CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)

NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)

FORM SIX PRE-NATIONAL EXAMINATION 2023

131/2 **PHYSICS 2**

MARKING SCHEME

a. (i) Because its density changes with change in its pressure ***(2marks)***

(ii) Given

Rate of change of volume $\frac{v}{t}$ = 1000cm$\frac{3}{5}$ radius of a pipe = 10cm. ***1mark.***

From the formula

$\frac{dv}{dt}$ = AV ***1mark***

$\frac{dv}{dt}$ = 1000cm^{3}5

But

A=πr^2

A=(10)$^2\pi$ ***1mark***

V= $\frac{1000CM^35}{100\pi\ CM^2}$

V= 3.18CM/S

= Velocity = 3.18cm/s ***1mark***

b. (i)ρ= Density of Fluid ***1mark***

(ii)p = Pressure ***1mark***

(iii)V= Volume ***1mark***

(iii) – The flow must be steady (Velocity, Pressure and density cannot change at any point) 2mark

- The flow must be incompressible even when the pressure varies, the density must remain constant along the streamline 2mark

c. Radius = 1m

Height(h) = 5m

Height(h) = 6m

Area = 10^{-5} m^2

(i) From the formula

$V = \sqrt{2gh}$

$V = \sqrt{2 \times 9.8 \times 5}$ ***1mark***

V= 9.9m/s

Initial speed = 9.9m/s $1/2$ marks

(ii) The initial horizontal distance

From

X = vt ***1mark***

$X = (\sqrt{2gt}) \frac{\sqrt{2h}}{g}$ ***1mark***

$X = \frac{\sqrt{2 \times 9.8 \times 5 \times 2 \times 5}}{9.8} = 10m$ ***1/2mark***

The horizontal distance from the tank = 10m ***1/2 mark***

(iii) Time taken to empty the tank

From

$t = 2\frac{A1}{A2} X \frac{\sqrt{h}}{2g}$ ***1mark***

$t = \frac{2\pi m2}{10\ M} X \frac{\sqrt{5M}}{2\ X\ 9.8M/S}$ ***(1mark)***

Time taken to empty the tank = 3.17 x 10^4s ***(1mark)***

2 (a)(i)Polaroid;

- ✓ is an artificial crystalline material which can be made in thin sheets.
- ✓ It has the property of allowing only light waves due to vibrations in a particular plane to pass through.
- ✓ Polaroid, because of its internal structure, transmits only those vibrations of light in a particular plane.(1 marks)

(ii) Polarising angle;

- ✓ The particular angle of incidence i on a transparent medium when the reflected light is almost completely plane-polarised. (1 marks)

(iii)

Unpolarised light	**Polarized light**
• Vibrations of ordinary light at a point. • **Unpolarised light**; refers to ordinary light in which vibrations are in every plane at right angles to the direction of the light.	• Plane polarized light; light due to vibrations in one plane. • **Plane polarized light**; the vibrations are only in one plane perpendicular to the direction of the light. (3 marks)

(b) (i) Difference between the sound waves and light waves

- ✓ Sound waves are longitudinal in nature whereas light waves are transverse.

- ✓ Wavelength of sound wave is quite large whereas the wavelength of light waves are extremely small.
- ✓ Sound waves can not travel through vacuum whereas light waves can do so.(3 marks)

(ii) No. only the frequency of a wave that undergoes a change where there is a motion of the source. (2.5 marks)

(iii) There are two basic conditions for an echo to be heard.

- The obstacle should be rigid and of large size.
- The obctacle should be at least a distance of 17 m from the source. But the length of a room is less than 17 m, therefore no echo is heard in the room.(2marks)

(c) (i) Given $R = 8.36\,Jmol^{-1}K^{-1}$, $\gamma_{gas} = 1.3$, $T = 143K$

Molecular weight of methane CH_4 =12+4=16g

The velocity of sound in a gas is given by

$$v = \sqrt{\frac{\gamma RT}{M}} = \sqrt{\frac{1.3\times 8.36\times 143}{16\times 10^{-3}}} = 311.6\,m/s$$ (2 marks)

(ii) Let t_1 and t_2 be the time taken by sound to cover a distance of 660 m in steel pipe and air respectively.

Speed of sound in steel, $v_s = \sqrt{\frac{K}{\rho}}$, where K is bulk modulus of elasticity of steel and ρ is its density.

From $v_s = \frac{l}{t_1}$

$$t_1 = \frac{l}{v_s} = l\sqrt{\frac{\rho}{K}} ----------------(i)$$ (2 marks)

Also $t_2 = \frac{l}{v_a} -----------------(ii)$

but $l = 660m$ and $v_a = 330\,m/s$

$$t_2 = \frac{660}{330} = 2s$$

It is given $t_2 - t_1 = 1.89$ ---------------- (iii)

$$2 - l\sqrt{\frac{\rho}{K}} = 1.89$$

$$l^2\frac{\rho}{K} = (2-189)^2 = 0.11^2$$

$$K = \frac{l^2\rho}{(0.11)^2} = (660)^2 \times \frac{8\times10^3}{(0.11)^2}$$

$$K = 2.88\times10^{11}\,N/m^2$$

(d) (i) A plane progressive wave travelling in the $x-$direction is given by;

$$y = a\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$$

Given $a = 2cm,\ v = 45m/s$ and $f = 75s^{-1}$ (1.5 marks)

$$T = \frac{1}{f} = \frac{1}{75} = 0.0133s$$

$$\lambda = \frac{v}{f} = \frac{45}{75} = 0.6m = 60cm$$

The equation of the wave is $y = 2\sin 2\pi(75t - \frac{x}{60})$ (2.5 marks)

(ii) Given distance $x = 135cm$ from the origin $t = 3s$, then

$$y = 2\sin 2\pi\left(75\times3 - \frac{135}{60}\right) = 2\sin 2\pi(225 - 2.25)$$

$$y = 2\sin(-4.5\pi)$$

$$y = -2cm$$

3(a) i) Hook's law states that provided that the elastic limit is not exceed, the extension of a
material is directly proportion to the tension applied. $\ldots..(02\ mark)$

ii) Solution

$$Stretching\ force\ \ F = EA\frac{e}{l}$$

$$Energy\ stored = \frac{1}{2}Fe\ \ldots..(01\ mark)$$

$$= \frac{1}{2} EA \frac{e^2}{l}$$

$= \frac{1}{2} \times 2 \times 10^{11} \times 3 \times 10^{-6} \times (1 \times 10^{-3})^2$ ..... (01 mark)

$Energy\ stored = 0.075J$ ..... (01 mark)

b) $Kinetic\ energy\ of\ an\ object\ =$
$Energy\ stored\ in\ the\ rubbe$ ..... (01 mark)

Force stretching rubber, $F = EA\frac{e}{l}$

$$= \frac{6 \times 10^8 \times 2 \times 10^{-6} \times 0.04}{0.2}$$

$= 240N$ ..... (01 mark)

Energy stored in the rubber $= \frac{1}{2} \mathrm{F} \cdot \mathrm{e}$

$$= \frac{1}{2} \times 240 \times 0.04$$

$= 4.8J$ ..... (01 mark)

$\therefore \frac{1}{2} mv^2 = 4.8N$

$$v^2 = \frac{2 \times 4.8}{0.01}$$

$$v = \sqrt{\frac{2 \times 4.8N}{0.01}}$$

$v = 31m/sec$ ..... (01 mark)

c) i) Proves of surface tension of water
- Pond skaters walk on water ponds..... (01 mark)

- A dry needle is made to float in water for some time although it is denser than water.. $(01\ mark)$
- Drop lets of water are found to be formed in tapes when closed. ..... $(01\ mark)$

ii) Solution

$$Work\ done = surface\ tension \times change\ in\ surface\ area ..(01\ mark)$$

$= \gamma \times 2(4\pi r^2)$ $\quad (2\ surfaces\ incontact\ with\ air)$
..... $(01\ mark)$

$= 2.5 \times 10^{-2} \times 2 \times 4\pi(5 \times 10^{-3})^2$ ..... $(01\ mark)$

$= 1.57 \times 10^{-5} J$ ..... $(01\ mark)$

d) Solution

$$number\ of\ drops = \frac{volume\ of\ large\ drop}{volume\ of\ small\ drop} ..... (01\ mark)$$

$$125 = \frac{\frac{4}{3}\pi R^3}{\frac{4}{3}\pi r^3}$$

$$125 = \frac{R^3}{r^3} ..... (01\ mark)$$

$$\frac{R}{r} = (125)^{1/3}$$

$$r = \frac{(125)^{1/3}}{R} ..... (01\ mark)$$

$$= \frac{5}{5}$$

r = 1 mm ..... $(01\ mark)$

The radius of small drops is 1 mm

4(a) i)Time constant of a capacitor is the time taken for a capacitor to discharge to $\frac{1}{e}$ of its initial charge. $\ldots..(02\ marks)$

ii)from

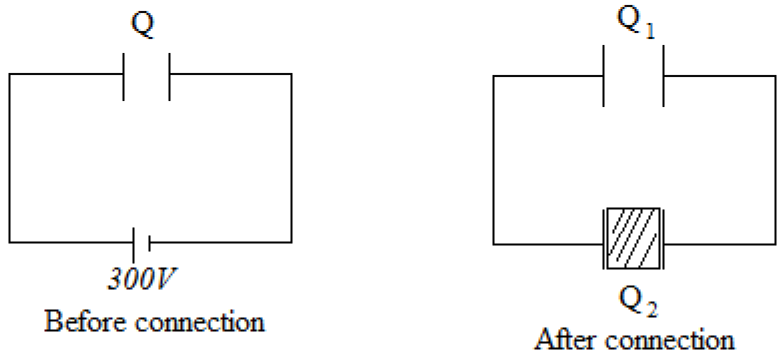
$$F = \frac{q^2}{2\varepsilon_0 A} \ldots..(02\ marks)$$

$$= \frac{(3 \times 10^{-9})^2}{2 \times 8.854 \times 10^{-12} \times 2.5 \times 10^{-4}} \ldots..(01\ mark)$$

$\mathrm{F} = 2 \times 10^{-3}\mathrm{N} \ldots..(01\ mark)$

b) i) Dielectric material is a non-conducting material inserted between the plates of a capacitor to increase the capacitance. $\ldots..(02\ marks)$

ii) Consider the circuit below



Before connection

$Q = CV$

$$Q = 300\frac{\varepsilon_0 A}{d} \ldots..(01\ mark)$$

After connection

$Q = Q_1 + Q_2 \ldots\ldots (01\ mark)$

$$300\frac{\varepsilon_0 A}{d} = (C_1 + C_2)75$$

$$300\frac{\varepsilon_0 A}{d} = \left(\frac{\varepsilon_0 A}{d} + \frac{\varepsilon_0 \varepsilon_r A}{d}\right)75 \ldots\ldots (01\ mark)$$

$1 + \varepsilon_r = 4$

$\varepsilon_r = 3 \ldots\ldots (01\ mark)$

The dielectric constant is 3

c) i) from $Q = It \ldots\ldots (01\ mark)$

$I = \frac{Q}{t}$ $\quad$ $but\ \sigma = {}^{Q}/_{A} \Rightarrow Q = \sigma A$

$I = \frac{\sigma A}{t}$ $\quad$ $but\ A = l \times b$

$I = \frac{\sigma\, l\, b}{t}$ $\quad$ $but\ \frac{l}{t} = v$

$I = \sigma v b \ldots\ldots (01\ mark)$

$I = 3 \times 10^{-5} \times 12 \times 0.1 \ldots\ldots (01\ mark)$

$= 3.6 \times 10^{-5}\text{A} \ldots\ldots (01\ mark)$

ii) $from \quad V = IR \ldots\ldots \left(00\frac{1}{2}\ mark\right)$

$= 3.6 \times 10^{-5} \times 4 \times 10^{10} \ldots\ldots \left(00\frac{1}{2}\ mark\right)$

$= 1.4 \times 10^{6}\text{V} \ldots\ldots (01\ mark)$

iii) $from \quad P = IV \ldots\ldots \left(00\frac{1}{2}\ mark\right)$

$= 3.6 \times 10^{-5} \times 1.4 \times 10^{6} \ldots\ldots \left(00\frac{1}{2}\ mark\right)$

$= 50.4\ \text{W} \ldots\ldots (01\ mark)$

5 (a) (i) The area of hysteresis loop represents a measure of energy wasted in a sample when it is taken through complete magnetization.

(ii) The hysteresis loop of a material tell us about hysteresis loss retentively and coercivity. This knowledge helps us in selecting materials for making electromagnetic, permanent magnets and core of transformers.

b) Radius of alpha particle r_1

$r_1 = \frac{M_1 V}{BQ_1}$……………………………………………..(i)

For proton path r_2 (**01 mark**)

$r_2 = \frac{M_2 V}{BQ_2}$……………………………………………...(ii)

Take equation (i) ÷ equation (ii)

$\frac{r_1}{r_2} = \frac{M_1 V}{BQ_1} \cdot \frac{BQ_2}{M_2 V}$ (**01 mark**)

$$\frac{r_1}{r_2} = \frac{Q_2}{Q_1} \cdot \frac{M_1}{M_2}$$

$\frac{r_1}{r_2} = \frac{1 \times 4}{2}$ (**01 mark**)

$\therefore r_1 : r_2 = 2:1$ (**02 marks**)

c) When a charged particle is projected perpendicular to a uniform magnetic field.

(i) Its path is circular in plane perpendicular to B and V
(ii) Its speed and kinetic energy remain the same.
(iii) The magnitude of force remains the same.
(iv) The force acting on the particle is independent of velocity and radius.
(v) The time period of revolution of the particle is independent of circular radius.

(**@ 01 mark = 05 marks**)

d) (i) $J = BANI \cos\theta$ (**01 mark**)

$B = 1.5T$

$A = \pi r^2 \approx 7.85 \times 10^{-3}$

$N = 50$

$I = 1A$

$\theta = 0'$ (**01 mark**)

$J = 1.5 \times (7.85 \times 10^{-3}) \times 50 \times 1$

$J = 0.589NM$ (**02 marks**)

(ii) Since torque on the loop is independent of its shape provided area remains the same, the magnitude of the torque will remain unaltered/unchanged.
(**02 marks**)

a(i) In Rutherford's Model electron revolve around the nucleus in any orbit while in Bohr's
model the electron revolve around the nucleus in orbit of defined radii

$..\left(01\frac{1}{2}\ mark\right)$

In Rutherford's mode electron lose energy continuously while in Bohr's model on atom emit radiation only when electron makes change of one energy level to another state

$..\left(01\frac{1}{2}\ mark\right)$

b) From

$$E_n = \frac{R_H hc}{n^2}$$

$$E_{ionization} = E_\propto - E_1$$

$$= R_H hc$$

$$= 13.6eV$$

$$E_n = \frac{-13.6eV}{n^2} \ \ldots..\left(00\frac{1}{2}\ mark\right)$$

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{-10}} \ \ldots..\left(00\frac{1}{2}\ mark\right)$$

$$E = 2.04 \times 10^{-18}J$$

$= 12.75eV \ldots .. \left(00\frac{1}{2}\ mark\right)$

Suppose electrons jumps from $n = 1\ to\ n = n$

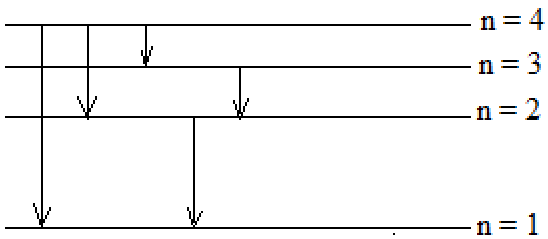
$$E_n = -\frac{R_H hc}{n^2} - \left(-\frac{R_H hc}{1^2}\right) \ \ldots .. \left(00\frac{1}{2}\ mark\right)$$

$$= R_H hc\left[1 - \frac{1}{n^2}\right]$$

$$12.75eV = R_H hc\left[1 - \frac{1}{n^2}\right]$$

$n = 4 \ldots .. (01\ mark)$

The resulting transitions



$00\frac{1}{2}$ mark

It is clearly that there are six visible lines $\ldots .. \left(00\frac{1}{2}\ mark\right)$

The longest wavelength is from $n = 4\ to\ n = 3$

$$\Delta E = \frac{13.6eV}{3^2} - \frac{13.6eV}{4^2} \ \ldots .. (01\ mark)$$

$$\Delta E = 0.667eV$$

$$\Delta E = 0.667 \times 1.6 \times 10^{-18} J$$

$$But\ \Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{\Delta E} = \frac{6.637 \times 10^{-34} \times 3 \times 10^{8}}{0.661 \times 1.6 \times 10^{-19}} \ldots\ldots (01\ mark)$$

$$\lambda = 18807\dot{A} \ \ldots\ldots (01\ mark)$$

c) Solution

Number of atom in kg $= \frac{2}{235} \times 6.02 \times 10^{26}$

$= 5.12 \times 10^{24} \ldots\ldots (01\ mark)$

$Fission\ rate = Number\ of\ atoms\ fissional\ in\ 1\ second$

$$= \frac{5.12 \times 10^{24}}{30 \times 24 \times 60 \times 60} \ldots\ldots (01\ mark)$$

$= 1.975 \times 10^{18}\ per\ second$

$Each\ fissions\ gives 185\ Mev\ energy \ldots\ldots (01\ mark)$

Therefore

$Power\ = 185 \times fission\ rate\ \ldots\ldots (01\ mark)$

$= 185 \times 1.975 \times 10^{18}\ \ldots\ldots (01\ mark)$

$= 58.46 \times 10^{6}\, J/s$

$Power = 58.46 MWatt\ \ldots\ldots (01\ mark)$

d) i) Because neutron has no charge, it hit the nucleus directly with no any repelling or attracting by the nucleus or electrons$\ldots\ldots (02\ marks)$

ii) Nuclear reactor is a device in which controlled fission chain reaction takes place.

$\ldots\ldots (02\ marks)$