NJOMBE REGION:

PRENATIONAL EXAMINATION 2024

PHYSICS II

MARKING SCHEME

Question 01

(a) (i) The height of the blood column is quite large at the feet than that at the brain. Likewise, the blood pressure in humans is greater at the feet than at the brain. ...2 marks

(ii) Data given;
Density of glycerine $= 1.3 \times 10^{3}\ kg\,m^{-3}$
Viscosity of glycerine $= 0.83\ Pa\,s$
Length of the tube $(L) = 1.5\,m$
radius of the tube $(r) = 1\,cm = 0.01\,m$
Mass of glycerine flowing per second $(m) = 4.0 \times 10^{-3}\ kg\,s^{-1}$

from

$$V = \frac{m}{\rho} = \frac{4.0 \times 10^{-3}}{1.3 \times 10^{3}} = 3.077 \times 10^{-6}\ m^{3}s^{-1}$$ ---- 01 mark

Now,

$$V = \frac{\pi p r^{4}}{8 \eta L}$$ ---- 00½ marks

$$p = \frac{8 V \eta L}{\pi r^{4}}$$

$$p = \frac{8 \times 3.077 \times 10^{-6} \times 0.83 \times 1.5}{\pi \times (0.01)^{4}}$$ ---- 01 marks

$$p = 975.52\ Pa.$$ ---- 00½ marks

(b)(i) velocity head $h = \frac{v^{2}}{2g}$. ---- 00½ marks

$$v^{2} = 2gh$$

$$v = \sqrt{2gh}$$

$$v = \sqrt{2 \times 9.8 \times 0.4} \quad \text{or}$$

$$v = \sqrt{2 \times 980 \times 40} = 280\ cm\,s^{-1}$$ ---- 00½ marks

1 (b)(ii) given;

$P_1 = 3.5 \times 10^5 Nm^{-2}$ (before opening pipe)

$P_2 = 3 \times 10^5 Nm^{-2}$ (on opening the valve)

$V_1 = 0$ (velocity flow before opening the pipe)

$V_2 = ?$ (velocity of flow on opening the pipe.)

For the flow of water along a horizontal pipe;

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$ ------ $01\frac{1}{2}$ marks

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$$

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - 0^2)$$ ------ $01\frac{1}{2}$ marks

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2$$ ------ $0\frac{1}{2}$ marks

$$v_2^2 = \frac{2(P_1 - P_2)}{\rho}$$

$$V_2 = \sqrt{\frac{2(P_1-P_2)}{\rho}}$$ ------ $01\frac{1}{2}$ marks

$$V_2 = \sqrt{\frac{2(3.5\times10^5 - 3\times10^5)}{1000}}$$ ------ 01 mark

$$V_2 = 10ms^{-1}$$ ------ 01 marks

(c) let a_1 - be the cross section area at point P

a_2 - be the cross section area at point Q

V_1 - be the velocity at point P

V_2 - be the velocity at point Q

h_1 - be the height of the ends P

h_2 - be the height of the ends Q

Then $a_1 = 4 \times 10^{-3} m^2$

$a_2 = 8 \times 10^{-3} m^2$

$h_1 = 2m$

$h_2 = 5m$

$V_1 = 1ms^{-1}$

and density of the liquid ρ be $10^3 kgm^{-3}$.

1 (c) According to the equation of Continuity; we have

$$a_1v_1 = a_2v_2$$

$$v_2 = \frac{a_1v_1}{a_2}$$ --- 00½ marks

$$v_2 = \frac{4\times10^{-3}}{8\times10^{-3}}\times1 = 0.5ms^{-1}$$ --- 00½ marks

If p_1 and p_2 are pressures at the ends P and Q, Then according to Bernoulli's theorem.

$$p_1 + \tfrac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \tfrac{1}{2}\rho v_2^2 + \rho g h_2$$ --- 00½ marks

→ Workdone by the pressure forces per unit volume is (p_1-p_2)

from the equation above.

$$(p_1-p_2) = \rho g(h_2-h_1) + \tfrac{1}{2}\rho(v_2^2-v_1^2)$$ --- 00½ marks

$$(p_1-p_2) = 10^{+3}\times9.8(5-2) + \tfrac{1}{2}\times10^3(0.5^2-(1)^2)$$

$$(p_1-p_2) = 10^3\times9.8(3) + \tfrac{1}{2}\times10^3(-0.75)$$ --- 00½ marks

$$(p_1-p_2) = 29400-375$$ --- 00½ marks

$$(p_1-p_2) = 29025\ Jm^{-3}$$ --- 00½ marks

→ work done by the gravity forces per unit volume is equal to $\rho g(h_2-h_1)$.

workdone by gravity Force $= \rho g(h_2-h_1)$ --- 00½ marks

$= 10^3\times9.8\times(5-2)$ --- 00½ marks

$= 10^3\times9.8\times3$

$= 29400\ Jm^{-3}$ --- 00½ marks

1 (d)(i) Due to the typical shape of the wings, the layers of the air (or the streamlines) above the wings comes closer to each other. Due to this, velocity of the air above the wings increases (in accordance with the equation of continuity). Now the air above the wings possesses more kinetic energy; according to Bernoulli's equation, pressure energy and hence pressure above the wings will become smaller. Due to the difference in pressure above and below the wings, the wings gets uplifted and help the aeroplane to rise up against gravity. ---------- 02marks

(ii) given - mass of a loaded Boeing aircraft = 3.3×10^5 kg = (M)

- Total area of the wings (A) = 500 m^2.

Let - P_1 be the pressure below the wings

- P_2 be the pressure above the wings

Then uplift force (F) = $(P_1 - P_2)A$ ---------- 00 $\frac{1}{2}$

$$mg = (P_1 - P_2)A. \quad \text{---------- } 00\tfrac{1}{2}$$

$$(P_1 - P_2) = \frac{mg}{A}.$$

$$(P_1 - P_2) = \frac{3.3 \times 10^5 \times 9.8}{500} \quad \text{---------- 01marks}$$

$$(P_1 - P_2) = 6.47 \times 10^3\ Nm^{-2}. \quad \text{---------- 01marks}$$

Question 02 :

(a)(i) Examples of transverse waves

- Ripples produced on the surface of water when stone is droped into it. — 00½ @ = 01 mark.
- waves produced in a rope at one end when the free end is turned up and down rapidly.
- waves in a stretched string of musical instrument when the string is plucked.

any 2 points

Examples of longitudinal waves.

- Sound waves travel through air in the form of longitudinal waves
- when a spring is alternately expanded and stretched longitudinal waves are set up. — 00½ @ = 01 mark
- vibration of air column in an open pipe are longitudinal

any two points

(ii) let L_1 and L_2 be the lengths of the closed pipe and open pipe respectively and f_1 and f_2 are their corresponding frequencies.

$$f_1 = \frac{v}{4L_1} \quad \text{and} \quad f_1 = \frac{v}{2L_2}$$ — 01 mark

- The frequency of the third overtone of the closed pipe $= 7f_1$ — 00½ mark
- The frequency of the first overtone for open pipe $= 2f_2$ — 00½ mark

it is given that

$$7f_1 = 2f_2$$ — 00½ mark

$$7 \times \frac{v}{4L_1} = 2 \times \frac{v}{2L_2}$$

$$\frac{L_1}{L_2} = \frac{7}{4}$$ — 00½ mark

2 (b) (i) - The light sources should be coherent. They must ~~be~~ have zero or constant phase difference.

- The two light sources used to produce interference should emit the monochromatic light.
- The amplitude of the waves that are interfering are equal.
- The two light sources should be narrow.
- The distance between the two light sources should be very small as compared to their distance from the screen.

any 4 points

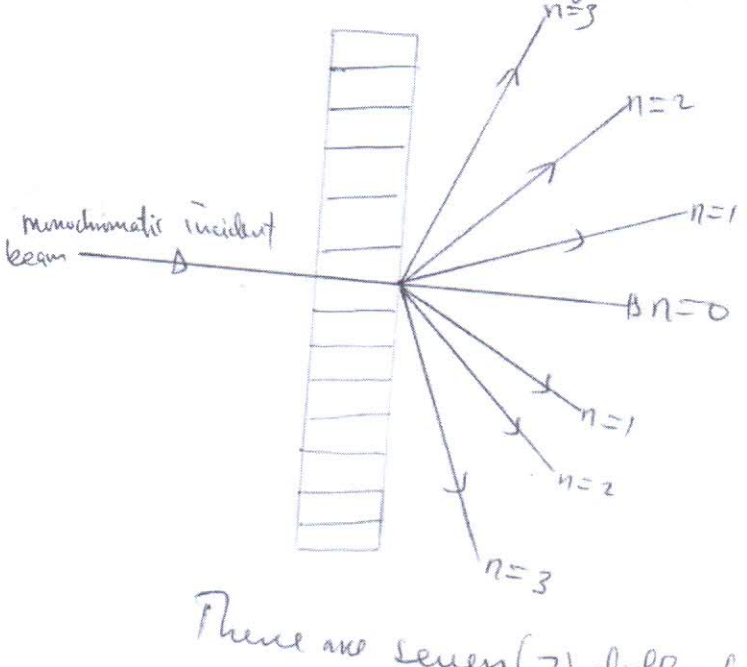
(ii) Solution:

$$\sin\theta = \frac{n\lambda}{d}$$ --- 01 mark

$$\frac{n\lambda}{d} \le 1.$$

$$n \le d/\lambda = \frac{2\times10^{-6}}{600\times10^{-9}} = 3.33.$$ --- 01 mark

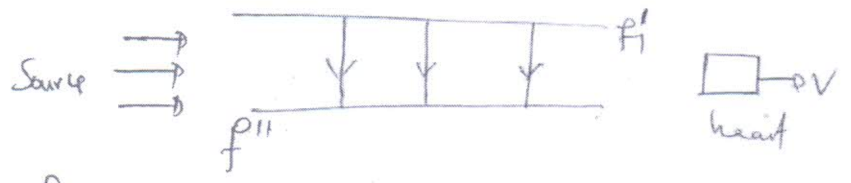
Since n must be an integer its maximum value is 3.



There are seven (7) diffracted beam. -- (01 mark)

2 (c) (i) Doppler effect is an apparent change in observed frequency of a wave due to relative motions between the source and the observer . . . . . . (01 mark)

(ii) Consider the figure below:



from $f' = \left(\frac{c-v}{c}\right)f$.

$\lambda' = \frac{c-v}{f'}$ and f . . . . . . — ✓(01 mark)

$f'' = c/\lambda' = \left(\frac{c}{c+v}\right)f'$

but

$\frac{c}{c+v} \cdot \frac{c-v}{c}f = f''$

$f'' = \left(\frac{c-v}{c+v}\right)f$

$f'' = \frac{1.54\times10^3 - v}{1.54\times10^3 + v} \times 2.25\times10^6$ — — — 01 mark

but maximum beat frequency $= f - f''$

$2.25\times10^6 - 2.25\times10^6\left(\frac{1.54\times10^3 - v}{1.54\times10^3 + v}\right) = 600$

on solving

maximum velocity $v = 0.205$ m/s on the surface of ... 01 mark

2 (d)(i) when white light strikes the soap film, particular thickness of a film constructs or cancels particular colour of light by interference from the upper surface and that reflected from the rere surface. If the thickness of the film cancels a colour of white light and its complementary colours appears. --- 02 marks

(ii) ωt - phase angle with respect to time ------ 01/2 marks
kx - phase angle with respect to displacement --- 01/2 marks
$(\omega t + kx)$ - phase angle of the wave. --- 01/2 marks
$\sin(\omega t + kx)$ - An oscillating terms ---- 01/2 marks

Question 03.

(a)(i) Ductile - A wire is said to be ductile, If the plastic region in the stress-strain graph is quite Large.
(ii) Brittle - A wire is said to be brittle, If the plastic region in the stress-strain graph is quite small (practically zero)
(iii) Elastomers - The materials which can be greately stretched
(iv) Elastic fatigue - The loss of elastic strength of the material, caused due to repeated altenating strains to which the material is subjected. 01 @ = 5 marks
(v) Elastic after effect - is the delaying in regaining the original state by a body after the removal of deforming force.

(b) given $a_1 = 1mm^2 = 10^{-6} m^2$
$a_2 = 2mm^2 = 2 \times 10^{-6} m^2$

Suppose that the mass 'm' is suspended from a point C at a distance x from the end P of the rod.
As a result T_1 and T_2 be the tensions in the wire A and B respectively.

(i) when the stress is the same in the two wires
stress in the steel wire $= \frac{T_1}{a_1}$ ------ 01/2 marks
stress in the aluminium wire $= T_2/a_2$

3 (b) (i) Since the stress the two wires are equal.

$$\frac{T_1}{a_1} = \frac{T_2}{a_2} \quad \text{------------} \quad 00\tfrac{1}{2} \text{ marks}$$

$$\frac{T_1}{T_2} = \frac{a_1}{a_2} = \frac{10^{-6}}{2\times10^{-6}} = 0.5 \quad \text{---} (i) \ldots \quad 00\tfrac{1}{2} \text{ marks}$$

As suspended system of the rod and the two wires is in equilibrium.

$$T_1 \times PC = T_2 \times QC$$

$$T_1 x = T_2(1.05 - x) \quad \text{------------} \quad 00\tfrac{1}{2} \text{ marks}$$

$$\frac{T_1}{T_2} = \frac{1.05 - x}{x} \quad \text{---------} (ii) \ldots \quad 00\tfrac{1}{2} \text{ marks}$$

$$\frac{1.05 - x}{x} = 0.5$$ from eqn (i) and (ii) above.

$$1.5x = 1.05$$

$X = 0.7$m or 70cm from the steel wire ---- $00\tfrac{1}{2}$ marks

(ii) When the strains in the two wires are equal

Now; $Y = \frac{\text{stress}}{\text{strain}}$ or $\text{strain} = \frac{\text{stress}}{Y}$ ------ $00\tfrac{1}{2}$ marks

Therefore, strain in the steel wire $= \frac{T_1/a_1}{Y_1} = \frac{T_1}{a_1 Y_1}$ --- $00\tfrac{1}{2}$ marks

Strain in the aluminium wire $= \frac{T_2/a_2}{Y_2} = \frac{T_2}{a_2 Y_2}$ --- $00\tfrac{1}{2}$ marks

Since the strains are equal in the two wires

$$\frac{T_1}{T_2} = \frac{a_1 Y_1}{a_2 Y_2} = \frac{10^{-6} \times 2\times10^{11}}{2\times10^{-6} \times 7\times10^{10}} = \frac{10}{7} \quad \text{------} (i) \quad 00\tfrac{1}{2} \text{ marks}$$

Again for the equilibrium of the system

$$T_1 PC = T_2 QC$$

$$T_1 x = T_2(1.05 - x)$$

$$\frac{T_1}{T_2} = \frac{1.05 - x}{x} \quad \text{------------} (ii) \quad \text{-----} \quad 00\tfrac{1}{2} \text{ marks}$$

$$\frac{1.05 - x}{x} = \frac{10}{7}$$ from eqn (i) and (ii) above.

$x = 0.4322$m or 43.2cm of the steel ---- $00\tfrac{1}{2}$ marks

$X = 0.432$m or 43.2cm

3 (c)(i) NO, stress is a scalar quantity. - - - - - - 01 mark

(ii) Let h be the required depth of the sea.

Now $K = \frac{P}{\frac{\Delta V}{V}} = \frac{\rho g h}{\Delta V / V}$ - - - - - 01 mark

here $\Delta V / V = 0.1\% = 0.001$

$K = 9.8 \times 10^8 Nm^{-2}$

$\rho_{sea} = 10^3 kg/m^3$.

$\therefore 9.8 \times 10^8 = \frac{10^3 \times 9.8 \times h}{0.001}$ - - - - 01 mark

$h = \frac{9.8 \times 10^8 \times 0.001}{10^3 \times 9.8}$

$h = 100m$. - - - - - - 01 mark

(d) (i) Surface energy = surface tension - - - -

(ii) Capillary action - - - - -

(iii) Let $r_1 = r$, Then $r_2 = r/3$.

Here $h_1 = 2cm$.

Let h_2 - be the height, to which liquid rises in the second tube

Now $h = \frac{2T\cos\theta}{r\rho g}$

or

$h \propto 1/r$. - - - - - - - - 01 mark

$\frac{h_1}{h_2} = \frac{r_2}{r_1}$

$h_2 = \left(\frac{2r}{r/3}\right) = 6cm$ - - - - - - 01 mark

∴ When the capillary tube is inclined: In the ascent formula, 'h' refers to the vertical height of the liquid in the capillary tube. If the tube is inclined at an angle θ with the vertical, then length [illegible] in the tube. (01 mark)

Question 04 :

@ (i) An electric field line - is the path along which a positive test charge would move if it is free to do so. ---------- 01 mark

(ii) Using the relation that:

$$\varepsilon_r = \frac{\varepsilon_m}{\varepsilon_o} \quad \text{Then} \quad \varepsilon_o\varepsilon_r = \varepsilon_m$$

$$E = \frac{Q}{4\pi\varepsilon_m r^2} = \frac{Q}{4\pi\varepsilon_o\varepsilon_r r^2} = \frac{kQ}{\varepsilon_r r^2}$$ ------ 01 mark

$$E = \frac{9\times10^9\,Nm^2c^{-2} \times 3.3\times10^{-9}}{5\times(10.0\times10^{-2})^2}$$ ------ 01 mark

$$E = 594\,NC^{-1}$$

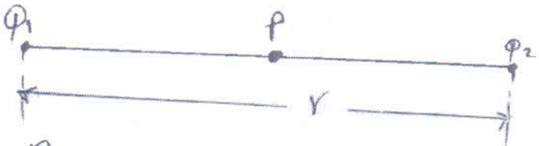
∴ The electric field intensity $(E) = 594NC^{-1}$ -- 01 mark

(b) (i) Electrostatic potential - Is equal to the workdone in bringing a positive charge from infinity to that point. ------ 01 mark

or

Is the potential energy per unit charge.

(ii)



by using the principle of superposition of electric potentials;

$$V_p = V_{Q_1} + V_Q$$ ------ 01 mark

$$V_p = \frac{kQ_1}{r/2} + \frac{kQ_2}{r/2}$$

hence $V_p = \frac{2k}{r}(Q_1 + Q_2)$ ------ 01 mark

$$V_p = \frac{2\times9\times10^9\,Nm^2c^{-2}}{20\times10^{-2}\,m} \times (20\times10^{-6}c + -20\times10^{-6}c)$$

$$V_p = 0V$$ ------ 01 mark

Electrostatic potential at a point midway is 0V.

4 (c) (i) → Surface area - from $C = \frac{A\varepsilon_0}{d}$.

Thus capacitance of a capacitor increases as the surface area increases. - - - - - - - - - 01 mark

→ Distance between the plates - from $C = \frac{A\varepsilon_0}{d}$.

Thus capacitance of a capacitor is inversely proportional to the distance between the plates. - - - - - - - - - 01 mark

→ Dielectric material - from $C = \frac{A\varepsilon_0}{d}$

Thus capacitance of a capacitor is direct proportional to the dielectric constant of the material used between the plates. - - 01 mark

(ii) from equation of the capacitance above:

$$C = \frac{A\varepsilon_0}{d}$$

$C_0 = \frac{A\varepsilon_0}{d}$; the capacitance with no dielectric material is;

$$C_0 = \frac{8.854 \times 10^{-12} C^2 N^{-1} M^{-2} \times 100 \times 10^{-4} m^2}{1.0 \times 10^{-3} m}$$

$$C_0 = 8.854 \times 10^{-11} F$$ - - - - 01 mark

The capacitance with dielectric material;

$$C = \frac{Q}{V} = \frac{0.12 \times 10^{-6} C}{120 V} = 1.0 \times 10^{-9} F$$ - - - 01 mark

The dielectric constant is;

$$\varepsilon_r = \frac{C}{C_0} = \frac{1 \times 10^{-9} F}{8.854 \times 10^{-11} F} = 11.3$$ - - - - 01 mark

Therefore, the dielectric constant of the material is 11.3.

4 (d) (i) If two equipotential surfaces could intersect; then at the point of intersection there would be two values of electric potential which is not possible. ---- 02 marks

(ii) workdone = charge x potential difference ---- 01 mark

$= q \times (V_B - V_A)$

$= q \times 0$ since $V_A = V_B$ over equipotential surface.

$= 0V$

---- 01 mark

by letting V_A and V_B be the potentials at point A and point B within the equipotential surfaces.

Thus there is no workdone in moving a test charge within the equipotential surfaces.

(iii) - Electric potential due to point charge, $V \propto 1/r$ while for dipole, $V \propto 1/r^2$.

- The potential due to dipole is axially symmetry while potential due to a point charge is spherically symmetric.

- The potential due to dipole not only depends on 'r' but also on the angle between the position vector $\vec{r}$ and dipole moment vector $\vec{p}$.

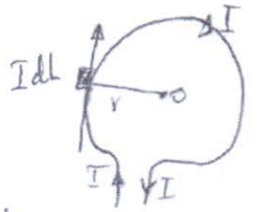
only 2 points

01 mark @ = 2 marks.

Question 05 :

(a) (i) Biot-savart law states that "The magnetic field dB at point P at a distance r from a small current elements Idl of a conductor carrying current is given by; $dB \propto \frac{I\,dl\sin\theta}{r^2}$ where θ is the angle between $\vec{dl}$ and $\vec{r}$. - - - - - - - 02 marks.

Consider the conductor in a circular shape below:



from Biot-savart law

$$dB \propto \frac{I\,dl\sin\theta}{r^2}$$

$$dB = \frac{K I\,dl\sin\theta}{r^2}, \text{ where } k = \frac{\mu_0}{4\pi} \text{ - - - - } 01/2 \text{ marks}$$

$$dB = \frac{\mu_0 I\,dl\sin\theta}{4\pi r^2}$$

$$\int dB = \frac{\mu_0 I\sin\theta}{4\pi r^2}\int dl \quad \text{where } \theta = 90^\circ \text{ - - - - } 01/2 \text{ marks}$$

$$B = \frac{\mu_0 I\sin 90\, L}{4\pi r^2}, \quad \text{where } L = 2\pi r = \text{circumference of the circular coil.}$$

$$B = \frac{\mu_0 I \cdot 2\pi r}{4\pi r^2} \quad \text{where } \sin 90 = 1 \text{ - - - - } 01/2 \text{ marks}$$

$$B = \frac{\mu_0 I}{2r}$$

∴ The magnetic field at the centre is $\frac{\mu_0 I}{2r}$ - - - - 01/2 marks.

5 (a)(ii) given; - radius $r = 0.5 nm$
- speed $v = 4 \times 10^6 m/s$.

Required B.

from $B = \frac{\mu_0 I}{2r}$ but $I = e/t$ ---- 01 mark

$B = \frac{\mu_0 e}{2rt}$.

Also $t = \frac{2\pi r}{v} = \frac{2\pi \times 5 \times 10^{-10}}{4 \times 10^6}$

$t = 7.85 \times 10^{-16}$ seconds. ---- 01 mark

$B = \frac{4\pi \times 10^{-7} \times 1.6 \times 10^{-19}}{2 \times 0.5 \times 10^{-9} \times 7.85 \times 10^{-16}}$.

$B = 0.256 T$ ---- 01 mark

∴ Thus the magnetic field at the centre is $0.256T$.

(b) (i) One ampere is the current flowing in each of the two infinitely long parallel conductors 1m apart, which result in a force of exactly $2 \times 10^{-7} N$ per metre length of each conductor. ---- 02 marks

(ii) The rule is Fleming's left hand rule which states that "stretch the fore finger, middle finger and thumb of your left hand in mutually perpendicular directions, If the fore finger points in the directions of current, then the thumb gives the direction of the force on the conductor".

- Right hand rule can also be used. ---- 02 marks.

(c) given $I_1 = 4A$, $I_2 = 6A$, $r = 3cm = 3 \times 10^{-2} m$,

Required F/L of the straight long conductor carrying current.

$F/L = f = \frac{\mu_0 I_1 I_2}{2\pi r}$. ---- 01 mark

$f = \frac{4\pi \times 10^{-7} \times 4 \times 6}{2\pi \times 3 \times 10^{-2}}$ ---- 01 mark

$f = 1.6 \times 10^{-4} N/m$. ---- 01 mark

Since the currents are in opposite direction, then the force is repulsive which means that the conductor of 4 A will be pushed away. ---- 01 mark

5 (d) (i) Faraday's law of electromagnetic induction states that "whenever the magnetic flux linking the conductor or coil changes an emf is induced in a conductor or coil which is directly proportional to the rate of flux linkages." — — — — — — — — 02 marks

Thus $emf\ (e) \propto N\frac{d\phi}{dt}$.

(ii) - The change of magnetic flux density.
- The change of the area (A) of the coil — 01 @ = 3 marks.
- The change of the orientation of the coil

Question 06.

(a) (i) The activity of a radioactive decay - is the rate of disintegration of radioactive substance. — — — — — — 01 mark

(ii) from $\frac{dN}{dt} = -\lambda N$. — — — — $00\frac{1}{2}$ marks

$\frac{dN}{N} = -\lambda dt$ .. integrate both sides

$\int_{N_0}^{N}\frac{dN}{N} = -\lambda\int_0^t dt$ — — — — — — $00\frac{1}{2}$ marks

$\left[\ln N\right]_{N_0}^{N} = -\lambda(t-0)$.

$\ln\left(\frac{N}{N_0}\right) = -\lambda t$

$\frac{N}{N_0} = e^{-\lambda t}$.

$N = N_0e^{-\lambda t}$ — — — — — — — $00\frac{1}{2}$ marks

when $t = t_{1/2}$, $N = N_0/2$

Then

$\frac{N_0}{2} = N_0e^{-\lambda t_{1/2}}$ — — — — — — — $00\frac{1}{2}$ marks

$\frac{1}{2} = e^{-\lambda t_{1/2}}$

$\ln(1/2) = \ln e^{-\lambda t_{1/2}}$

$\ln 2^{-1} = -\lambda t_{1/2}\ln e$ — — — — — — $00\frac{1}{2}$ marks

$-\ln 2 = -\lambda t_{1/2}$

$\ln 2 = \lambda t_{1/2}$

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

6 (a) (iii) given that; Half life $t_{1/2} = 5.3$ years

Activity (A) $= 1\times10^{-3}$ Ci

mass (m) = ?

$A = 1\times10^{-3} \times 3.7\times10^{10}$ dis/s (Bq) ---- 00½ marks

$t_{1/2} = (5.3 \times 365 \times 24 \times 3600)$ seconds. ---- 00½ marks

But $A = \frac{\ln 2}{t_{1/2}} \cdot N$ ------ 00½ marks

$N = \frac{1\times10^{-3} \times 3.7\times10^{10} \times 5.3\times365\times24\times3600}{0.693}$ ---- 00½ marks

$N = 8.92\times10^{15}$ atoms.

but $n = N/N_A = \frac{8.92\times10^{15}}{6\times10^{23}} = 1.486\times10^{-8}$ mol

$\therefore n = 1.486\times10^{-8}$ mol. ---- 01 marks.

Again $n = \frac{\text{Mass}}{\text{Molar mass (Mr)}}$

Mass $= n\times Mr = 1.486\times10^{-8}$ mol $\times 605$ mol^{-1} g.

Mass $= 8.92\times10^{-7}$ g. ---- 01 marks

(b) (i) The negative total energy means that an electron is bound to the nucleus. ---- 01 mark

(ii)

Rutherford's model	Bohr's model.
-electrons can revolve around the nucleus in any orbit	-electrons can revolve around the nucleus in orbit of definite radii
-Electrons loose energy continuously and hence produce continuous spectrum	- Electrons emits radiations only when it makes a sudden change from one energy state to another energy state.

02 = 02 marks

(iii) The magnitude of energy of electron in the first orbit of hydrogen atom is

$$E_1 = \frac{me^4}{8h^2\varepsilon_0^2}$$ ---- 00½ marks.

6 (b) (iii)

$$hf = \frac{me^4}{8\varepsilon_0^2 h^2}$$ ---- 01/2 marks

$$f = \frac{me^4}{8\varepsilon_0^2 h^3}$$

$$T = 1/f = \frac{8\varepsilon_0^2 h^3}{me^4}$$ ---- 01/2 marks

$$T = \frac{8 \times (8.85\times10^{-12})^2 \times (6.62\times10^{-34})^3}{9.1\times10^{-31} \times (1.6\times10^{-19})^4}$$ ---- 01 mark

$T = 0.305\times10^{-15}$ seconds. ---- 01/2 marks

(c) (i) The mass of the nucleus is always less than the sum of the masses of its constituents protons and neutrons. The mass difference (energy) hold the nucleus together and is called the total binding energy. ------ 02 marks.

(ii) The fusion reaction is given by;

$${}_1H^2 + {}_1H^2 \longrightarrow {}_2He^4 + \text{energy}\,(\varphi)$$

Mass defect $\Delta m = (2\times 2.0141) - 4.0026$

$\Delta m = 0.0256$ a.m.u. ---- 01/2 marks

1 a.m.u $= 931$ MeV, the energy released in the reaction is

$\varphi = 0.0256 \times 931 = 23.833$ MeV ---- 01/2 marks

Useful energy available per reaction.

$= 25\%$ of φ.

$= 0.25 \times 23.833$

$= 5.9582$ MeV

$= 5.9582\times10^6 \times 1.6\times10^{-19}$ J

$= 9.533 \times 10^{-13}$ J ---- 01/2 marks

Energy obtained per day;

$= 200\times10^6 \times 24 \times 60 \times 60$

6 (c) (ii) Mass of deuterium fuel needed for reaction

$= 2 \times 2.0141 = 4.0282$ a.m.u. --- 01/2 marks

Now : $\frac{4.0282}{6.02 \times 10^{23}} = 0.6691 \times 10^{-23} g$ --- 01 mark

Mass of deuterium required per day.

$= \frac{0.6691 \times 10^{-23} \times 1.728 \times 10^{13}}{9.533 \times 10^{-13}}$ ---- 01/2 marks

$= 121.3 g$. ------ 01/2 marks