

CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)
NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)



FORM SIX PRE-NATIONAL EXAMINATIONS 2023

132/2

CHEMISTRY 2

MARKING SCHEME

1. (a) (i) Ideal solution is a solution that is mad from completely miscible liquids whose intermolecular forces are the same as the intermolecular forces within the liquid involved in forming the solution and obey Raoults law. (02 marks)

(ii) Factors or condition for ideal solution formation

- Solution must obey Raoults law. (01 marks)

-There should not be any volumetric effects (no change in volume). (01 marks)

- There should not be any thermal effects (Heat is neither evolved nor absorbed). (01 marks)

-The forces of interactions in individual components are the same as the interactive forces in the solution. (01 marks)

(iii) DIAGRAM OF THE POSITIVE DEVIATION FROM RAOULT'S LAW (06marks)

(b)(i) From

$$6g=1000ml$$

$$x=700ml \quad (001 \ 2 \ \text{marks})$$

$$x= 6g \times 700ml / 1000ml \quad x=4.2g \quad (002 \ \text{marks})$$

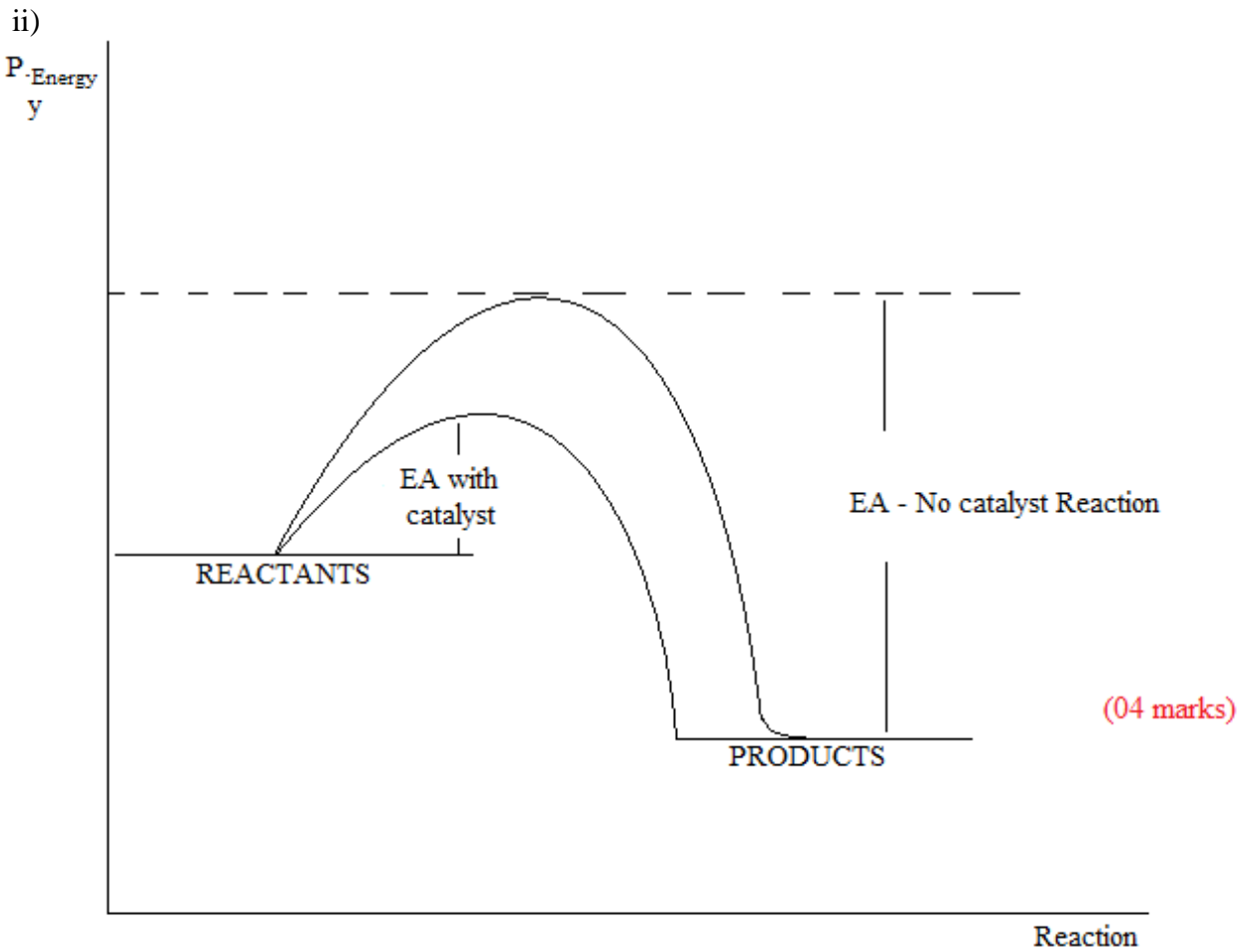
But when shaken with 200ml 3.21g was extracted so mass remain= 0.99g

$K_d = \text{mass of solute volume of organic layer} \times \text{volume of solvent mass remain}$ (02 marks)

$$K_d = 3.21g \ 200ml \times 700ml \ 0.99g \ (001 \ 2 \ \text{marks}) \quad K_d = 11.35 \ (01 \ \text{marks})$$

(ii) After further shaking $K_d = \frac{\text{mass extracted}}{\text{volume of organic layer} \times \text{volume of solvent}}$
 $\text{mass of solvent} \quad (001 \ 2 \ \text{marks}) \quad 11.35 = x \ 200\text{ml} \times 700\text{ml} \ 0.99 - x \quad (001 \ 2 \ \text{marks}) \quad 11.35 = 7x$
 $2(0.99 - x) \quad 11.35 = 7x \ 1.98 - 2x \ 7x = 22.473 - 22.7x \quad (001 \ 2 \ \text{marks}) \quad 29.7x = 22.473 \ x = 0.757\text{g}$
 Mass of B remained is 0.233g (03 marks)

2. a) i) Is the time taken for the concentration of a reactant to drop to half its initial value
 (01 mark)



b) i) At 60 Sec there were
 2 partile of A
 6 partile of B
 6 partile of C (01 mark)

ii) Since it is the first order reaction, then

$$t_{1/2} = \frac{0.69}{K} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$K = \frac{0.69}{t_{1/2}} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$K = \frac{0.69}{30.00} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$
$$= 2.31 \times 10^{-2} \text{S}^{-1} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

iii) After 90 sec there half-lives will have passed. So there will be 1 particle of A , 7 particles of B and C

$$\text{Mole fractions of B} = \frac{7}{1 + 7 + 7} = \frac{7}{15}$$

$$X_B = 0.467 \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$\text{From } P_B = X_B P_{\text{Total}} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

Where

P_B = Partial pressure of B

X_B = mole fraction of B

P_{Total} = Total pressure

$$P_B = 0.467 \times 5.00 \text{atm} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$= 2.33 \text{ atm} \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

c) i) The intermediate species is NO_3 $\left(00 \frac{1}{2} \text{ mark}\right)$

ii) $R_{(\text{forward})} = K_1[\text{NO}][\text{O}_2]$ $\left(00 \frac{1}{2} \text{ mark}\right)$

$$R_{(reverse)} = K_{-1}[NO_3] \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$R_2 = K_2[NO_3][NO] \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

At equilibrium

$$R_{(forward)} = R_{back\ ward} \dots\dots (01 \text{ mark})$$

$$K_1[NO][O_2] = K_{-1}[NO_3] \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

Make $[NO_3]$ the subject..... $\left(00 \frac{1}{2} \text{ mark}\right)$

$$[NO_3] = \frac{K_1[NO][O_2]}{K_{-1}} \dots\dots (01 \text{ mark})$$

Substitute the $[NO_3]$ to R_2

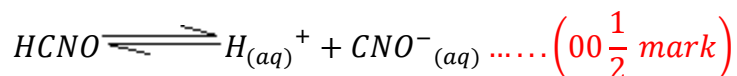
$$R_2 = K_2[NO_3][NO] \dots\dots (01 \text{ mark})$$

$$R_2 = \frac{K_2K_1}{K_{-1}} [[NO][O_2]][NO] \dots\dots (01 \text{ mark})$$

$$= K [NO]^2[O_2] \dots\dots (01 \text{ mark})$$

The proposed mechanism is not consistent with the rate law $R = K [NO]^2[O_2]$ (02 mark)

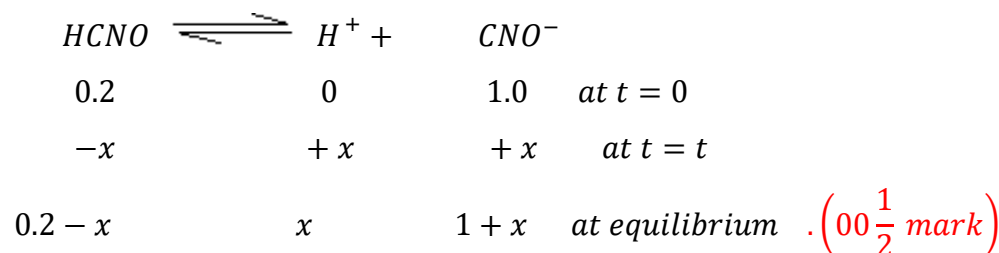
3. a) i) Ionization of HCNO (cyanic acid)



$$K_a = \frac{[H_{aq}^+][CNO^-]}{[HCNO]} \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$2.0 \times 10^{-4} = \frac{[H_{aq}^+][CNO^-]}{HCNO} \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$HCNO = \frac{0.10 \text{ mol}}{0.50 \text{ litre}} = 0.2 \text{ M (mol dm}^{-3}\text{)}$$



But $1.0 + x \approx 1.0 \text{ M}$ and $0.2 - x \approx 0.2 \text{ M}$ (00 $\frac{1}{2}$ mark)

$$K_a = \frac{x \times 1.0}{0.2} \text{ (00 } \frac{1}{2} \text{ mark)}$$

$$2.0 \times 10^{-4} = \frac{xM^2}{0.2M}$$

$$x = 4.0 \times 10^{-5} \text{ M}$$

$$[H^+] = 4.0 \times 10^{-5} \text{ M (00 } \frac{1}{2} \text{ mark)}$$

$$p^H = -\log[H^+]$$

$$= -\log(4.0 \times 10^{-5}) \text{ (00 } \frac{1}{2} \text{ mark)}$$

$$= 4.4 \text{ (00 } \frac{1}{2} \text{ mark)}$$

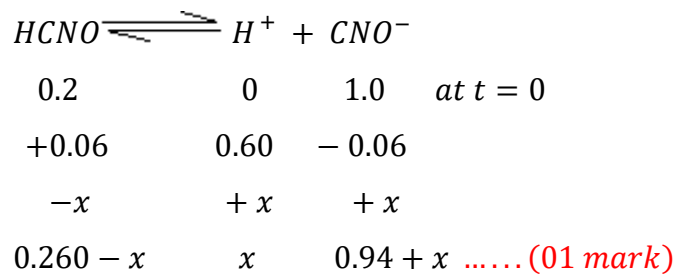
ii)

$$[HCl] = \frac{0.030 \text{ mol}}{0.5L} \text{ (01 mark)}$$

$$= 0.060 \text{ mol L}^{-1}$$

$$[HCl] = 0.060 \text{ mol L}^{-1} \text{ (01 mark)}$$

then



Assume $0.260 - x = 0.260M$ and $0.94 + x = 0.94$

then

$$K_a = \frac{[\text{H}^+][\text{CNO}^-]}{[\text{HCNO}]}$$
$$= \frac{(x) \times 0.94}{0.26} \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$2.0 \times 10^{-4} = \frac{0.94x}{0.260} \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$x = \frac{0.26 \times 2.0 \times 10^{-4}}{0.94}$$

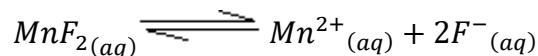
$$x = 5.5 \times 10^{-5} M = [\text{H}^+]$$

$$p^H = -\log[\text{H}^+]$$

$$= -\log(5.5 \times 10^{-5}) \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$p^H = 4.26 \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$\begin{aligned} \text{Molar solubility of } \text{MnF}_2 &= \frac{6.60 \text{g/L}}{92.9 \text{g/L}} \\ &= 0.071044 \text{ mol/l}^{-1} \dots\dots (01 \text{ mark}) \end{aligned}$$

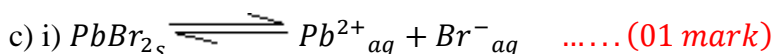


$$K_{sp} = [Mn^{2+}] [2F^{-}]^2 \quad \dots\dots (01 \text{ mark})$$

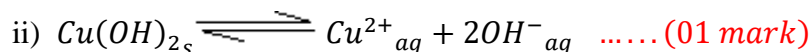
$$[Mn^{2+}] = 0.071044M \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

$$[F^{-}] = 0.14209M \quad \dots\dots \left(00 \frac{1}{2} \text{ mark}\right)$$

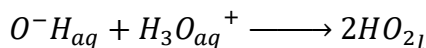
$$K_{sp} = [0.071044M] [0.14209M]^2 \\ = 1.4 \times 10^{-3} M^{-3} \quad \dots\dots (01 \text{ mark})$$



Br^{-} is the anion of HBr as strong acid so it does not react with H_3O^{+} . Has no effect on its solubility $\dots\dots (01 \text{ mark})$



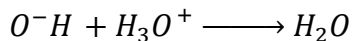
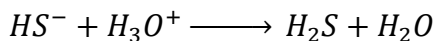
OH is the anion of HO_2 , a very weak acid it will react with H_3O^{+} ,



Addition of strong acid will cause an increase on solubility



S^{2-} is the anion of HS^{-} is weak acid and strong base, it will react completely with H_2O to form HS^{-} and $O^{-}H$, both of these ions will react with added H_3O^{+} ,

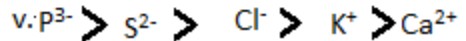
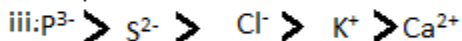
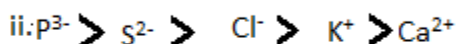


So addition of strong acid will cause an increase in solubility $\dots\dots (01 \text{ mark})$

4.(a) Polarizing power is the ability of small cation to distort the valency shell of large anion

While Polarizability is the easiness of large anion to be distorted by small cation. (01marks)

(b)



(2@=10marks)

(c) i. Mg has large number of shells compared to Mg^{2+}

Also Mg has more screening or shielding effect due to large number of shells

ii. This is due to the large ionic size of K^+ compared to Li

iii. This is because Al has high nuclear charge leading to more contraction of the valency shell compared to Fe

iv. This is because its valency electron is found in s-orbital hence is located in the s-block (2@)=08marks)

(d) i. It shows the correct position of hydrogen in the periodic table

ii. It shows the position of isotopes in the periodic table

iii. The table assigned the correct position of noble gases

iv. Elements of the same chemical properties were placed in the same group

(any two points [0.5@=01marks](#))

5. a) i)

- They form colored compounds
- They have variable oxidation state
- They form complex compounds with ligands
- They are catalytic in nature
- They have magnetic property

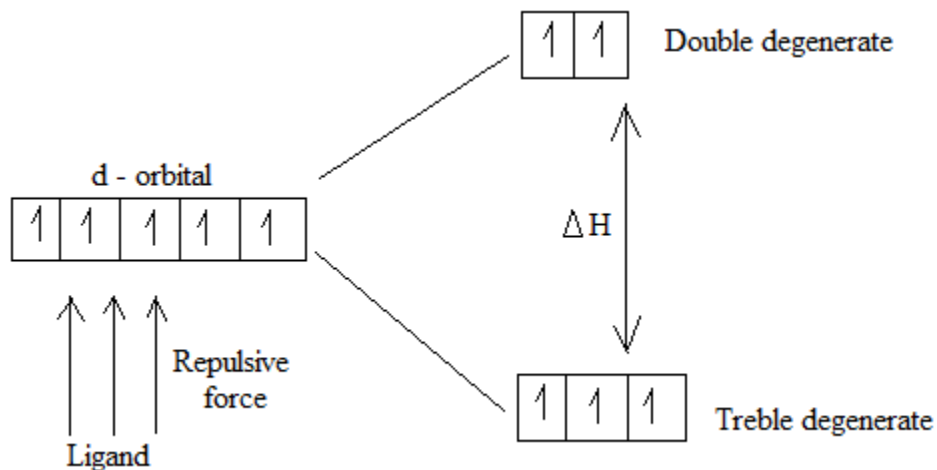
ii) According to crystal field theory, there must be two conditions which are:

- a) Presence of unpaired electron in the d-orbital
- b) Presence of $-ve$ charged species called ligand

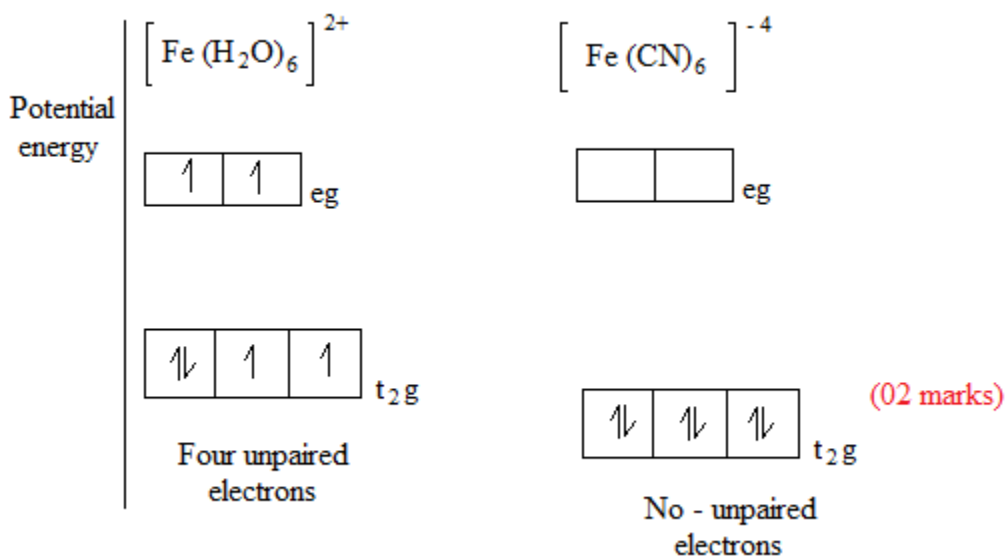
The process starts when the ligand approaches the d-orbital containing unpaired electron which exerts repulsive effect causing the splitting of d-orbital into two parts which are double degenerate and triple degenerate.

The double degenerate has raised energy hence found on upper part while the triple degenerate has lower energy and found on the lower part. The gap separation between the double and triple degenerate is very small, thus the normal radiant energy can excite electron from triple to double degenerate making it to be unstable. To maintain the stability of electron it has to fall from higher level (double degenerate) to triple

degenerate by emitting radiant energy whose wavelength are within the visible part of hydrogen spectrum, hence can be visible to human eyes.



b) i)



ii) $[Ni(H_2O)_6]Cl_2$

- Charge of central ions is +2 and coordination number is 6..... (01 mark)

$[Cr(en)_3](ClO_4)_3$

- Charge of central ion is +3 and coordination number is 6 (01 mark)

c) i) Diclorobis(ethylenediamine) platinum (IV) chloride (01 mark)

ii) Diaminesilver (I) dicyanoargentate (I) (01 mark)

d) i) $(NH_4)_2[CuCl_4]$ (01 mark)

ii) $[Pt(NH_3)_5Cl]Br_3$ (01 mark)

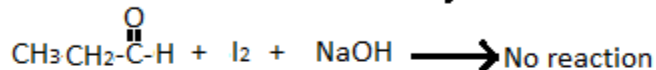
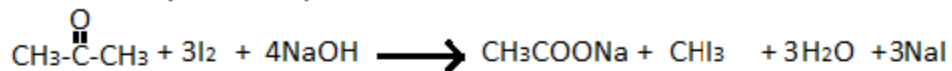
iii) $(NH_4)_2[Ni(C_2O_4)_2(H_2O)_2]$ (01 mark)

iv) $Na_2[NiCl_4]$ (01 mark)

v) $[Co(en)_3]_2(SO_4)_3$ (01 mark)

6. (a) Iodoform test is the reaction between iodine gas in alkaline condition with organic compounds that contain terminal methyl attached to the alpha carbon especially carbonyl compounds and alcohol

(b) Propan-2-one respond positively on iodoform because it contain terminal methyl while propanal does not react with iodoform test due to the absence of terminal methyl at the alpha carbon as shown below:-



(c)

