THE UNIVERSITY OF YAOUNDE I
ECOLE NORMALE SUPERIEURE ANNEXE BAMBILI
COMMON ENTRANCE EXAMINATION JUL 2010 SEESION
FIRST CYCLE-GENERAL EDUCATION
**PAPER: PHYSICS (MINOR) SERIES: CHEMISTRY 3 HRS-COEF 2**



## EXERCISE 1 (3mks)

A very long string has a linear density of 5.0 $g/cm$ and is stretched with a tension of 8.0 $N$. Then 100 $Hz$ waves with amplitudes of 2.0 $cm$ are generated at the ends of the string.

1.1. What is the node spacing along the resulting standing wave?
1.2. What is the maximum displacement of the string?

## EXERCISE 2 (9mks)

2.1 Give the precise and concise definitions of: energy, power.
2.2 State the law of conservation of mechanical energy.
2.3 State the law of conservation of linear momentum.
2.4 A billiard ball moving at $v_1 = 10.0\ m/s$ along the positive $x$-axis collides with a second billiard at rest. The balls have identical masses. After the collision, the incoming ball moves on with a speed of $v_2 = 7.7\ m/s$ at an angle of 40° from the $x$-axis. What is the speed and direction of motion of the struck ball?
2.5 A 200 $g$ steel ball hangs on a 1.0 $m$ long string. The ball is pulled sideways so that the string is at a 45° angle, then released. At the very bottom of its swing the ball strikes a 500 $g$ steel paperweight that is resting on a frictionless table. To what angle does the ball rebound?

## EXERCISE 3 (3mks)

Eight point charges, each of magnitude $q$, are located on the corners of a cube of side $s$ as shown in *Fig 1*.

3.1 Determine the $x$, $y$, and $z$ components of the resultant force exerted on a test charge $Q$ located at the centre of the cube.

3.2 The charge at point $A$ is removed. What are the magnitude and direction of this resultant force on the charge $Q$ at the centre of the cube?

EXERCISE 4 (5mks)

4.1 Gas confined by a piston in a heat engine expands against a constant pressure of $100\ kPa$. When a $2 \cdot 10^4\ J$ of heat are absorbed by the system, the volume of the gas expands from $0.15\ m^3$ to $0.25\ m^3$.

a. What is the work done by the system during this process?

b. State the first law of thermodynamics.

c. Determine the change in internal energy of the system.

4.2 A $100\ g$ copper calorimeter contains $300\ g$ of water at room temperature ($T = 23°C$). If $50\ g$ of ice at $0°C$ is added to the calorimeter, what is the final temperature of the system? Take: $L = 80\ cal/g$ for ice, $c_w = 1\ cal/g \cdot °C$, $c_c = 0.092\ cal/g°C$.

4.3 Repeat the calculations of question 3.2 and explain what will happen if the initial mass of ice is $100\ g$.

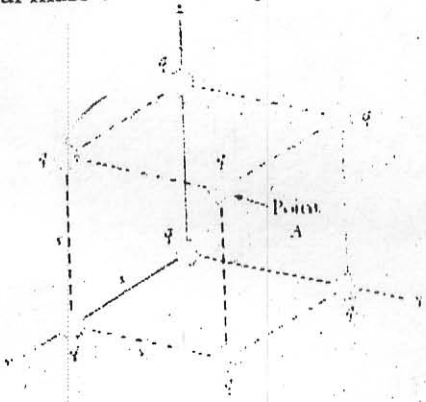


*Fig. 1*

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2010

PAPER: CHEMISTRY (MAJOR) SERIES: CHEMISTRY 3 HRS COEF. 4

CHEM

Exercise 1 :

Aqueous potassium permanganate reacts with hydrochloric acid to give manganese dichloride, chlorine, potassium chloride

$KMnO_4 + HCl \longrightarrow MnCl_2 + Cl_2 + KCl + H_2O$ (E)

1.1 Show that it is an oxidation reduction reaction

1.2 Balance each half equation below

$MnO_4^- + H^+ + e^- \longrightarrow Mn^{2+} + H_2O$

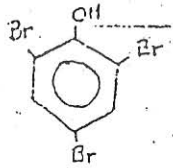
$Cl^- \longrightarrow Cl_2 + e^-$

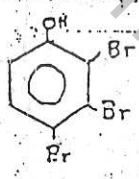
1.3 Give the over all equation of the two half- equations then from it balance equation (E) above.

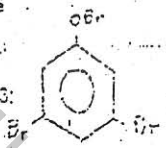
Exercise 2

Two vessels A and B contain phenol and Hex – 1-ene respectively. Bromine is added into each vessel. In each reaction one product is isolated from A and one from B.

2.1 Choose among the following which is the product isolated from A (Whose molecular formula is $C_6H_3OBr_3$) and give the reason (s) of your choice

A1: 

A2: 

A3: 

2.2 Choose among the following which is the product isolated from B (Whose molecular is $C_6H_{12}Br_2$) and give the reason (s) of your choice

B1: $CH_2Br-CH_2-CH_2-CH_2-CH_2-CH_2Br$ B2: $CH_2Br-CHBr-CH_2-CH_2-CH_2-CH_3$

B3: $CH_3-CHBr-CH_2-CH_2-CH_2-CH_3$

2.3 Choose among the following one for each vessel which is the type of reaction that takes place in it.

- Electrophilic addition
- Nucleophilic addition
- Electrophilic substitution
- Nucleophilic substitution

2.4 Write a balanced equation for the reaction that takes place in each vessel.

2.5 Phenol reacts faster than benzene with bromine (no need of catalyst while there must be a catalyst with benzene). How can you explain this?

Exercise 3

3.1. Give the Lewis structures and the shapes of $NH_3$ and $SF_3$ molecules.

3.2 $NH_3$ forms a complex with $BF_3$. Give the type of bonds in the complex

Exercise 4

The acid dissociation constant, Ka for nitrous acid $HNO_2$ is $4.0 \times 10^{-4}$

An aqueous solution of nitrous acid has a molar concentration of 0.1 mol/l.

4.1 Calculate the concentrations of $H_3O^+$, $NO_2^-$ and $HNO_2$ in the solution

4.2 What is the pH of a solution containing 0.05 mol/l of $HNO_2$ and 0.05mol/l of $KNO_2$?

4.3 When a small amount of hydrochloric acid is added to the buffer solution of 4.2 how change the concentrations of $HNO_2$ and $NO_2^-$?

Exercise 6

The rate of the reaction $2A + B \longrightarrow$ has been determined experimentally. Determine the rate law from the following data and calculate the rate constant.

| Experiment | [A] i (mol/l) | [B]i (mol/l) | Initial rate (mol/l.s) |
|---|---|---|---|
| 1 | 0.1 | 0.01 | $1.2 \times 10^{-3}$ |
| 2 | 0.1 | 0.02 | $4.6 \times 10^{-3}$ |
| 3 | 0.1 | 0.04 | $1.9 \times 10^{-2}$ |
| 4 | 0.2 | 0.01 | $2.4 \times 10^{-3}$ |
| 5 | 0.3 | 0.01 | $3.6 \times 10^{-3}$ |

Exercise 7

Give the names of the following complex molecules

M: $[Co(NH_3)_6]^{3+}$ N: $K_2[Ni(CN)_4]$