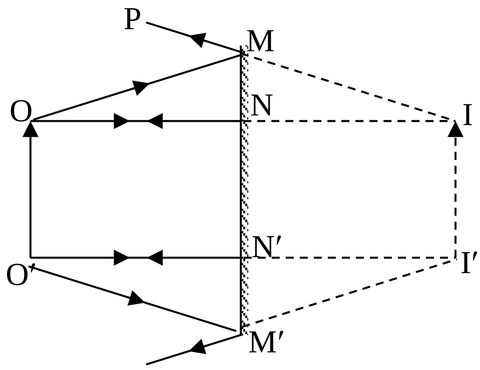
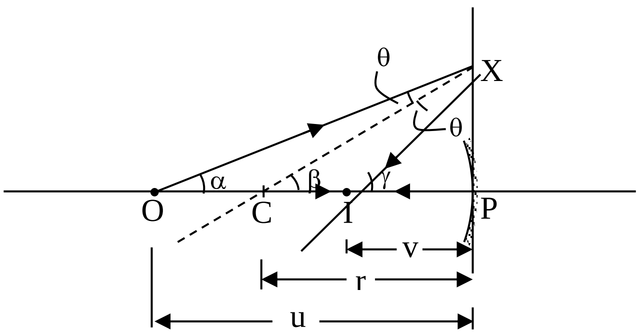
Qn	Answer	Marks
1 (a)	(i) - The reflected ray, the incident ray, and the normal to the mirror at the point of incidence all lie in the same plane. - The angle of incidence is equal to the angle of reflection	1 1
	(ii) 	1
	Suppose OO′ is an object in front of a plane mirror MM′. A ray ON, from O normal to MM′, is reflected back along the same path. Another ray, OM, is reflected along MP and the two reflected rays appear to come from I, which is therefore the image of O. Similarly, the ray O′N′ and O′M′ from O′, when they are reflected, appear to come from I′, which therefore is the image of O′. Because of the laws of reflection, $\angle MON = \angle MIN$ and $\angle M'O'N' = \angle M'I'N'$ it follows that the trapezia OO′M′M and II′M′M are congruent, with a common side MM′. So $\overline{OO'} = \overline{II'}$ $\Rightarrow$ same size	½ ½ ½ ½ ½ ½
(b)		½ ½
	Consider an object at O on the principal axis. A ray OX is reflected at X to go along XI.	

Another ray OP along the principal axis, strikes the mirror at P and is reflected ½
back along the same path. ½
The reflected rays meet at I. So I is the image of O. ½
Now, the normal at X must be passing through the centre of curvature, C.
According to the laws of reflection, $\angle OXC = \angle CXI = \theta$
From the geometry of the figure, ½

$$\alpha + \theta = \beta \ldots\ldots\ldots (1)$$ ½

$$\beta + \theta = \gamma \ldots\ldots\ldots\ldots (2)$$

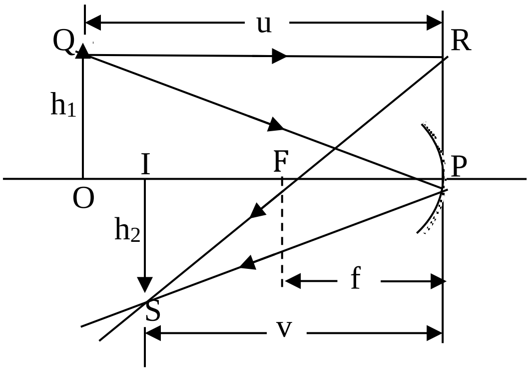
From (1) and (2) $\alpha + \gamma = 2\beta$
All these are small angles. ½

So $\alpha \approx \tan\alpha = \frac{XP}{OP} = \frac{XP}{u}$, $\gamma \approx \tan\gamma = \frac{XP}{IP} = \frac{XP}{v}$ and $\beta \approx \tan\beta = \frac{XP}{CP} = \frac{XP}{r}$

Thus $\frac{XP}{u} + \frac{XP}{v} = \frac{2XP}{r}$ ½

Hence $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ since r = 2f ½

ALTERNATIVE DERIVATION



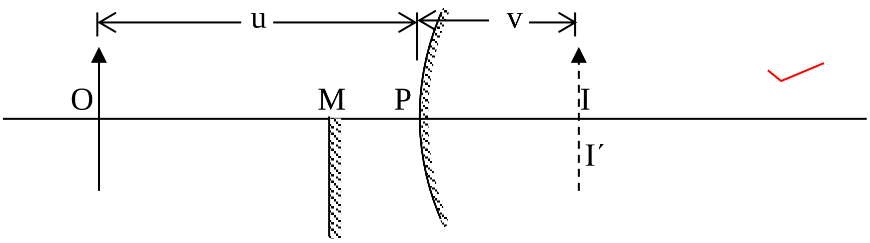
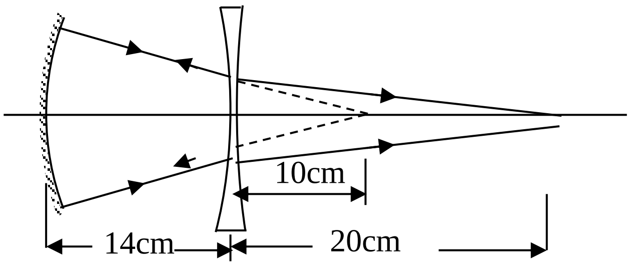
Imagine an object OQ of height h_1 at O.
A ray QR parallel to the principal axis is reflected through F, the principal focus.
A ray QP, incident at the pole, is reflected through S such that $\angle QPO = \angle SPI$ and the point, S, where the two reflected rays meet is the image of Q. Also I is the image of O since O is on the principal axis, and IS is the image of OQ.
Now ΔQPO is similar to ΔSPI

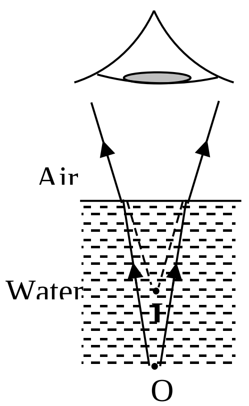
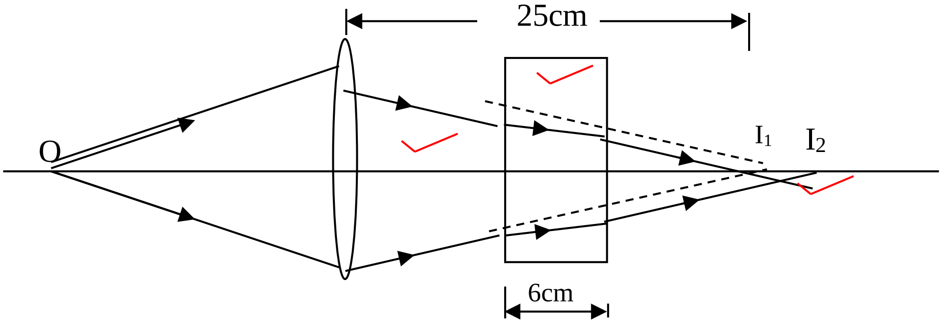
So $\frac{h_2}{h_1} = \frac{IP}{OP} = \frac{v}{u} \ldots\ldots (1)$

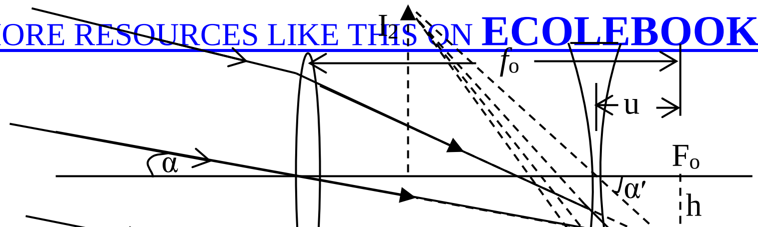
And ΔSIF is similar to ΔRPF

So $\frac{SI}{PR} = \frac{IF}{PF}$ which leads to $\frac{h_2}{h_1} = \frac{v-f}{f} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$

From (1)and (2) $\frac{v}{u} = \frac{v-f}{f}$

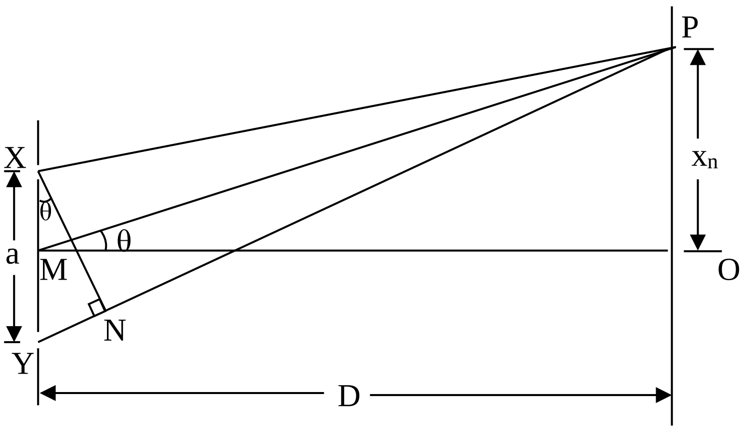
	Dividing through by v and rearranging, we have $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$	
(c)		1
	A pin O is placed to form an image I in the convex mirror.	½
	Then a small plane mirror, M, facing O is moved between O and P until the image, I´, of the lower part of O coincides with I.	1
	The distances OP and MP are measured.	½
	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	½
(d)		
	Radius of curvature, r = 2f = 24 cm	1
	∴ for the lens, object distance u = -10cm and v = 20 cm	1
	Using $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ where f is the focal length of the concave lens	
	$\frac{1}{-10}+\frac{1}{20}=\frac{1}{f}$ ⇒ f = **-20 cm**	2
	Total = 20	
2. (a)		

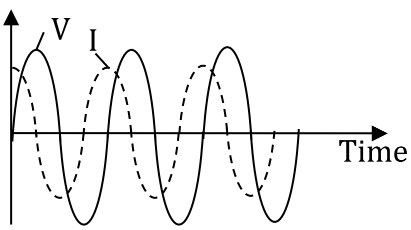
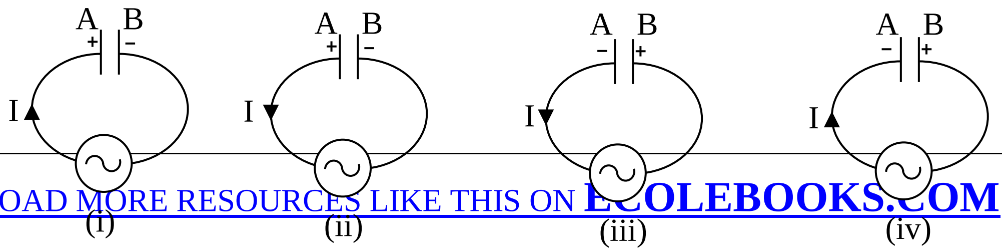
	(i) Refraction is the change of speed of light usually resulting in change of direction of travel as light crosses from one medium to another of different optical density.	1
	(ii) …. the angle incidence for which the refracted ray grazes the interface between the two media.	1
(b)	 Let O be a point at the bottom of the pond. Rays of light coming from O are refracted away from their respective normals 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
(c)	(i) 	1 1 1
	(ii) The screen will be shifted from I_1 to I_2. Let the displacement I_1I_2 be d Then, using $n = \frac{\text{real depth}}{\text{apparent depth}}$ $1.6 = \frac{6}{6-d} = 9.6 - 1.6d = 6$ $\therefore$ d = **2.25 cm**	1 1 1 1

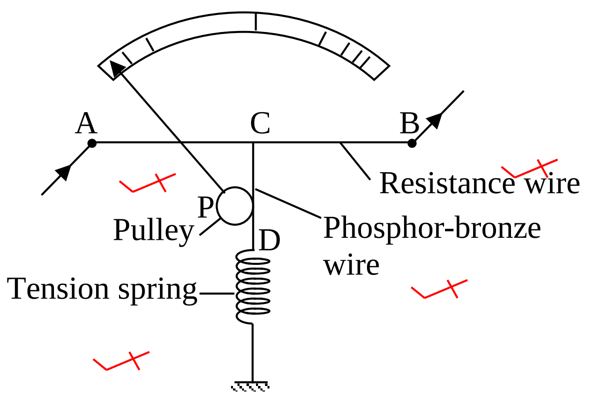


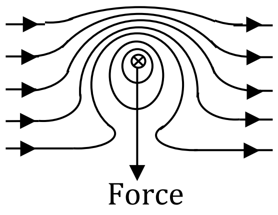
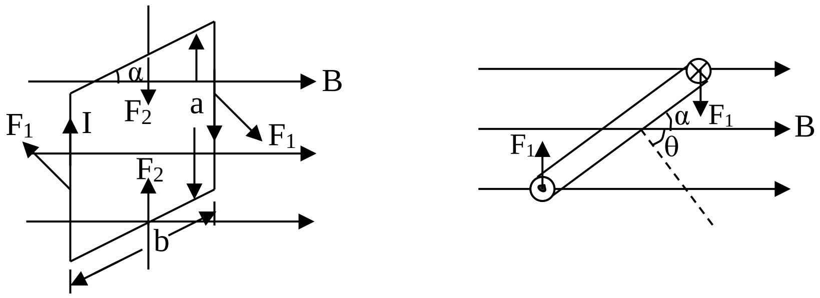
(d)	(i)	½ ½ 1
	F_o is the principal focus of the objective lens. Rays from a point on a distant object arrive at the objective lens as a parallel beam. The objective converges the rays to its focal plane and would form an intermediate image there if the eyepiece were not in place. In this case the eyepiece is adjusted in such a way that it diverges the rays to appear to come from I_2 at the near point. This time the intermediate image acts as a virtual object for the eyepiece.	½ ½ ½ ½
	(ii) α is the angle subtended at the objective and is the visual angle as would be perceived by a necked eye. α′ is the visual angle due to the final image. All these are small angles. So $\alpha = h/f_o$ and h/u , where f_o = focal length of the objective and u = the distance between the eyepiece and the intermediate image of height h Using $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ $\frac{1}{-f_e} = \frac{1}{-D}+\frac{1}{u}$ (eyepieces is diverging) $\therefore\ u = \frac{f_e D}{f_e - D}$ Now, angular magnification, $M = \frac{\alpha'}{\alpha} = \frac{h/u}{h/f_o} = \frac{f_o}{u}$ Therefore $M = \frac{f_o}{f_e}\frac{(f_e - D)}{D}$ $\therefore\ M = \frac{f_o}{f_e}\left(\frac{f_e}{D} - 1\right)$	1 ½ ½ 1 1
	Total = 20	

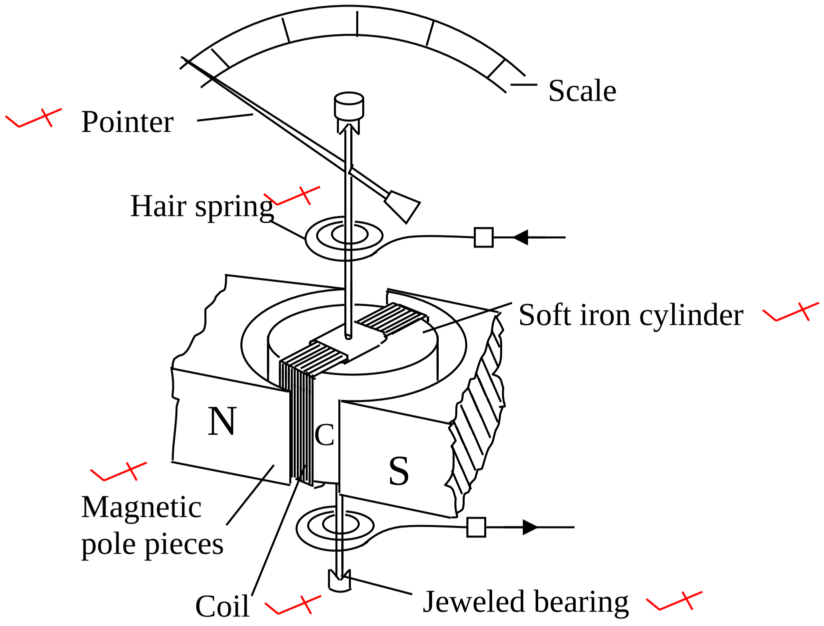
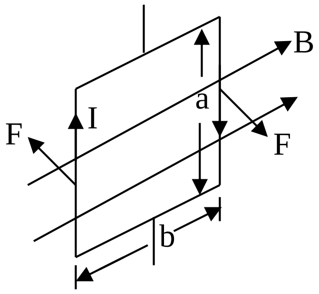
3. (a)	(i) … the distance between successive points that are in phase	1
	(ii) … the relative position of the note on a musical scale	1
(b)	(i) In the direction of the observer, the f waves produced in a second occupy a distance V + u_s So the apparent wavelength $\lambda' = \frac{V+u_s}{f}$ The apparent velocity observed, $V' = V + u_o$ So, the apparent frequency, $f' = \frac{V'}{\lambda'} = \left(\frac{V+u_o}{V+u_s}\right)f$	1 1 1 2
	(ii) If the observer is faster that the source, f′ > f So the pitch of the sound heard will be higher.	1 1
(c)	(i) $\frac{\mathbf{v}}{\mathbf{c}}\boldsymbol{\lambda}$	1
	(ii) A photograph of the star's spectrum is taken. The spectral lines are then compared with the same lines obtained by photographing, in the laboratory, an arc spectrum of an element present in the star. The shift, Δλ, of the wavelength is measured. The speed of the star is $v = \frac{\Delta\lambda}{\lambda}c$	1 1 1 1
(d)	(i) l_1 = 0.78m, c_1 = 0.017m, l_2 = 0.80m, c_2 = 0.015m Now $\lambda_1 = 2(l_1 + 2c_1) = 2(0.78 + 0.034) = 1.628$ m and $\lambda_2 = 2(l_2 + 2c_2) = 2(0.80 + 0.030) = 1.660$ m Beat frequency, $\frac{V}{\lambda_1} - \frac{V}{\lambda_2} = 5$ $\therefore V = \frac{5 \times \lambda_1\lambda_2}{\lambda_2 - \lambda_1} = \frac{5 \times 1.628 \times 1.660}{1.660 - 1.628} = \mathbf{422.3\ m\ s^{-1}}$	1 1 1 1
	(ii) $f_1 = \frac{V}{\lambda_1} = \frac{422.3}{1.628} = \mathbf{259.4\ Hz}$ $f_2 = \frac{V}{\lambda_2} = \frac{422.3}{1.660} = \mathbf{254.4\ Hz}$	1 1
	Total = 20	

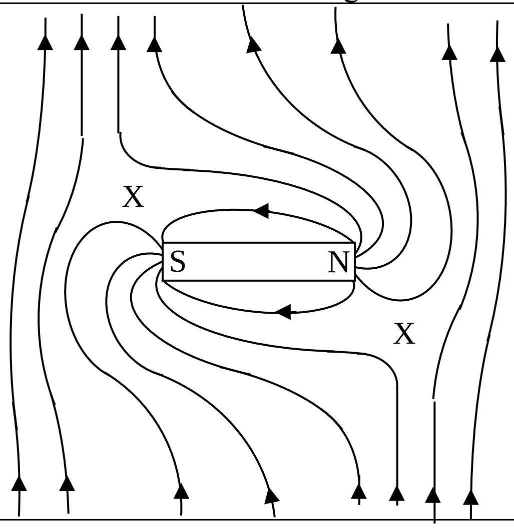
4. (a)	(i) Light can undergo polarisation while sound cannot.	1
	(ii) This what is achieved when a wave front meets two (or more) apertures and each aperture behaves like a source. So a number of wavefronts are obtained like they are from different coherent sources.	1 1
(b)	 Suppose P is the position of the nth bright fringe, so that YP – XP = nλ. Let OP = x_n, where O is the centre of the fringe system. OM is the perpendicular bisector of AB. If a length PN equal to PA is described on PY, then YN = YP – XP = nλ. In practice AB is very small compared to PM so that AN meets AN practically at right angles. Hence ∠PMO = ∠YXN = θ, say Now, $\sin\theta = \frac{YN}{XY} = \frac{n\lambda}{a}$ Also from ΔPMO, $\tan\theta = \frac{PO}{MO} = \frac{x_n}{D}$ Since θ is very small, tan θ = sin θ $\therefore \quad \frac{x_n}{D} = \frac{n\lambda}{a}$ $\therefore \quad x_n = \frac{nD\lambda}{a}$ ……………………………(1) For the (n + 1)th bright fringe, $x_{n+1} = \frac{(n+1)D\lambda}{a}$ …. (2) ∴ the separation, y, between successive fringes $= x_{n+1} - x_n = \frac{\lambda D}{a}$	1 ½ ½ ½ ½ ½ ½ ½

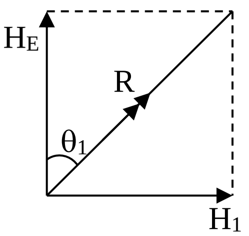
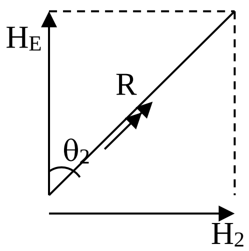
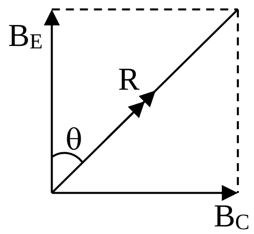
		½
(c)	(i) Coloured interference fringes are observed, with the central fringe white.	2
	(ii) The fringes gradually disappear. This is because the slit is then equivalent to many narrow slits, each producing its own fringe system at different places. The bright and dark fringes of different systems therefore overlap into a uniform illumination.	1 1 1
	(iii) - A red filter is placed in front of the slits and produces red fringes. - The microscope is focused on the Perspex ruler R and the average distance ,y, between the fringes is measured on R. - The distance, a, between the slits is found by using a travelling microscope (or a magnifying glass). - The distance, D, between the slits and the sreen is measured using a metre rule. Then the wavelength, $\lambda = \frac{ay}{D}$	1 1 1 1
(d)	$x_n = \frac{nD\lambda}{a}$, where n = 8 $\therefore \quad D = \frac{ax_n}{n\lambda} = \frac{6 \times 10^{-3} \times 0.7 \times 10^{-3}}{8 \times 6.3 \times 10^{-7}} = \mathbf{0.833\ m}$	1 1 1
Total = 20		
5. (a)	… the opposition to the flow of an alternating current offered by a combination of loads, inductive, capacitive and resistive.	1
(b)	(i) 	1 1
	(ii) In one cycle of the alternating current four processes are performed. Let A and B be the capacitor plates as shown below. 	

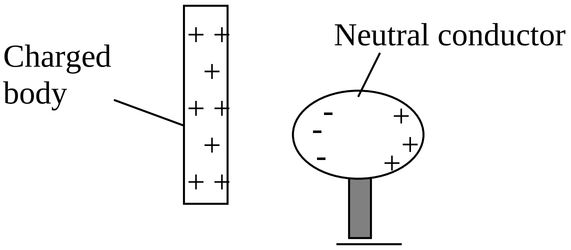
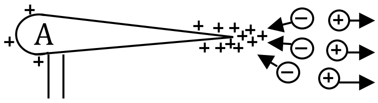
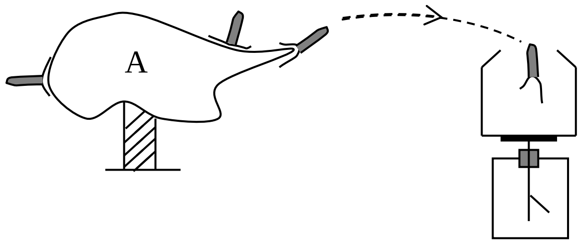
	Let us start with a quarter of the cycle when A is charging positively (fig(i)). The current is flowing clockwise until the capacitor is fully charged. In the next quarter the plates are discharging. So the current reverses but the polarity of the capacitor remains until it is fully discharged (fig (ii)). In the next quarter, B is now charging positively while A negatively. So the current remains flowing anticlockwise until the capacitor is fully charged. In the last quarter the plates are discharging. So the current reverses and flows in that direction until the capacitor is fully discharged and the cycle repeats. This way an alternating current flows in the circuit.	1 ½ ½ 1 1
(c)	 It consists of a fine resistance wire AB. Another fine wire CD, whose one end is fixed to the mid-point, C, of AB wraps round a pulley P and has its other end fixed to a tension spring. The spring keeps CD taut. The current to be measured is led through AB, which heats up. So AB expands and sags, the sag is taken up by CD, which is held taut by the tension spring. The expansion stops when the resistance wire is losing heat at the same rate as it is developed in it by the current. Due to the wrapping of CD round the pulley, the pulley rotates and turns the pointer clockwise, which is attached to it. The rate at which heat is generated in AB is proportional to the square of the current. So the scale is non-linear.	1 ½ ½ ½ ½ ½ ½ ½ ½
(d)	(i) Peak voltage, $V_o = 300\sqrt{2}$ volts, $\omega = 320$ rad s^{-1}	

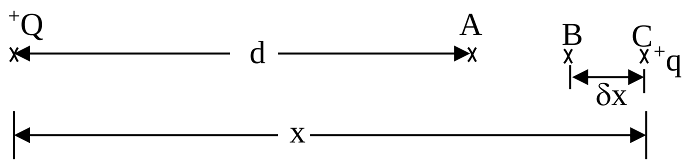
	Capacitive reactance, $X_C = \frac{1}{\omega C} = \frac{10^6}{320 \times 250} = 12.5\ \Omega$ Impedance, $Z = \sqrt{X_C^2 + R^2} = \sqrt{12.5^2 + 20^2} = 23.6\ \Omega$ $I_{rms} = \frac{V_{rms}}{Z} = \frac{V_o}{Z\sqrt{2}} = \frac{300\sqrt{2}}{23.6\sqrt{2}} = \mathbf{12.72\ A}$	2 1 1 1
	(ii) Energy is supplied to pure resistance only $\therefore$ Power $= I_{rms}^2 R = 12.72^2 \times 20 = \mathbf{3236\ W}$	1
	(iii) Phase angle, $\theta = \tan^{-1}\left(\frac{X_C}{R}\right) = \tan^{-1}\left(\frac{12.5}{20}\right) = \mathbf{32^o}$	2
	Total = 20	
6. (a)	(i) A current flowing in a conductor produce a magnetic field around the conductor. The two fields interact and this results in clustering of magnetic field lines of force on one side of the conductor. E.g.  Now, the tendency of the lines of force is to straighten and spread out. This is achieved by forcing the conductor away from the region of clustering.	½ ½ ½ ½ 1
	(ii) **Bib sin θ**	1
	(iii)  The forces F_2 cancel out one another. Now, $F_1 = BIa$ for one turn The torque on the coil is $\tau = F_1 b\cos\alpha$ $\therefore \tau = BIab\cos\alpha = BIA\cos\alpha$, where ab = A = area of the coil	1 ½

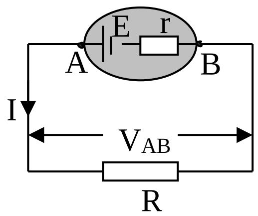
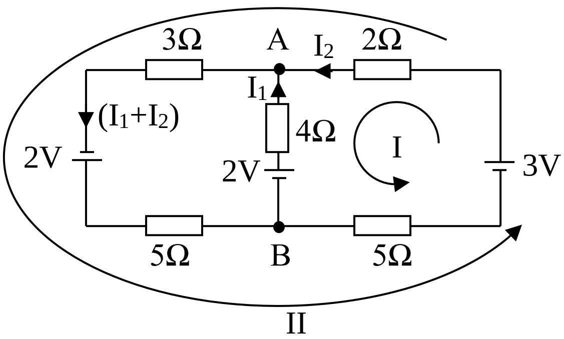
	For N turns, $T = BIAN\cos\alpha = BIAN$ since $\cos 0 = 1$	½ ½ ½
(b)	(i) 	½ ½ ½ ½
	Consider one turn of the coil of length a and width b.	1
		
	Since the magnetic field is radial, the plane of the coil is always parallel to the field. The force exerted by the field B on each of the sides parallel to the axis of the cylinder C, experiences a force $F = BIa$ The torque exerted by the force F on each turn is	
	$\tau = Fb = BIab = BIA$, where $A = ab$ = area of the coil.	½
	If the coil has N turns, then the total torque exerted on it by the current is $T = N\tau = BIAN$ ……………..(1)	½
	The coil turns until the opposing torque due to the twisting of the springs is equal to T. The opposing torque is directly proportional to the twist θ, which is the deflection of the coil. Thus, if k is the constant of suspension (torque per unit twist),	1
	Then $T = k\theta$ $\therefore$ $BIAN = k\theta$	

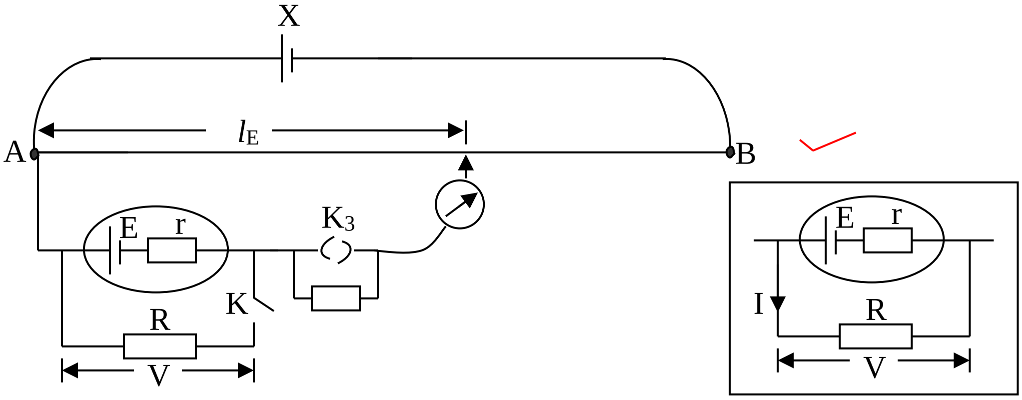
	$\therefore \quad \theta = \frac{BANI}{k}$ Thus the deflection θ is directly proportional to the current I. So the instrument can be calibrated directly in units of current.	½ ½
	(ii) From this it can be established that the factors determining current sensitivity are - strength of the magnetic field - area of the coil - number of turns of the coil - constant of suspension	½ ½ ½ ½
(c)	$B = \mu n I_s$, where I_s 2A and n = 1000 Torque, $T = BI_cAN$, where $I_c = 1A$ and N =10 Thus, $T = \mu n I_s I_c .\pi r^2 N$ $= 4\pi \times 10^{-7} \times 1000 \times 2 \times 1 \times \pi \times 0.025^2 \times 10$ $=$ **4.93×10^{-5} Nm**	1 1 1 1 1
Total = 20		
7. (a)	(i) …. is a vertical plane through the magnetic north and south poles.	1
	(ii) … the angle between the magnetic meridian and the geographic meridian.	1
	(iii) … a point where the resultant magnetic force is zero.	1
(b)	(i)  Pattern → 1 Neutral points → 2	3
	(ii) $\frac{\mu NI}{2r}$, where μ is the permittivity	1

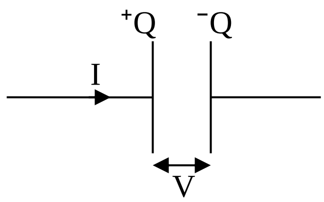
(c)	- The magnetometer is placed or suspended on a horizontal wooden table and adjusted to bring the pointer position to the zero mark(s). - One of the fields under test, say of intensity H_1, is applied east-west through the location of the magnetometer and the pointer deflection, θ_1, is noted. - The procedure is repeated using the other field intensity, say H_2, and the deflection, θ_2, is noted. Now, when the field is applied perpendicular to the earth's horizontal component, the two fields interact and the magnet of the magnetometer turns to lie along the resultant.	½ 1½ 1 ½
		½
	Let H_E be the earth's horizontal magnetic intensity Then, from the diagrams $H_1 = H_E \tan\theta_1$ and $H_2 = H_E \tan\theta_2$ $\therefore \frac{H_1}{H_2} = \frac{\tan\theta_1}{\tan\theta_2}$	½ ½ 1
(d)	(i) The axis of the magnet may not lie exactly in the effective plane of the coil.	1
	(ii) The coil produced a field perpendicular to the earth's field.  We take the average deflection $\theta = \frac{1}{2}(47 + 49) = 48^o$ Let B_C = flux density due to the coil B_E = horizontal flux density of the earth Then $B_E = B_C \cot\theta = \frac{\mu NI}{2r}\cot\theta$ $= \frac{4\pi \times 10^{-7} \times 10 \times 7.0 \times \cot 48^o}{2 \times 0.10}$ $= \mathbf{3.96 \times 10^{-4}\ T}$	1 1½ ½ 1
	(iii) The deflection would be zero	1
	(iv) $B_C = B_E \tan\theta$	½

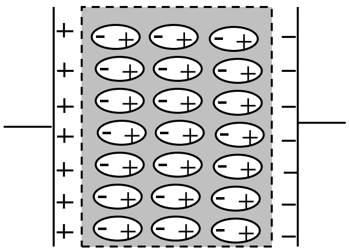
	$\therefore \quad \frac{\mu NI}{2r} = B_E \tan\theta$ $\therefore \quad \mathbf{\tan\theta \propto \frac{1}{r}}$	½
	Total = 20	
8. (a)	(i)  When the two bodies are near each other, electrostatic induction occurs in the conductor such the unlike charges get nearer each other than the like charges. So the unlike charges attract each other more than the like ones do. Hence the net result is an attraction between the two bodies.	1 1 ½ ½
	 Suppose a pointed conductor A is charged positively. Most of the charge concentrates at the tip creating an intense electric field there. This ionises the air near the tip. The negative ions are attracted to the tip and are neutralised while the positive ions are repelled. The net result is that positive charge is being sprayed from the tip into the air.	1 ½ ½ ½ ½
(b)	 The conductor, A, is supported on an insulator and given a charge. Proof planes of the same area, but shaped to fit the various respective parts of the conductor, are prepared.	½ ½

	A proof plane (on an insulating handle) at a time is placed on the part it fits and charged by induction. The charged proof plane is then transferred to the inside of a hollow can connected to the cap of a neutral electroscope (without making contact with the can), each time noting the divergence of the leaf. It is observed that proof planes from sharper parts cause greater divergence. This implies that ***surface density*** (charge per unit area) increases with curvature.	1 1 ½ ½
(c)	(i) Suppose A is the point whose potential, V_A, is required. Then imagine a small point charge q placed at point C, distance x from Q.  The force acting on q is $F = \frac{Qq}{4\pi\varepsilon x^2}$ Suppose q is now moved a small distance δx to B, δx being so small that the field due to Q is not affected. Over this small distance, the force F may be regarded as constant. So the work done by the external agent over δx against the force of the field is $\delta W = F(-\delta x)$ $\therefore \quad \delta W = \frac{Qq(-\delta x)}{4\pi\varepsilon x^2}$ The total work done in bringing q from infinity to point A is $W = \frac{-Qq}{4\pi\varepsilon}\int_{\infty}^{d}\frac{1}{x^2}dx = \frac{-Qq}{4\pi\varepsilon}\left[\frac{-1}{x}\right]_{\infty}^{d} = \frac{Qq}{4\pi\varepsilon d}$ The potential V_A at point A is the work done per unit positive charge brought from infinity to A. Hence $V_A = \frac{W}{q} = \mathbf{\frac{Q}{4\pi\varepsilon d}}$	½ ½ 1 1 1 1
	(ii) Potential at P, $V_p = \frac{Q_1}{4\pi\varepsilon r_1} + \frac{Q_2}{4\pi\varepsilon r_2} = \frac{1}{4\pi\varepsilon r}(Q_1 + Q_2)$ $= \frac{9 \times 10^9}{0.10}(6+4) \times 10^{-6} = 9 \times 10^5$ V Potential at P, $V_p = \frac{Q_1}{4\pi\varepsilon r'}(Q_1 + Q_2) = \frac{9 \times 10^9}{0.05}(6+4) \times 10^{-6} = 18 \times 10^5$ V	1 1

	Work done = Charge moved x potential difference = $Q(V_C - V_P)$ = $-4 \times 10^{-6}(18 - 9) \times 10^{5}$ = **-3.6 J** The negative sign implies that the charge instead does work in moving from P to C	1 1 1
	Total = 20	
9. (a)	(i) The potential difference between two points is the work done in moving one coulomb of positive charge from one of the points to the other.	1
	(ii) The volt is the p.d. between two points in a circuit in which 1 J of electrical energy is converted when 1 C passes from point to the other.	1
(b)	 A source has internal resistance, r, and when the source is giving out a current I, the terminal p.d, V_{AB}, is given by $V_{AB} = E - Ir$, where E is the emf Now, when the current increases, the p.d Ir across the internal resistance increases. Thus, the remainder, which is the terminal p.d, decreases.	1 ½ ½ 1
(c)	(i)  Loop I: $2I_2 - 4I_1 + 5I_2 = 3 - 2$ ∴ $-4I_1 + 7I_2 = 1$ …………………….... (1) Loop II: $2I_2 + 3(I_1 + I_2) + 5(I_1 + I_2) + 5I_2 = 5$ $8I_1 + 15I_2 = 5$ …………………….. (2) Eq(1) x 15: $-60I_1 + 105I_2 = 15$ …………………. (3) Eq(2) x 7: $56I_1 + 105I_2 = 35$ ………………… (4) Eq(4) - Eq(3): $116I_1 = 20$	1 1 1

	$\therefore \quad I_1 = \frac{20}{116} = \mathbf{0.172\ A}$	1
	(ii) $V_{AB} = 2 - 4I_1$ $= 2 - (4 \times 0.172) = 2 - 0.688 = \mathbf{1.31\ V}$	1 1
(d)		1
	A circuit is connected as shown, with R a standard resistance - With switch K open a balance length, l_E, is found for the emf E. - Then K is closed and another balance length, l, for the terminal p.d, V, is found. In this case a circuit like the one in the inset on the right is completed. Let r = internal resistance of the cell V = p.d. across R E = emf of the cell Then $\frac{E}{V} = \frac{R+r}{R}$ But $\frac{E}{V} = \frac{l_E}{l}$ $\therefore \quad \frac{l_E}{l} = \frac{R+r}{R} \Rightarrow r = R\left(\frac{l_E}{l} - 1\right)$	½ ½ ½ ½ ½ ½ 1
(e)	Let k = p.d. per cm along the potentiometer wire and E = emf of cell C Then, $2 + E = 80k$ ……. (1) and $2 - E = 16k$ …….. (2) From (1) and (2) $\frac{2+E}{2-E} = \frac{80}{16}$ $\therefore \quad 2 + E = 10 - 5E$	 1 1 1

	∴ $E = \frac{8}{6} = \mathbf{1.33\ V}$	1
	Total = 20	
10 (a)	(i) The dielectric constant is the ratio of the capacitance with the dielectric in between the plates to the capacitance when the space between the plates is vacuum.	1
	(ii) Suppose that at a certain instant during charging when the p.d between the plates is V, the charging current is I and the charge on either plate is Q.  Then the rate at which work is being done to charge the capacitor is the electrical power, $P = IV = I\frac{Q}{C}$ Now, the current, $I = \frac{dQ}{dt}$ (rate of flow of charge to the capacitor plates) ∴ $P = \frac{Q}{C}\frac{dQ}{dt}$ The total work done in accumulating the charge from zero to a quantity, say Q_o, is $W = \int Pdt = \int_0^{Q_o} \frac{Q}{C}\frac{dQ}{dt}dt = \int_0^{Q_o} \frac{QdQ}{C} = \frac{Q_o^2}{2C}$ Now, $Q_o = CV$ ∴ $W = ½CV^2$ = energy stored in the capacitor ALTERNATIVELY Imagine a capacitor of capacitance C charged to a p.d V. Suppose that now the charge on its plates is to be increased from Q to Q + δQ, where δQ is small. Then a charge δQ must be transferred from the negative plate to the positive plate. This would increase the p.d by δV. Since δQ is small, it follows that δV is also small compared to V. Hence the p.d V may be regarded as constant.	1 1 1 1 1

	Then the work done in transferring the charge δQ is $\delta W = V.\delta Q$ (from the definition of p.d). But $V = Q/V$ $\therefore \quad \delta W = \frac{Q\delta Q}{C}$ Therefore the total work done in raising the charge of the capacitor from zero to, say Q_o is $\int dW = \int_0^{Q_o} \frac{Q.dQ}{C} = \frac{Q_o^2}{2C}$ This is the energy stored by a capacitor of capacitance C carrying a charge Q_o. Alternatively, $Q_o = CV$, where V is the p.d across the capacitor $\therefore \quad W = ½CV^2$ = energy stored in the capacitor	
(b)	 When a p.d is applied between the plates, the molecules of the dielectric get polarised, with their positive ends facing the negative plate, and their negative ends facing the positive plate. Charge inside the material cancel each other's influence but the surfaces adjacent to the plates develop charge opposite to that on the near plate. This arrangement reduces the positive potential of the positive plate and does the same on the negative potential of the negative plate. So the potential difference between the plates is lowered. Electrons are then drawn from the positive plate and get deposited on the negative one to restore the potential difference to that of the supply. This way the dielectric assists the plates to store charge.	1 ½ ½ ½ ½ ½ ½
(c)	- A capacitor of known capacitance, C_o, is charged to a p.d, V_o, and then discharged through the ballistic galvanometer and the throw, θ_o, is noted. Then the charge, $Q_o = C_oV_o = k\theta_o$ …….. (1)	1 ½

	- The capacitor under test is then charged to a p.d. V and then discharged through the ballistic galvanometer. - The throw, say θ, is noted Let C = capacitance of the capacitor under test Then $CV = k\theta$ ……. (2) From (1) and (2) $C = \frac{C_o V_o \theta}{V}$	1 ½ ½ ½
(d)	(i) The total charge remains the same Let V = common p.d. after connection Then $(C_1 + C_2)V = C_1V_1$ $\therefore \quad V = \frac{C_1V_1}{C_1 + C_2} = \frac{5 \times 52}{5+8}$ = **20 V**	 1 1
	(ii) Energy before = $\frac{1}{2}C_1V_1^2 = \frac{1}{2} \times 5 \times 10^{-6} \times 52^2$ = **6.76×10^{-3} J** Energy after = $\frac{1}{2}(C_1 + C_2)V^2$ = $\frac{1}{2}(5 + 8) \times 10^{-6} \times 20^2$ = **2.6×10^{-3} J**	1 1 1
	(iii) The difference is dissipated as heat in the connecting wires as the charge flows to redistribute itself among the capacitors.	1
Total = 20		