ZnSO_4) = \frac{2.09}{161.5} = 0.01294 = 1.29 \times 10^{-2}$

$ZnSO_4$ = 161 gives $1.30 \times 10^{-2}$ (1)

**(iii)** mass of $H_2O$ driven off = 77.97 – 76.34 = 1.63 g (1)

$n(H_2O) = \frac{1.63}{18} = 0.0905 = 9.1 \times 10^{-2}$ (1)

**(iv)** $1.29 \times 10^{-2}$ mol $ZnSO_4$ are combined with $9.1 \times 10^{-2}$ mol $H_2O$

1 mol $ZnSO_4$ is combined with $\frac{9.1 \times 10^{-2}}{1.29 \times 10^{-2}}$

= 7.054 ≡ 7 mol $H_2O$

answer must be expressed as a whole number
allow ecf on candidate's answers to **(b)(ii)** and **(b)(iii)** (1) [7]

**(c) (i)** $n(Zn) = n\ (CH_3CO_2)_2Zn.2H_2O$ (1)

$n(Zn) = \frac{0.015}{65.4} = 2.290 \times 10^{-4}$

$= 2.29 \times 10^{-4}$ (1)

mass of crystals = $2.29 \times 10^{-4} \times 219.4 = 0.0502655$ g
= 0.05 g = 50 mg (1)

**(ii)** concentration of $(CH_3CO_2)_2Zn.2H_2O = \frac{2.29 \times 10^{-4}}{0.005} = 0.0458$
$= 4.58 \times 10^{-2}$ mol $dm^{-3}$ (1)

allow correct answers if Zn = 65 is used [4]

**[Total: 13]**

**2 (a) (i)** thermal stability decreases down Group VII (1)

**(ii)** from C*l* to I, atomic size increases **or**
the bonding pair is further from the nucleus of X **or**
H—X bond becomes longer **or**
smaller orbital overlap occurs (1)
hence H—X bond strength decreases down Group VII (1) [3]

**(b)** $K_c = \dfrac{[HI]^2}{[H_2] \times [I_2]}$ (1)

no units – must be clearly stated (1) [2]

**(c) (i)** no change (1)
$K_c$ has no units **or**
same no. of molecules / moles each side of equilibrium (1)

**(ii)** equilibrium moves to RHS (1)
$K_c$ increases with decreasing temperature **or**
forward reaction is exothermic **or**
reverse reaction is endothermic (1) [4]

**(d)**

| | $H_2(g)$ | + | $I_2(g)$ | ⇌ | $2HI(g)$ |
|---|---|---|---|---|---|
| initial moles | 0.02 | | 0.02 | | 0 |
| equil. moles | (0.02 – y) | | (0.02 – y) | | 2y |
| equil. conc/mol $dm^{-3}$ | $\frac{(0.02 - y)}{1}$ | | $\frac{(0.02 - y)}{1}$ | | $\frac{2y}{1}$ |

(1)

$K_c = \dfrac{HI^2}{[H_2] \times [I_2]} = \dfrac{(2y)^2}{(0.02 - y)^2} = 59$ (1)

$\dfrac{2y}{(0.02 - y)} = \sqrt{59} = 77$

$2y = (7.7 \times 0.02) - 7.7y$

$9.7y = 0.154$

gives $y = \dfrac{0.154}{9.7} = 0.0159 = 0.016$ (1)

**at equilibrium**

$n(HI) = 2 \times 0.016 = 0.032$ **and**
$n(H_2) = n(I_2) = (0.02 - 0.016) = 0.004$ (1)

allow ecf where possible [4]

**[Total: 13]**

**3 (a) (i)** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ **or**
$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

state symbols required (1)

**(ii)** **pressure** between 60 and 250 atm **or**
between $60 \times 10^5$ Pa and $250 \times 10^5$ Pa (1)

**temperature** between 300 and 550 °C (1)

**catalyst** iron / iron oxide (1)

**(iii)** manufacture of $HNO_3$ / as a cleaning agent / refrigerant / fertiliser / manufacture of fertilisers / explosives / to remove $SO_2$ from combustion products of hydrocarbon fuels (1) [5]

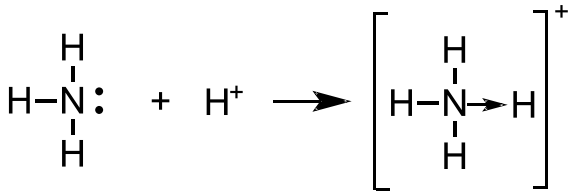
**(b) (i)** $NH_4Cl$ **and** $Ca(OH)_2$
**both formulae** required (1)

**(ii)** $2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$ **or**
$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

correct products (1)
correctly balanced equation (1)

**(iii)** CaO (1)
it is not an acid / it is basic / it does not react with $NH_3$ **or**
**both** $P_2O_5$ / $P_4O_{10}$ **and** $H_2SO_4$ are acidic / react with $NH_3$ (1) [5]

**(c)**



correct displayed eqn.,
with positive charge clearly shown (1)
lone pair on $NH_3$ (1)
co-ordinate / dative bond clearly shown (1) [3]

**[Total: 13]**

**4 (a) (i)**

| reaction | organic compound | reagent | structural formulae of organic products |
|---|---|---|---|
| A | $(CH_3)_3COH$ | $Cr_2O_7^{2-}/H^+$ heat under reflux | no reaction |
| B | $CH_3CH_2CHO$ | Fehling's reagent warm | $CH_3CH_2CO_2H$ **or** $CH_3CH_2CO_2^-$ |
| C | $HCO_2CH(CH_3)_2$ | NaOH(aq) warm | $HCO_2Na$ **or** $HCO_2^-$<br>$(CH_3)_2CHOH$ |
| D | $CH_2=CHCHO$ | $NaBH_4$ | $CH_2=CHCH_2OH$ |
| E | $(CH_3)_3COH$ | $NaBH_4$ | no reaction |
| F | $CH_3CH_2COCH_3$ | $MnO_4^-/H^+$ heat under reflux | no reaction |

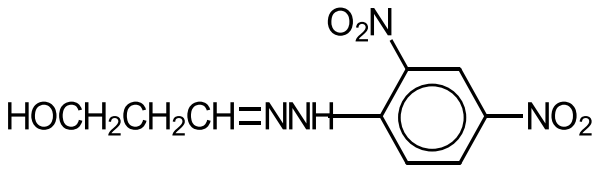
each correct answer gets (1) (7 × 1)

**(ii)**

| reaction | colour at the beginning of the reaction | colour at the end of the reaction |
|---|---|---|
| B | blue | brick red |

each correct answer gets 1 (1 +1 + 1) [10]

**(b) (i)**




(1)

**(ii)** red **or** orange (1) [2]

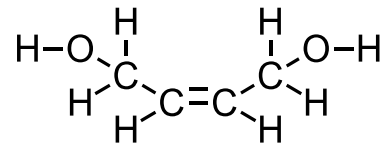
**[Total: 12]**

**5 (a) (i)** carboxylic acid **or** alcohol present **or**
carboxylic acid **and** alcohol present
**not** acid **or** carboxyl **or** hydroxyl (1)

**(ii)** carboxylic acid **not** present **or**
only alcohol present (1)

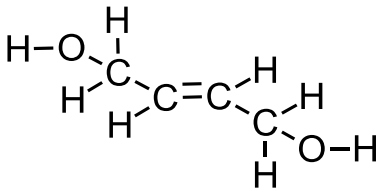
**(iii)** alkene **or** >C=C< present (1) [3]

**(b) (i)**



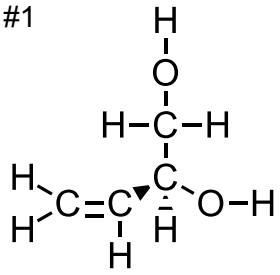
each correct structure gets (1) (4 × 1)

**(ii) pair 1** geometrical **or** *cis-trans* **or** *E*/*Z* isomerism (1)

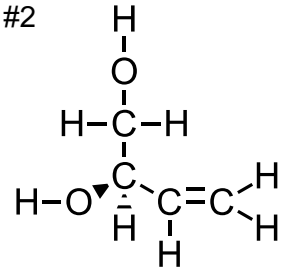


**pair 2** optical isomerism – accept chiral compounds (1) [6]

#1



#2



**[Total: 9]**