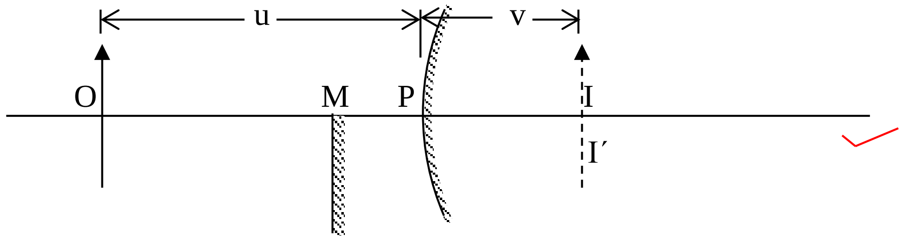
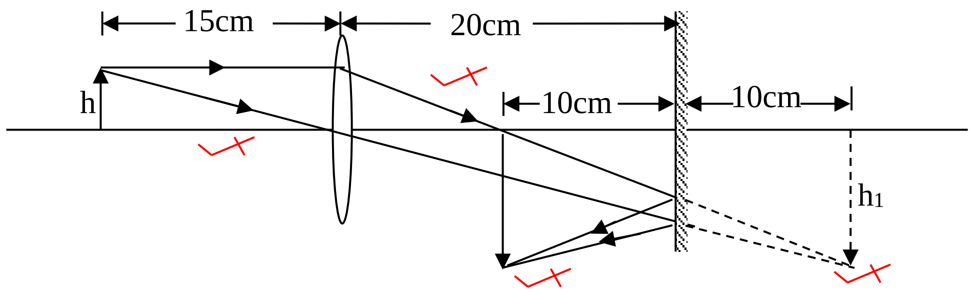
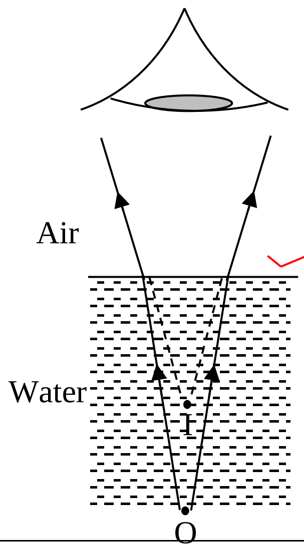
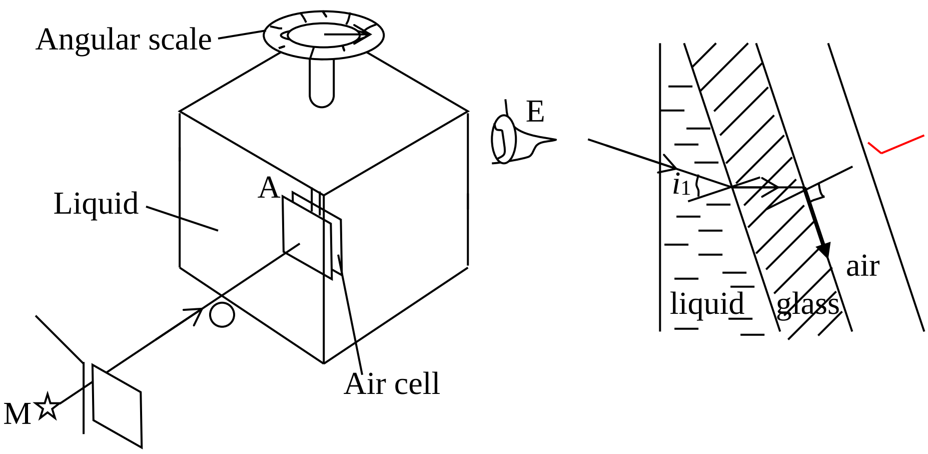
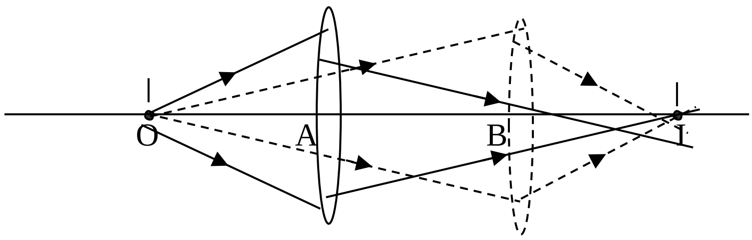
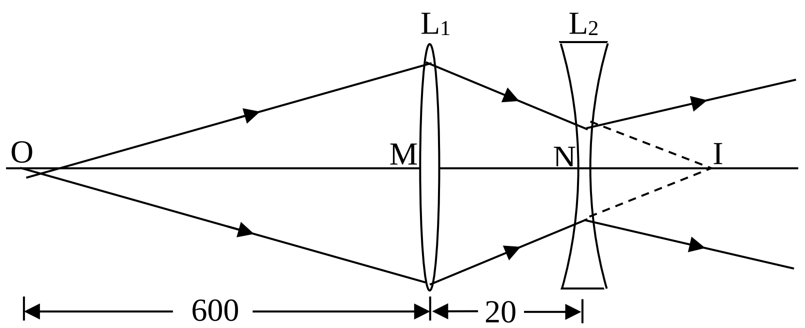
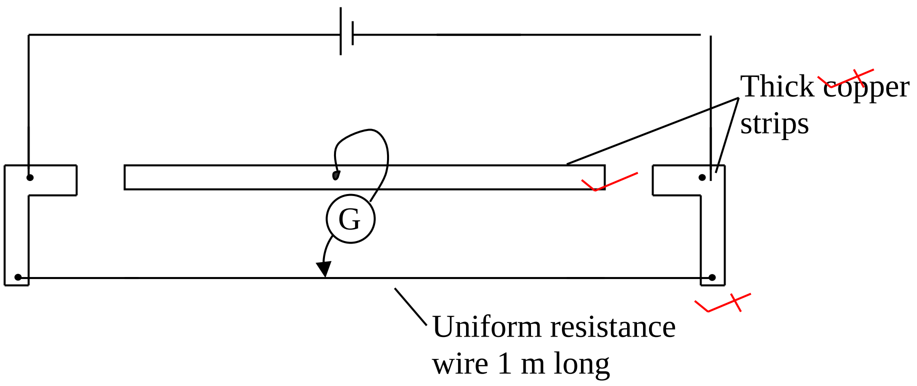
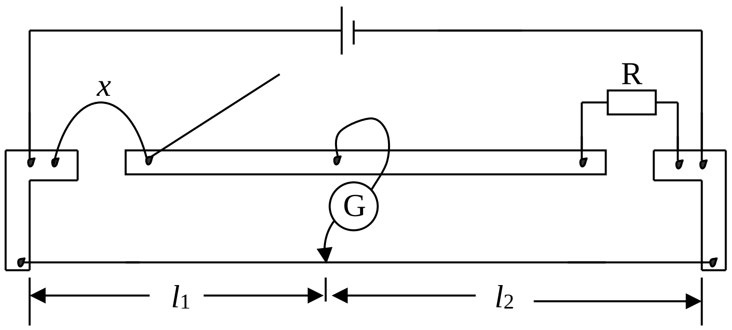
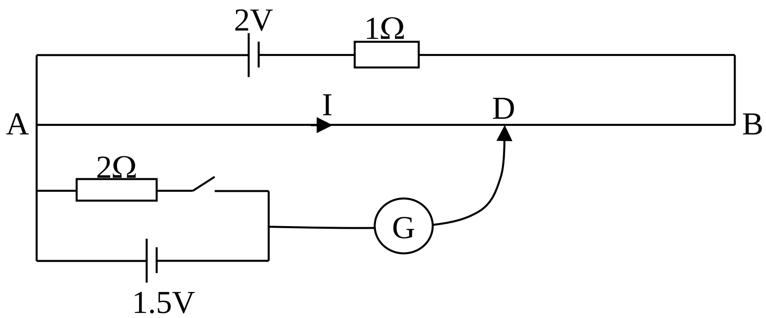
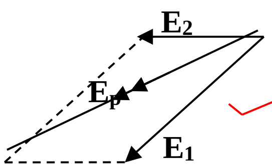
Qn	Answer	Marks
1. (a)		1
	A pin O is placed to form an image I in the convex mirror.	½
	Then a small plane mirror, M, facing O is moved between O and P until the image, I′, of the lower part of O coincides with I.	1
	The distances OP and MP are measured.	1
	Due to the plane mirror, OM = MI	½
	∴ v = OM – MP (virtual) and u = OP (real)	
	The procedure is repeated for several positions of O each time working out u and v.	½
	A graph of 1/v against 1/u is plotted.	½
	The intercept on each axis gives 1/f	1
(b)	Let the ends be A and B, with A at 40 cm from the mirror	
	For A $\frac{1}{-25} = \frac{1}{40} + \frac{1}{v_A}$	½
	∴ $v_A = -\left(\frac{40 \text{ x } 25}{40 + 25}\right) = 15.4 \text{ cm}$	1
	For B $\frac{1}{-25} = \frac{1}{140} + \frac{1}{v_B}$	½
	∴ $v_B = -\left(\frac{140 \text{ x } 25}{140 + 25}\right) = 21.2 \text{ cm}$	1
	∴ Length of the image = 21.2 – 15.4 = **5.8 cm**	2
(c)	(i) 	2

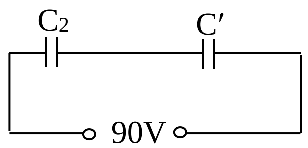
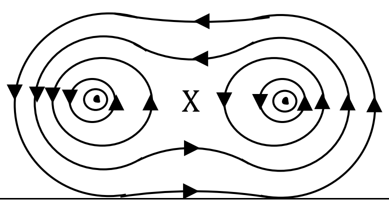
	(ii) v = 30 cm $\frac{1}{f} = \frac{1}{15} + \frac{1}{30}$ $\therefore \quad f = \frac{30 \times 15}{15 + 30} = \mathbf{10\ cm}$	1 1 2
	(iii) $m = \frac{30}{15} = 2 = \frac{h_1}{3}$ $\therefore \quad h_1 = \mathbf{6\ cm}$	2 1
	Total = 20	
	(i) Refraction is the change of direction of travel of light resulting from change of speed when light crosses from one medium to another of different optical density.	1
2. (a)	(ii)  Let O be a point at the bottom of the pond. Rays of light coming from O are refracted away from their respective normal as they cross the water-air boundary. This makes them appear to come from I as they enter the observer's eye. So the bottom of the pond appears raised to I	1 1 1
	(iii) An air cell is formed by cementing together two thin plane-parallel glass plates so as to contain a thin film of air of constant thickness. 	1

	The liquid is poured in a glass vessel having thin plane-parallel sides. The air cell A is placed in the liquid. Bright light from a source, M is directed to one side of A in a constant direction MO, and is observed at E on the other side. A is first positioned so that the incident light from M strikes it normally and goes through undeviated. A is now rotated (slowly) until the light is suddenly cut off from E. The angle, i_1, turned through is noted. It is the angle of incidence in the liquid when light just grazes the glass-air boundary. Since the boundaries are parallel nsin i =constant ∴ $n_1 \sin i_1 = n_g \sin i_2 = 1 \times \sin 90°$, where n_1 is the refractive index of the liquid ∴ $n_l \sin i_1 = 1$ ∴ $n_l = \dfrac{1}{\sin i_l}$	1 ½ ½ ½ ½ ½ ½ ½ ½
(b)	Let the respective positions of the lens be A and B  Let h = height of the object m_1 = magnification when the lens is in position A m_2 = magnification when the lens is in position B then $m_1 = h_1/h$ = AI/AO……………………….(1) and $m_2 = h_2/h$ = BI/BO……………………….(2) But AI = BO and AO =BI (since O and I are conjugate points) $h/h_1 = h_2/h$ ∴ $h = \sqrt{h_1 h_2}$	½ 1 1 ½ ½ ½
(c)	 For lens L_1: u = 600 cm, f = 30 cm	

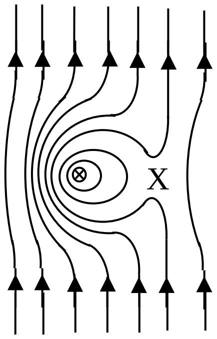
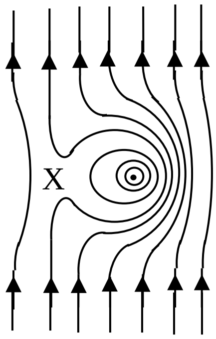
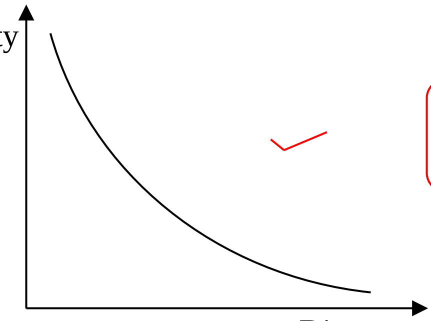
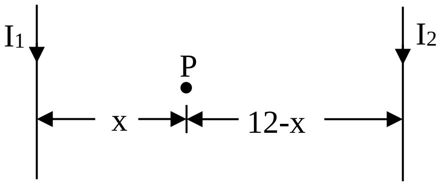
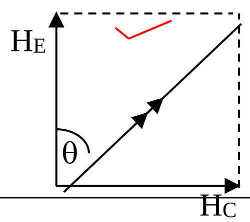
	(i) Using $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ we have $\frac{1}{v}+\frac{1}{600}=\frac{1}{30}$ $\therefore \quad v = \frac{30 \times 600}{600-30} = \frac{30 \times 600}{570} = 31.6$ cm For lens L_2, I is a virtual object. Thus, $u' = {}^{-}(31.6 - 20) = {}^{-}11.6$ cm $\therefore \quad \frac{1}{v'}+\frac{1}{{}^{-}11.6}=\frac{1}{{}^{-}5}$ $\therefore \quad v' = \frac{11.6 \times 5}{5-11.6} = {}^{-}8.8$ cm So the image is **virtual** and is **8.8 cm** to the left of L_2	1 1 1 1
	(ii) Overall magnification, $m = m_1 \times m_2$ $= \frac{v}{u} \times \frac{v'}{u'} = \frac{31.6}{600} \times \frac{8.8}{11.6} = \mathbf{0.04}$	2
	Total = 20	
3. (a)	This is the resistance per unit cross-sectional area per unit length of a material	1
(b)	(i) 	½ 1 ½
	(ii) 	1

	- A length x of the wire is connected in one gap of the metre bridge while a standard resistor, R, is connected in the other gap and so chosen as to bring the balance points in the middle third during the experiment. - The circuit is connected as shown, and the balance point is found. Balance lengths l_1 and l_2 are noted. - The experiment is repeated for several different lengths x, each time noting the corresponding balance lengths l_1 and l_2. - A graph of $\frac{l_1}{l_2}$ against x is plotted - The diameter, d, of the wire is measured and noted. Let β = resistivity of the wire Then the resistance of the wire of length x is $R_x = \frac{4\beta x}{\pi d^2}$ Now $\frac{R_x}{R} = \frac{l_1}{l_2}$ $\therefore \quad \frac{l_1}{l_2} = \frac{4\beta}{\pi d^2 R}x$ So the slope of the graph, $s = \frac{4\beta}{\pi d^2 R}$ $\therefore \quad \beta = \frac{1}{4}\pi d^2 Rs$	1 ½ 1 ½ ½ 1 ½
	(iii) $R_o = \frac{45}{55} \times 5 = 4.09\ \Omega$ and $R_{100} = \frac{52.8}{47.2} \times 5 = 5.59\ \Omega$ $\alpha = \frac{R_{100} - R_o}{100R_o}$ $= \frac{5.59 - 4.09}{4.09 \times 100} = \mathbf{3.67 \times 10^{-3}\ K^{-1}}$	1 1 1 2
(c)	(i)  $I = \frac{2}{9+1} = 0.2\ A$ $V_{AD} = 1.5\ V$	½

	$\therefore \quad 0.2 \times \overline{AD} \times \frac{9}{100} = 1.5$ $\therefore \quad \overline{AD} = \frac{1.5}{0.2 \times 0.09} = \mathbf{83.3\ cm}$	½ 1
	(ii) Terminal p.d $= \frac{70}{100} \times 0.2 \times 9 = 1.26$ V $\therefore \quad 2 \times \frac{1.5}{2 + r} = 1.26$ $\therefore \quad 3 = 2.56 + 1.26r$ $\therefore \quad r = \frac{0.44}{1.26} = \mathbf{0.35\ \Omega}$	½ 1 ½ 1
	Total = 20	
4.(a)	(i) An electric field is a region in which an electric force is detected.	1
	(ii) The electric potential at a point in a field is the work done in moving a positive charge of one coulomb from infinity to the point.	1
(b)	(i) $E_1 = \frac{Q_1}{4\pi\varepsilon r_1^2} = \frac{3 \times 9 \times 10^9 \times 10^{-6}}{0.1^2} = 2.7 \times 10^6\ NC^{-1}$ $E_2 = \frac{Q_2}{4\pi\varepsilon r_2^2} = \frac{2 \times 9 \times 10^9 \times 10^{-6}}{0.1^2} = 1.8 \times 10^6\ NC^{-1}$  $E_p^2 = E_1^2 + E_2^2 + 2E_1E_2 \cos 60^o$ $= [2.7^2 + 1.8^2 + 2 \times 2.7 \times 1.8 \times 0.5] \times 10^{12}$ $= 15.37 \times 10^{12}$ $\therefore E_p = \mathbf{3.92 \times 10^6\ NC^{-1}}$	1 1 1 1 1
	(ii) At point Y the magnitudes of the intensities are equal. So $E_1 = E_2$ Let x = distance of point Y from Q_1. Then $\frac{Q_1}{4\pi x^2} = \frac{Q_2}{4\pi(10 - x)^2}$ $\therefore \frac{3}{x^2} = \frac{2}{(10 - x)^2}$	½ 1 ½

	$\therefore \quad x^2 - 60x + 300 = 0$ $\therefore \quad x = \dfrac{60 \pm \sqrt{60^2 - 1200}}{2} = 5.5 \text{ or } 54.5$ Since x must be less than 10 cm, x must be **5.5 cm**	1
(c)	(i) C_2 is in series with $(C_1 + C_3) = C'$  $C' = 40 + 20 = 60\ \mu F$ Equivalent capacitance of the whole circuit, $C = \dfrac{C_2 C'}{C_2 + C'} = \dfrac{30 \times 60}{30 + 60} = 20\ \mu F$ $\therefore$ Energy stored in the circuit, $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 20 \times 10^{-6} \times 90^2$ $= \mathbf{8.1 \times 10^{-2}\ J}$	1 1 1 1 1
	(ii) The capacitance of C_2 becomes $3 \times 30 = 90\ \mu F$ This is in series with $(C_1 + C_3) = 60\ \mu F$ The equivalent capacitance for the whole circuit is $C = \dfrac{C_2(C_1 + C_3)}{C_2 + C_1 + C_3} = \dfrac{90 \times 60}{150} = 36\ \mu F$ Energy stored, $E' = \frac{1}{2} \times 36 \times 10^{-6} \times 90^2 = 1.46 \times 10^{-1}$ J Change in energy $= E' - E = 0.146 - 0.081$ $= \mathbf{0.055\ J}$	1 1 1 1 1
	Total = 20	
5. (a)	(i) ***Hysteresis*** is the lagging of the flux density behind the magnetising intensity. This is because once iron has been magnetized, some domains remain aligned even when the magnetizing force is removed.	1 1
	(ii) ***Remanance***, is the retained magnetic flux density in an originally magnetised material when the magnetising force has been removed. It is due to the tendency of the domains to stay put once they have been aligned.	1 1
	(iii) The ***coersive force*** is the minimum opposing magnetising force required to bring the residual flux density to zero. It is the measure of the difficulty of breaking up the alignment of the domains.	1 1
(b)	(i)  ***Neutral point*** ***Pattern and direction***	½ ½

X = neutral point

	(ii)  OR  **Neutral point** **Pattern and** X = neutral point	½ ½
(c)	(i) Two equal but opposite magnetic forces act at the point	1
	(ii)  **Award only if the axes are labeled**	1
	(iii) Length of the conductor in the field Strength of the magnetic field Magnitude of current Angle between the conductor and the field	½ ½ ½ ½
(d)	 I_1 = 2A and I_2 = 4A At the neutral point P, $B_1 = B_2$ $i.e. \quad \frac{\mu_o I_1}{2\pi x} = \frac{\mu_o I_2}{2\pi(12-x)}$ $\therefore \quad \frac{2}{x} = \frac{4}{12-x}$ $\therefore \quad 2x = 12 - x$ $\therefore \quad x =$ **4 cm** from I_1	1 1 1 1
(e)	 $H_E = H_C \cot\theta$ $= \frac{NI}{2r} \cot 50^o$ $= \frac{100 \times 0.8}{2 \times 20 \times 10^{-2}} \cot 50^o$	2 1

	$= \mathbf{167.8\ A\ m^{-1}}$ ✓	1
	Total = 20	