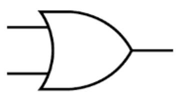
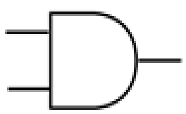
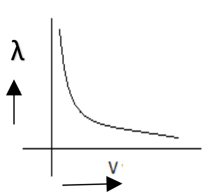
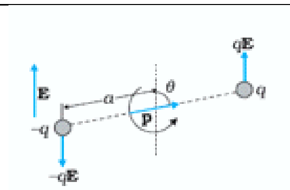
S.NO	Value Points / Expected Answers	Marks	Total
1	Any one property of paramagnetic materials. (e.g. (i) It attracts field lines, weakly. (ii) It moves from weaker towards stronger field. or any other property.) **OR** No.	 ½ ½ 1	 1
2	OR GATE  **OR** AND GATE 	½ ½ ½ ½	 1
3	Whether students write **yes** or **no** award 1 mark	1	1
4	If electric field is not perpendicular but has a component tangential to the surface of the conductor, it will exert force on charge and make them more. It means electrostatic condition is violated.	1	1
5	$\lambda = \frac{h}{\sqrt{2meV}} or \lambda \alpha \frac{1}{\sqrt{V}}$ 	½ ½	 1
6	a) Condition for no deflection - 1 b) Conclusion for greater radius - 1 (a) No deflection if electron moves parallel or anti parallel to the magnetic field	 1	

	(b) $r = \frac{mv}{Bq}$ $\frac{r_1}{r_2} = \frac{B_2}{B_1}$ $As\ B_1 \langle B_2\ \ r_2 \langle r_1$ *Alternatively* $[r \alpha \frac{l}{B}$ r_2 *is smaller because B*]	½ ½ ½ ½	2
7	Value of resistance of shorter wire after stretching- 1 Net resistance of combination- 1 *Shorter Wire* *Longer Wire* $\text{Resistance}: \frac{R}{3}$ $\frac{2R}{3}$ $length: \frac{l}{3}$ $\frac{2l}{3}$ $New\ Length: \frac{2l}{3}$ $\therefore New\ Resistance\ R' = \rho \frac{2l/3}{A/2}$ $= \frac{4}{3}R$ $R_p = \frac{\left(\frac{4}{3}R\right)\left(\frac{2}{3}R\right)}{\left(\frac{4}{3}R + \frac{2}{3}R\right)}$ $= \frac{4R}{9}$	1 1	2
8	Diagram - ½ Expression for torque - 1 Direction of torque - ½		



½

Force on either charge F = qE

Magnitude of torque = Either of force X ⊥ distance between them.

$\tau = qE\ 2a \sin\theta$ ½

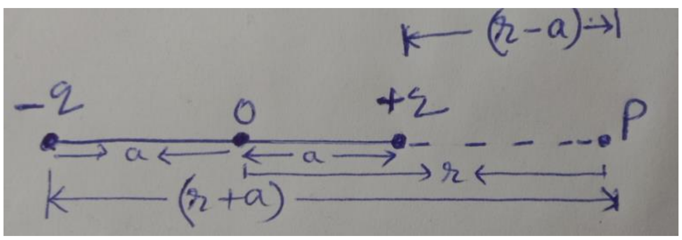
$\tau = pE \sin\theta$ ½

$\vec{\tau} = \vec{p} \times \vec{E}$

Direction is normal to the paper coming out of it ½ 2

OR

Expression for field at an axial point	-	1½
Field at large distance	-	½



½

$E_- = \dfrac{q}{4\pi\varepsilon_0 (r+a)^2}\ along\ (-)\vec{p}$ ½

$E_+ = \dfrac{q}{4\pi\varepsilon_0 (r+a)^2}\ along\ \vec{p}$

$\therefore Total\ field\ at\ P,\ E = E_- - E_+$

$= \dfrac{q}{4\pi\varepsilon_0}\left[\dfrac{1}{(r-a)^2} - \dfrac{1}{(r+a)^2}\right]$ ½

$= \dfrac{q}{4\pi\varepsilon_0}\dfrac{2pr}{(r^2-a^2)^2}$

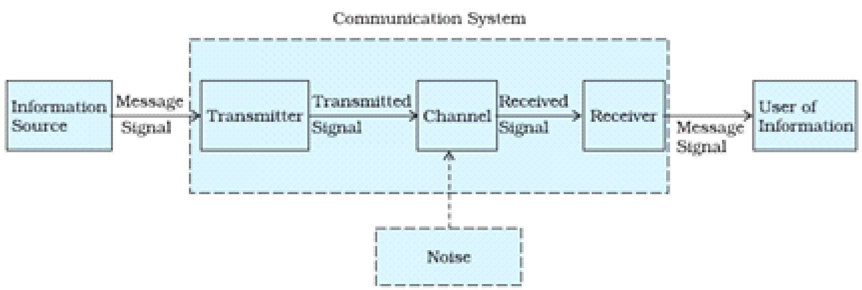
For

$r \rangle\rangle a$

$E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2p}{r^3}$ ½

2

9	(i) Voltage across each capacity – 1 (ii) Charge on each capacity - 1 (i) V = 10 V (ii) Q = C V = 200 pC	1 ½ ½	2
10	Expression for frequency of Side bands -1/2 Carrier frequency -1/2 Modulating frequency -1/2 Band width -1/2 $f_u = f_c + f_m = 660\ kHz$ $f_l = f_c - f_m = 640\ kHz$ $\therefore\ 2f_c = 1300\ kHz$ $\therefore\ f_c = 650\ kHz$ and $2f_m = 20\ kHz$ $fm = 10\ kHz$ Band width $= f_u - f_l$ $= 2f_m$ $= 20\ kHz$	½ ½ ½ ½	2
	OR		
	Frequency of two side bands - ½ + ½ Amplitude of side bands - 1 $f_u = f_c + f_m = (10000 + 10)\ kHz$ $= 10010\ kHz$ $f_l = f_c - f_m = (10000 - 10)\ kHz$	½	

	$= 9990\ kHz$	½	
	$Amplitude\ of\ Side\ bands = \mu\frac{A_C}{2}$	½	
	$= 0.3 \times \frac{40}{2} = 6V$	½	2
11	Block diagram - 1 Function of Transmitter - ½ Function of Receiver - ½  (<u>Also accept</u> if the student just writes communication system in the central box) Transmitter: A transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception. Receiver: A receiver extracts the desired message signals from the received signals at the channel output.	1 ½ ½	2
12	Magnetic fields due to two coils at the common center ½ + ½ Resultant magnetic field at the common center - 1 $B_P = \frac{\mu_0}{4\pi}\left(\frac{2\pi I}{R}\right) = \frac{\mu_0 I}{2R}$ $B_Q = \frac{\mu_0\left(2I\sqrt{3}\right)}{2\times 2R}$ $B = \sqrt{B_P^{\ 2} + B_Q^{\ 2}}$ $= \frac{\mu_0 I}{R}$ [Direction of B cannot be determined as directions of current are not known Hence no marks allocated for this part]	½ ½ 1	2

13.

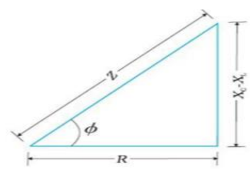
> (a) Identification: X, Y and Z - ½ + ½ + ½
> (b) (i) Power factor - 1
> (ii) Condition for reasons - ½

X is resistor ½

Y is a capacitor ½

Z is an inductor ½

[Alternatively]



½

$$Power\ Factor = \frac{V_R}{V}$$

$$= \frac{R}{Z}$$

$$= \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$$

½

(ii) *Circuit* is in *resonance when*

$$X_L - X_C = 0$$

Alternatively

$$\omega = \frac{1}{\sqrt{\omega L}}$$

½

3

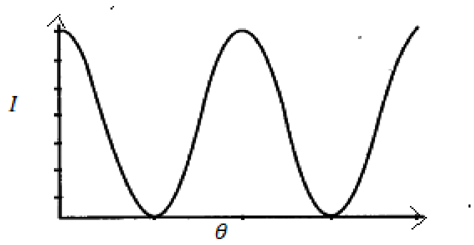
14.

> (a) Reason to use polaroid 1
> (b) Explanation 1
> (c) Graph 1

(a) Polaroid sunglasses are preferred over colored sun glasses, because they reduce intensity of light 1

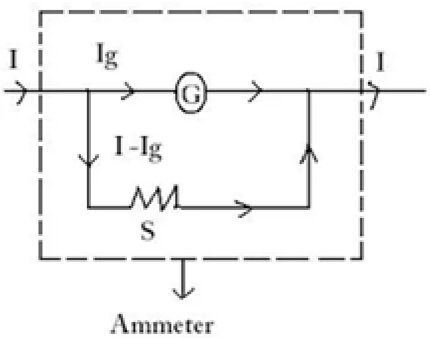
(b) Light in which vibrations of electric field vectors are restricted to one plane containing directions of polarisation 1

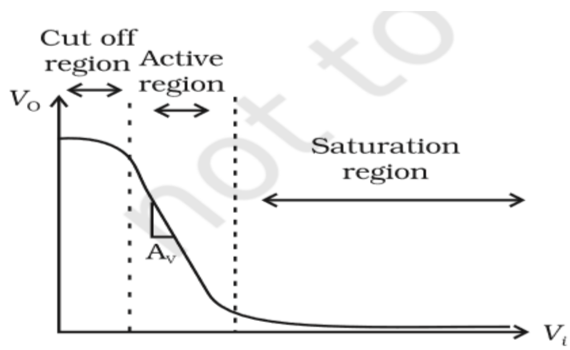
(c)

		1	3
15.	Expression for total Q. – 1 Expression for common potential – 2 $Q = q_1 + q_2$ $= 4\pi\sigma(r^2 + R^2)$ *Potential at common centre* $V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r} + \frac{q_2}{R}\right]$ $= \frac{1}{4\pi\varepsilon_0} \times \left[\frac{4\pi r^2\sigma}{r} + \frac{4\pi R^2\sigma}{R}\right]$ $= \frac{(r+R)\sigma}{\varepsilon_0}$ $= \frac{1}{4\pi\varepsilon_0}\left[\frac{Q(r+R)}{r^2+R^2}\right]$	1 ½ ½ ½ ½	3
	OR		
(a)	Expressions for potential of shells A,B,C – 1+1+1/2 Relation b/w a,b,c ½	½	

(b)	$V_A = \frac{kQ_A}{a} + \frac{kQ_B}{b} + \frac{kQ_C}{c}$ $V_A = \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{a} - \frac{4\pi b^2\sigma}{b} + \frac{4\pi c^2\sigma}{c}\right]$ $= \frac{\sigma}{\varepsilon_0}[a - b + c]$ $V_B = \frac{kQ_A}{b} + \frac{kQ_B}{b} + \frac{kQ_C}{c}$ $V_B = \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{b} - \frac{4\pi b^2\sigma}{b} + \frac{4\pi c^2\sigma}{c}\right]$ $V_B = \frac{\sigma}{\varepsilon_0}\left[\frac{a^2 - b^2}{b} + c\right]$ $V_C = \frac{kQ_A}{c} + \frac{kQ_B}{c} + \frac{kQ_C}{c}$ $V_C = \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{c} - \frac{4\pi b^2\sigma}{c} + \frac{4\pi c^2\sigma}{c}\right]$ $= \frac{\sigma}{\varepsilon_0}\left[\frac{a^2 - b^2 + c^2}{c}\right]$ $V_A = V_C$ $a - b + c = \frac{a^2 - b^2}{c} + c$ $c = a + b$	½ ½ ½ ½ ½	3
16	Expression for threshold frequency - 2 Whether K_{max} gets doubled with reason -1 By Einstein's photoelectric equation. $e\,V_1 = h\nu_1 - h\nu_0$	½	

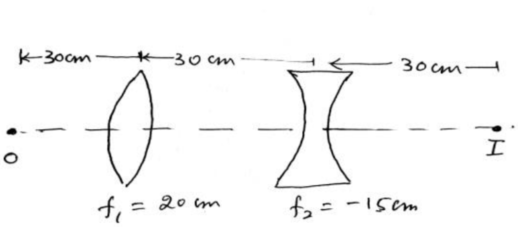
	and $eV_2 = \frac{h\nu_1}{2} - h\nu_0$ $2eV_2 = h\nu_1 - 2h\nu_0$ On solving the above equations $\Rightarrow e(V_1 - 2V_2) = h\nu_0$ $\Rightarrow \nu_0 = \frac{e}{h}(V_1 - 2V_2)$ If the frequency is doubled, maximum kinetic energy will not be doubled. $K_{max} = h\nu - h\nu_0$ $K^1_{max} = 2h\nu - h\nu_0$ $= h\nu + K_{max}$	½ 1 ½ ½	3
17	Principle - 1 Working & expression for deflection - 1 Current Sensitivity - 1 Principle - A current carrying coil experiences a torque in a magnetic field. Working - When current is passed through the coil torque produced is τ = NIAB sin θ = NIAB (θ=90°) Restoring torque $\tau' = k\phi$ At equilibrium $\tau = \tau'$ NIAB = kϕ $\phi = \left(\frac{NAB}{k}\right)I$ *Current sensitivity* : $\frac{\phi}{I} = \frac{NAB}{k}$	1 ½ ½ 1	

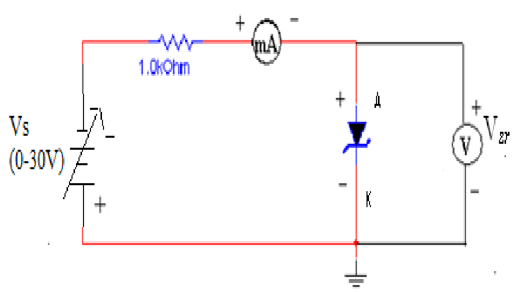
	[Alternatively: It is deflection per unit current]		3
	OR		
	Conversion of galvanometer into ammeter - 1 Expression for shunt resistance -1 Effective resistance of ammeter - 1 A galvanometer is converted into an Ammeter when a suitable shunt resistance is connected in parallel with the galvanometer.  $GI_g = (I - I_g)S$ $\Rightarrow S = \frac{I_g}{(I - I_g)} G$ $R_{eff} = \frac{GS}{G+S}$	½ ½ ½ ½ 1	3
18	Formula - 1 Calculation of energy levels involved - 1½ Specification of spectral series - ½ $\frac{1}{\lambda} = R\left(\frac{1}{{n_f}^2} - \frac{1}{{n_i}^2}\right)$ $\frac{1}{\lambda R} = \left(\frac{1}{1^2} - \frac{1}{n^2}\right)$ $n_2 = 2 \,\&\, 4$ *Lymen series*	1 1 ½	

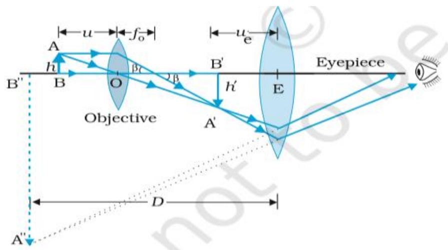
	[Award full marks even if the student correctly finds the relevant energy level for any one of the two wave lengths]	½	3
19 (a) (b)	(a) Three segments of transistor ½ +½+½ (b) Graph and required portion 1+½ i) Emitter : It is of moderate size and heavily doped semi conductor. ii) Base – It is very thin and lightly doped. iii) Collector – It is moderately doped and larger in size than the emitter.  In the graphs the active region of the transfer characteristics is used for the amplification purpose. This is because in this region I_C increases almost linearly with the increase of V_i.	 ½ ½ ½ 1 ½	3
20	(a) For defining Isotopes and example ½ + ½ For defining Isobars and example ½ + ½ (b) For giving e.g. ½ + ½ (a) Isotopes have same atomic number & isobars have same mass number Isotopes e.g $^{12}_{6}C$, $^{14}_{6}C$ Isobars e.g $^{3}_{2}He$, $^{3}_{1}H$ (b) Mass of a nucleus is is less than its constituents because in the bound state same mass is converted into binding energy which is energy equivalent of mass defect e.g. mass of $^{16}_{8}O$ nucleus is less than the sum of masses of 8 protons and 8 neutrons.	 ½ + ½ ½ + ½ ½ ½	

	OR		
	(a) Clarification of nuclides ½ ½ + ½ (b) Non dependence of nuclear density on size of nucleus 1½ (i) Isotones: $^{198}_{80}Hg$ & $^{197}_{79}Au$ Having same number of neutrons (i.e. A - Z) (ii) Isotopes: $^{12}_{6}C$, $^{14}_{6}C$ (same atomic number) (iii) For Isobars: $^{3}_{2}He$, $^{3}_{1}H$ (same mass number) The radius of a nucleus having the mass number A as $R= r_o A^{1/3}$ r_o is constant. Volume of the nucleus= $\frac{4}{3}\pi R^3 = \frac{4}{3}\pi(r_o A^{1/3})^3$ $= \frac{4}{3}\pi(r_o)^3 A$ If 'm' be the average mass of a nucleon then mass of the nucleus= mA Nuclear density = $\frac{mass}{Volume} = \frac{mA}{\frac{4}{3}\pi(r_o)^3 A} = \frac{3m}{4\pi r_o^3}$ i.e. nuclear density is independent of the size of the nucleus.	½ ½ ½ ½ ½ ½	
21	(a) Definition of coherent source - ½ (b) Expression for intensite in interference pattern - 1 ½ Condition for conductive and restrictive interference - ½ + ½		
(a)	Source which emit waves continuously of the same type same frequency and have a constant or no phase difference between the waves emitted by them are called coherent sources.	½	
(b)	Displacement product by two sources at a point on the screen is given by $y_1 = a \cos wt$ $y_2 = a \cos (wt + \phi)$	½	

	By super position (one word) $y = y_1 + y_2$ $= a\left[\cos\omega t + \cos\left(\omega t + \phi\right)\right]$ $= \left\{2a\cos\frac{\phi}{2}\right\}\cos\left(\omega t + \frac{\phi}{2}\right)$ $\therefore Intensity\ at\ the\ po\text{int}$ $I\ \alpha \left[2a\cos\frac{\phi}{2}\right]^2$ $I\ \alpha\ a^2$ $\frac{I}{I_P} = 4\cos^2\frac{\phi}{2}$ $\Rightarrow I = 4I_0\cos^2\frac{\phi}{2}$ $For\ Constructive\ Interference:$ $I = 1$ $\Rightarrow \cos^2\frac{\phi}{2} = 1$ $\Rightarrow \phi = 0, \pm 2\pi, \pm 4\pi, ...$ $For\ destructive\ Interference:$ $I = 0$ $\Rightarrow \cos^2\frac{\phi}{2} = 0$ $\Rightarrow \phi = \pm\pi, \pm 3\pi, \pm 5\pi.....$	½ ½ ½ ½	3
22	Value of v+ u ½ Value of v - u ½ Calculation of v and u 1 Calculation of f 1 v+u = 90 v-u = 20 v = 55 cm u = 35 cm $f = \frac{55x35}{55+35}$ = 21.4 cm	½ ½ ½ ½ 1	3

	[or any other correct method used]		
	OR		
	Diagram ½ Image distance for convex lens 1 Image distance for concave lens 1 Would the result change ½		
		½	
	For Image formed by convex lens: $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ $\frac{1}{20}=\frac{1}{v}+\frac{1}{30}$ $v = \frac{20\times30}{30-20} = 60cm$	1	
	u for concave lens = + 30cm and $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ $\frac{1}{-15}=\frac{1}{v}-\frac{1}{30}$ $v=\frac{15\times30}{15-30}=-30cm$	1	
	Final Image formed at I No, the result image will not change from principle of reversibility	½	3

23	Definition of displacement current – 1 Expression for displacement current – 1 Value of displacement current - 1 Displacement current is the current due to the changing of electric flux. It provides continuity of current in all types of circuits. $I_d = \varepsilon_o \frac{d\phi_e}{dt}$ [Even if students write current award ½ mark] Yes, the value of displacement is equal to the conduction current. [Explanation not required]	1 1 1	3
24	(i) For identification of diode 1 (ii) For cut diagram 1 (iii) For explaining the use of device 1 (a) The diode used is Zener diode (b)  (c) The Zener diode used can be used as a voltage regulator because, In its breakdown region. The Zener voltage remains constant even when the current through the Zener diode changes. [Award this one mark even if the student just writes" the Zener diode can be used as voltage regulator"] [This one mark can also be awarded if student draws the circuit diagram of a Zener diode as a voltage regulator]	1 1 1	3
25	(a) Ray diagram 1 (b) Reason for short 'f' and aperture 1 (c) (i) Calculation of Magnifying power 2 (ii) Length of microscope 1		

(a)	Ray diagram  The magnifying power of compound microscope $m = m_0 \times m_e = \frac{L}{f_0} \times (1 + \frac{D}{f_e})$	1	
(b)	To have high magnifying power and high resolution, the focal length of the objective and its aperture should be short. Focal length of eyepiece is comparatively greater than the objective so that image formed by objective lens may form within the focal length of eyepiece and the final magnified image may be formed.	1	
(c)	$u_0 = -6cm \quad v_e = -D = -25cm$ $for \;\; objective\, lens$ $\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$ $\frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0} \;\; = \frac{1}{4} + \frac{1}{-6}$ $v_0 = 12cm$ Since for eyepiece $\frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{-25} - \frac{1}{10}$ $u_e = -7.14cm$	1	
	(i) For magnifying power of compound microscope $m = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$ $m = \frac{12}{6}\left(1 + \frac{25}{10}\right) = 7$ (ii) Length of Microscope	1	

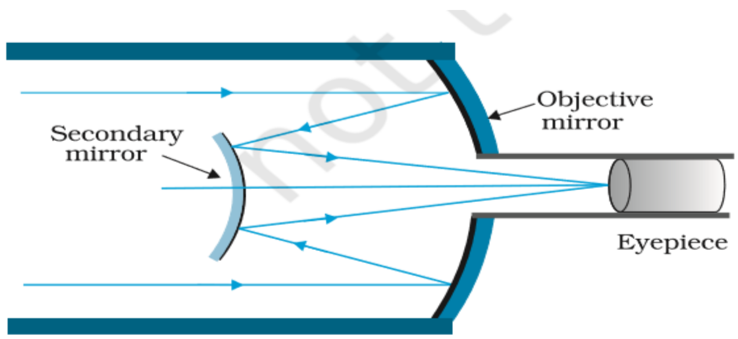
$$L = v_0 + |u_e| = 12 + 7.14$$
$$L = 19.14 cm$$ 1

5

OR

(a) Ray diagram and explanation	2+1
(b) Calculation of Sun's sign	2

(a)



2

It consists for large concave (primary) parabolic mirror having in its central part a hole. There is a small convex (secondary) mirror near the focus of concave mirror. Eye pieces if placed near the hole of the concave mirror . The parallel rays from distance object are reflected by the large concave mirror . These rays fall on the convex mirror which reflects these rays outside the hole. The final magnified image in formed. 1

(b) For eyepiece.

$$\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$$

$$or \ \frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{v_e} = \frac{1}{40} - \frac{1}{10}$$ ½

$$u_e = \frac{40}{3} cm$$ ½

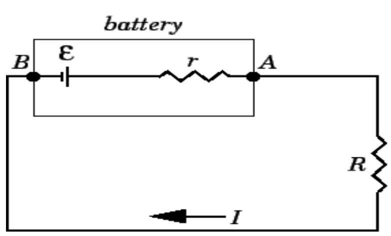
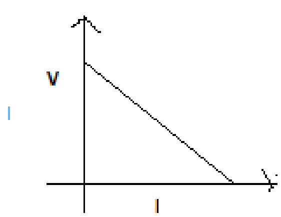
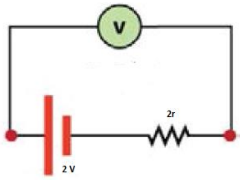
Magnification produced by eye pieces is

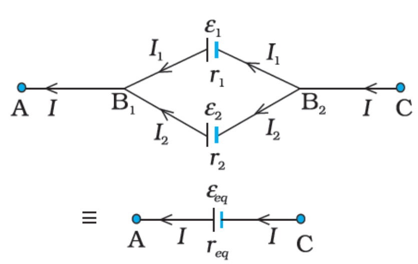
$$m_e = \frac{v_e}{|u_e|} = \frac{40}{40/3} = 3$$

Diameter of the image formed by the objective is

d = 6/3 = 2cm ½

If D be the diameter of the SUN then the angle subtended by it on the objective will be

	$\alpha = \frac{D}{1.5\times10^{11}} rad$ Angle subtended by the image at the objective = angle subtended by the SUN $\therefore \alpha = \frac{size\,of\ image}{f_o} = \frac{2}{200} = \frac{1}{100} rad.$ $\therefore \frac{D}{1.5\times10^{11}} = \frac{1}{100}$ *or* $D = 1.5\times10^{9} m$	½	5
26	a) Relation between E, V, r — 1 Graph V v/s I — 1 Significance of graph — 1 (b) Current in voltmeter — 1 Potential difference across voltmeter — ½ Percentage Error — ½		
(a)	 E- IR – rI = 0 E – v – Ir = 0 E = V + Ir  [Award 1 mark even if student writes the relation directly] Significance of Graph – To find emf and internal resistance of cell.	½ ½ 1	
(b)			

	$V = E - Ir$ $998 \times I = 2 - 2I$ $1000 \times I = 2$ $I = \frac{.2}{1000} = .002\ A$ $V = .002 \times 998$ $V = 1.996\ V$ % error = $\frac{.004}{2} \times 100 = 20\%$	½ ½ ½ ½	5
	OR		
(a)	a) Expression of current in terms of E and V — 1 Expression of voltage in terms of emf and internal resistance — 1 Expression for Eeq and req — ½ + ½ b) Value of current & value of internal resistance — 1+ 1  $I = I_1 + I_2$ Potential difference across $B_1 B_2$ $V = E_1 - I_1 r_1 \quad \Rightarrow I_1 = \frac{E_1 - V}{r_1}$ $V = E_2 - I_2 r_2 \quad \Rightarrow I_2 = \frac{E_1 - V}{r_2}$ $I = I_1 + I_2$	½ ½	

$= \frac{E_1 - V}{r_1} + \frac{E_2 - V}{r_2}$

$= \left(\frac{E_1}{r_1} + \frac{E_2}{r_2}\right) \;-\; V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$ ½

$V = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2} \;-\; \frac{I r_1 r_2}{r_1 + r_2}$ ½

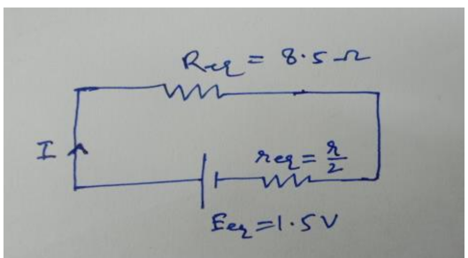
Compare with

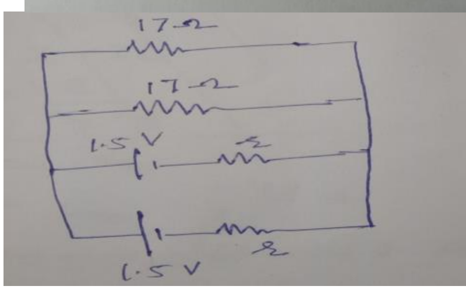
V = E eq – I r_{eg}

$E_{eq} = \frac{E_1 r_1 + E_2 r_2}{r_1 + r_2}$ ½

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

(b)





Equivalent circuit

$I = \frac{V}{R_{eq}} \;=\; \frac{1.4}{8.5}\;A$ 1

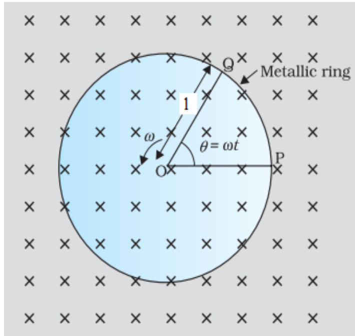
And $V = E_{eq} - I r_{eq}$

$\Rightarrow 1.4 = 1.5 - \frac{1.4}{8.5}\,X\,\frac{r}{2}$ 1

$\Rightarrow r = 1.21\Omega$

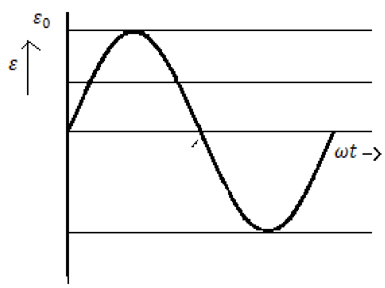
27

(a) (i) Induced emf and current	1+1
(ii) Expression for force	1½
(iii) Expression for power	1
(b) Effect on the force	½

			
(a)	**(i)**		
	$\varepsilon' = Blv$		
	$\varepsilon = Bl\dfrac{v}{2}$		
	$\varepsilon = Bl\left(\dfrac{l\omega}{2}\right)$		
	$\varepsilon = \dfrac{bl^2\omega}{2}$ [Student may use any method to arrive at this result]	1	
	$I = \dfrac{\varepsilon}{R} = \dfrac{bl^2\omega}{2R}$	1	
	(ii) $\vec{F} = (\vec{l} \times \vec{b})$	½	
	$F = \dfrac{bl^3\omega B}{2R}$	½	
	Direction of force is perpendicular to both l and $\vec{B}$	½	
	iii)		
	$Power = i^2R = \left(\dfrac{bl^2\omega}{2R}\right)^2 R$	½	
	$= \dfrac{b^2l^4\omega^2}{4R}$	½	
(b)	Since induced current will reduce, it will be a little easier to remove the coil **[Even if student writes induced current decreases award ½ mark]**	½	
	OR		

	(a) Expression for induced emf and current	1½ +1	
	Their peak values	½ + ½	
	Graph	1	
	(b) Nature of rod	½	

(a)

	$\phi = N\vec{B}.\vec{A}$	½	
	$\phi = NBA\cos\omega t$	½	
	$\varepsilon = \dfrac{-d\phi}{dt}$	½	
	$\varepsilon = NBA\omega\sin\omega t$	½	
	$here \quad \varepsilon_0 = NBA\omega$	½	
	$i = \dfrac{\varepsilon}{R} = \dfrac{NBA\omega}{R}\sin\omega t$	½	
	$i_0 = \dfrac{NBA\omega}{R}$	½	
		1	
	(b)Bar is magnetic Reason: Lenz's law/(Induced emf/current opposes its cause)	½	5