TANZANIA HEADS OF ISLAMIC SCHOOLS COUNCIL

FORM SIX (6) INTER ISLAMIC MOCK EXAMINATION

131/2

PHYSICS 2

(MARKING GUIDE)

OF MODERATED EXAM

YEAR: 2024

1 (a) i) Machine parts jammed in winter due to a low temperature in winter, the viscosity of lubricants used in machine parts increases. As a result the machine part get jammed. (02 marks)

ii) Because terminal velocity of a raindrop (sphere) is directly proportional to the square of radius of the drop (sphere). (02 marks)

iii) Viscous drag force (F) is proportional to size (r) (as $F = 6\pi\eta r v$) and the parachute has large surface area hence experience large viscous force while decending. As a result the terminal velocity becomes very small and person does not hurt when reach the ground. (02 marks)

(b) i) Take two identical measuring cylinders fill each cylinder with different liquid (of different viscosity) to the same height. Allow identical ball bearings to fall through each cylinder. The ball bearing will fall slowly through a liquid of higher viscosity (03 marks)

ii) Sln

Given

Specific gravity = R.D = 0.9

Density of air (ρ_a) = $1.293\ kg\,m^{-3}$

Viscosity of liquid = $0.15\ Nsm^{-2}$

Viscosity of water = $10^{-3}\ Nsm^{-2}$

Radius of air bubble = 0.8 mm.

Density of liquid = $\rho_w \times R.D$

$= 1000 \times 0.9 = 900\ kg\,m^{-3}$ — 01

from Stoke's law

$$V_T = \frac{2gr^2(\rho - \sigma)}{9\eta}$$ 01/2

$$V_{T_L} = \frac{2 \times 9.8 \times (0.4 \times 10^{-4})^2 \, (1.29 - 900)}{9 \times 0.15}$$ 0/2 mark

$V_{T_L} = \underline{-0.21\,ms^{-1}}$ 0/2 mark — -ve sign shows bubble rise up 0/2 mark

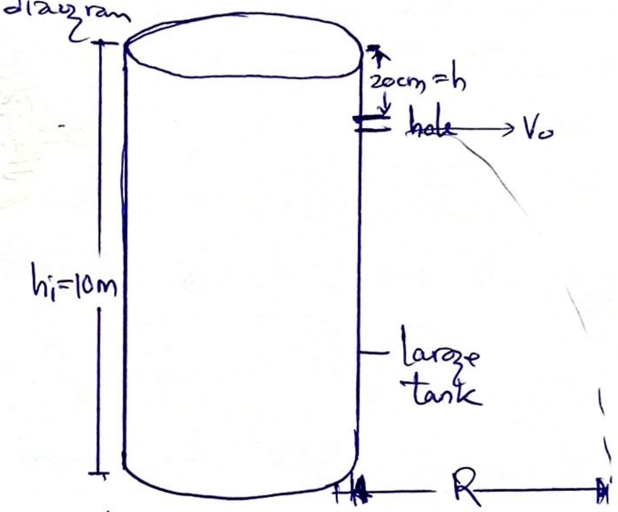
If the coefficient of viscosity of water is $10^{-3}\,Nsm^{-2}$

$$V_{T_w} = \frac{2 \times 9.8 \, (0.4 \times 10^{-4})^2 \times (1.29 - 1000)}{9 \times 10^{-3}}$$ 01 mark

$V_{T_w} = \underline{-0.34\,ms^{-1}}$ 0/2 mark

(-)ve sign shows buble rise up 0/2 mark

1 c) Conside the diagram



01 mark

i). Speed at which water emerge V_o

from $V_o = \sqrt{2gh}$ where $h = 20cm = 0.2m$ 01 mark

$V_o = \sqrt{2 \times 9.8 \times 0.2}$ 01 mark

$\underline{V_o = 1.979\,ms^{-1}}$ 0/2 mark

ii) The distance R

from $R = V_x t$ 0/2 mar

where $t = \sqrt{2h_1/g}$ 0/2 mark

$R = V_x \sqrt{2h_1/g}$ where $V_x = V_o = 1.979$ 0/2 mark

$h_1 = 10 - 0.2 = 9.8m$

$R = 1.979 \sqrt{\frac{2 \times 9.8}{9.8}} = 1.979 \times \sqrt{2}$ 0/2 mark

$\underline{R = 2.799\,m}$ 0/2 mark

2 (a) i)

Stationary Wave	Progressive wave
• The wave doesnot advance but remain confined at a particular region	• The wave advances with a constant speed
• The amplitud varies for all particles in the path of wave	• The amplitude is the same to the position
• Energy is associated with the wave but there is no transfer of energy across any section of the medium.	• Energy is transmitted in direction of propagation of wave

any two (2marks)

ii) fundamental frequency of the wire is given by;

$$f_o = \frac{1}{2L}\sqrt{\frac{T}{m}} \quad \text{--- (i)}$$ 01/2 Mark

– on increasing tension by 21% the new tension will be $1.21T$ and frequence $f_o + 5$, that

$$f_o + 5 = \frac{1}{2L}\sqrt{\frac{1.21T}{m}} \quad \text{--- (ii)}$$ 01/2 mark

Divide eqn (ii) by (i)

$$\frac{f_o + 5}{f_o} = \sqrt{1.21} = 1.1$$ 01/2 Mark

Solving the value of fo

$$f_o = 50\,Hz$$ 01/2 Mark

from relation btn f and L

$$f \propto \frac{1}{L}$$

$$f_1 L_1 = f_2 L_2$$ 01 mark

where $f_1 = f_o = 50$, $L_1 = L$ and $L_2 = 1.1L_1 = 1.1L$

$$\frac{f_0 L}{1.1L} = \frac{f_2(1.1L)}{1.1L}$$ 0½ Mark

$$f_2 = \frac{50}{1.1} = 45.45\ Hz$$ 0½ Mark

frequence will become 45.45 Hz

2 (b) i) let t°c be the required temperature

from

$$\frac{V_2}{V_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{273+t}{273}}$$ 01 Mark

$V_2 = 2V_1$

$$\frac{V_2}{V_1} = 2 = \sqrt{\frac{273+t}{273}}$$ 01 Mark

$$4 = \frac{273+t}{273}$$

$t = (273 \times 4) - 273$

$t = 819°C$ 01 mark

ii) Given

frequence of train's siren $f = 480Hz$

Velocity of sound $V = 340$

$U_o = 10ms^{-1}$

$U_s = 20ms^{-1}$

- Before train has passed

$$f' = \left(\frac{V+U_o}{V-U_s}\right)f = \left(\frac{340+10}{340-20}\right)480$$ 02 mark

$f' = 525\ Hz$

0½ Mark

Apparent frequency f' befor train has passe is 525 Hz

• After the train has passed

from $f' = \left(\frac{V - u_o}{V + u_s}\right) f$ 01 mark

$f' = \left(\frac{340 - 10}{340 + 20}\right) 480$ 01 mark

$f' = 440\,Hz$ 01/2 Mark

Apparent frequence after train has passed is 440Hz

2 C) i) when in air for dak rings

$D_m^2 = 4Rm\lambda$ —— (i)

$D^2_{(m+10)} = 4R(m+10)\lambda$ —— (ii) 01 Mark

Take (ii) substract with eqn(i)

$D^2_{(m+10)} - D_m^2 = 4R(m+10)\lambda - 4Rm\lambda$

01 Mark

$D^2_{m+10} - D_m^2 = 40R\lambda$

$R = \frac{D^2_{m+10} + D_m^2}{40\lambda}$ where $D_{m+10} = 8.1 \times 10^{-3}$, $D_m = 5.72 \times 10^{-3}$ and $\lambda = 5.46 \times 10^{-7} m$

$R = \underline{1.5m}$ 01 mark

ii) When in liquid L, Refractive index = ?

Liquid L

from $\eta = \lambda / \lambda_L$

$\lambda_L = \frac{\lambda}{\eta}$ 01/2 Mark

$D_m^2 = 4Rm\lambda_L = 4Rm\frac{\lambda}{\eta}$ —— (i)

$D^2_{m+10} = 4R(m+10)\frac{\lambda}{\eta}$ —— (ii) 01/2 mark

(ii) − (i)

$D^2_{m+10} - D^2_m = \frac{4R(m+10)\lambda}{\eta} - 4Rm\frac{\lambda}{\eta}$ 01/2 Mark

$$D^2_{(m+10)} - D^2_m = \frac{40R\lambda}{\eta}$$

$$\eta = \frac{40R\lambda}{D^2_{m+10} - D^2_m}$$ ½ Mark

where $D^2_{m+10} = 7.02\times10^{-3}$

$D^2_m = 4.95\times10^{-3}$

$\lambda = 5.46\times10^{-7}$ m

$R = 1.5$ m

$$\eta = \frac{40\times1.5\times5.46\times10^{-7}}{(7.02\times10^{-3})^2 - (4.95\times10^{-3})^2}$$ ½ Mark

$\eta = 1.322$ ½ Mark

$\underline{\eta \simeq 1.3}$

3 (a) i) Young's Modulus (E) is the ratio of tensile stress to tensile strain. 01 mark

$$E = \frac{F/A}{e/L} = \frac{FL}{Ae}$$

$$[E] = \frac{[Force][Length]}{[Area][Length]} = \frac{MLT^{-2} \cdot L}{L^2 \cdot L}$$

$$[E] = ML^{-1}T^{-2}$$

Its Dimension is $\underline{ML^{-1}T^{-2}}$ 01 mark.

ii) Given

$A = 2mm^2 = 2\times$

$L_o = 0.2m$

$L_f = 0.24m$

$M_s = 10g = 0.01kg$

KE attained by stone $= \frac{1}{2}m_s v^2$ 01/2 Mark

KE of stone = Energy stored in streched rubber 01/2 mark

$$\text{Energy stored in streched ruber} = \frac{1}{2}Fe = \frac{1}{2}\frac{AEe^2}{L}$$ 01/2 mark

$$\frac{1}{2}m_s v^2 = \frac{1}{2}\frac{AEe^2}{L}$$

$$V = \sqrt{\frac{AEe^2}{M_s L}}$$ 02 Marks

where $e = L_f - L_o = 0.04m$

On substituting and solving.

$$\underline{V = 31\ ms^{-1}}$$ 01/2 Mark

∴ The initial velocity of the object when it just leaves the catapult is $\underline{31ms^{-1}}$

3 (b) i) Inorder to avoid slipping during playing - The stud decrease the area of contact btn the feet of player and ground as result pressure of foot increase and the player become attached to the ground as stud penetrated due to its large pressure, thus play can run without slipping

02 Marks

ii) A piece of chalk have very large number of narrow capillaries, Due to capillary action as water rises displaces air present in capillaries and forced out in form of bubbles.

02 Marks

iii) The adhesive force among oil-water molecules is greater than cohesive force among oil molecules. In second case cohesive force among molecules of water is greater than the adhesive force

02 Marks

c) Soln

i) from r.m.s value of velocity is proportional to square root of absolute temperature

ie $V_{rms} \propto \sqrt{T}$

$$\frac{V_1}{V_2} = \sqrt{\frac{T_2}{T_1}}$$

01 mark

$$T_2 = \left(\frac{V_2}{V_1}\right)^2 \times T_1 \quad \text{where } V_2/V_1 = 2, \; T_1 = 25^\circ C = 298K$$

01 mark

$$T_2 = (2)^2 \times 298K = \underline{\underline{1192\,K}} = \underline{\underline{919^\circ C}}$$

01 mark

ii) from relation $KE = \frac{3}{2} KT$

01 mark

where $k = 1.38 \times 10^{-23}\, JK^{-1}$ $T = 27^\circ C = 300K$

$$KE = \frac{3}{2} \times 1.38 \times 10^{-23} \times 300 = 6.21 \times 10^{-21} J$$

02 Marks

$\therefore$ Average translational KE of an ideal gas molecule is 6.21×10^{-21} Joules.

3 c) iii) Using relation

$KE = \frac{3}{2} nRT$ 0½ mark

$KE = \frac{3}{2} \times 1\,mol \times 8.314\,J\,mol^{-1}K^{-1} \times 300\,K$ 01 mark

$KE = 3741.3\,J$ 0½ mark

$\therefore$ The Random KE of molecules in 1 mol of gas is

$\underline{\underline{3741.3\,J}}$

4 (a) i) Inorder to discharge to the ground during landing all of charges generated by friction during take-off and flight.
(02 marks)

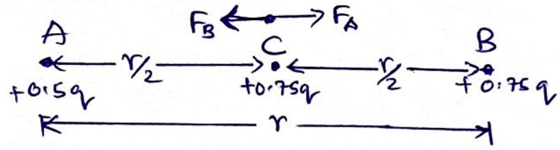
ii) Given

- Initial charge of sphere A & B is +q
Let Separation between them be 'r'

$$F = 10^{-5}N = \frac{Kq^2}{r^2}$$

- When C touched to A acquires $+\frac{q}{2}$ charges leaves A with $+\frac{q}{2}$
- And then, when C touched to B becomes with +0.75 q and leaves B with +0.75q

The system can be presented as follow. after C placed btn A & B



0/2 Mark

force on C due to A

$$F_{AC} = \frac{K(0.5 \times 0.75)q^2}{(\frac{r}{2})^2} = 1.5K\frac{q^2}{r^2}$$ 1/2 Mark

force on C due to B

$$F_{BC} = \frac{(0.75)^2 q^2}{(\frac{r}{2})^2} = 2.25K\frac{q^2}{r^2}$$ 01 mark

$$F_{net} = F_{BC} - F_A = (2.25 - 1.5)K\frac{q^2}{r^2} = 0.75K\frac{q^2}{r^2}$$ 01 mark

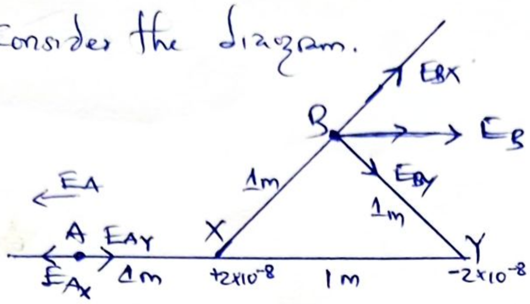
$$F_{net} = 0.75 \times 9.0 \times 10^9 \frac{q^2}{r^2}$$ 0 1/2 Mark

$$\underline{\underline{F_{net} = 6.75 \times 10^9 \frac{q^2}{r^2}}}$$ toward A (agrees with direction of force on C due to B).

0 1/2 Mark

4 (b) Consider the diagram.

i)



0/2

- V at A due to X

from $V = \frac{KQ}{r}$

$$V_{XA} = \frac{KQ_X}{r_{XA}} = \frac{9\times10^9 \times (2\times10^{-8})}{1} = 1.8\times10^2 V$$ $\frac{0}{2}$ mark

- V at A due to Y

$$V_{YA} = \frac{KQ_Y}{r_{YA}} = \frac{9\times10^9 \times (-2\times10^{-8})}{2} = -0.9\times10^2 V$$ $\frac{0}{2}$ mark

∴ The V at A due to X & Y

$$V_A = V_{XA} + V_{XB} = 1.8\times10^2 + -(0.9\times10^2)$$

$$\underline{\underline{V_A = 0.9\times10^2 = 90V}}$$ 0/2 Mark

- V at B due to X

$$V_{BX} = \frac{KQ_X}{r_{BX}} = \frac{9\times10^9 \times 2\times10^{-8}}{1} = 1.8\times10^2 V$$ 0/2 mark

$$V_{BY} = \frac{KQ_Y}{r_{BY}} = \frac{9\times10^9 \times (-2\times10^{-8})}{1} = -1.8\times10^2 V$$ $\frac{0}{2}$ Mark

$$V_B = V_{BX} + V_{BY} = 0 V$$ 0/2 Mark

ii) - E at A due to X

$$E_{AX} = \frac{K|Q_X|}{r_{AX}^2} = \frac{9\times10^9 \times 2\times10^{-8}}{1^2} = 1.8\times10^2 V/m$$ 0/2 Mark

- E at A due to Y

$$E_{AY} = \frac{KQ_Y}{r_{AY}^2} = \frac{9\times10^9 \times 2\times10^{-8}}{2^2} = 0.45\times10^2 V/m$$ 0/2 Mark

- Resultant E due to X & Y, $E_A = E_{AX} + E_{AY}$ 0½ Mark

$E_A = (1.8 - 0.45) \times 10^2$ 0½ Mark

$\underline{E_A = 1.35 \times 10^2\ V/m}$ toward left (E_{AX}) ½ Mark

- E at B due to X and Y is equal to $E_{AX} = 1.8 \times 10^2\ V/m$

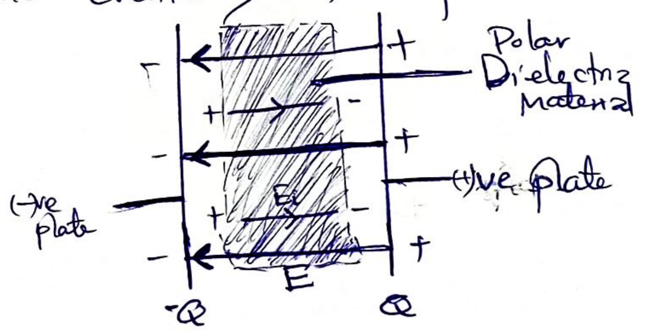
- $E_B = E_{XB}\cos 60 + E_{YB}\cos 60$ 0½ Mark

where $\cos 60 = \frac{1}{2}$

Resultant E_B due to X & Y: $E_B = (1.8\cos 60 + 1.8\cos 60) \times 10^2\ V/m$ 0½ Mark

$\underline{E_B\ 1.8 \times 10^2\ V/m}$ toward right 0½ Mark

4 c) i) Polar dielectric material orients its dipole moments which induces electric field in opposite direction to the direction of electric field between plates. This reduce the electric field of plate and therefore reduces the potential difference and eventually the capacitance increases 02 marks



Labelling 0½
Drawing 0½

ii) soln

C_1, C_2 & C_3 are parallel so their equivalence

$C_T = C_1 + C_2 + C_3$ 01 mark

where $C_T = 3.3\mu F$, $C_2 = 0.2\mu F$ & $C_3 = 0.3\mu F$

$C_1 = C_T - C_2 - C_3 = 3.3\mu F - 0.3\mu F - 0.2\mu F$ 02 marks

$C_1 = 2.8\mu F$

∴ The value of $\underline{C_1 \text{ is } 2.8\mu F}$ 01 mark

5 (a) i) "The flux density dB at a point P due to a small element dl of a conductor carrying a current is given by $dB \propto \frac{Idl \sin\theta}{r^2}$ where r is the distance from point P due to element, θ is angle between the element and the line joining it to P" 02 Marks

ii) from
$$I = neV_dA$$
$$V_d = \frac{I}{neA}$$ 01 mark
$$V_d = \frac{5}{1\times10^{29} \times (1.6\times10^{-19})\times(2\times10^{-6})}$$
$$V_d = 1.56\times10^{-4}\,ms^{-1}$$ 01 mark

force on each electron
$$F = qBV\sin\theta$$
$\sin\theta = 1$ for $\theta = 90$ 01 mark
$$F = q_eBV$$
$$F = 1.6\times10^{-19}\times0.15\times1.56\times10^{-4}$$ 01 mark
$$\underline{F = 3.75\times10^{-24}N}$$

(b) i) Inorder to minimize the inductance of coil. The wire is doubled back on itself as a result, There are equal and opposite current in each section of the coil. Therefore the coil has no net magnetic field and no net induced emf 03 Marks

ii) Maximum emf induced in the coil is given by
$$E = NABw = 100\times3\times0.04\times60$$ 01 Mark
$$= 720V$$
Max. current supplied $(I_o) = \frac{E_o}{R} = \frac{720}{500} = 1.44A$ 01 Mark

Maximum power dissipated in the coil.

$$P_{max} = E_o I_o = 720 \times 1.44$$

$$P_{max} = 1036.8\,W$$ 02 Marks

$\therefore$ The maximum power dissipated in the coil is $\underline{1036.8\,W}$

5 c) i) • North (X) components 01 mark
• East (Y) component 01 Mark
• Vertical (Z) component 01 mark

ii) Sln

Given $\Phi = 1.1 \times 10^{-2}\,Wb$

turns $= 2230$

Area $= 7.2 \times 10^{-4}\,m^{-2}$

Mean Diameter $(D) = 0.17\,m$, radius $= \left(\frac{0.17}{2}\right) m$

Current $(I) = 37\,A$

$\mu_r = ?$

from $\Phi = BA = (\mu H) A$

but $H = \frac{NI}{L}$ 01 Mark

$$\Phi = \frac{\mu N I A}{L}$$ where $\mu = \mu_o \mu_r$

$$\Phi = \frac{\mu_o \mu_r N I A}{L}$$ 01 Mark

$$\mu_r = \frac{\Phi L}{\mu_o N I A}$$

$$\mu_r = \frac{1.1 \times 10^{-2} \times 2\pi \times \left(\frac{0.17}{2}\right)}{4 \times \pi \times 10^{-7} \times 2230 \times 37 \times 7.2 \times 10^{-4}}$$ 01 Mark

$$\mu_r = 78.69\,Wb\,A^{-1}H^{-1} = 78.69$$

where $H = Wb/A$

$\therefore \underline{\mu_r = 78.69}$ 01 mark

6 (a) i) In Rutherford's experiment of the α-particles passed straight through gold foil, very few of α-particle were reflected back, This indicate that (positive charge) nucleus is very small part of atom (It was estimated nucleus is about $\frac{1}{8000}$ of size of atom).

03 Marks

ii) Soln

Since $V_n = \frac{2\pi r_n}{T}$

01 Mark

According to Bohr's postulate

$$m v_n r_n = \frac{nh}{2\pi}$$

01 Mark

$$m\left(\frac{2\pi r_n}{T}\right) r_n = \frac{nh}{2\pi}$$

$$n = \frac{(2\pi)^2 m r_n^2}{Th}$$

01/2 Mark

$$n = \frac{(2\times3.14)^2 \times 10 \times (8000\times10^3)^2}{2\times3600\times 6.62\times10^{-34}}$$

01 Mark

$$n = 5.3\times10^{45}$$

01/2 Mark

∴ Quantum number of satellites orbit is 5.3×10^{45}

6 (b) i) Soln

from $f_o = c/\lambda_o$ where $c = 3\times10^8\, ms^{-1}$, $\lambda_o = 750\times10^{-9}\,m$

01 Mark

$$f_o = \frac{3\times10^8}{750\times10^{-9}\,m} = 3.997\times10^{14}\,Hz$$

01/2 Mark

$$f_o = 3.997\times10^{14}\,Hz$$

01/2 Mark

~~from~~ ∴ Threshold frequency is $3.997\times10^{14}\,Hz$.

6 b ii) work function $\Phi_0 = hf_0$ 0½ Mark

$$\Phi_0 = (6.62\times10^{-34}) \times 3.997\times10^{14} J$$ 01 Mark

$$\Phi_0 = 2.646\times10^{-19} J$$ 0½ Mark

In eV,

$$\Phi_0 = \left(\frac{2.646\times10^{-19}}{1.6\times10^{-19}}\right) eV = 1.65 eV$$ 0½ Mark

$$\therefore \Phi_0 = 1.65 eV$$

iii) Max. speed.

from

$$hf = \Phi_0 + \frac{1}{2} m V_{max}^2$$ 0½ Mark

$$\frac{1}{2} mV_{max}^2 = -\Phi_0 + hf = hf - \Phi_0$$

$$V_{max} = \sqrt{\frac{2(hf-\Phi_0)}{m}} = \sqrt{\frac{2(hc/\lambda - \Phi_0)}{m}}$$

$$V_{max} = \sqrt{\frac{2\left[\left(\frac{6.62\times10^{-34}\times3\times10^8}{500\times10^{-9}}\right) - 2.64\times10^{-19}\right]}{9.1\times10^{-31}}}$$ 01 Mark

$$V_{max} = \sqrt{\frac{7.944\times10^{-19} - 5.28\times10^{-19}}{9.1\times10^{-31}}}$$ 0½ Mark

$$\underline{V_{max} = 5.4\times10^5 ms^{-1}}$$ 0½ Mark

6 (c) i) Mass defect - Is the defference between the sum of masses of nucleons and that of the nucleus. 02 Mark

ii) Mass defects

Given He - has 2 protons and 2 electrons 0½ Mark

Mass of proton = 1.00727amu
Mass of electron = 1.008666amu

Actual mass of nucleus (M) = 4.001509amu

Mass of nucleons (A) = ΣMass of proton + ΣMass of electron

$= 2(1.00727) + 2(1.008666)$

$= 4.031886$ a.m.u 01 Mark

Mass defect (Δm) = $A - M$ 01/2 Mark

$= (4.031886 - 4.001509)$ amu

$\Delta m = 0.030377$ amu

$\therefore$ Mass defect is 0.030377 amu 01 Mark

- Binding energy per nucleon

from Binding energy $= \Delta m \times C^2$ 01/2 Mark

$= 0.030377 \times 1.6 \times 10^{-27} \times (3\times10^{8})^2$

$= 28.3 \times 10^{6}$ eV

$= 28.3$ MeV 01/2 Mark

$\frac{B.E}{\text{nucleons of He}} = \frac{28.3}{4} = 7.07$ MeV 01 Mark

$\therefore$ Binding energy per nucleon of helium is 7.07 MeV