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QUESTION ONE -1-

1(a)(i) - A vector is a physical quantity with both magnitude and direction ✓
- A scalar is a physical quantity with only magnitude. ✓ (2)

(ii) A newton is a force that gives a mass of one kilogram an acceleration of $1 ms^{-2}$ ✓ (1)

(b) $N kg^{-1} \Rightarrow$ Force $\times$ (mass)$^{-1}$; [Force][mass]$^{-1}$
$= MLT^{-2} \cdot M^{-1} = LT^{-2}$ ✓✓
$ms^{-2} \Rightarrow$ Length $\times$ (Time)$^{-2}$ = [length][time]$^{-2}$ ✓✓
$= LT^{-2}$ ✓✓ (2)

(c) $F_y = 3\sin 60 + 4.5\sin 30 - 5\sin 70 = 0.1496$ ✓✓
$F_x = 3.5 + 3\cos 60 - (4.5\cos 30 + 5\cos 70) = 0.607$ ✓✓
$F = [0.1496^2 + (-0.607)^2]^{\frac{1}{2}} = 0.625 N$ ✓✓
$F = ma$ ✓ $0.5a = 0.625 \Rightarrow a = 1.25 ms^{-2}$ ✓✓
$s = ut + \frac{1}{2}at^2$ ✓ $\Rightarrow s = 0 + \frac{1}{2} \times 1.25 \times 5^2$ ✓ $= 15.6m$ ✓ (6)

(d)(i) When moving upwards; $T_1 - mg > 0 \Rightarrow T_1 > mg$ ✓
When moving downwards; $mg - T_2 > 0 \Rightarrow T_2 < mg$ ✓
$\therefore T_1 > T_2$ ✓ (3)

(ii) $mg - R = ma$ $\therefore R = mg - ma$ ✓; when $a = g$, $R = 0$ ✓ therefore a person feels weightless when the lift falls freely under gravity ✓ (2)

(e) $s = ut + \frac{1}{2}at^2$ ✓; $60 = 0 + \frac{1}{2} \times 9.81 t^2$ ✓ $\therefore t = 3.497$ ✓
Distance travelled horizontally $= 30 \times \sqrt{\frac{120}{9.81}}$ ✓
$= 105m$ ✓ (4)

Total = 20

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Qn2 -2-

a) (i) Accn is the rate of change of velocity ✓ (1)

(ii) Is the rate of change of disp. at apt of time ✓(1)

(b)(i) On graph paper.

(ii) From graph; height of pole = 7.0m ✓ (1)

(c) (i) - Friction opposes the relative motion btn two surfaces in contact ✓

- Limiting frictional force is proportional to the normal reaction ✓

- Friction is independent of the area of contact provided normal reaction remains constant ✓

OR: Frictional force is proportional to the normal reaction and independent of relative velocity (3)

(ii) $m_1u_1 + m_2u_2 = m_1v + m_2v_2$ ✓

$5u + 3\times15 = 3V \quad \therefore V = \frac{5u+45}{3}$ ✓

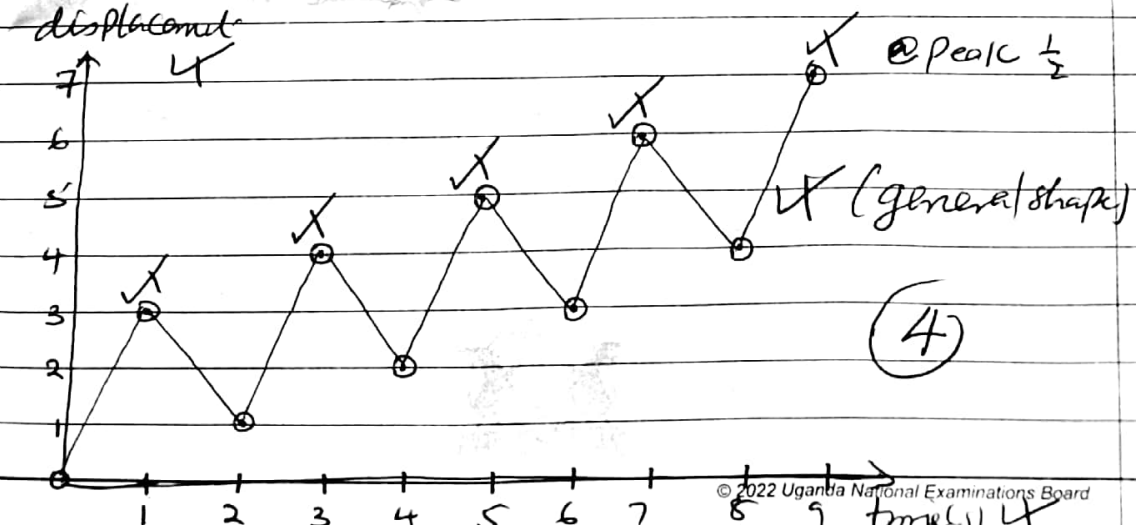
Retarding force, $F = ma$ ✓ $= \mu mg$ ✓ $\therefore a = \mu g$.

$a = 0.25\times9.81$; $a = 2.45\,ms^{-2}$ ✓

$v^2 = u^2 + 2as$ ✓ $\Rightarrow 0^2 = V^2 - 2\times2.45\times8.5$ ✓

$\therefore V = 19.98$

$\Rightarrow 19.98 = \frac{5u+45}{3}$ ✓ $\therefore u = 2.99\,ms^{-1}$ ✓ (5)



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(d) As stone moves its velocity is directed along the tangent to the path. When the string breaks, the centripetal force stops to act on the stone ✓. The stone then moves along a tangent to the path ✓. Bse of accn due to gravity ✓ the stone describes a parabolic path ✓ until it hits the ground ✓ (5)

Total = 20

Qn 3

(a) Extension (deformation) of an elastic material is directly prop. to the force applied provided the prop. (elastic) limit is not exceeded ✓ (1)

(ii) - For two molecules near each other there is a mean position where attractive force is equal to repulsive force and hence the net force btn them is zero ✓
- When a force is applied to increase the distance btn the molecules an attractive force which develops is prop. to the increase in distance ✓
- When a force is applied to reduce the distance btn the molecules a repulsive force which develops is prop. to the decrease in distance ✓
- Beyond a certain distance from each other, the attractive force btn the molecules is negligible and Hooke's law is not obeyed ✓ (4)

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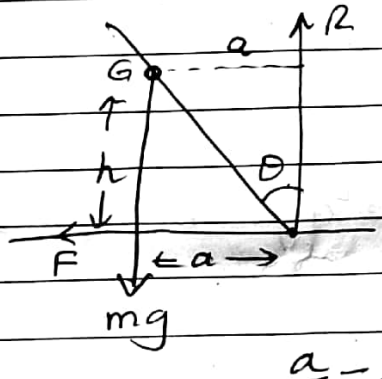
(b) Smoke particles are introduced in a glass cell and the top covered by glass ✓. Smoke ples are illuminated by strong light from a lamp ✓.
- The smoke ples are observed in a microscope and found to be in a state of continuous random motion ✓.
- This confirms that gases are made up of molecules (tiny ples) in cts random motion ✓ (4)

(c)(i) On a banked track the centripetal force is provided by both the component of friction ✓ and the component of the normal reaction ✓. These two provide a bigger centripetal force ✓ hence allowing the car to negotiate a bend at a higher speeds ✓ (2)

(ii)



$R = mg$ ✓ and $F = \frac{mv^2}{r}$ ✓

$\overrightarrow{G}$; $Ra = Fh$ ✓ $\therefore \frac{F}{R} = \frac{a}{h}$

$\frac{mv^2}{r} \div mg = \frac{a}{h}$

$\Rightarrow \frac{v^2}{rg} = a/h$ ✓ (3)

$\frac{a}{h} = \tan\theta$ ✓ $\Rightarrow \frac{v^2}{rg} = \tan\theta$

$\therefore v = \sqrt{rg\tan\theta}$ ✓; [Accept $v = \sqrt{\mu rg}$].

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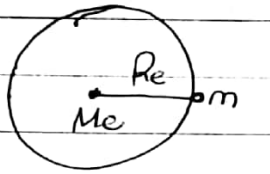
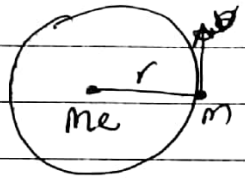
(d)(i)



$\frac{mv^2}{Re} = mg$ ✓ $\therefore v = \sqrt{gRe}$ ✓ (3)

ALT;



$\frac{mv^2}{r} = \frac{Gmem}{r^2}$ ✓✓

$v^2 = \frac{Gme}{r} \Rightarrow v = \sqrt{\frac{Gme}{r}}$ ✓ (3)

$Gme = gRe^2$ ✓ and $r \simeq Re$ ✓ $\therefore v = \sqrt{\frac{gRe^2}{Re}} = \sqrt{gRe}$ ✓

(ii) $T = \frac{2\pi R}{v} = 2\pi\sqrt{\frac{Re}{g}}$ ✓ $= 2\pi\sqrt{\frac{6.4\times10^6}{9.81}}$ ✓ (3)

$= 5.0776\times10^3 s$ ✓

Total = 20

Qn 4

(a) (i) ~~Force~~ Surface tension is the force per unit length acting in the surface perpendicular to one side of a line drawn in a liquid surface ✓. (1)

Angle of Contact is the angle btn the solid surface and the tangent to the liquid surface measured through the liquid ✓ (1)

(ii) Surface tension decreases with increase in temp ✓ b'se the intermolecular forces of attraction are reduced ✓ owing to the increase in KE of the molecules ✓ (3)

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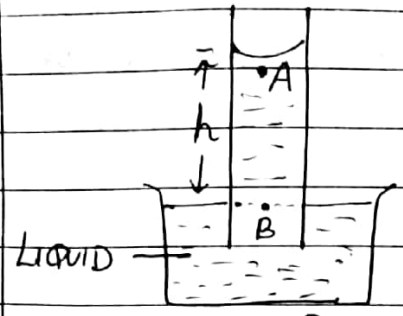
(b) Consider the diagram below



Given that atmospheric pressure is H then we have;

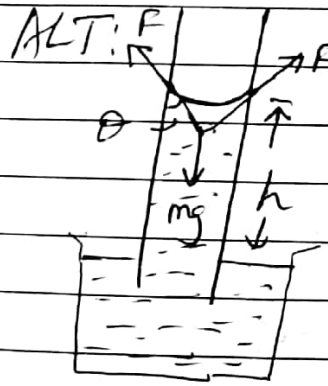
Pressure at A; $P_A = H - \frac{2\gamma}{r}$ ✓

Pressure at B; $P_B = P_A + h\rho g$ ✓

and $P_B = H \Rightarrow H = H - \frac{2\gamma}{r} + h\rho g$ ✓

$\therefore h = \frac{2\gamma}{r\rho g}$ ✓ (4)

ALT:



$F\cos\theta = mg$ ✓; $m = \rho V$

$\therefore F\cos\theta = \rho V g$, $V = \pi r^2 h$

$\therefore F\cos\theta = \pi r^2 h \rho g$ ✓

Also $\gamma = F/2\pi r \Rightarrow F = 2\pi r\gamma$ ✓

$\Rightarrow 2\pi r\gamma\cos\theta = \pi r^2 h\rho g$; $\cos\theta = 1$

$\therefore h = \frac{2\gamma}{r\rho g}$ ✓ (4)

ALT defn of surface tension;
W.D to increase the surface of a liquid by $1m^2$ under isothermal conditions ✓

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(c)(i) $A_1V_1 = A_2V_2$ ✓ But $A = \pi r^2$ ✓

$\therefore \pi r_1^2 V_1 = \pi r_2^2 V_2 \Rightarrow V_1 r_1^2 = V_2 r_2^2$

$\therefore V_2 = \frac{V_1 r_1^2}{r_2^2} = \frac{3(1.2\times10^{-2})^2}{(0.6\times10^{-2})^2} = 12.0\ ms^{-1}$ ✓ ✓ (3)

(ii) $P_1 + \frac{1}{2}\rho V_1^2 + h_1\rho g = P_2 + \frac{1}{2}\rho V_2^2 + h_2\rho g$ ✓

$3.6\times10^5 + \frac{1}{2}\times1000\times3^2 + 1000\times9.81\,h_1 = P_2 + \frac{1}{2}\times1000\times12^2 + 1000\times9.81\,h_2$ ✓ ✓

$h_2 - h_1 = 6m$ $\therefore P_2 = 2.3364\times10^5\ Nm^{-2}$ ✓ (4)

(d)

$W = \frac{4}{3}\pi r^3\rho g$ ✓, $U = \frac{4}{3}\pi r^3\delta g$ ✓

$F = 6\pi\eta r V$ ✓ ; $W = U + F$ ✓

$\therefore \frac{4}{3}\pi r^3\rho g = \frac{4}{3}\pi r^3\delta g + 6\pi\eta r V$ ✓

$\therefore V = \frac{2}{9\eta} r^2 g(\rho - \delta)$ ✓ (4)

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Ans

(a) (i) Is water in a liquid phase at a temp. above the normal b.P at a given high pressure ✓ (1)

(ii) Is a vapour at a temp. lower than the b.P at a given low pressure ✓ (1)

(b) (i) The molecules move randomly and continuously colliding with the walls of the container ✓ The rate of change of momentum per unit area constitutes the pressure ✓ (3)

(ii) The earth absorbs radiations from the sun and the earth re-emits radiations ✓. These are trapped ✓ by the atmosphere. This makes it warm ✓ (3)

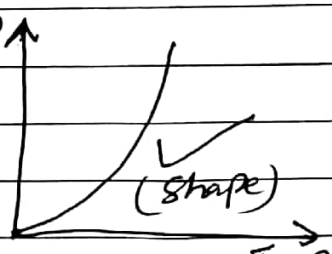
(c) (i) $n = \frac{PV}{RT} \checkmark\checkmark = \frac{1.5\times10^{4}\times0.2}{8.31\times300} \checkmark = 1.203$

$N = nN_A \checkmark = 1.203 \times 6.02\times10^{23} = 7.24\times10^{23}$ ✓ (3)

(ii) $c^2 = \frac{3RT}{M} \checkmark\checkmark = \frac{3\times8.31\times300}{2\times10^{-3}} \checkmark = 3.7395\times10^{6}\ m^2s^{-2}$ ✓ (3)

(iii) $c^2 = \frac{3RT}{M} \checkmark$; $\sqrt{c^2} = \sqrt{\frac{3\times8.31\times300}{32\times10^{-3}}} \checkmark = 4.834\times10^{2}\ ms^{-1}$ ✓ (2)

(d)



When temp increases, more liquid molecules join the vapour ✓. Hence mass of the vapour increases ✓ This leads to a non Linear increase in SVP ✓ (4)

Total = 20

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Qn 6 -9-

a) (i) Is flow of heat through matter without movement of matter as a whole ✓
(ii) Is flow of heat through matter when molecules of matter flow from one part to another ✓ (3)
(iii) Is flow of heat by electromagnetic waves ✓
(b) (i) Is the rate of heat flow per unit cross section area per unit temp. gradient ✓; $Wm^{-1}K^{-1}$ ✓ (2)
(ii) Thin - to have a measurable rate of heat flow ✓
long - to have a measurable temp. gradient ✓ (2)

(c) (i) Stellar flux $= \frac{4\pi r^2 \sigma T^4}{4\pi R^2}$ ✓ ✓ $= 5.67\times10^{-8} \times 6000^4 \left(\frac{7\times10^8}{1.5\times10^{11}}\right)^2$ ✓
$= 1600.3\ Wm^{-2}$ ✓ (3)
(ii) Power on mirror $= 1600.3 \times \pi \times 0.4^2 = 804.4W$ ✓
$Pt = ml$ ✓
$\Rightarrow 804.4t = 2.5 \times 3.36 \times 10^5$ ✓ $\therefore t = 1044.3s$ (3)

(d) (i) - The strip is connected to a wheatstone bridge, its resistance is measured ✓
- Radiation is allowed to fall on the strip, it is absorbed and its temp rises ✓
- The new resistance is measured; the difference in resistance indicates the presence of radiation ✓ (4)
ALT:- Strip is connected to a wheatstone bridge and variable resistor adjusted until galvanometer shows no deflection ✓
- Radiation is allowed to fall on the strip, it is absorbed and its temp. rises ✓

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- The galvanometer is seen to deflect ✓ showing presence of a radiation ✓ (4)

(ii) - On top of the earth's atmosphere, the radiation from the sun is falling on a smaller area than on surface of the earth ✓
- Also as the radiation passes through the atmosphere some of it is absorbed ✓ by the atmosphere. Some of the radiation is reflected, refracted and scattered in the atmosphere ✓. Therefore the intensity is higher on top of the earth's atmosphere than on the surface of the Earth. (3)

Total = 20

Qn 7

a) (i) - Isothermal process takes place at constant temp. ✓
- Adiabatic process takes place when no heat enters or leaves the system ✓. [reject constant heat] (2)

(ii)

Isothermal process	Adiabatic process
• Container of the gas shd be thin walled ✓ a good conductor ✓ of heat, surrounded by a constant temp. bath. Expansion and contraction shd be take place slowly	• Container shd be thick walled ✓ Poor conducting ✓ expansion and contraction shd take place rapidly

(4)

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(iii) Air coming out of the ball is expanding adiabatically ✓ The energy needed for expansion is supplied by the molecules of the gas themselves ✓. Hence energy of the molecules reduces ✓ and the gas cools ✓ (2)

(b) (i) For Adiabatic process $P_1V_1^{\gamma} = P_2V_2^{\gamma}$ ✓

$76(2000)^{1.4} = P_2(4000)^{1.4}$ ✓ $\Rightarrow P_2 = 28.8$ cmHg ✓

For Isothermal Process; $P_2V_2 = P_3V_3$ ✓

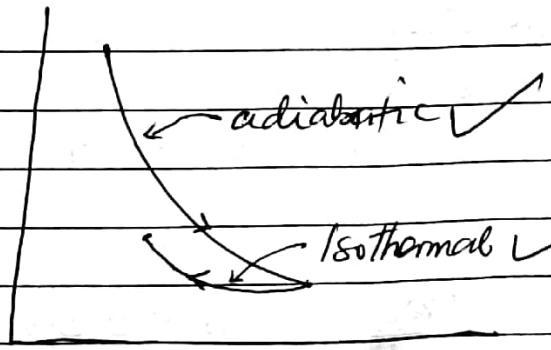
$28.8 \times 4000 = P_3 \times 3000$ ✓ $\therefore P_3 = 38.4$ cmHg ✓

Also for adiabatic process;

$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$ ✓

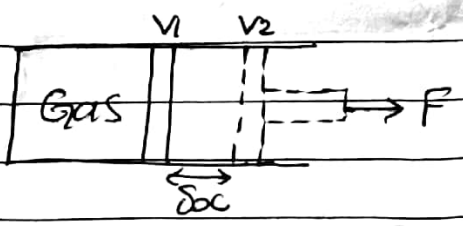
$293(2000)^{0.4} = T_2(4000)^{0.4}$ ✓ $\therefore T_2 = 222.05$K ✓ (6)

(ii)



(2)

(c)



Consider a gas at a pressure P, suppose a force, F acts on the piston so that it moves a distance, δx. When δx is very small, then F is constant. Workdone, $\delta W = F\delta x$ ✓

but $F = PA$ ✓; also $A\delta x = \delta V$ ✓ (4)

$\Rightarrow \delta W = P\delta V \Rightarrow W = \int_{V_1}^{V_2} P\,dV = P(V_2 - V_1)$ ✓

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Qn 8 -12-

a) (i) A nuclide is an atom (or a nucleus) characterised by protons and neutrons ✓ (1)

(ii) Isotopes are atoms of the same element having the same atomic number but different mass numbers ✓ (1)

ALT: Is one of two or more atoms of same element having the sum number of protons but different number of neutrons.

Carbon-12 ✓, Carbon-14 ✓ ^{35}Cl, ^{37}Cl. (1)

(iii) Irradiation is exposure to any radiation ✓ (1)

(b) . Alpha ples; ✓ tracks are short, straight, thick ✓
. Beta ples; ✓ tracks are thin, tortuous, ✓
. γ ples; ✓ tracks are cloudy, dust-like (diffuse) ✓ (3)

(c) (i) $^{210}_{84}Po \longrightarrow {}^{4}_{2}He + {}^{206}_{82}Pb + (Energy)$ ✓ (1)

(ii) $209.983U = 4.003U + 205.986U + \Delta M$ ✓
mass difference; $\Delta M = 6 \times 10^{-3}U$ ✓
$E = 6 \times 10^{-3} \times 931$ ✓ $= 5.60 MeV$ ✓ (4)

(iii) Ke of α-ples $= \left(\frac{206}{206+4}\right) \times 5.6$ ✓ $= 5.49 MeV$ ✓
$\frac{1}{2} \times 4 \times 1.66 \times 10^{-27} V^2$ ✓ $= 5.49 \times 1.6 \times 10^{-13}$ ✓
$\therefore V = 1.63 \times 10^{7} ms^{-1}$ ✓ (4)

(d) (i) They have same no of protons ✓ and chemically identical ✓ (2)

Biological - Radiotherapy ✓
- Sterilization
- Mutants
- Treatment of [illegible]

Industrial: ✓
- Detection of rate of wear
- Automatic control of thickness
- Detection of leakages (2)

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ALT: $m_1u_1 = m_2u_2 \quad \therefore u_1 = \left(\frac{m_2u_2}{m_1}\right)$

$E = \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 \quad \therefore 2E = \frac{m_1m_2^2u_2^2}{m_1^2} + m_2u_2^2$

$\therefore u_2^2 = \frac{2EM_1}{m_2(m_1+m_2)}$

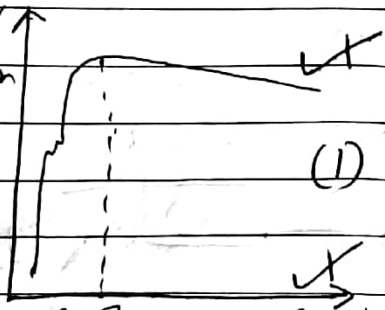
$= \frac{2\times 5.6\times10^6\times1.6\times10^{-19}\times 205.986}{1.66\times10^{-27}\times 4.003\,(205.986+4.003)}$

$\therefore u_2 = 1.63\times10^7 ms^{-1}$

Question 9

(a) - Fusion is the union of two light nuclei to form a heavy nucleus (with release of energy) ✓ (1)
- Fission is the splitting of a heavy nucleus into two lighter nuclei (with release of energy) ✓ (1)

(b)(i)



✓ ✓ (1) ✓

(ii) - Nuclides with low mass number have a low binding energy per nucleon hence are unstable ✓.
- These combine to form a nucleus of higher binding energy per nucleon (which is stable) ✓
- The mass of the resulting nucleus is less than the mass of the two lighter nuclei ✓. The mass defect accounts for energy released ✓

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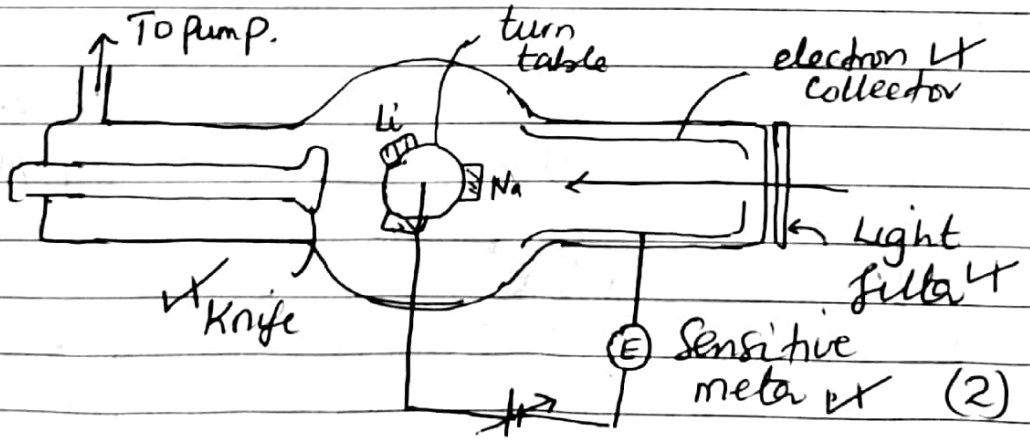
- Nuclides with large mass number have a low binding energy per nucleon and hence are unstable ✓✓.
- Those split into lighter nuclei which are stable ✓✓. The mass of the heavier nucleus is greater than the mass of the resulting nuclei ✓✓ The mass defect accounts for the energy released ✓✓ (4)

(b) (i) Emission of electrons by a metal surface when radiation of high enough frequency falls on it ✓ (1)

(ii) $hf = W_o + \frac{1}{2}mV^2_{max}$ ✓
h = Planics constant ✓✓, f = freq. of incident radiation ✓✓, W_o = work function
$\frac{1}{2}mV^2_{max}$ = kinetic energy of electron. (2)

(iii)



(2)

- Monochromatic light of known freq. f ✓✓ is made to fall on the metal.
- Electrons are emitted and current flows through E ✓✓

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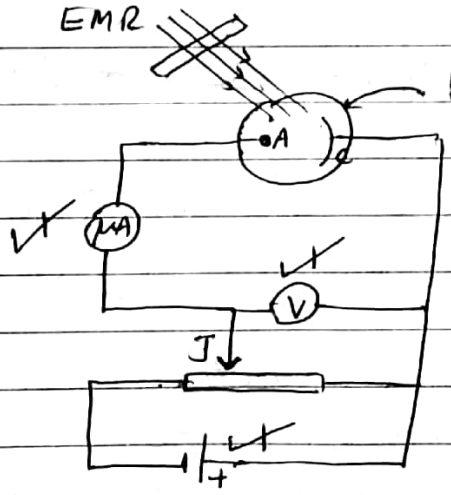
- The variable d.c is adjusted until E reads zero current ✓ The pd, V is noted ✓ and the frequency f (from the filter) noted.
- The experiment is repeated ✓ for different values of f. A graph of V against f is plotted ✓ The slope, s of the graph is determined ✓ Planks constant $h = se$ ✓ where e = electron charge ✓ (5)

ALT:



Photocell ✓

(Circuit + any 3)

(2)

Electromagnetic radiation of known freq. f ✓ is directed onto the cathode, C, electrons are emitted and current flows ✓ The jockey J is moved along the potential divider until the micro ammeter reading is zero ✓ The stopping potential, V is recorded ✓ The expt is repeated ✓ with light of diff. frequencies. A graph of V against f is plotted ✓ The slope, s ✓ of the graph is obtained. Planks constant, $h = se$ ✓ where e is the electron charge ✓ (05)

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(d) Consider an electron of charge, e projected horizontally with speed V in a field of intensity E.

$y = \frac{1}{2}at^2$ ↓, but $F = Ee = ma$ ↓ $\therefore a = \frac{Ee}{m}$

and $x = Vt$ →

$\therefore y = \frac{1}{2}\frac{Ee}{m}\left(\frac{x}{V}\right)^2 \therefore y = \frac{Ee}{2mV^2}x^2$ ✓; (3)

$y = kx^2$.

Qn 10

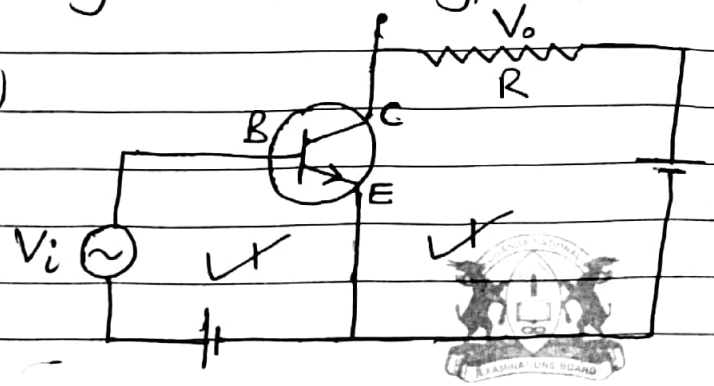
(a) (i) An intrinsic material is a pure semiconductor ✓ (1)

(ii) The P-type semiconductor is formed by doping a semiconductor with a group (iii) element ✓ where by the holes become the majority charge carriers ✓

Then the n-type semiconductor is formed by doping a semiconductor with a group (V) element ✓; where by the electrons become the majority charge carriers ✓ (5)

Now a P-n junction is formed by fusing together the P-type and n-type pieces ✓

(iii)



(1)

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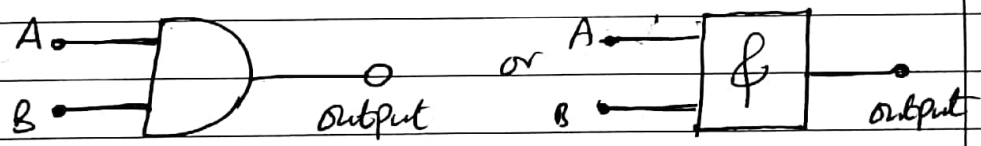
The small a.c voltage, V_i is applied to the base-emitter circuit ↓ and the voltage causes small changes in base current I_B ↓ which produces large changes in the collector current I_C ↓. The collector current flows through the load resistor, R ↓. R converts these current changes into voltage changes ↓, which forms the ac output voltage ↓, $V_o = I_c R$. (3)

(b)(i) AND logic gate:



Truth table

Inputs		output
A	B	AB
0	0	0 ↓
0	1	0 ↓
1	0	0 ↓ (2)
1	1	1 ↓

(ii) One input is connected to a high voltage ↓. and the other connected to a circuit designed to give a high voltage during the dark ↓ and no voltage when there is light ↓ When there is darkness both inputs will

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Therefore have a voltage ✓ giving rise to a voltage in the output ✓ that sounds the alarm ✓ (3)

(c) - Positive rays are positively charged and cathode rays are negatively charged ✓
- Positive rays have varied velocities and cathode rays have the same velocity ✓
- Positive rays are massive compared to cathode rays ✓
- Positive rays are deflected less in electric and magnetic fields than cathode rays. (3)

ALT. For 9(b) Total=20

- During fusion lighter nuclei combine to form a heavier nucleus of higher binding energy per nucleon ✓ whose mass is less than that of combined nuclei ✓. This difference in mass accounts for energy released ✓
- During fission a heavier nucleus splits into lighter nuclei of higher BE per nucleon ✓ whose total mass is less than that of split nucleus ✓. This difference in mass accounts for the energy released ✓ (4)

END