CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)

NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)

FORM SIX PRE-NATIONAL EXAMINATIONS 2023

132/1 CHEMISTRY 1

MARKING SCHEME

1.(a)

(i) (01 mark)

Emission spectrum	Absorption spectrum
-It is created when the atoms of an element releases energy	-It is created when the atoms of an elements of an element absorbs energy
-Constitutes of coloured lines which can be seen in the spectrum	-It constitutes the dark lines in the spectrum

(ii) **(01 mark)**

Line spectrum	Continuous spectrum
-Seen as isolated lines separated by large gaps contain only few wavelength.	-Contain all the wavelength in given range
-It is characteristic of an atom	-It is characteristic of molecules

(iii) **(01 mark)**

Atomic orbital	Degenerate orbital
-Can have different energy levels	-Have the same energy level

(b) $n_1 = 2$

$n_2 = 5$

$RH = 1.09678 \times 10^7 m^{-1}$

$\lambda = ?$

$1/\lambda = RH\ (1/n_1^2 - 1/n_2^2)$ **(01 marks)**

$1/\lambda = 1.09678 \times 10^7\ (1/2^2 - 1/5^2)$ **(01marks)**

$= 2, 303238 m^{-1}$

$\lambda = 4.342 \times 10^1 0^{-7} m$ **(01 marks)**

$1nm = 10^{-9} m$

$x = 4.342 \times 10^{-7} m$

$x = 4.342 \times 10^{-7} m \times 1nm\ 1 \times 10^{-9} m$

$x = 4.342 \times 10^2 nm$

$= 434.2nm$ **(01 marks)**

The wave length of the photon is 434.2nm Region visible (01 marks)

(c) Given

$\Delta x = 0.4A^{\circ} = 0.4 \times 10^{-10} m$

$\Delta p = m\Delta V$

$h = 6.63 \times 10^{-34} Js$

From $\Delta x.\Delta p \geq h/2\pi$

$\Delta p \geq h/2\pi\Delta x$ **(01 marks)**

but, $\Delta p = m\Delta V$

$m\Delta V \geq h/2\pi\Delta x$

$\Delta V \geq h/2\pi\Delta xm$

$\Delta V \geq 2.63\times10^{-34}/2\pi\times9.11\times10^{-31}\times0.4\times10^{-10}$ **(01 marks)**

$\Delta V \geq 2.896\times10^{6}$m/s

∴ the uncertainty in velocity is 1.149×10^{6}m/s **(01 marks)**

2. (a)

i. Hydrogen bond is the bond formed between hydrogen atom of one molecule and the most electronegative element of another molecule or within the same molecule
ii. Van der Waal forces is the weak intermolecular forces that exist between un charged atoms or molecules
iii. Dative bond is type of covalent bond formed by one side sharing of electrons.
iv. Polar covalent bond is the bond formed between atoms with large electronegativity difference. Also it can be defined as the type of covalent bond that has un equal sharing of electrons between the two bonded atoms
v. Intramolecular hydrogen bond is the type of hydrogen bond formed between hydrogen atom and the most electronegative element within the same molecule.

(b) i. Tetrahedral in shape. Example saturated hydrocarbon, water, ammonia e.t.c

ii. Trigonal planar. Example all alkene, BF3 e.t.c

iii.Octahedral in shape. Example SF6, PCl6, Hexaaquacobalt(iii) ion

(c)This is because CO2 is linear in shape, hence its dipole moment is zero While SO2 has bent structure due to the lone pair of sulfur hence its dipole moment is greater than zero.

(d) i.Only the molecule at which hydrogen atom is attached to the most electronegative atom can form hydrogen bond

ii. The most electronegative atom must be small in size

iii.The most electronegative atom must contain at least one lone pair

3. a) i) Charles law

State that "At a constant pressure, the volume of a fixed mass of a gas is directly proportional to the absolute temperature.

$$V \propto T$$

$$V = kT \qquad \ldots\ldots(01\ mark)$$

ii) State that "At the same temperature and pressure equal volume of gases contain number of particles

$$V \propto n$$

$$V = kn \qquad \ldots\ldots(01\ mark)$$

iii) State that "The total pressure of a mixture of gases is equal to the sum of the partial pressure of all the gases in the mixture"

$$P_T = P'_A + P'_B + P'_C \cdots \quad \ldots\ldots (01\ mark)$$

b) i) Because yeast release bi-products carbon dioxide and alcohol from a dough. When the bread is baking (increase in temperature) the carbon dioxide makes tiny bubbles i.e increase in volume of carbon dioxide and thus causes the bread to become fluffy. This is an application of Charles law. $\ldots\ldots (01\ mark)$

ii) It shrinks because at a constant pressure, if the temperature drops, the volume decreases also Charles law application. $\ldots\ldots (01\ mark)$

c) Data

$V_{N_2} = 15.3\ cm^3$

$T = 25°C + 273 = 298K$

$P = 755mmHg/760 = 0.9934\ atm$

$Mr_{Azide} = Na + 3N$

$= 23 + (3 \times 14)$

$M_r = 65\ g/mol$

$M_{N_2} = 28\ g/mol$

$m = ?$

From

$2NaN_{3(s)} \longrightarrow 2Na_{(s)} + 3N_{2(g)} \ldots\ldots (01\ mark)$

1st Find no. of moles of N_2

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{0.9934atm \times 15.3 \times 10^{-3}dm^3}{0.0821atmdm^3mol^{-1}K^{-1} \times 298}$

$n = 6.21 \times 10^{-4} mol$ $\ldots\ldots\left(00\frac{1}{2}\ mark\right)$

No of moles of NaN_3 from equation

$$2\ moles\ of\ NaN_3 \longrightarrow 3\ moles\ of\ N_2$$

$$x? \longrightarrow 6.21 \times 10^{-4}$$

$$x = \frac{6.21 \times 10^{-4} \times 2}{3}$$

$$x = 4.142 \times 10^{-4}\ moles\ of NaN_3 \quad \ldots\ldots\left(00\frac{1}{2}\ mark\right)$$

$mass\ of\ sodium\ azide.$

$$no\ of\ moles = \frac{mass}{molar\ mass}$$

$$mass = no\ of\ moles \times molar\ mass$$

$$= 4.142 \times 10^{-4}\ moles \times \frac{68g}{mol}$$

$$= 0.02691g \quad \ldots\ldots\left(00\frac{1}{2}\ mark\right)$$

Therefore mass of sodium Azide decomposed is $0.02691g$

4. (a) Colligative properties are the ones which depend only on the number of solute particles present, not on the identity of the solute particles.

(b) -Vapor pressure lowering

-Boiling point elevation

-depression of freezing point of solvent in solution

-Osmotic pressure

(c) -Molecular mass of substances can be determined.

-Whether a solution is iso-osmotic or not can be found.

-The behavior of solution of electrolytes can be understood.

-The osmotic properties of body fluids such as lacrimal fluids and blood can be evaluated.

- Isotonic solutions can be prepared.

(d) Rault's Law states that"

(e) Correct derivation of Rault's equation

5.(a) Soluble metal sulphate are prepared by the action of sulphuric acid on metal oxide, metal hydroxide, metal carbonate or active metals

Example.

$$Mg + dil.H_2SO_4 \longrightarrow MgSO_4 + H_2$$

$$ZnCO_3 + dil.H_2SO_4 \longrightarrow ZnSO_4 + CO_2 + H_2O$$

Insoluble metal sulphate are prepared by precipitation method of the soluble salt of barium and lead.

Example

$$BaCl_2 + H_2SO_4 \longrightarrow BaSO4 + HCL$$

$$Pb(NO_3)_2 + H_2SO_4 \longrightarrow PbSO4 + HNO_3$$ (04marks)

(a) i. V is $CuCO_3$ and Y is CuO

ii.X is CO_2 and Z is NO_2

iii. $CuCO_3 + 2HNO_3 \longrightarrow Cu(NO_3)_2 + CO_2 + H_2O$

iv. $2Cu(NO_3)_2 \longrightarrow 2CuO + 4NO_2 + O_2$ (06marks)

6. a)

i. Is the enthalpy change that takes place when one mole of a compound is found from its elements ……$(01\ mark)$

ii. Is the amount of heat absorbed or evolved when the reaction goes to completion.

……$(01\ mark)$

iii. Is the enthalpy change of a system when one mole of the substance is completely burnt in oxygen ……$(01\ mark)$

iv. Is the heat evolved or absorbed when a substance changes from one physical form to another ……$(01\ mark)$

b) i) Equation

$CH_3OH_{(l)} + \frac{3}{2}O_{2(g)} \longrightarrow CO_{2_{(g)}} + 2H_2O_{(l)}$ ……$(01\ mark)$

ii) $\Delta_C H = \sum \Delta_f H_{products} - \sum \Delta_f H_{(reactants)}$

$= (-394 + (2 \times -286)) — (-234)\ KJmol^{-1}$

$= -732 KJmol^{-1}$ ……$\left(00\frac{1}{2}\ mark\right)$

c) i) $\Delta H = \sum(enthalpy\ of\ bonds\ broken\ ) - \sum((enthalpy\ of\ bonds\ formed\ ))$

$\Delta H_{(broken\ bonds\ )} = \left((18 \times C - H + (2 \times C - C) + (5 \times O = O)\right)$

$= (18 \times 413) + (2 \times 347) + (5 \times 498)\ KJmol^{-1}$

$= 6488\ KJmol^{-1}$ ……$\left(00\frac{1}{2}\ mark\right)$

$\Delta H_{(\ bonds\ formed\ )} = \left((6 \times C = O) + (8 \times O - H)\right)$

$= \left((6 \times 743) + (8 \times 464)\right) KJmol^{-1}$

$= 8170\ KJmol^{-1}$ ……$\left(00\frac{1}{2}\ mark\right)$

$\Delta H = 6488\ KJmol^{-1} - 8170\ KJmol^{-1}$

$= -1682\ KJmol^{-1}$ ……$\left(00\frac{1}{2}\ mark\right)$

ii)

ΔH is negative therefore reaction is exothermic ……$(01\ mark)$

7. (a)(i) Homogeneous catalyst is the catalyst which is in the same phase as both reactants and products. **(01 marks)**

(ii) Heterogeneous equilibrium is the equilibrium which involves the species in different phases. **(01 marks)**

(iii) Dynamic equilibrium is the equilibrium in steady state since the forward reaction occur at the same rate **(01 marks)**

(b)Equilibrium constant.

$N_2O_4(g) \longleftrightarrow 2NO_2(g)$ K_1 0.115.....(i)

$2N_2O_4(g) \longleftrightarrow 2N_2O(g) + 3O_2(g)$ K_2 $1.37\times10-1$.....(ii)

Inverting equation 1: $2NO_2(g)$ $N_2O_4(g)$ $K_1^{-1} = 1/0.115 = 8.696$.....(iii) **(01 marks)**

$2N_2O_4(g) \longleftrightarrow 2N_2O(g) + 3O_2(g)$ K_2 1.37×10^{-1}.....(iv)

Multiply equation (iii) by 2

$4NO_2(g) \longleftrightarrow 2NO_4(g)$ $(K_1^{-1})^2 = 75.62$.....(v)

$2N_2O_4(g) \longleftrightarrow 2N_2O(g) + 3O_2(g)$ $K_2 = 1.37\times10^{-1}$.....(iv) **(01 marks)**

Addition of equation (v) and (iv)

$4NO_2(g) \longleftrightarrow 2NO_4(g)$ $(K_1^{-1})^2 = 75.62$.....(v)

+

$2N_2O_4(g) \longleftrightarrow 2N_2O(g) + 3O_2(g)$ K21.37×10−1.....(iv)

$4NO_2(g) \longleftrightarrow 2N_2O(g) + 3O_2(g)$ $(K_1^{-1})^2 \times K_2 = 10.36$

∴ $K_3 = 10.36$ **(01 marks)**

(c)Finding the reaction quotient,QC

$QC = [NH_3]^2 / [N_2][H_2]^3$ **(0.5 marks)**

$[NH_3] = 6.42\times10^{-4}$ mol 3.50L = 1.83×10^{-4}mol/L

$[N_2]$ = 0.249mol in 3.50L = 0.0711mol/L **(01 marks)**

$[H_2] = 0.24\times10^{-2}$mol in 3.50L = 9.17×10^{-3}mol/L

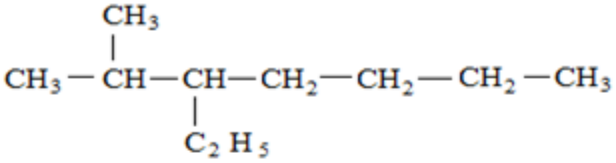
QC = $(1.83\times10-4\ )^2$ /$(0.0711)(9.17\times10-3)^3$ **(01marks)**

QC = $5.14\times10^{-5}L^2mol^{-2}$

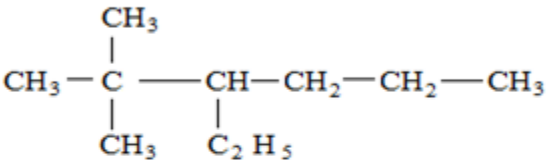
Given KC = 1.2 Then QC < KC the system is not at equilibrium In order to establish equilibrium the system has to move forward.**(01 marks)**

8. a)

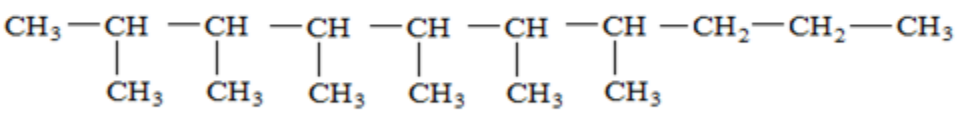
i)



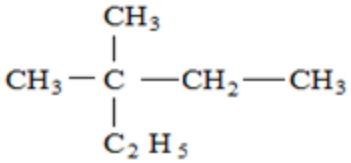
ii)



iii)



iv)



(02marks)

(b) i. CH_3CH_2-C(CH_2CH_3)-$CH_2CH_2CH_2CH_3$ 3-ethyl-2-methylheptane

ii. CH_3-C(Br)(Cl)-$CHCH_2CH_3$ (with $CH_2CH_2CH_3$) 2-Bromo-2-chloro-3-ethylpentane

iii. H-C ≡ C - CH=$CHCH_3$ Pent-3-en-1-yne

iv. CH_3CH(Br)-CH_2CH(CH_2CH_3)-$CH_2CH_2CH_2CH_3$ 2-Bromo-4-ethyloctane

v. $CH_3CH = CH-CH = CH-CH_3$ Hex-2,4-diene

(10marks)

c)

i) $CH_2 = CH_2 \xrightarrow{Br_2} BrCH_2CH_2Br \xrightarrow[Alcohol]{KOH} CH_2 = CHBr \xrightarrow{NaNH_2} HC \equiv CH$

$\ldots\ldots(01.5\ mark)$

ii) $CH \equiv CH \xrightarrow{NaNH_2} HC \equiv C^-Na^+ \xrightarrow{CH_3CH_2Br} HC \equiv CCH_2CH_3$ $\ldots\ldots(01.5\ mark)$

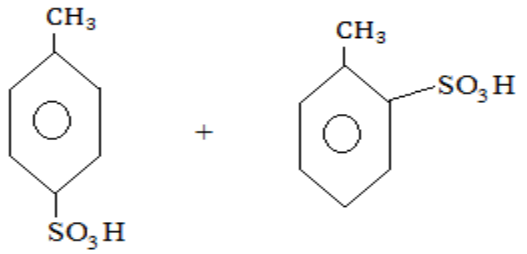
9. a) i) $2,3 - dibromo - 5 - chloronitrobenzene$ $\ldots\ldots(01\ mark)$

ii) $2,3,4,5 - tetrachlorophenol$ $\ldots\ldots(01\ mark)$

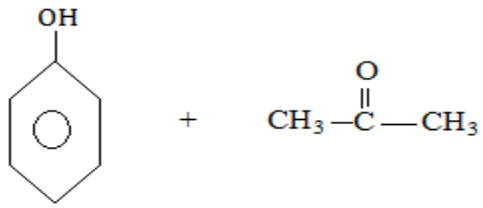
iii) $1 - Bromo - 2 - phenythlethane$ $\ldots\ldots(01\ mark)$

iv) $1 - methylethylbenzene$ $\ldots\ldots(01\ mark)$

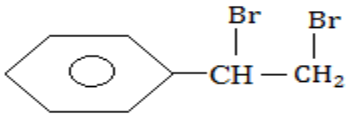
b)

i) 

(02 marks)

ii) 

(02 marks)

iii) 

(02 marks)

iv) $C_6H_6 + HBr$ (02 marks)

C.

A —— $CH_3CH_2CH_2CH_2CH_3$

B —— $CH_2 = CH_2$

C —— $CH_3CH_2CH_3$

D —— $HO\text{-}CH_2CH_2\text{-}OH$

E —— $H\text{-}C \equiv C\text{-}H$

F —— 

10 10. (a).

i. Active soil acidity is the quantity of hydrogen ions that are present in a soil water solution

ii. Potential soil acidity is the soil resistance to the change in Ph

iii. Liming material are material rich of calcium and magnesium that are added to the soil to increases the ph of the soil

iv. Cation exchange capacity is the maximum quantity of the total cations of any clas that a soil is capable of holding at a given ph value available for exchange with soil solution.

or Cation exchange capacity is the sum of exchangeable cations held in 100g of oven dry soil.

v. Percentage base saturation is the percentage of cations exchange site occupied by a basic cation (05marks)

(b)(i) CEC of the soil

=number of exchangeable base cations +number of exchangeable acid cations

= (9.9+2.1+2.0+7.6+0.6+1.0)meq

= 22.3 meq

Hence CEC if the soil is 22.3meq/100g (01mark)

ii)percentage base saturation

recall CEC of the soil = number of base cation + number of acidic cation

number of basic cation = CEC of the soil- number of acidic cation

= 22.3 – 8.2

= 14.1 meq/100g (02marks)

$$\text{Percentage of base saturation(PBS)} = \frac{\text{Number of basic cation}}{\text{Cation exchange capacity}} \times 100\%$$

$$= \frac{14.1}{22.3} \times 100\%$$

$$= 63.23\%$$

Hence percentage base saturation is 63.23% (02marks)

(iii)

$$\text{Percentage of aluminium saturation} = \frac{\text{Number of aluminium ion}}{\text{CEC of the soil x100\%}}$$

$$= 7.6/22.3 \times 100\%$$

$$= 34.1\%$$

Hence percentage aluminium saturation is 34.1%

(02marks)

(c) - Heavy rains and irrigation which cause leaching of bases eg Na , K +, Ca2+ and Mg^{2+}

- Microbial activities and decomposition of organic matter which produces CO_2 which form H_2CO_3 with water.
- Presence of acidic radicals such as NO^{-3} , SO_4^{2-} , and Cl^-
- Application of acid forming fertilizers eg Ammonium sulphate
- Acid deposition
- Disposal of organic wastes. **(Any four points@01 marks)**