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# ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

**General Certificate of Education Advanced Level**

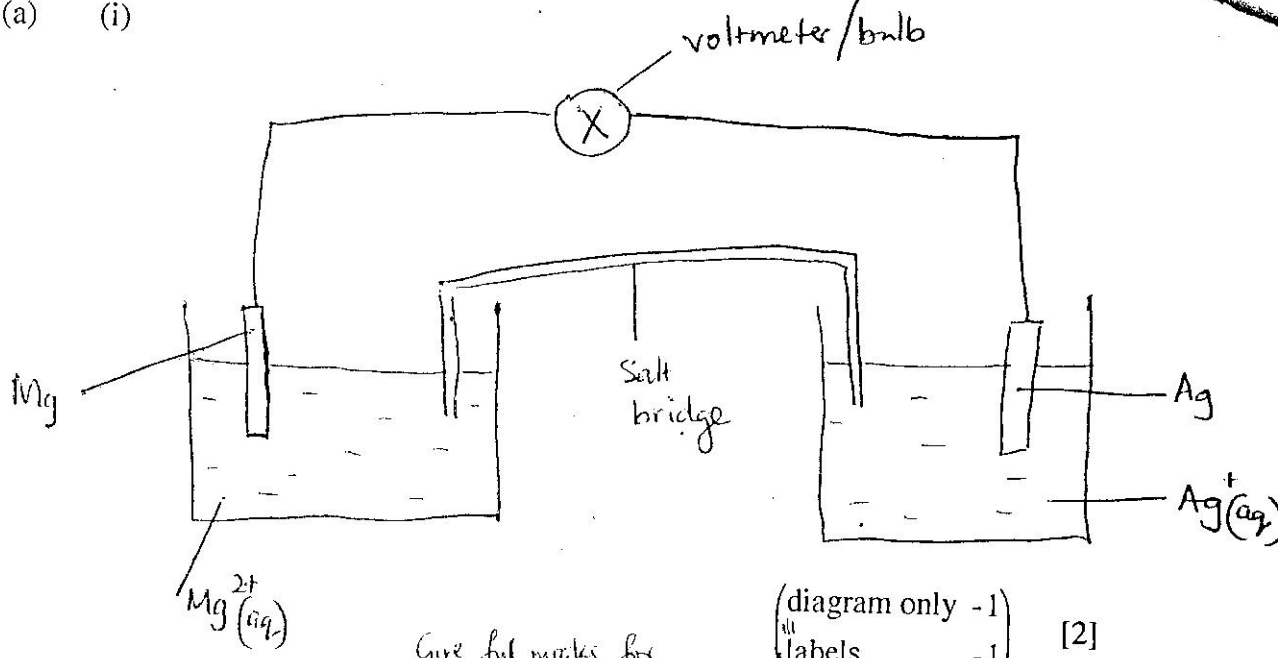
## MARKING SCHEME

## NOVEMBER 2009

## CHEMISTRY 9189/1

(e) 2

1 (a) (i)




(diagram only -1 / all labels -1) [2]

Give full marks for eqns.

award (ii) $Ag^+ + e^- \rightarrow Ag_{(s)}$ $E^\Phi = +0.8V$
$Mg^{2+} + 2e^- \rightarrow Mg_{(s)}$ $E^\Phi = -2.38V$ ; Penalise once for sign and units [1]

$E^\Phi_{cell} = 0.8 - (-2.38) = +3.18$ V; [1]

~~with sign and (volts)~~

(iii) $n(Mg) = \frac{0.08}{24} = 3.3 \times 10^{-3}$ moles; [1]

n(electrons given off by Mg) = $2 \times 3.3 \times 10^{-3} = 6.6 \times 10^{-3}$ moles; [1]

1 mole $e^- \rightarrow$ 96 500 C
$6.6 \times 10^{-3}$ moles $e^- \rightarrow 6.6 \times 10^{-3} \times 96\,500 \div 636.9$C; [1]

$I = \frac{Q}{t} = \frac{636.9}{5 \times 60} = 2.12$ amp (answer with units); [1]

(iv) $2H^+ + 2e^- \rightarrow H_{2(g)}$ would take place more readily than
$Mg^{2+} + 2e^- \rightarrow Mg$ (on attempt to recharge)/changing/changing ions
$Mg^{2+}$ to $Mg_{(s)}$ has a (large) negative $E^\Phi$ value; /A w. [1]

(b) (i) $Pb_{(s)} + PbO_2 + 4H^+ \rightarrow 2Pb^{2+} + 2H_2O$; [1]

(ii) Limited mileage between recharging; high mass; low voltage; (any two) [2]
/current.

[Total: 12]

2 (a) (i) It is when in a reversible reaction the rate of the forward reaction equals the rate of the backward reaction/AW; [1]

(ii) Temperature - Increase in temperature shifts equilibrium to the endothermic reaction/AW/vice verser;

Concentration - Increase in concentration of reactants shift equilibrium to the products side/AW/vice verser;

Pressure - Increase in pressure shifts equilibrium to the side with fewer moles of gas/vice verser; AW [2]
(any two)

(iii) A catalysts increases the rate of both the forward and the backward reactions; [1]

(b) (i) $n(OH^-) = n(H^+) = \frac{18}{1000} \times 0.2 = 0.0036 (\text{moles};)$ [1]

(ii) $n(OH^-)$ from $M(OH)_3 = 0.0036 - n(OH^-)$ from KOH

$= 0.0036 - \frac{25}{1000} \times 0.1 = 0.0011 (\text{moles};)$ [1] ecf

Penalize for units once wrong ones have been used. Pearl

$\therefore [OH^-](\text{from } M(OH)_3) = \frac{0.0011 \times 1000}{25} = 0.044 (\text{mol dm}^{-3})$ [1] ecf

(iii) $[M^{3+}] = \frac{1}{3}[OH^-](\text{from } M(OH)_3) = \frac{1}{3} \times 0.044 = 0.01467 (\text{mol dm}^{-3})$ [1] ecf

(iv) It is the amount of a substance that dissolves in a specific volume of solvent at a specified temperature; /AW. [1]

Solubility of $M(OH)_3$ in 0.1 Mol $dm^{-3}$ KOH =
$s = 0.01467$ mol $dm^{-3}$; [1] ecf
(1 mole $M(OH)_3$ gives 1 mole $M^{3+}$ ions in solution)

(v) $K_{sp} = S(3S + 0.1)^3$ ($\because 0.1 >> 3S$) credit. ecf
$\therefore K_{sp} = s \times (0.1)^3 = 0.01467 \times (0.1)^3 = 1.5 \times 10^{-5} \text{ mol}^4\text{dm}^{-12}$; [2]

(working - 1 mark
answer - 1 mark
with correct units)

[Total: 12]

3 (a) (i) $C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$; [1]

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$; [1]

(ii) Let volume of butane be $x$ and that of propane be $y$ then:

$x + y = 1\,dm^3$; (eqn I) [1]

$\frac{x}{24} \times 3000 + \frac{y}{24} \times 2280 = 118.08$; (eqn II) [1]

[From equ I $x = 1 - y$; substitute for $x$ in eqn II

$(1-y)\frac{3000}{24} + \frac{2280}{24}y = 118.08$

$125 - 125y + 95y = 118.08$]

$\therefore y = \frac{118.08 - 125}{-30} = 0.2307 \Rightarrow 23.1\%$; [1]

$x = 1 - 0.2307 = 0.7693 \Rightarrow 76.9\%$; [1]

6 max 5

(b) (i) heat absorbed by water $= \frac{70}{100} \times 118.08 = 82.656kJ$; [1]

then

$(82.656 \times 1000J = mc\theta = m \times 4.2 \times (100 - 22)$

$m = \frac{82656}{4.2 \times 78} = 252.308g$; [1]

$\therefore$ Volume of water = 252.3 $cm^3$/0.252 $dm^3$; [1]

(ii) Assumption – water has a density of 1g/$cm^3$; [1]

(c) (i) $C_4H_{10} + 5O_2 \rightarrow C_{(s)} + CO_{(g)} + 2CO_2 + 5H_2O$ [1]

$C_3H_8 + \frac{7}{2}O_2 \rightarrow C_{(s)} + CO_{(g)} + CO_2 + 4H_2O$;

(ii) CO – poisonous if inhaled; [1]

C – causes smog; [1]

[Total: 12]

4 (a) $XO + \frac{1}{2}O_2 \rightarrow XO_2$ (where X is C, Ge or Sn); [1]
(+4 more stable)

SiO-too unstable to exist, $SiO_2$ very stable; [1]

$Sn^{2+} + 2I^- \rightarrow Sn^{4+} + 2I^-$ / $Sn^{2+} + Hg^{2+} \rightarrow Sn^{4+} + Hg$ / $PbCl_4 \rightarrow PbCl_2 + Cl_2$ [1]

$Pb^{4+} + 2e^- \rightarrow Pb^{2+}$ $E^\ominus = +1.69$

$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ (+4 more stable) $E^\ominus = +0.15$

$PbO_2 \xrightarrow{\text{heat}} PbO + \frac{1}{2}O_2$; $PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$; [2]
(+2 more stable)

Stability of +2 increases down the group while that of +4 decreases; [1]
(Reject reverse trend)

ns electrons are less screened by inner electrons compared to p electrons hence tend to behave as inner electrons down the group/inner pair effect; /AW [1]

(b) (i) Covalent bonding; simple molecular structure; tetrahedral shape; [3]

(ii) Both $SnI_4$ and $I_2$ are (non polar) covalent substances that dissolve ~~both~~ in organic solvents; /AW. [1]

$SnI_4$ would not form in water as it may be hydrolysed; /reacts in water [1]
[Total: 12]

5 (a) $3I_2 + 6OH^- \rightarrow 5I^- + IO_3^- + 3H_2O$; / [1]
$3I_2 + 6KOH \rightarrow 5KI + KIO_3 + 3H_2O$

Only $I^-$ reacts with con $H_2SO_4$ to reform $I_2$; [1]

$\therefore$ Fraction $= \frac{5}{6} (= 0.833)$; [1]

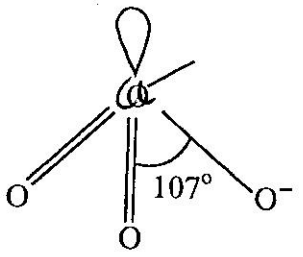
(b) H – I ; [1]

HCl – 431kJmol$^{-1}$
HBr – 366kJmol$^{-1}$
HI – 299kJmol$^{-1}$ ; [1]

H-X bond energy values decrease down the group [1]
$\therefore$ bonds become weaker; /AW

(c) $ClO_3^-$

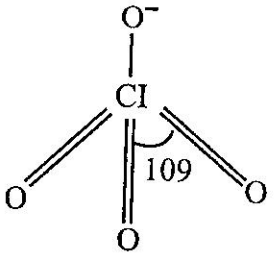
one lone pair
3 bonded pairs
shape trigonal pyramidal




Bond angle ≈ 107°;

$ClO_4^-$

no lone pairs
4 bonded pairs
shape tetrahedral




bond angle 109°; [4]

(1 mark for each shape and one mark for each angle)

(d) Simultaneous oxidation and reduction of the same species; [1]

$2NaClO_3 \rightarrow NaClO_4 + NaClO_2$ [1]

[Total: 12]

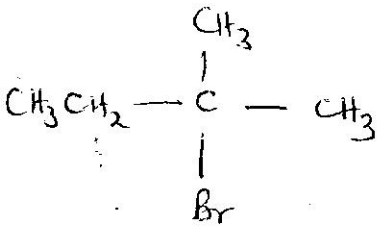
6 (a) Treat with hot concentrated $KMnO_4$; Then treat product with 2.4 dinitrophenyll hydrazine; [3]

A gives an orange-red ppt B does not;

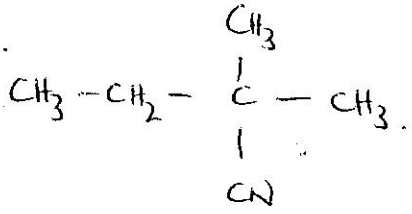
(b) (i) II - KCN; dissolved in ethanol, reflux/heat; [2]

III - heat/reflux; in dilute sulphuric/hydrochloric acid; [2]

(ii) C



D



[2]

(iii) It would not exhibit optical activity;
It has no chiral carbon;

[2]

(c) Boiling points; [1]
B has higher boiling point; [1]
More efficient packing of molecules than in branched A; [1]

[Total: 12]

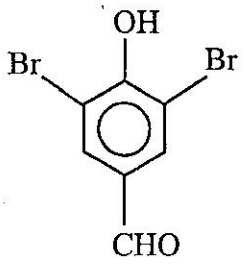
7 (a) (i) E and F – position; E/F and G – functional group; [2]

(ii) E < F < G; accept G > F > E [1]

E forms intramolecular hydrogen bonding hence only weak Van der Waal's forces hold molecules together; [1]

Both F and G form intermolecular hydrogen bonds but there is more (or stronger) in G than F; [1]

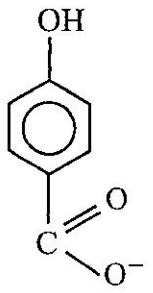
(b) (i) (Bromine decolourised) and white ppt formed;




(ii) silver mirror; reject black

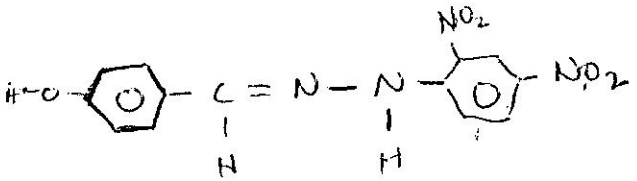
black/grey ppt/ silver ppt.

accept silver lining




(iii) orange-red ppt; orang/

accept yellow




[6]

(c) condensation/~~nucleophilic substitution~~; addition–elimination [1]

[Total: 12]

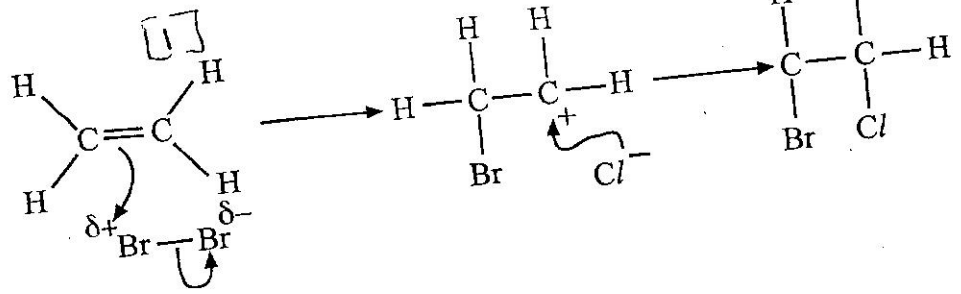
(a) $HCN \rightleftharpoons H^+ + CN^-$ ;

Alkalis shift above equilibrium to the right releasing $CN^-$ to attack carbonyl carbon; [1]

reject catalyst

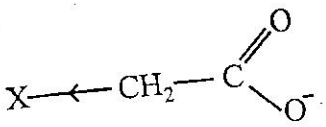
Acids shift above equilibrium to the left hence no $CN^-$ to attack carbonyl carbon; [1]

(b)



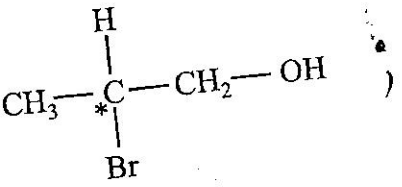

mechanism described in words [1]

(c) F is more electronegative than I; hence causes a greater negative inductive effect and more stabilisation of the anion: AW




more weakening of O–H bond. [1]

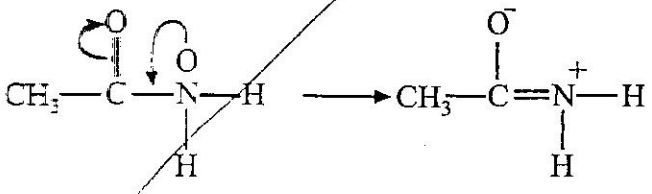
(d) An equimolar mixture of D and L forms is formed, effects cancel each other out (racemic mixture); AW [1]

product: 


AW
– rotation of light
– equal amounts

(e) $CH_3CH_2NH_2$ can accept a proton via the lone pair of electrons on the nitrogen atom; [1]

The lone pair on the nitrogen atom of $CH_3CONH_2$ is not available for protonation due to the delocalisation shown below:



(f) Ethanoic acid partially ionises in solution to give a weakly acidic solution.

$$CH_3COOH \rightleftharpoons CH_3CO_2^- + H^+$$ [1]

Ethanoyl chloride is hydrolised by water to give HCl which completely ionises in solution.

$$CH_3COCl + H_2O \rightarrow CH_3CO_2H + H^+ + Cl^-;$$ [1]

check complete ionisation

[Total: 12]

* Cancelled and not corrected consider.