N.N. 5

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

MARKING SCHEME

NOVEMBER 2012

CHEMISTRY **9189/1**

1 (a) (i) Empirical formula - smallest number ratio of atoms of elements present in a molecule; /AW [1]

(ii) molecular formula - actual number of atoms of different elements present in one molecule of a compound; /AW [1]

(b) (i)

	N	H
% composition	87.5	100-187.5 / 12.5
ratio of moles	$\frac{87.5}{14}$	$\frac{12.5}{1}$
	$= \frac{6.25}{6.25}$	$\frac{12.5}{6.25}$
	$= 1$	2

calculation and formula.

$\therefore$ Empirical Y = NH_2 [1]

(i) Let molecular formula of Y be $(NH_2)_n$

$(14+2)n = 32$

$16n = 32$

$n = 2$

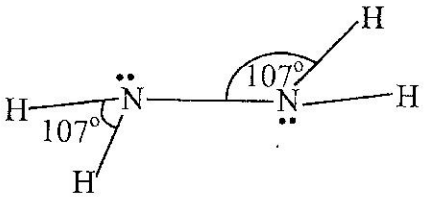
$\therefore$ molecule formula of Y = $(NH_2)_2$

= N_2H_4 / NH_2NH_2 [1]

(ii)

[1]

Trigonal pyramidal at each nitrogen atom; / diagram. [1]



NNH bond angle is 107°. [1]

(Correct diagram)

(c) (i) $N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$ [1]

	BE/kJmol^{-1}
N-N	160
N-H	390
O=O	496
N≡N	994
O-H	460

[1]

$\Delta H_r = BE(N-N) + 4BE(N-H) + BE(O=O) - BE(N\equiv N) - 4BE(O-H)$

$= 160 + 4(390) + 496 - 994 - 4(460)$ [1]

$= -618$ kJmol^{-1} [1]

Y can be used as a fuel [1]

[Total 12]

2 (a) (i) $2NH_3(l) \rightleftharpoons NH_4^+(l) + NH_2^-(l)$ [1]

$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ [1]

(ii) $K_b = \dfrac{[NH_4^+][OH^-]}{[NH_3]}$ [1]

(iii) $K_b = \dfrac{(4.3\times10^{-4})^2}{0.01} = 1.85\times10^{-5}$ moldm^{-3} [1]

Assumption $[NH_3]$ remains constant [1]

~~$[NH_4^+] = [OH^-]$~~

(b) (i) alkaline/basic buffer;

~~mixture of a weak base and its salt~~

~~pH of the buffer > 7;~~ [1]

(ii) In acid : $NH_3 + H^+ \rightarrow NH_4^+$ [1]

In base $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$; [1]

(iii) Concentration of NH_4Cl = $\frac{1}{53.5}$

ecf Kb.

= 0.0187 moldm^{-3} [1]

ecf. calculation steps!

pOH = $-\log(1.85\times10^{-5}) - \log\left(\frac{0.01}{0.0187}\right)$ [1]

= 4.73 + 0.27

= 5.00 [1]

pH = 14 – pOH

= 14 – 5.00

= 9.00 [1]

/ Awarding Give 4)

[Total 12]

3 (a) 1 (i) Ammonia forms hydrogen bonds with water but methane does not; / AW [1]

2 (ii) Silicon (IV) oxide has strong covalent / giant molecular bonds whereas carbon dioxide has weak Van der waals forces / simple molecular (R) if no comparison [1]

3. (iii) Hydrogen bonding gives ice its open structure, [1]
which make it less dense than water; / [1]

the ice floats on top of the warmer water beneath, ice insulates the water; [1]

(b) A : giant molecular since it has high melting and boiling points and does not conduct; [1]

Salvage mark provided all the structures are correct.

B : giant ionic + high melting and boiling points and ~~does not~~ conducts in liquid ; [1]

C : simple molecular + low melting and boiling points and does not conduct; [1]

(c) (i) molecules are point centres of mass; / negligible volume [1]
no intermolecular forces/ collision between molecules are elastic; [1]

Refer to molecules or particles

(ii) gas molecules far apart resulting in no intermolecular forces; volume occupied by molecules very small proportion of the total volume; [1] [1]

[Total 12]

4 (a) (i) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ If State [1]

$CaO_{(s)} + SiO_{2(s)} \rightarrow CaSiO_{3(s)}$ [1]

(ii) $CaCO_3$ is less stable/ decomposes at a lower temperature; /AW . . [1]

2) charge density of the atom.

Ca^{2+} has a larger charge density than Ba^{2+} /AW [1]

$\therefore$ Power of Ca^{2+} to polarise CO_3^{2-} (and weaken the C – O bond is greater than that of Ba^{2+}) AW. [1]

(b) (i) CaO lumps get hot, swell and crumble to a powder/ CaO reacts vigorously with water to form $Ca(OH)_2$ which is only slightly soluble in water; /AW [1]

BaO readily reacts with water (to produce a highly alkaline solution;) [1]

(ii) CaO _____ pH ~~9~~ 10 – 11

BaO _____ pH 12 – ~~14~~ [1]

(c) (i) $CaCO_{3(s)} + SO_{2(g)} \rightarrow CaSO_{3(s)} + CO_{2(g)}$ / $CaCO_3 \rightarrow CaO + CO_2$; $CaO + SO_2 \rightarrow CaSO_3$. [1]

$2CaSO_{3(s)} + O_{2(g)} \rightarrow 2CaSO_{4(s)}$ [1]

make the correct first unless there is a contradiction

(ii) $CaCO_3$ manufacture of cement/ glass / building construction / tooth paste [1]

lowering of acidity of salt.

$CaSO_4$ plaster (of paris) / chalk / fertilizer / manufacture of H_2SO_4 [1]

[Total 12]

5 (a) Transition element

(i) (d – block) element which form ~~same~~ one or more stable ions with incomplete d – orbitals; /AW. [1]

Ligand

(ii) Molecule or anion containing at least one lone pair of electrons; [1]

(A) formation of dative bond

(b) (i) Lone pairs of electron on (six) water molecules are donated into vacant orbitals of Cu^{2+} to form six dative / coordinate bonds / AW; Accept diag. [1]

(ii) Observation: blue ppt which dissolves to form a deep blue solution; [1] [1]

$(NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-)$

I

$[Cu(H_2O)_6]^{2+}_{(aq)} + 2OH^-_{(aq)} \rightleftharpoons Cu(OH)_{2(s)} + 6H_2O_{(l)}$ [1]

$Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \rightleftharpoons Cu(OH)_{2(s)}$

II

$$\left[Cu(H_2O)_6\right]^{2+}_{(aq)} + 4NH_{3(aq)} \rightleftharpoons \left[Cu(NH_3)_4(H_2O)_2\right]^{2+} + 4H_2O \quad [1]$$

$$Cu(OH)_{2(s)} + 4NH_{3(aq)} \rightleftharpoons \left[Cu(NH_3)_4\right]^{2+}_{+} + 2OH^-_{(aq)}$$

Establishment of equilibrium II lowers concentration of $\left[Cu(H_2O)_6\right]^{2+}$ thereby shifting equilibrium I to the left causing ppt to dissolve;

Excess $NH_{3(aq)}$ causes displacement of H_2O ligands by NH_3 ligands Thereby shifting equilibrium II to the right forming a deep (blue complex of $\left[Cu(NH_3)_4\right]^{2+}_{(aq)}$; [1]

(c)

	$\in^{\ominus}$/v	
$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O$	+1.52	
$2SO_4^{2-} \rightarrow S_2O_8^{2-} + 2e^-$	− 2. 01	; [1]
$2Cl^- \rightarrow Cl_2 + 2e^-$	−1 . 36	

Overally

$$2MnO_4^- + 16H^+ + 10Cl^- \rightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$$

$\in^{\ominus}$ cell=+0.16v; [1]

$$2MnO_4^- + 16H^+ + SO_4^{2-} \rightarrow 2Mn^{2+} + 8H_2O + 5S_2O_8^{2-}$$

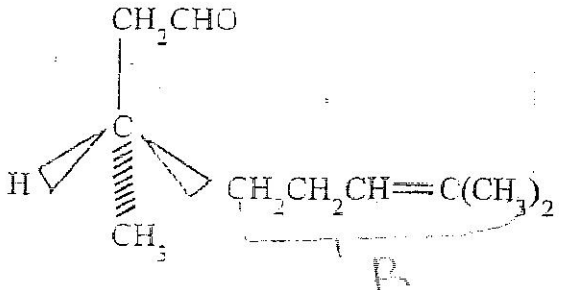
$\in^{\ominus}$ cell=- 0.49v; [1]

Since $\in^{\ominus}$ is –tve SO_4^{2-} ions are not oxidised by MnO_4^- ions in a side reaction but Cl^- ions are oxidised by MnO_4^- ions in a side reaction since $\in^{\ominus}$ cell is +ve; [1]

[Total = 12]

6 (a) In structural isomerism isomers differ in structure where in optical isomerism isomers differ in orientation of atoms in space/ AW; [1]

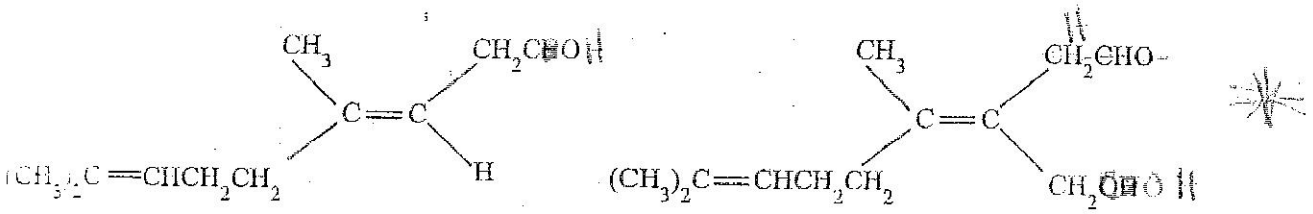
(b) (i) A – optical isomerism; [1]



Plus correct mirror image

[1]

B – cis – trans/ Geometric ; [1]



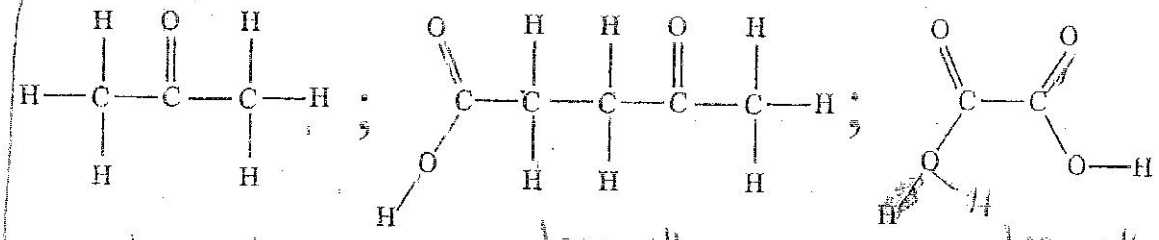
[1]

(ii) PCl_5; white fumes (of HCl) with B only; [2]

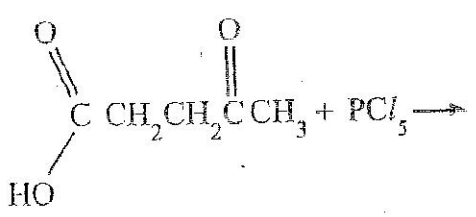
$Na_{(s)}$; effervescence (of $H_{2(g)}$) only with B;

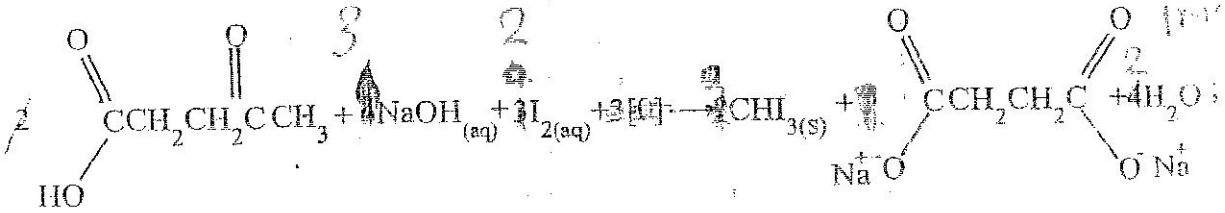
2,4 DNPH; orange/yellow ppt only with A;

(c) (i)



(ii)





[Total 12]

7 (a) (i) electron deficient species;
electron rich species A/W;

[1]

(b) (i) But – 2 - ene

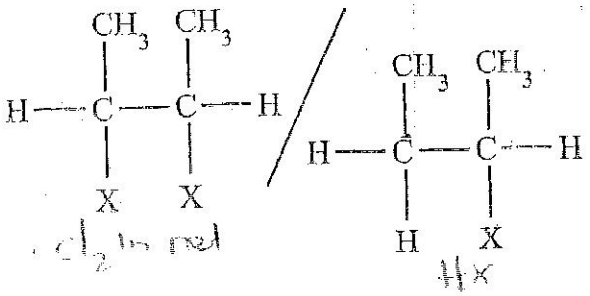
Cl_2/Br_2 ; Insert solvent
Conc HX / steam; H_3PO_4
330°C; (60 atm)

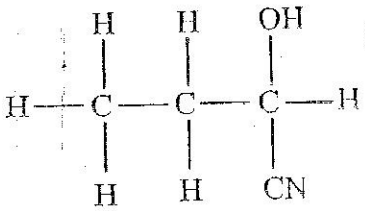
Butanal

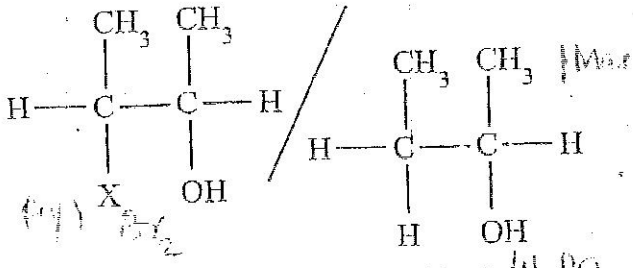
HCN; NaOH
NaCN catalyst;

[3]

(ii)

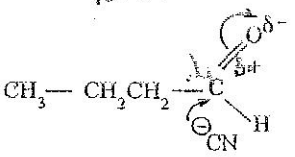


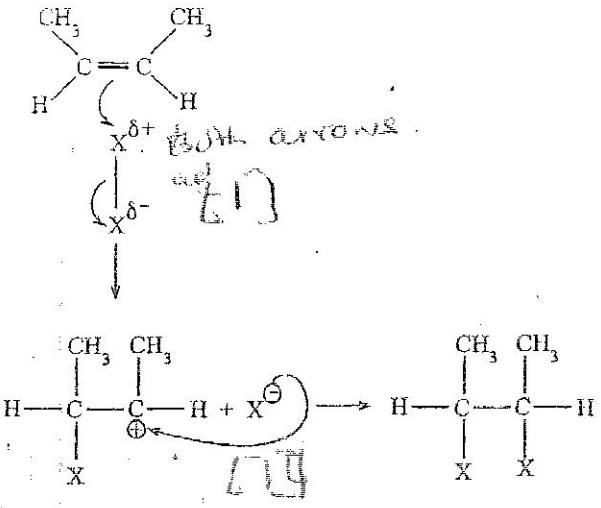


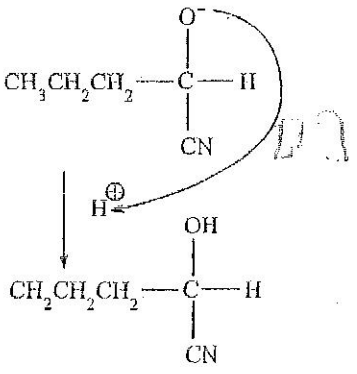


[1]

(iii)





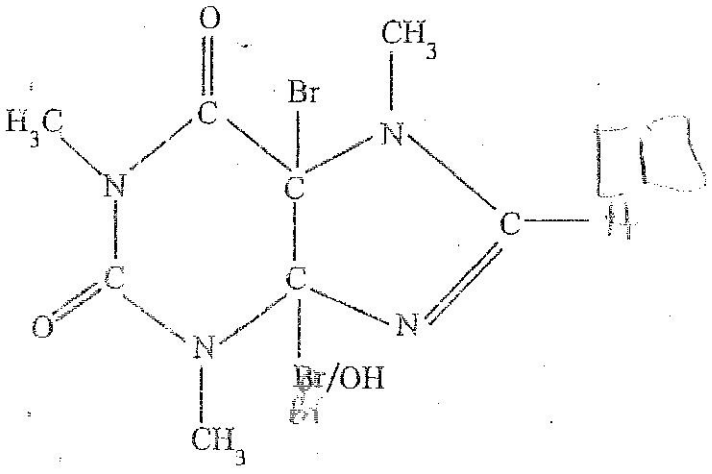


[3]

Amide; Alkene; Amine; [2]

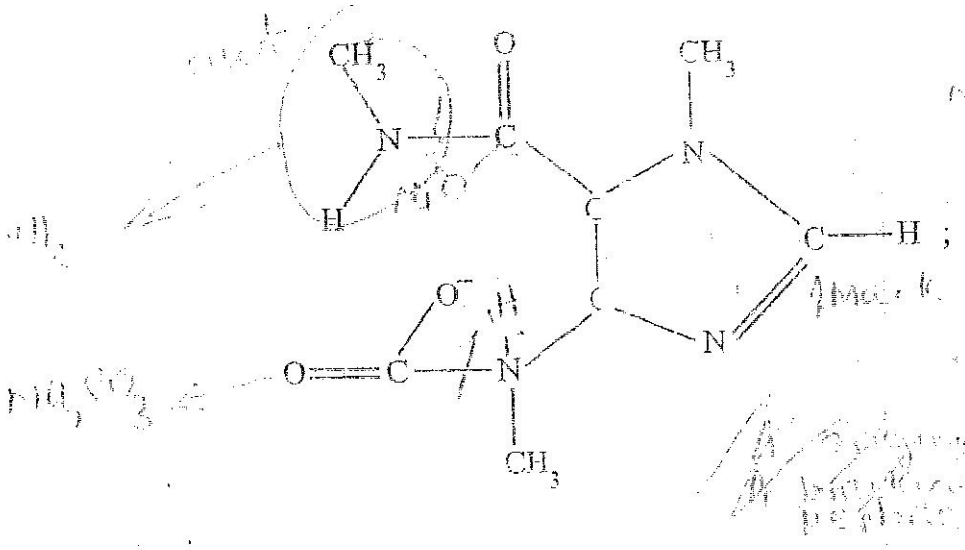
[3]

(b) (i)

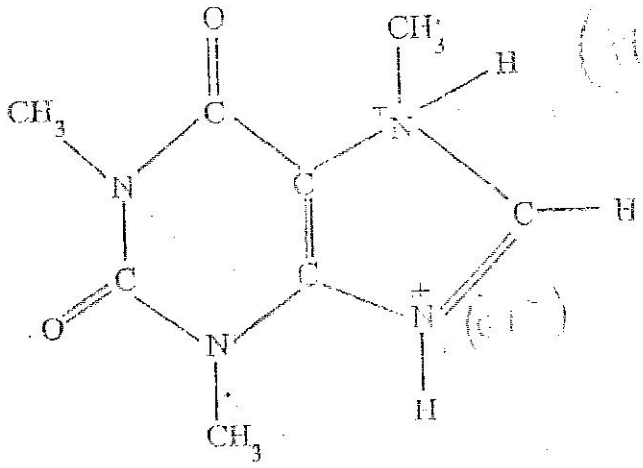


Electrophilic ; addition; [2]

(ii) ;Hydrolysis; [2]



(iii) ;Acid/base/neutralisation; [1]



[2]

(c) M_r Caffeine = 194; [1]

moles caffeine = $\frac{3 \times 10^{-2}}{194} = 1,5 \times 10^{-4}$ moles; [1]

conc. = $\frac{1,5 \times 10^{-2} \times 1\,000}{300} = 5,15 \times 10^{-4}$ moldm^{-3} [1]

[Total 12]