ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

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MARKING SCHEME

NOVEMBER 2005

1. STATE symbols: Any chemical rxn (R) wrong state symbols
2. If a concept/idea is not relevant to the answer but is wrongly given (R) the answer.
3. Any wrong or unbalanced eqn given in chemical symbols should not be ignored.
4. If an explanation contradicts an answer (R)
5. If reagents are wrong but conditions correct (R) everything.

CHEMISTRY 9189/1

Qn 2 Na^+ not Na.
- at least 2 hexagons per layer.
- covalent and V.D.W. forces for graphite.

2 a(ii) Sliding linked to V.D. Waals.

Qn 3 - graph - wrong shape (R) all 3 marks.

Qn 4 -

1 **(a)** **(i)** Lead has four isotopes; ^{204}Pb, ^{206}Pb, ^{207}Pb and ^{208}Pb; (1)

Relative abundance: $^{208}Pb > ^{206}Pb > ^{207}Pb > ^{204}Pb$; (1)

(ii) Relative abundance $= \dfrac{\text{Peak height}}{\text{Total heights}} \Rightarrow$ For $^{204}Pb = 0.02$

$^{206}Pb = 0.24$; $^{207}Pb = 0.22$ and $^{208}Pb = 0.52$ (1)

Ar $= (204 \times 0.02) + (206 \times 0.24) + 207 \times 0.22) + 208 \times 0.52)$; (1)

$= 207.2$; (1)

(b) **(i)** Mass of combined oxygen = 110.3 – 100.0 = 10.3 g; [1]

Pb	O
$\dfrac{100}{207}$	$\dfrac{10.3}{16}$
$\dfrac{0.483}{0.483}$	$\dfrac{0.644}{0.483}$;
1×3	1.3×3
3	4

$\Rightarrow Pb_3O_4$; (1)

(ii) number of moles of oxygen used $= \dfrac{10.3}{32}$/0.322 moles (1)

$\therefore$ volume $= 0.322 \times 24$ (dm^3) (1)

$= 7.73\ dm^3$; (with units) (1)

(iii) oxidation state: $3x + 4(-2) = 0 \Rightarrow x = \dfrac{8}{3} = 2.67$; (1)

Thus lead must be in different oxidation states (i.e mixture of PbO and PbO_2); (1)

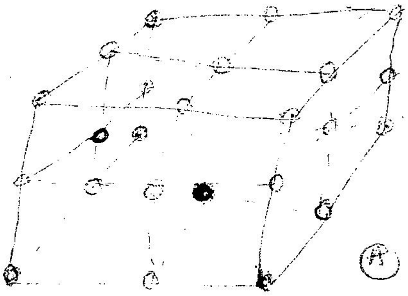
[Total: 12]

2 (a) (i) Sodium chloride

1. Ionic bonding. Each Na loses an electron to Cl. Resultant ions held together by electrostatic forces; btw. oppositely ions

Giant ionic structure. Each ion surrounded by 6 others of the opposite charge.

(1)



(A) at least one side to show the face centred

(A) Incomplete structure + 6.6 coordination [illegible] minimum of one cube [illegible] alternate Na^+ & Cl^-

(R) Na & Cl

(1)

2. Graphite

Each carbon atom covalently bonded to three others forming a layer of hexagonal rings. Fourth electron delocalised.

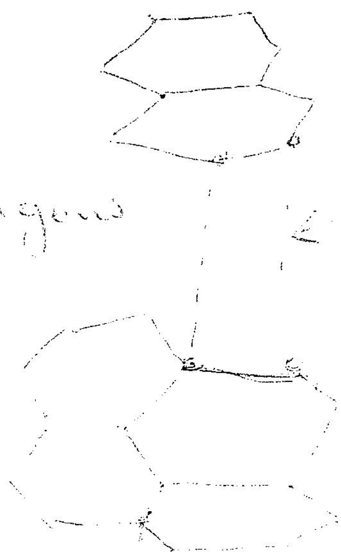
(1)

Giant molecular structure. Different layers held together by Van der Waal's forces.

(1)

may use information from diagrams

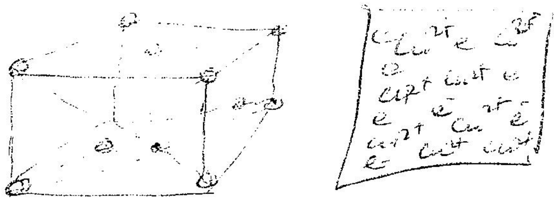
at least 2 hexagons & 2 layers.



Van der Waals/London dispersion forces

3. <u>Copper</u>

Metallic bonding. Cu^{2+} ions held together by a sea of delocalised electrons.



(Giant metallic face centred cubic close packed structure.)

(ii) Due to weak Van der Waal's forces between layers, they can slide over each other;/AW (1)

(b) (i) Hydrogen bonding: X — H ⋯⋯ :Y — H

An electrostatic force of attraction between a hydrogen atom bonded to a highly electro negative atom; and the ~~lone pair of electrons~~ ~~of electrons~~ of another highly electronegative atom; (1)

(ii) Ice 109.5 (1) Water 104.5 (1)

ice occuppies more space /AW/

(iii) Water freezes from the top insulating liquid below;/AW (1)

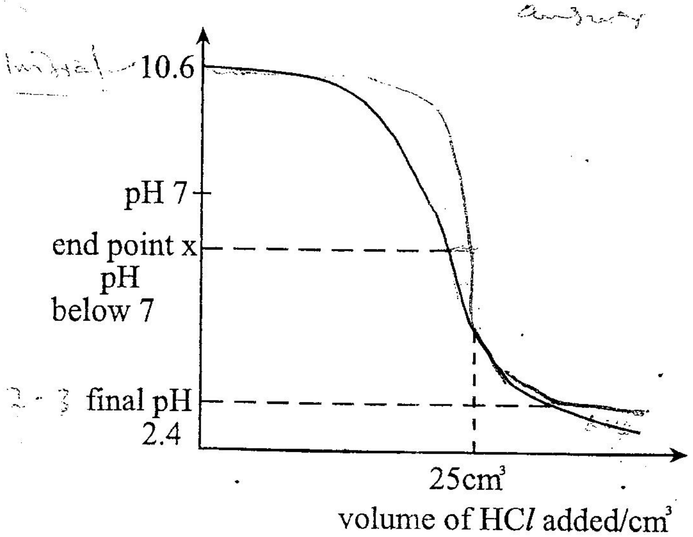
[Total: 12]

3 **(a)** Negative logarithm to base ten of the molar hydrogen ion concentration/ $pH = -lg\,[H^+]$ (1)

(b) **(i)** $pOH = -lg\sqrt{K_b \times [NH_3]} = -lg\sqrt{1.8\times10^{-5}\times 0.01} = 3.4$ (1)

$pH = 14 - pOH = 14 - 3.4 = 10.6;$ (1)

(ii)



General shape of sketch; (1)
Indication of end point volume and end point pH; (1)
Indication of initial and final pH; (1)

(c) **(i)** <u>addition of acid</u>

$NH_3 + H^+ \rightarrow NH_4^+;$ (1)

<u>addition of base</u>

$NH_4^+ + OH^- \rightarrow NH_3 + H_2O;$ (1)

(ii) Equal volumes added $\Rightarrow$ concentrations are halved;

$pOH = -lg\,1.8\times10^{-5} + lg\left(\dfrac{0.05}{0.05}\right) = 4.745$

hence $pH = 14 - 4.745 = 9.26;$ (1)

(iii) number of moles of HC*l* added = $\frac{1}{1000} \times 1 = 0{,}001$ moles

hence: new $[NH_4^+] = 0.05 + 0.001 = 0.051$ mol dm^{-3}
new $[NH_3] = 0.05 - 0.001 = 0.049$ mol dm^{-3}; (1)

$$pOH = 4.745 + \lg\left(\frac{0.051}{0.049}\right) = 4.762$$

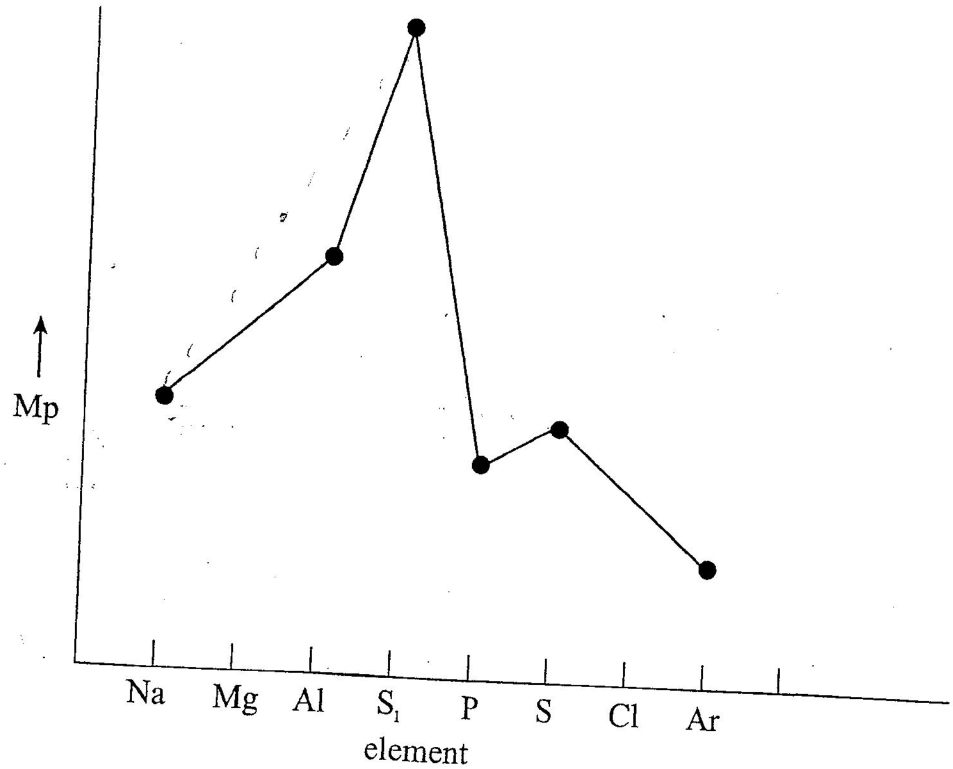
$\Rightarrow pH = 14 - 4.762 = 9.24$ (1)

pH change = 9.26 – 9.24 = 0.02; (1)

3 max 2
[Total: 12]

4 (a) Melting point trend

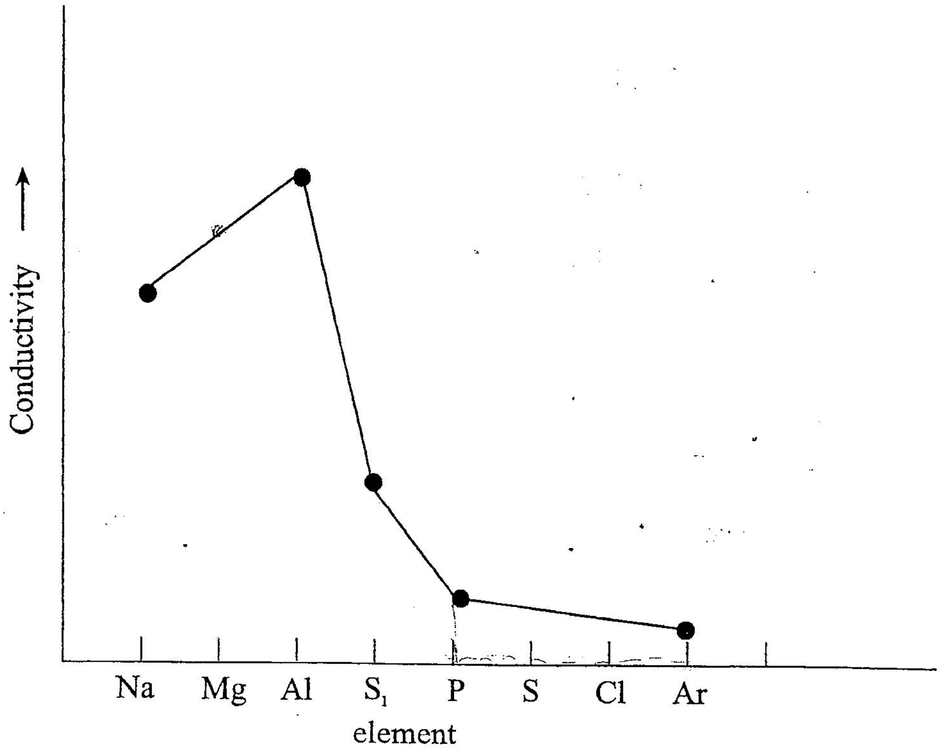
Increase from sodium to silicon, sharp drop to phosphorous slight increase to sulphur and decrease to argon.



(1)

Conductivity trend

Increase from sodium to aluminium, a drop to silicon and a further drop to very low values for phosphorous to argon.



- Number of delocalised electrons increase from Na to Al hence increase in conductivity and strength of metallic bond; (1)
- Si: (Covalent) giant molecular (more energy required to break strong covalent bonds;) (1)

  metalloid/semiconductor (hence drop in conductivity;) (1)
- P to Ar - simple molecular (less energy required to break Van der Waal's Forces;) (1)
- Van der Waals's forces decrease in the order $S_8 > P_4 > Cl_2 > Ar$; (1)
- electron localised in P to Ar hence poor conductors; (1)

[8 max 7]

(b) **(i)** Group III; (1)

There is a large jump in ionisation energy from 3rd to 4th; (1)

(ii) $4Y + 3O_2 \rightarrow 2Y_2O_3$; (1)

1. $Y_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaY(OH)_4$; (1)

2. $Y_2O_3 + 6HCl \rightarrow 2YCl_3 + 3H_2O$; (1)

[Total: 12]

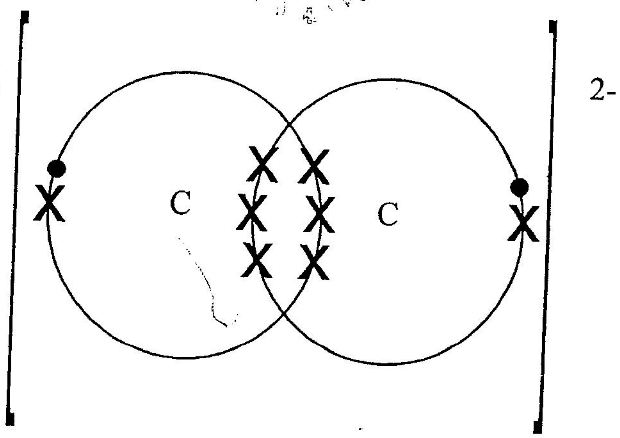
5 **(a)** From Mg^{2+} to Ba^{2+} ionic radii increase hence charge density decreases; (1)

Thus hydration energy decrease; (1)

Cationic radius << SO_4^{2-} radius; (1)

Thus Lattice energy hardly changes; (1)

(b) **(i)**



(ii) $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$;

(iii) number of moles of calcium oxide = $\frac{1000}{56.1}$

= 17.83 moles; (1)

From $2CaO + 5C \rightarrow 2CaC_2 + CO_2$

Ratio	CaO	:	CaC_2	:	C_2H_2
	1	:	1	:	1

hence number of moles of C_2H_2 = 17.83; (1)

∴ volume = 17.83 × 22.4 = 399.3 dm^3; (1)

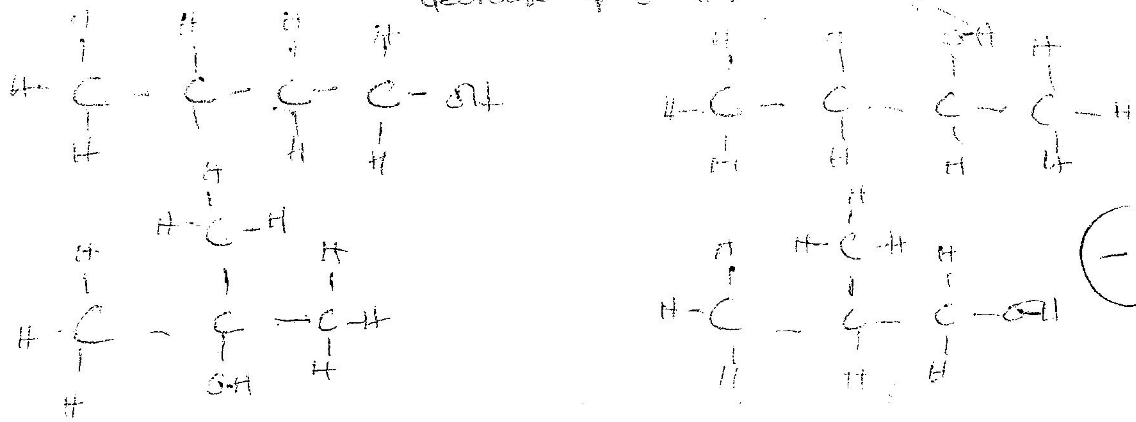
(c) (i) $MO_{(s)} + H_2O_{(l)} \rightarrow M(OH)_2(s)$ (1)

(ii) pH increases; (1)

solubility of hydroxides increases down the group; (1)

decrease

6 (a)



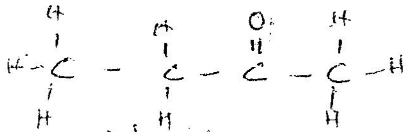
Penalise one for (-OH)

(-1)

(b) (i) $NaOH(aq)$ and $I_2(aq)$; [1] Yellow crystals/ppt [1] (2)

$CH_3CH_2COCH_3$

(ii)



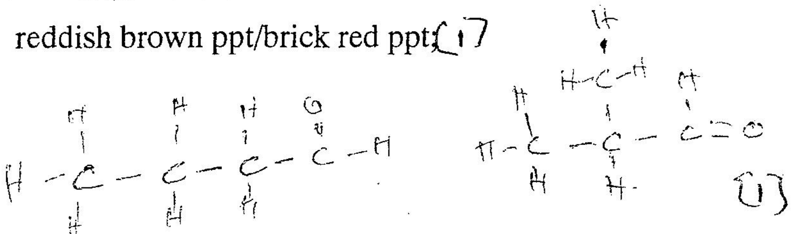
| $CH_3CH_2COCH_3$. [1]

[1]

* oxidation

[4]

(c) (i) reddish brown ppt/brick red ppt; [1] (2)



[1] [1]

$CH_3CH_2CH_2CHO$

(ii) structural/functional group isomerism; [1] (1)

[Total: 12]

A $CH_3-CH=C(CH_3)-CH_2-C(CH_3)=C(CH_3)_2$;

B $CH_3-C(=O)OH$;

C $CH_3-C(=O)-CH_2-C(=O)-CH_3$;

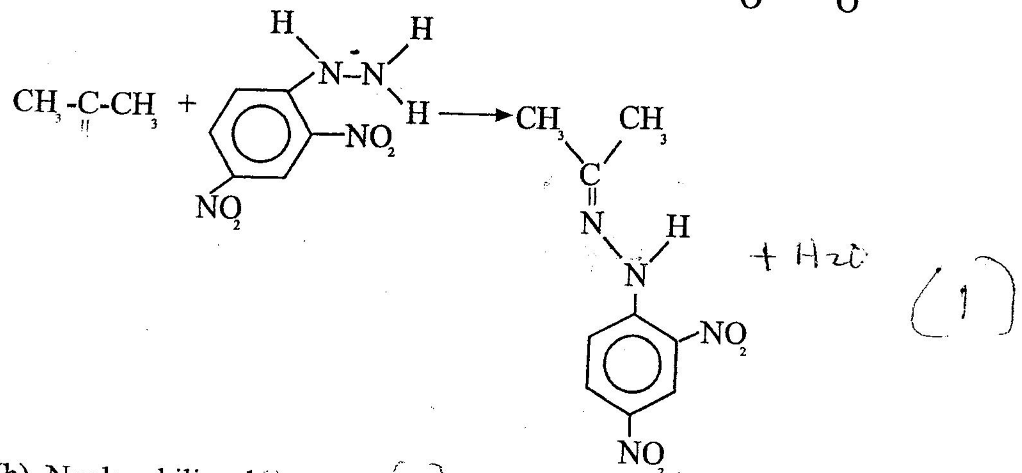
D $CH_3-C(=O)-CH_3$;

$$CH_3-CH=C(CH_3)-CH_2-C(CH_3)=C(CH_3)_2 + 2Br_2 \rightarrow CH_3-CHBr-CBr(CH_3)-CH_2-CBr(CH_3)-CBr(CH_3)-CH_3$$; (1)

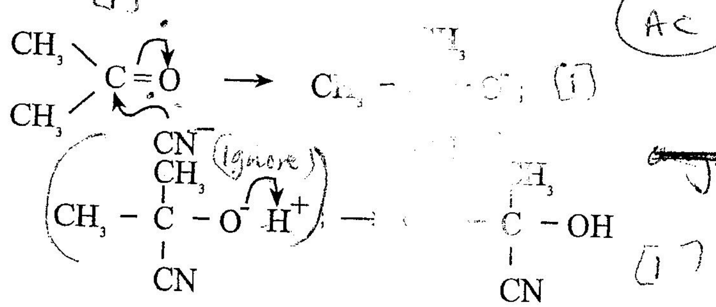
$$2\,CH_3C(=O)OH + Na_2CO_3 \rightarrow 2CH_3-C(=O)O^-Na^+ + CO_2 + H_2O$$; (1)

$$CH_3-CH=C(CH_3)-CH_2-C(CH_3)=C(CH_3)_2 \xrightarrow{[O]} CH_3-C(=O)OH + CH_3-C(=O)-CH_2-C(=O)-CH_3 + CH_3-C(=O)-CH_3$$ (1)

C/D



(b) Nucleophilic addit (1)



8 (a) (i) Chloro benzene - 300°C, 200 – 300 atm/boil under pressure; (1)

benzoylchloride – room temperature; (1)

chlorophenyl methane – (heat under) reflux; (1)

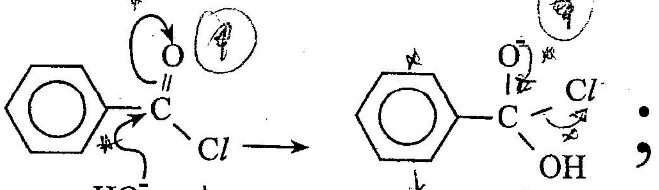
(ii) Chlorobenzene – Cl atom delocalises its electrons into the ring making the C – Cl bond much stronger and more difficult to break; (1)

benzoylchloride – stronger electrophilic carbon due to two electron withdrawing atoms Cl and O/positive charge forms on the C atom being attacked as follows (1)

R – phenyl group

Chlorophenylmethane – weaker electrophilic carbon only one electron withdrawing atom Cl; (1)

(iii)



(b) Step I H_2SO_4, $K_2Cr_2O_7$/alkaline $KMnO_4$; (1)

Step II PCl_5, room temperature/$SOCl_2$, room temperature; (1)

X –