SET – II

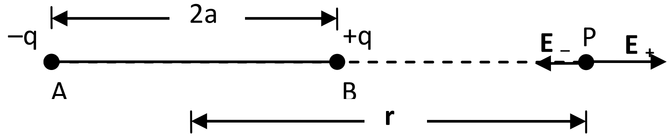
Subject Code: 042

COMMON PRE-BOARD EXAMINATION 2017-2018

PHYSICS

1.	There will not be any change in the balancing length Reason: Voltage across AB remains constant.	½ ½	1
2.	Drift velocity obtained per unit electric field Unit – $m^2 v^{-1} s^{-1}$ or $m N^{-1} C^{-1} s^{-1}$	½ ½	1
3.	$\omega = \frac{1}{\sqrt{LC}}$ L should be changed to L/2	½ ½	1
4.	1. I_R radiations are used in thermal imaging cameras. 2. Used in remote controls 3. Used in heat therapy. 4. Cooking food (Any two uses) ½ each	½ X 2	1
5.	Collector current - decreases Base current – increases	½ ½	1
6.	We know that $u_E = \frac{1}{2}\varepsilon_0 E_{rms}{}^2$ $= \frac{1}{2}\varepsilon_0 c^2 B_{rms}{}^2$ [$E_{rms} = c B_{rms}$] $= \frac{1}{2}\varepsilon_0 \frac{1}{\varepsilon_0\mu_0} B_{rms}{}^2$ [$c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$] $= \frac{1}{2}\frac{1}{\mu_0} B_{rms}{}^2$ $u_E = u_B$	½ ½ ½ ½	2

7.



½ 2

Let P be a point on the axial line of a dipole of dipole moment **p** = 2qa, as shown in the figure.

Electric field at the point P due to $+\mathrm{q} = \vec{\boldsymbol{E}}_+$

$$\vec{\boldsymbol{E}}_+ = k\,\frac{q\ \widehat{\boldsymbol{p}}}{(r-a)^2}$$

Electric field at the point P due to $-\mathrm{q} = \vec{\boldsymbol{E}}_-$

$$\vec{\boldsymbol{E}}_- = k\,\frac{q\ (-\widehat{\boldsymbol{p}}\,)}{(r+a)^2}$$

Total field at point $P = \vec{\boldsymbol{E}}_{\boldsymbol{axial}}½\vec{E}_{axial} = \vec{\boldsymbol{E}}_+ + \vec{\boldsymbol{E}}_-$

$$= k\,\frac{q\ \widehat{\boldsymbol{p}}}{(r-a)^2} + k\,\frac{q\ (-\widehat{\boldsymbol{p}}\,)}{(r+a)^2}$$ ½

$$= k\,q\,\widehat{\boldsymbol{p}}\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right]$$

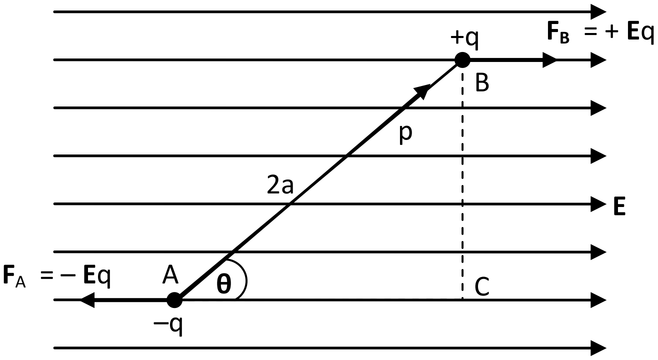
$$= k\,\frac{4raq\ \widehat{\boldsymbol{p}}}{(r^2-a^2)^2}$$ ½

$$\vec{E}_{axial} = k\,\frac{2\overrightarrow{\boldsymbol{p}}\ r}{(r^2-a^2)^2}$$

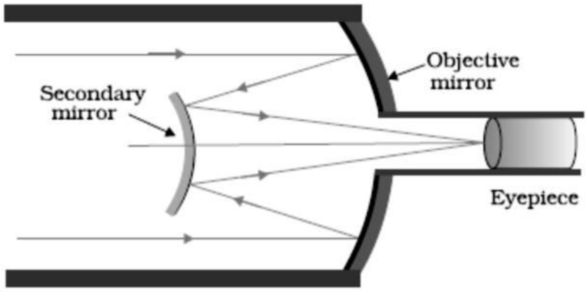
If $r >> a$ then,

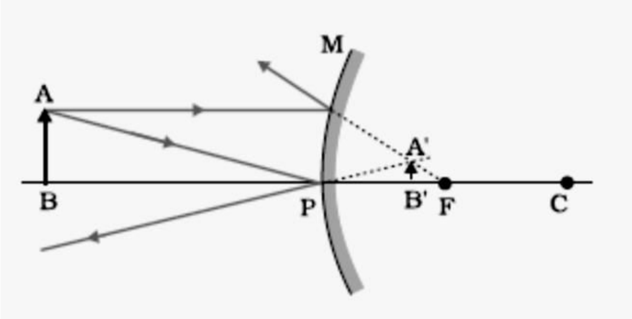
$$\vec{E}_{axial} = \frac{2k\overrightarrow{\boldsymbol{p}}}{r^3}$$ ½

OR

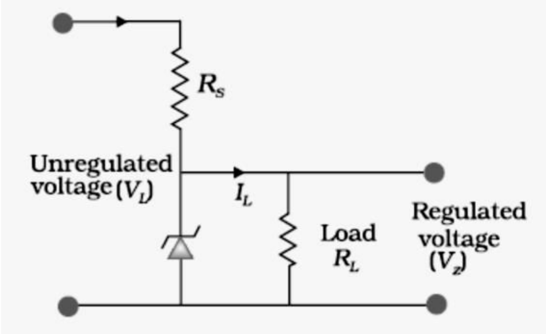
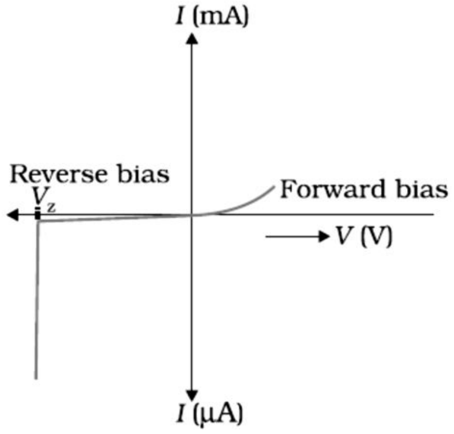
OR	Force on the charge – q = $\mathbf{F_A = -Eq}$ (along CA) Force on the charge + q = $\mathbf{F_A = Eq}$ (along AC) Because of the two equal and opposite forces acting at the two ends of the dipole, a torque is experienced by the dipole. So the dipole will rotate till it becomes parallel to the electric field. Torque on dipole = F X Perpendicular distance $\tau = Eq \times BC$ $\tau = Eq \times 2a \sin\theta$ $\tau = (q \times 2a)E \sin\theta$ $\tau = pE \sin\theta$ $\vec{\tau} = \vec{p} \times \vec{E}$  	½ ½ ½ ½	2
8.	Attenuation: The loss of strength of a signal while propagating through a medium is known as attenuation. Transducer: Any device that converts one form of energy into another form is known as transducer. In communication system transducer converts some physical variables into electrical signals or optical signals and vice versa.	1 1	2
9.	(i) Frequency (ii) All same.	½ ½	2

	Stopping potential is same for radiation Kinetic energy is directly proportional to the frequency/ Stopping potential is directly proportional to the frequency.	½ ½	
10.	E = hc/λ = 4.5 eV Therefore transition B will give photon of wavelength 275 nm Transition A corresponds to emission of maximum wavelength	½ ½ ½ ½	2
11.	(a) We know that in a capacitor voltage lags behind the current by $\frac{\pi}{2}$. If instantaneous voltage is $v = V_o \sin \omega t$ Then $i = I_o \cos \omega t$ Instantaneous power $p = vi$ $p = V_o \sin \omega t \; I_o \cos \omega t$ $p = \frac{V_o I_o}{2} \sin 2\omega t$ Average power over complete cycle $< p > = \frac{V_o I_o}{2} < sin\, 2\omega t >$ $< p > = 0$ (b) Capacitance of the capacitor increases when a dielectric slab is inserted in between the plates of the capacitor. This causes decrease in the capacitive reactance offered by the capacitor and leads to more current in the circuit. Therefore brightness of the lamp will increase.	½ ½ ½ ½ 1	3

12.	(i) 12μF and 6μF are connected in parallel therefore they have a common potential difference. We know that, $U_6 = \frac{1}{2}C_6V^2$ $U_{12} = \frac{1}{2}C_{12}V^2$ $\frac{U_6}{U_{12}} = \frac{C_6}{C_{12}}$ Therefore $U_{12} = 2E$ (ii) Equivalent capacitance of the 12μF and 3μF $C_{18} = C_6 + C_{12} = 12\mu F + 6\mu F = 18\mu F$ Total energy possessed by $C_{18} = 2E + E = 3E$ C_{18} and C_3 are connected in series therefore they have same charge $U_{18} = \frac{1}{2}\frac{Q^2}{C_{18}}$ $U_3 = \frac{1}{2}\frac{Q^2}{C_3}$ $\frac{U_{18}}{U_3} = \frac{C_3}{C_{18}}$ Therefore $U_3 = 18E$ (iii) Total energy possessed by the combination $= 18E + 3E = 21E$	½ ½ ½ ½ ½ ½	3
13.	 They are free from chromatic aberration. Spherical aberration can be minimized by using parabolic mirrors. They are light in both cost and weight. Large aperture for objective can be achieved easily. (**Any two Points)**	1 1+1	3

14.	Potential energy = –mBcosθ		
	(a) Configuration Q_1 and Q_2 $\theta = 90^0$	½+½	**3**
	(b) (i) Stable Q_3 and Q_6 $\theta = 0^0$	½	
	(ii)Unstable Q_4 and Q_5 $\theta = 0^0$	½	
	(c) Lowest potential energy for configuration Q_6 = – mB	½+½	
15.		½	**3**
	$\Delta\, ABP \approx \Delta\, A'B'P$		
	$\therefore\ \frac{AB}{A'B'} = \frac{BP}{B'P}$ − − − − − − − (i)		
	$\Delta\, MPF \approx \Delta\, A'B'F$		
	$\therefore\ \frac{MP}{A'B'} = \frac{FP}{FB'}$ ----------------------(ii)		
	But $MP = AB$ [aperture of the mirror is very samll & AM is paraxial ray]		
	∴ equ (ii) becomes		
	$\frac{AB}{A'B'} = \frac{FP}{FB'}$ ----------------------(iii)		
	Comparing equ (i) and (iii)		
	$\frac{FP}{FB'} = \frac{BP}{B'P}$ -------------------------(iv)		
	From the ray diagram $FB' = FP - B'P$		
	∴ equ (iv) becomes		
	$\frac{FP}{FP - B'P} = \frac{BP}{B'P}$ -------------------------(v)	½	
	Using sign convention, we hve		
	$FP = f,\ B'P = v\ \&\ BP = -u.$		
	∴ equ (v) becomes		

	$\frac{f}{\mathrm{v}-(\mathrm{f})}=\frac{-u}{\mathrm{v}}$ Rearranging the terms we get $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ Assumptions used 1. aperture of the mirror is very samll 2. Incident rays are paraxial rays	½ ½ ½ ½	
16.	(i) Total charge $Q = -2+8 = 6\mu C$ Therefore charge on each sphere $= 6\mu C/2 = 3\mu C$ (ii) Repulsion (iii) $V_A = V_B$ $\frac{kQ_A}{R}=\frac{kQ_B}{2R}$ $Q_A + Q_B = 6\mu C$ $Q_A = 2\ \mu C$ $Q_B = 4\ \mu C$ (iv) 1. Charge is conserved, 2. Charge is additive in nature	½ ½ ½ ½ ½ ½	3
17.	(i) Angular separation of the fringes remains constant ($=\lambda/d$). The actual separation of the fringes increases in proportion to the distance of the screen from the plane of the two slits. (ii) Let s be the size of the source and S its distance from the plane of the two slits. For interference fringes to be seen, the condition $s/S < \lambda/d$ should be satisfied; otherwise, interference patterns produced by different parts of the source overlap and no fringes are seen. Thus, as S decreases, the interference pattern gets less and less sharp, and when the source is brought too close for this condition to be valid, the fringes disappear. Till this happens, the fringe separation remains fixed.	1 1	3

	(iii) The interference patterns due to different component colours of white light overlap (incoherently). The central bright fringes for different colours are at the same position. The fringe closest on either side of the central white fringe is red and the farthest will appear blue. After a few fringes, no clear fringe pattern is seen.	1	
18.	 The unregulated dc is connected to the Zener diode through a series resistance R_s such that the Zener diode is reverse biased. If the input voltage changes, the current through R_s and Zener diode also changes. This changes the voltage drop across R_s without any change in the voltage across the Zener diode and load. This is because in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes. Thus the Zener diode acts as a voltage regulator. 	1 1 ½	3
19.	**Observations** 1. Intensity of scattered electrons is maximum at scattering angle		3

	$\varphi = 50^0$. 2. When accelerating voltage is 54V intensity of scattered electrons obtains maximum **Explanation** The selective reflection of the 54 V electrons at an angle of 50^0 is due to the diffraction of electrons from the regularly spaced electrons of the nickel crystal by virtue of their wave nature. $\theta = \frac{1}{2}(180 - \varphi)$ $\varphi = 50^0$, $\theta = \frac{1}{2}(180 - 50^0) = 65^0$ According to Braggs law $2d \sin\theta = n\lambda$ For first order diffraction n = 1 For nickel , the distance between atomic planes , d = 0.91 x 10^{-10} m Therefore $\lambda = 2 \times 0.91 \times 10^{-10} \sin 65$ $= 1.66 \times 10^{-10}\, m$ --------(i) According to de – Broglie wavelength of the electron accelerated through 54V $\lambda = \frac{12.27 \times 10^{-10}}{\sqrt{54}}$ $= 1.65 \times 10^{-10}\, m$ ---------(ii) As the two results (i) and (ii) are in agreement, the experiment establishes the wave nature of an electron.	½ ½ ½ ½ 1	
	OR		
OR	$\lambda = \frac{h}{p}$ Where p is momentum of the particle of mass ‘m’ and charge ‘q’	½	**3**

We know that

$$p = \sqrt{2\,mE_k}$$ ½

Where E_k is kinetic energy of the particle accelerated by through a potential difference of V

We know that ½

$E_k = Vq$

$\therefore\ p = \sqrt{2\,mVq}$ ½

$\therefore\ \lambda = \dfrac{h}{\sqrt{2\,mVq}}$ ½

For an electron $m = 9.1 \times 10^{-31}\,kg$ and $q = 1.6 \times 10^{-19}\,C$

$\lambda = \dfrac{12.27 \times 10^{-10}}{\sqrt{V}}\ m$ ½

20. Truth table for the given logic circuit is as given below **3**

A	B	C_1	C_2	y
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	1	1	0

1

This truth table can be used to write the values of the signals C1 and C2 for the given input signals

A	B	C_1	C_2	y
1	0	0	1	1
1	1	1	1	0
1	1	1	1	0
0	0	1	1	0

1

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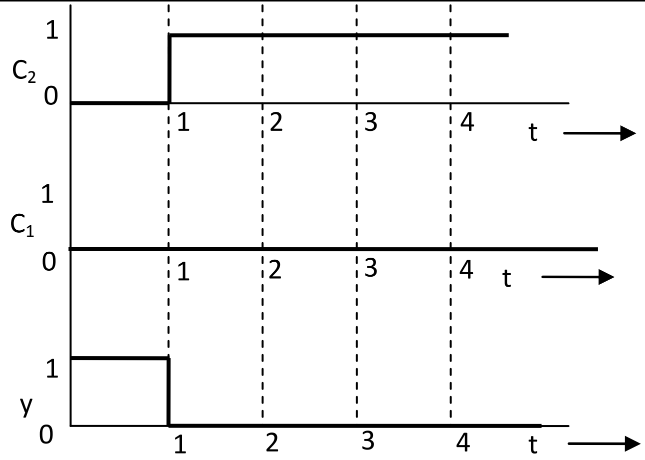
<td>
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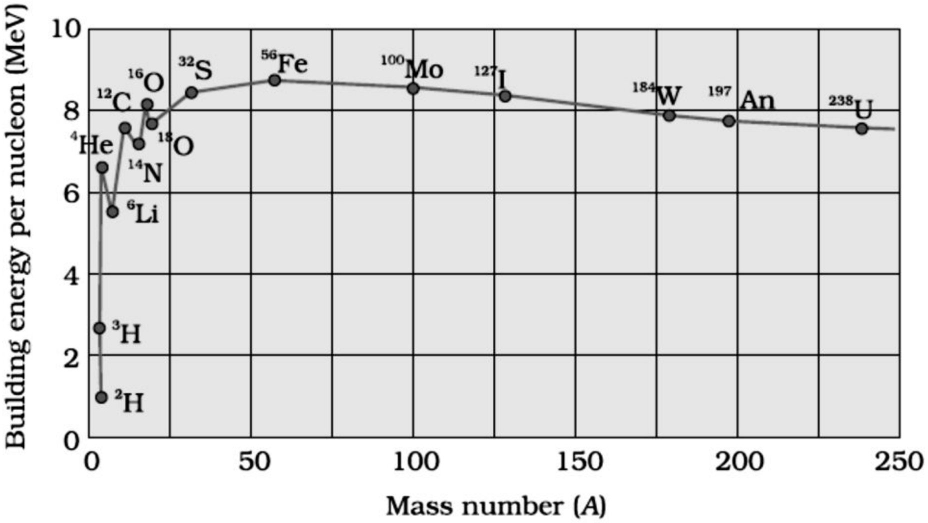
<td>

A very heavy nucleus, say A = 240, has lower binding energy per nucleon compared to that of a nucleus with A = 120. Thus if a nucleus A = 240 breaks into two A = 120 nuclei, nucleons get more tightly bound. This implies energy would be released in the process. [fission]

Consider two very light nuclei (A≤ 10) joining to form a heavier nucleus. The binding energy per nucleon of the fused heavier nuclei is more than the binding energy per nucleon of the lighter nuclei. This means that the final system is more tightly bound than the initial system. Again energy would be released in such a process of fusion.</td>
<td>1
1
1</td>
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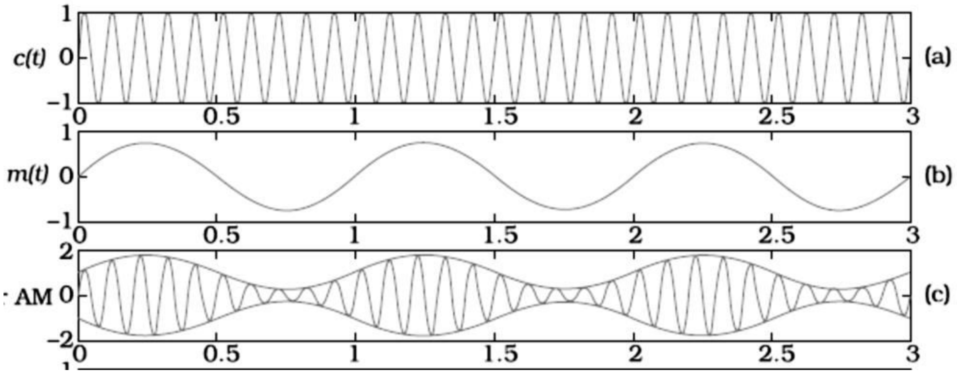
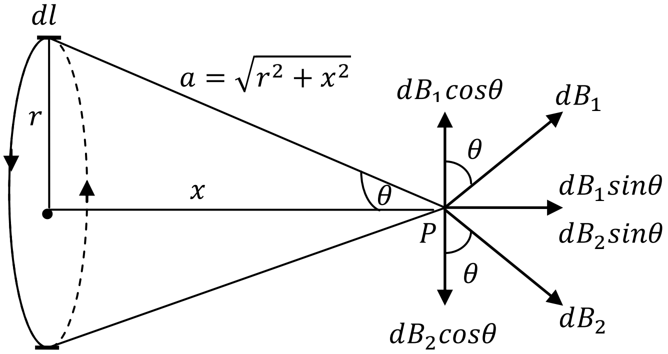
22.	(a) (i) Practical antenna height For efficient transmission and reception, the antennas must have a length equal to quarter wavelength of message signal. i.e. $L= \lambda/4$. For an audio signal of frequency 15 kHz, the length of antenna is approximately 5000 m. This height of antenna is not practical. (ii) Effective power radiated by an antenna It is found that power radiated by an antenna α $(l/ \lambda)^2$. From this equation it is clear that for the same antenna height, the power radiated by the short wavelength or high frequency would be large. For the effective transmission, we need high power. (iii) Mixing up of signals from different transmitters. If all transmitters are transmitting baseband information simultaneously then all signals will get mixed up and there is no way to distinguish between them **(Any two points)**	1+1	3
	(b)  	1	
23.	(a) Respect and value for human life, Presence of mind or mentally aware of the situation happening around him.	1+1	4
	(b) Current passes only when there is difference in potential.	½	
	(c) $P=V_{rms}I_{rms}\cos\phi$, Where $\cos\phi$ is the power factor. To transmit power at a given voltage V_{rms}, if $\cos\phi$ is small then	½	

	I_{rms} has to be increased accordingly. Hence the power loss $I^2_{rms}R$ in transmission will increase. Hence to avoid the electric power from a power plant is set, to a very high voltage before transmitting so as to avoid the power loss.	1	
24.	(a)  Consider a circular loop of radius r carrying current I placed in such a way that its plane is perpendicular to the plane of the paper. Let P be a point which is at a distance x from the centre of the loop. Consider a small element of length dl in the wire. $Field\ at\ P\ due\ to\ this\ element\ dB_1 = \frac{\mu_o}{4\pi}\frac{Idl\,sin\,\emptyset}{a^2}$ $dB_1 = \frac{\mu_o}{4\pi}\frac{Idl}{a^2}\quad ------(1)\qquad [sin\,\emptyset = 1]$ Consider a small element of length dl which is at diametrically opposite point as shown in the figure. $Field\ at\ P\ due\ to\ this\ element\ dB_2 = \frac{\mu_o}{4\pi}\frac{Idl\,sin\,\emptyset}{a^2}$ $dB_2 = \frac{\mu_o}{4\pi}\frac{Idl}{a^2}\quad ------(2)\qquad [sin\,\emptyset = 1]$ From equ (1) & (2) , it clear that $dB_1 = dB_2$ But they are in different direction. From the figure, we can find that the vertical components cancel each	½ ½ ½	5

	other and field at the point P is due to the horizontal components.		
	$Effective\ field\ at\ P\ due\ to\ the\ element\ dl\ = dB$	½	
	$dB = dB_1 sin\theta$		
	$= \frac{\mu_o}{4\pi}\frac{Idl}{a^2}sin\theta$		
	$= \frac{\mu_o}{4\pi}\frac{Idl\,r}{a^3}$		
	Total field at P due to the whole loop $= B = \oint dB$		
	$B = \oint \frac{\mu_o}{4\pi}\frac{Idl\,r}{a^3}$	½	
	$B = \frac{\mu_o}{4\pi}\frac{I\,r}{a^3}2\pi r$		
	$B = \frac{\mu_o}{4\pi}\frac{I\,2A}{(r^2+x^2)^{\frac{3}{2}}}$ $[\pi r^2 = A]$		
	$B = \frac{\mu_o}{4\pi}\frac{2M}{(r^2+x^2)^{\frac{3}{2}}}$ $[IA = M]$	½	
	Where $\boldsymbol{IA = M}$ is known as **magnetic moment** of the loop		
	(b)	½	
	$Mg = BIL$		
	$\lambda Lg = BIL$	½	
	$\lambda g = BI$	½	
	$B = \frac{\lambda g}{I}$		
	Direction of magnetic field is along horizontal and perpendicular to the length of the wire.	½	
	OR		
OR	(a) The line integral of the magnetic field around any closed loop is equal to the $\boldsymbol{\mu_0}$ times the algebraic sum of the currents which pass through the loop.	½	**5**
	$\oint \vec{B}.\vec{dl} = \mu_0 I$		

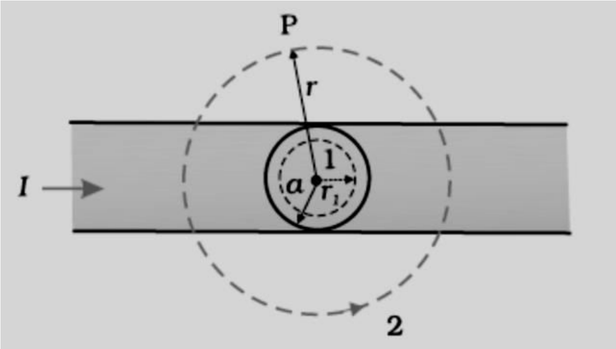
(b)

(i) **B** is tangential to the loop and is a non-zero *constant* B, *or*

(ii) **B** is normal to the loop, *or* 1½

(iii) **B** vanishes

(c)



½

Consider the case $r > a$. The Amperian loop, labelled 2, is a circle concentric with the cross-section. For this loop,

$$L = 2\pi r$$

I_e = Current enclosed by the loop = I

$$B\,(2\pi r) = \mu_o I$$

$$B = \frac{\mu_o I}{2\pi r}$$ ½

Consider the case $r < a$. The Amperian loop is a circle labelled 1. For this loop, taking the radius of the circle to be r,

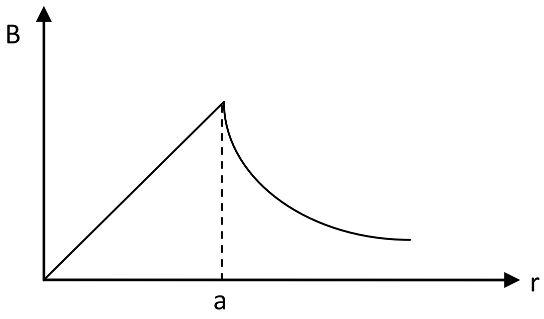
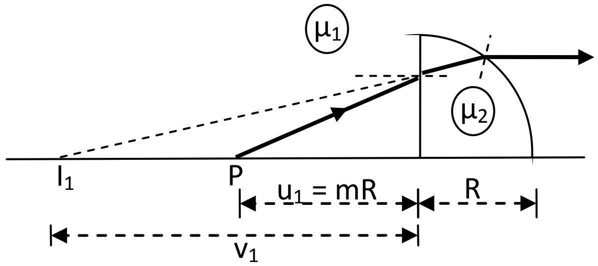
$$L = 2\pi r$$

Now the current enclosed I_e is not I, but is less than this value. Since the current distribution is uniform, the current enclosed is,

$$I_e = I\left(\frac{\pi r^2}{\pi a^2}\right) = \frac{I r^2}{a^2}$$

Using Ampere's law, ½

$$B\,(2\pi r) = \mu_o \frac{I r^2}{a^2}$$

	$B = \left(\frac{\mu_o I}{2\,\pi\, a^2}\right) r$	½	
	(d) 	1	
25.	(a) Focal length increases	1	5
	We know that		
	$\frac{1}{f} = \left(n_g - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	½	
	Since refractive index of the in water is less than that in air, focal length increases.	½	
	(b) 	½	
	Refraction at plane surface		
	$-\frac{1}{u_1} + \frac{\mu}{v_1} = \frac{\mu - 1}{R_1}$	½	
	$u_1 = -mR\,;\quad R_1 = \infty\,;\ \mu = 1.5 \quad \therefore\ v_1 = -1.5mR$	½+½	
	Refraction at curved surface		
	$-\frac{1}{u_2} + \frac{\mu}{v_2} = \frac{\mu - 1}{R_2}$		
	$u_2 = -(v_1 + R) = -(1.5mR + R);\quad R_1 = -R\,;\ \ ; v_2 = \infty;\ \mu = 1.5$	½	
	$\therefore\ m = \frac{4}{3}$	½	

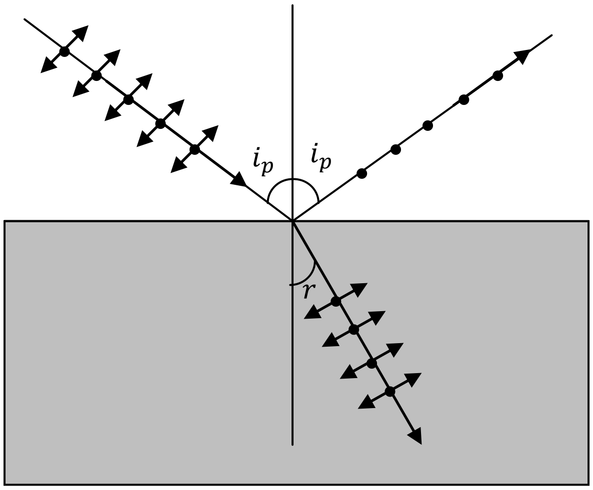
OR

OR (a)

Brewster's law **5**

When light is incident at polarizing angle at the interface of a refracting medium, the refractive index of the medium is equal to the tangent of the polarizing angle. **1**

$$\mu = \tan i_p \qquad ----(i)$$



½

$$\mu = \frac{\sin i_p}{\sin r} \qquad -----(ii)$$ **½**

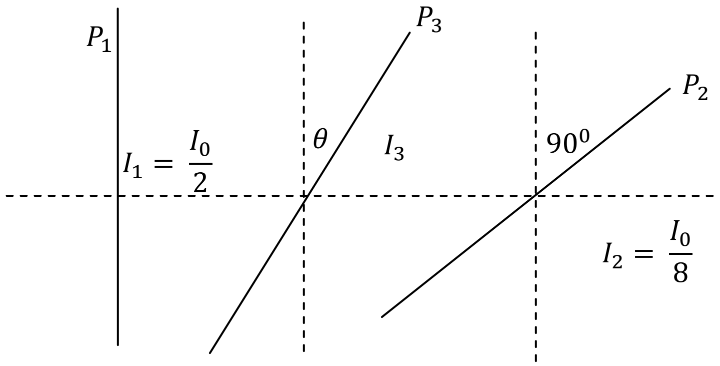
Using (i) & (ii)

$$\frac{\sin i_p}{\sin r} = \tan i_p \implies \frac{\sin i_p}{\sin r} = \frac{\sin i_p}{\cos i_p}$$ **½**

$$\sin r = \cos i_p \implies \sin r = \sin(90^o - i_p)$$

$$r = 90^0 - i_p \implies 90^0 = r + i_p$$ **½**

Hence reflected and the refracted ray are perpendicular to each other, when the angle of incidence is equal to polarizing angle.

	(b)  Intensity of light from Polaroid P_1 $I_1 = \frac{I_0}{2}$ According to the law of Malu's Intensity of light from the Polaroid P_3 $I_3 = I_1 \cos^2\theta$ Intensity of light from the Polaroid P_2 $I_2 = I_3 \cos^2(90-\theta)$ $I_2 = I_1 \cos^2\theta \sin^2\theta$ $I_2 = \frac{I_0}{4} 2\cos^2\theta \sin^2\theta$ $I_2 = \frac{I_0}{4}\sin^2 2\,\theta$ Given that $I_2 = \frac{I_0}{8}$ $\therefore \frac{I_0}{8} == \frac{I_0}{4}\sin^2 2\,\theta$ Solving we get $\theta = 45^o$	½ ½ ½ ½	
26.	(i) Since cells are connected in parallel, voltages across the cells are same, which is equal to V and total current drawn from the combination is I. $I = I_1 + I_2 - - - - - (i)$ And Voltage across the first cell = $V = \varepsilon_1 - I_1 r_1$	½	5

$$I_1 = \frac{\varepsilon_1}{r_1} - \frac{V}{r_1} \quad ---(ii)$$ ½

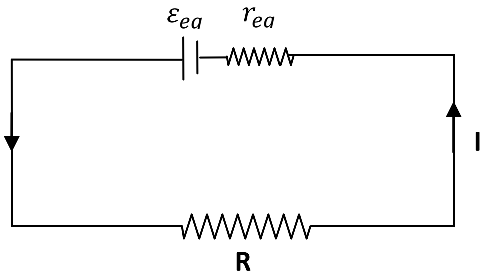
Voltage across the second cell $= V = \varepsilon_2 - I_2 r_2$

$$I_2 = \frac{\varepsilon_2}{r_2} - \frac{V}{r_2} \quad ---(iii)$$

Using $(i), (ii)$ *and* (iii)

$$V = \left(\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_{2+}r_1}\right) - I\left(\frac{r_1 r_2}{r_{2+}r_1}\right) \quad ---(iv)$$ ½

If ε_{eq} is the equivalent emf and r_{eq} is the internal resistance of the effective (equivalent) cell,



then

$$V = \varepsilon_{eq} - I r_{eq} \quad ------(v)$$ ½

Comparing (iv)& (v)

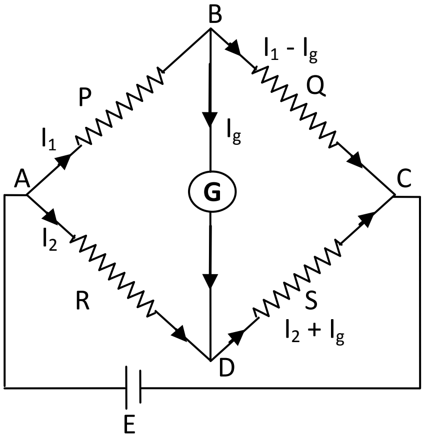
$$\boldsymbol{\varepsilon_{eq}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}$$

$$\boldsymbol{\varepsilon_{eq}} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$$ ½

$$\boldsymbol{r_{eq}} = \frac{r_1 r_2}{r_{2+}r_1}$$ ½

(ii) Voltage across the resistor V = ε₁ ½

We know that $V = \varepsilon - Ir$

	Since $V = \varepsilon_1$ Current drawn from the cell $\varepsilon_1 = 0$ $\therefore V = \varepsilon_2 - Ir_2$ $\varepsilon_1 = \varepsilon_2 - Ir_2$ But we know $I = \frac{\varepsilon_2}{R + r_2}$ $\therefore \varepsilon_1 = \varepsilon_2 - \frac{\varepsilon_2 r_2}{R + r_2}$ Solving the above equation we get $R = \frac{r_2 \varepsilon_1}{\varepsilon_2 - \varepsilon_1}$	½ ½ ½	
	OR		
OR	 (a) Wheatstone bridge is said to be balanced, when no current is flowing through the galvanometer. i.e when potential at B = potential at D Appling Kirchhoff's Loop rule in loop ABDA $-I_1P - I_gG + I_2R = 0 \quad ---(i)$ Appling Kirchhoff's Loop rule in loop BCDB $-(I_1 - I_g)Q + (I_2 + I_g)S + I_gG = 0 \quad ---(ii)$	1 ½ ½	5

When the bridge is balanced $I_g = 0$ ½

$$(i) \Rightarrow -I_1P + I_2R = 0$$

$$I_1P = I_2R \quad ----(iii)$$

$$(ii) \Rightarrow -I_1Q + I_2S = 0$$

$$I_1Q = I_2S \quad ---(iv)$$

$$\frac{(iii)}{(iv)} \Rightarrow \quad \frac{I_1P}{I_1Q} = \frac{I_2R}{I_2S}$$

$$\frac{P}{Q} = \frac{R}{S}$$ ½

(b) Condition for balancing

$$\frac{R_1}{R_2} = \frac{4}{6} ---------- \quad \text{(i)}$$ ½

When 10 Ω connected in series with R_1

$$\frac{R_1 + 10}{R_2} = \frac{6}{4} ---------- \text{(ii)}$$ ½

Using (i) and (ii)

$$\frac{R_1}{R_1 + 10} = \frac{16}{36} ------ \text{(iii)}$$ ½

Solving (iii) we get R1 = 8 Ω and R2 = 12 Ω ½