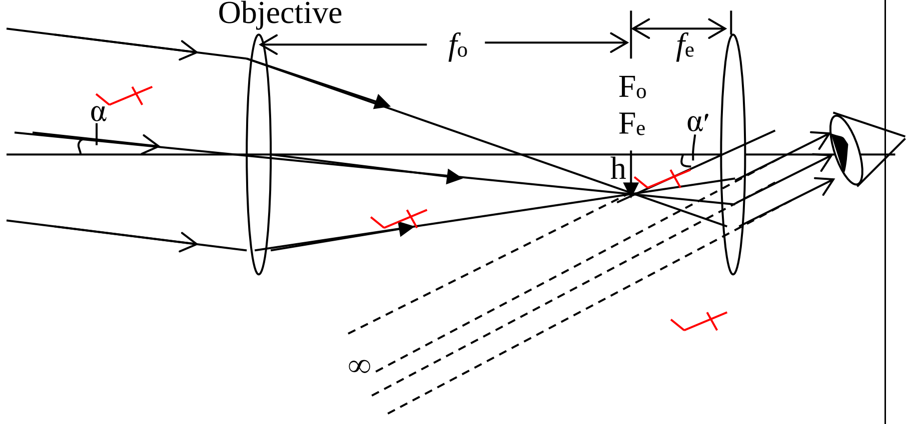
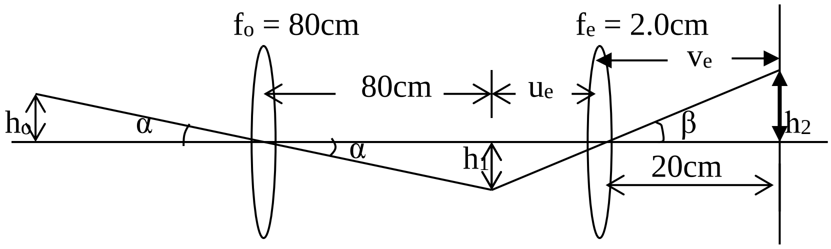
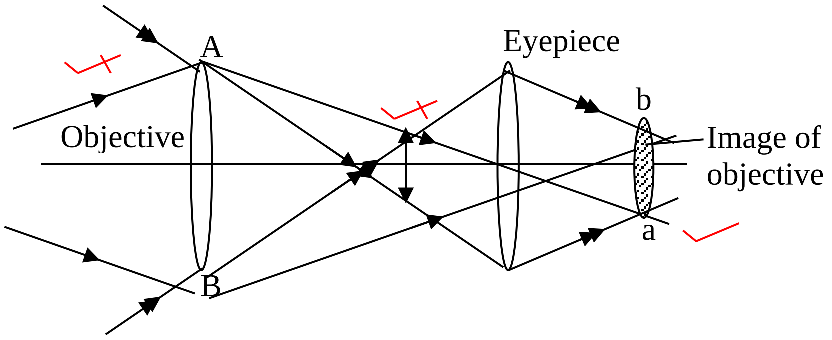
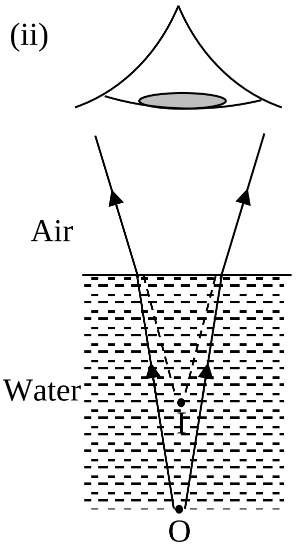
Qn	Answer	Marks
1. (a)	(i) Magnifying power is the ratio of the angle subtended at the eye by the final image when using an optical instrument to the angle subtended at the unaided eye, by the object. Magnification is the ratio of the image size to the object size. Magnifying power is concerned with the visual angles while magnification is concerned with the ratio of physical sizes.	1 1 ½ ½
	(ii) Normal adjustment in the case of an astronomical telescope the arrangement in which the image of a distant object is formed at infinity.	1
	(iii)  F_o is the principal focus of the objective lens while F_e is that of the eyepiece. - Rays from a point on a distant object arrive at the objective lens as a parallel beam.½ - The objective converges the rays to its focal plane and forms an intermediate image there. - The intermediate image then acts as the object for the eyepiece. - The arrangement of the lenses is such that their principal foci coincide so that the final image due to the eyepiece is at infinity.	½ ½ ½ ½ ½ ½ ½ ½
(b)	 (i) Let h_1 denote diameter of the intermediate. and h_2 that of the final image	1

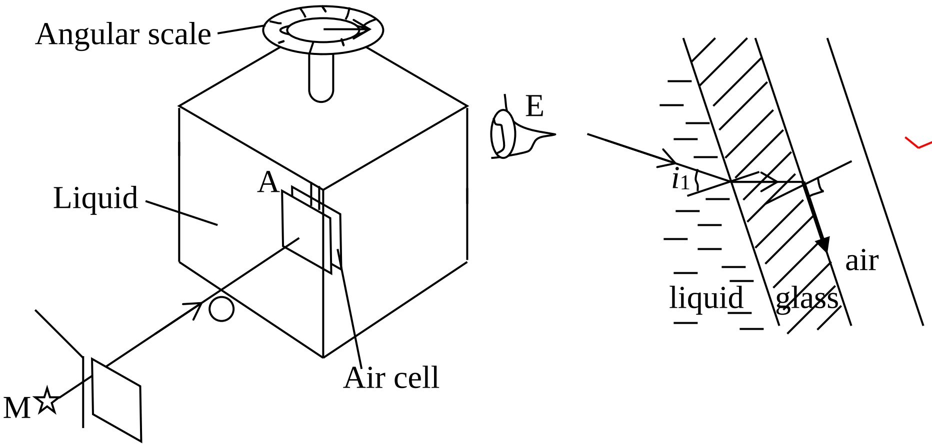
	Since α is a small angle, $\tan\alpha \approx \alpha = \frac{h_1}{80}$ in radians $\therefore h_1 = f_o\tan\alpha = f_o\alpha = 80 \times 8.0 \times 10^{-3} = \underline{\mathbf{0.64\ cm}}$	1 1
	(ii) Now, the intermediate image serves as the object for the eyepiece Using $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ for the eyepiece, we have that $u_e = \frac{f_e v_e}{v_e - f_e} = \frac{2.0 \times 20}{20 - 2.0} = \frac{40}{18} = 2.22$ cm Linear magnification, $m = \frac{h_2}{h_1} = \frac{v_e}{u_e} = \frac{20}{2.22}$ where h_2 is the diameter of the final image on the screen $\therefore h_2 = \frac{20}{2.22} \times 0.64 = \underline{\mathbf{5.77cm}}$	1 1 1
	(iii) Separation of the leaves $= 80 + u_e$ $= 80 + 2.22 = 82.22$ cm	1 1
(c)	 Only those rays bound by the perimeter of the objective enter the telescope and are refracted through the eyepiece to form an image ab of the objective AB	½ ½ 1 1 1
	Total = 20	
2. (a)	(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

(ii)



Let O be a point at the bottom of the pond.
Rays of light coming from O are 1
refracted away from their respective 1
normal as they cross the water-air
boundary. 1
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

(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. 1

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. ½

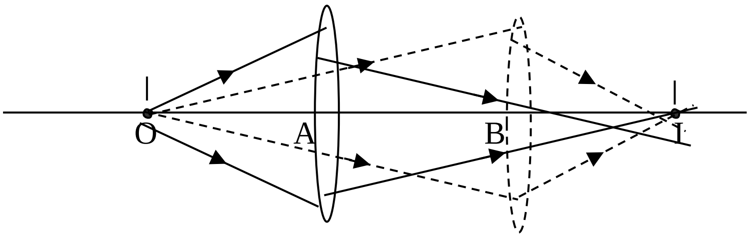
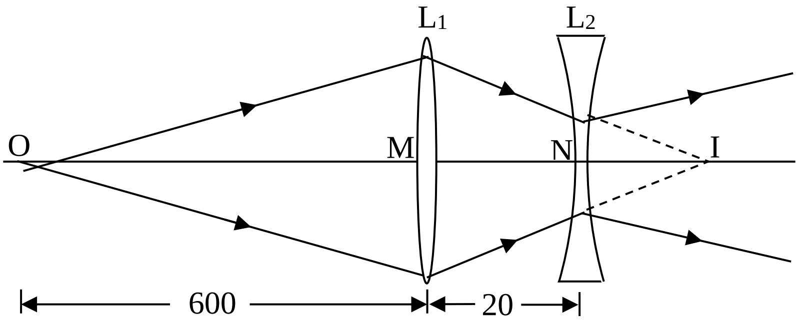
A is first positioned so that the incident light from M strikes it normally and goes through undeviated. ½

A is now rotated (slowly) until the light is suddenly cut off from E. ½

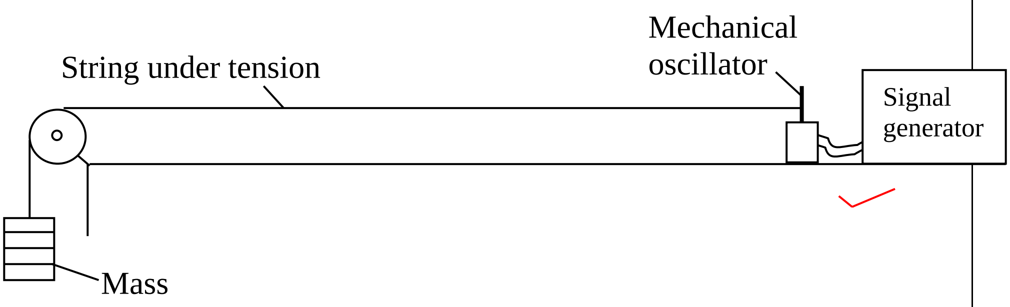
The angle, i_1, turned through is noted. ½ It is the angle of incidence in the liquid when light just grazes the glass-air boundary. ½

Since the boundaries are parallel nsin i =constant ½

∴ $n_1 \sin i_1 = n_g \sin i_2 = 1 \times \sin 90°$, where n_1 is the refractive index of the liquid ½

	∴ $n_l \sin i_1 = 1$	
	∴ $n_l = \dfrac{1}{\sin i_l}$	½
(b)	Let the respective positions of the lens be A and B	
		½
	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)	1
	and $m_2 = h_2/h = BI/BO$……………………(2)	1
	But AI = BO and AO = BI (since O and I are conjugate points)	½
	$h/h_1 = h_2/h$	½
	∴ $h = \sqrt{h_1 h_2}$	½
(c)		
	For lens L_1: u = 600 cm, f = 30 cm	
	(i)	
	Using $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$ we have	
	$\dfrac{1}{v} + \dfrac{1}{600} = \dfrac{1}{30}$	
	∴ $v = \dfrac{30 \text{ x } 600}{600 - 30} = \dfrac{30 \text{ x } 600}{570} = 31.6$ cm	1
	For lens L_2, I is a virtual object. Thus, $u' = {}^-(31.6 - 20) = {}^-11.6$ cm	1
	∴ $\dfrac{1}{v'} + \dfrac{1}{{}^-11.6} = \dfrac{1}{{}^-5}$	

<table>
<tr><td></td><td>∴ $$v' = \frac{11.6 \text{ x } 5}{5 - 11.6} = {}^{-}8.8 \text{ cm}$$ ✓
So the image is **virtual** ✓ and is **8.8 cm** ✓ to the left of L_2</td><td>1
1</td></tr>
<tr><td>(d)</td><td>(ii) Overall magnification, $m = m_1$ x m_2 ✓
$$= \frac{v}{u} \text{ x } \frac{v'}{u'} = \frac{31.6}{600} \text{ x } \frac{8.8}{11.6} = \mathbf{0.04}$$ ✓</td><td>2</td></tr>
<tr><td colspan="3">***Total = 20***</td></tr>
<tr><td>3. (a)</td><td>(i)
<table>
<tr><th>PROGRESSIVE</th><th>STATIONARY</th></tr>
<tr><td>Profile of the wave moves</td><td>Profile of the wave is stationary</td></tr>
<tr><td>Neighbouring particles along the direction of the wave vibrate out of phase</td><td>There are segments in which all the particles vibrate in phase</td></tr>
<tr><td>Particles vibrate with the same amplitude</td><td>The amplitude of the particles varies along the direction of the wave</td></tr>
<tr><td>Energy is transmitted</td><td>No energy is transmitted.</td></tr>
</table></td><td>✓1
✓1
✓1
1
✓</td></tr>
<tr><td>(b)</td><td>



✓

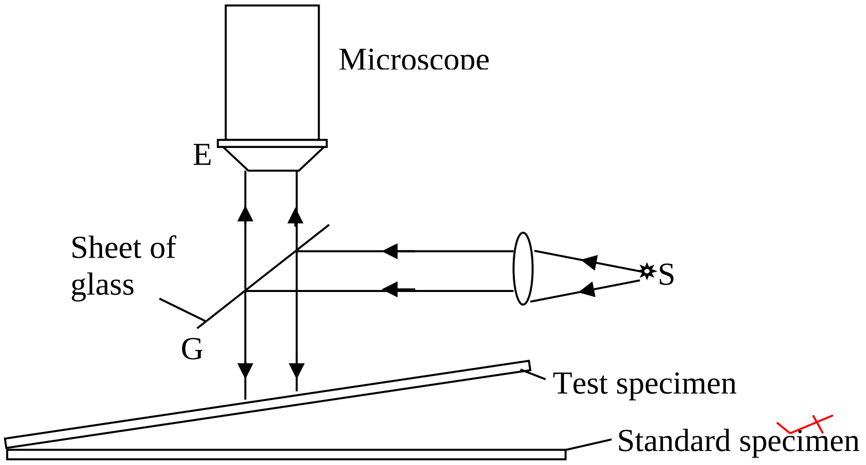
- A string supporting a mass is passed over a pulley and fixed to a mechanical oscillator which is actuated by a signal from a signal generator ✓
- The frequency of the signal generator is increased from a low value: At first very little happens to the string. Eventually, at the fundamental frequency, f_1 the string vibrates with a large amplitude in a single loop. ✓
- As the frequency is increased further, the vibrations die out and when the frequency reaches $2f_1$, the amplitude increases again, but the string this time vibrates in two loops. ✓
- At another frequency, $3f_1$, the string vibrates with 3 loops. ✓

Now for a string under tension, the natural frequencies are f, 2f, 3f, ….., where f is the fundamental frequency.
Thus, the string responds well to those forcing frequencies equal to its natural frequencies.</td><td>1
1
1
1
1</td></tr>
</table>

(c)	(i) $v = \sqrt{\frac{T}{\mu}}$ ✓ $= \sqrt{\frac{200}{2 \times 10^{-2}}}$ ✓ $=$ **100 ms^{-1}** ✓	2
	(ii) $\lambda = 2l$ ✓ and $v = fv$ $\therefore\ f = \frac{v}{\lambda}$ ✓ $= \frac{100}{2 \times 1.00}$ ✓ $=$ **50 Hz** ✓	3
(d)	(i) When two notes of nearly equal frequencies are sounded together, at some instant waves from both sources arrive at the observer's ear in phase. ✓ So they reinforce each other and produce loud sound. ✓ At another subsequent instant a compression from one arrives together with a rarefaction from the other. ✓ So destructive interference occurs and low or no sound is heard. ✓ This periodic rise and fall in loudness of sound is what is referred to as beats.	1 ½ 1 ½
	(ii) Let f_1 and f_2 be the frequencies of the two sounds (where $f_1>f_2$) and T the beat period. Then in time T the wave train of frequency f_1 makes one cycle more than the other of frequency f_2. ✓ Thus, the number of cycles of frequency f_1 in time T = f_1T ✓ the number of cycles of frequency f_2 in time T = f_2T ✓ $\therefore\ f_1T - f_2T = 1$ ✓ $\therefore\ f_1 - f_2 = \frac{1}{T}$ ✓ But $\frac{1}{T}$ = beat frequency $\therefore$ Beat frequency $= f_1 - f_2$ ✓	½ ½ ½ ½ ½ ½
	Total = 20	
4. (a)	(i) This is the superposition of wave trains from coherent sources resulting in alternate regions of maximum and of minimum amplitude.	2
	(ii) Sources of the waves must be coherent ✓ The waves must cross into each other ✓	1 1

(iii)

The surface under test is made to form an air wedge with a plane glass surface of standard smoothness.



½

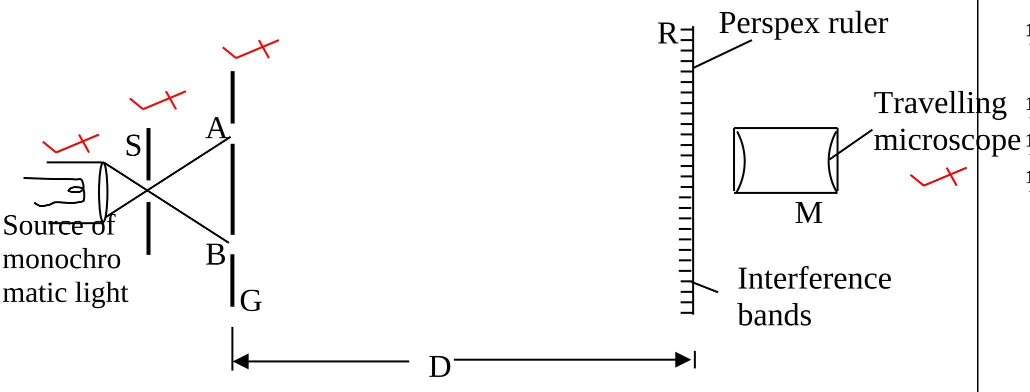
A parallel beam of monochromatic light from a source S is reflected from a glass plate G to fall almost normal to the air wedge. ½

The light reflected from the wedge is observed. ½

An interference pattern is observed. ½

Irregularities in the surface of the test specimen will show up as irregularities in what should have been parallel equally spaced fringes. 1

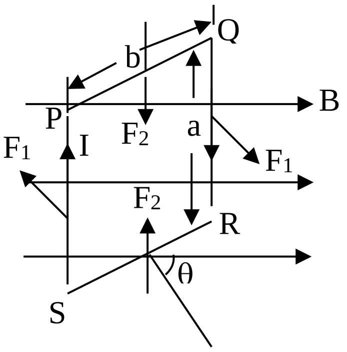
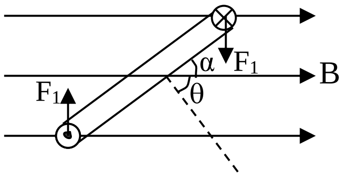
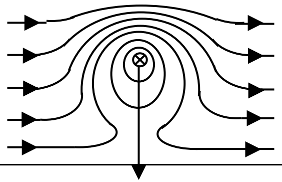
(b)

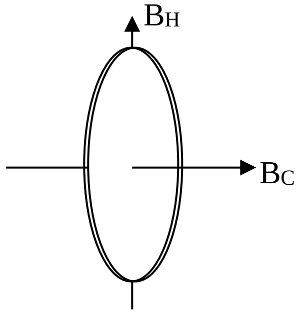
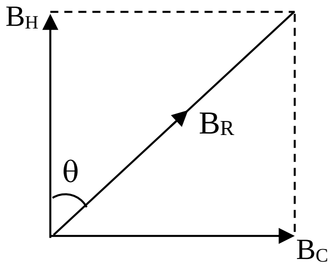


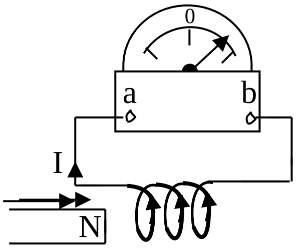
½
½
½
½

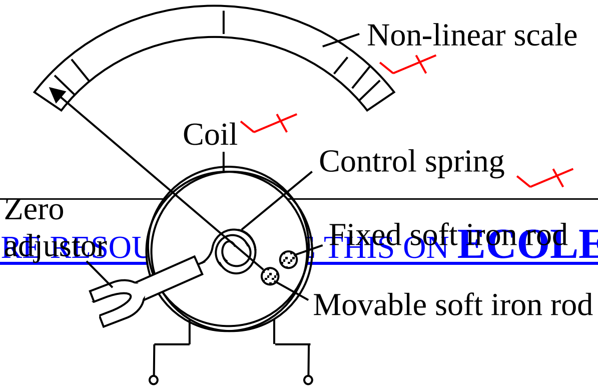
- Monochromatic light is focused by a lens on to a narrow slit S. ½
- Two narrow slits A and B, about 0.5 mm apart are placed a short distance in front of S. ½
- The travelling microscope, M, is focused on the perspex ruler R and the average distance, y, between the fringes is measured on R. ½
- The distance, a, between the slits is found by using a travelling microscope (or a magnifying glass). ½
- D is measured using a metre rule ½

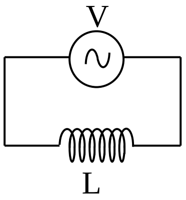
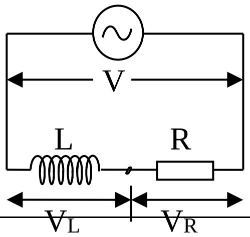
Then $\lambda = \frac{ay}{D}$ ½

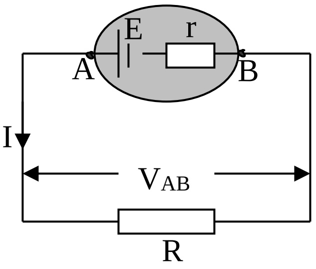
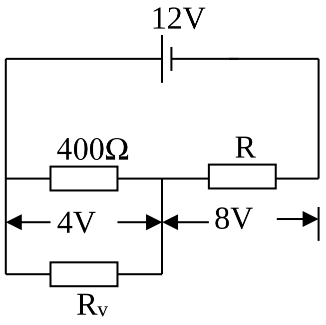
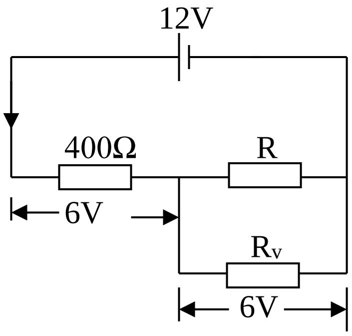
(c)	(i) Equally spaced alternate dark and bright fringes are observed. The fringes are parallel to the edge of contact of the wedge.	1 1
	(ii) The wavelength in the liquid decreases Fringe separation is reduced	1 1
(d)	Diffraction grating equation: $d \sin \theta_n = n\lambda$ $\therefore \quad d = \dfrac{2(5.8 \times 10^{-7})}{\sin 27} = 2.555 \times 10^{-8}$ m $\therefore$ Number of lines per cm $= \dfrac{1}{2.555 \times 10^{-5}} =$ **3.91×10^3** lines per cm	1 1 2
	Total =20	
5. (a)	(i) The tesla is the flux density of a uniform field in which the force on a conductor one metre long, placed perpendicular to the field and carrying a current of one ampere is one newton.	1
	(ii)   Force on PQ = BNIb sinθ (vertically downwards) Force on SR = BNIb sinθ (vertically upwards) These forces cancel out one another Force on limb PS = BNIa (into the plane of the paper) Force on limb QR = BNIa (out of the plane of the paper) These two forces constitute a couple whose moment is the torque $T = F_1 b \sin\theta$ $\therefore \quad T = BNIab \sin\theta$ But ab = A, where A = area of the coil $\therefore$ **T = BIAN sinθ**	½ ½ ½ ½ ½ ½ ½ ½ 1
(b)	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. 	½ ½ ½

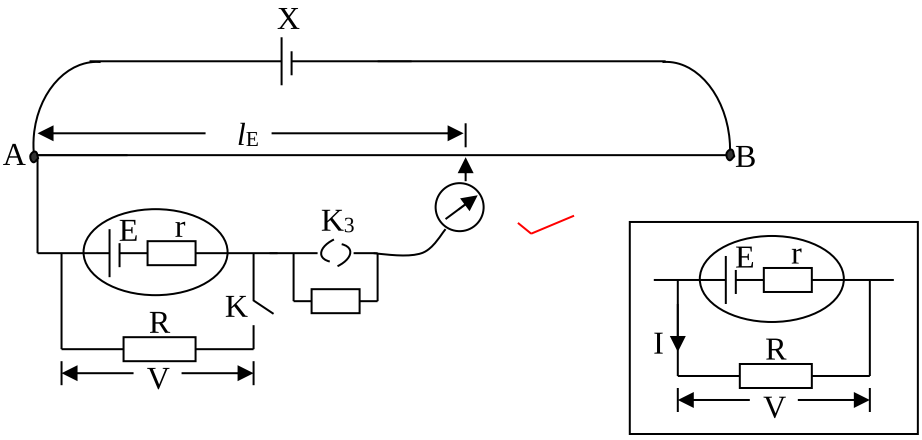
	Now, the tendency of the lines of force is to straighten and spread out. This is achieved by forcing the conductor away from the region of clustering.	½ 1
(c)	(i) The angle of dip is the angle between the direction of the earth's resultant magnetic flux density and the horizontal.	1
	(ii)   Let B_C = flux density due to the current in the coil. Then $B_C = \frac{\mu_o NI}{2R} = \frac{4\pi \times 10^{-7} \times 0.35 \times 4}{2 \times 5.5 \times 10^{-2}} = 1.6 \times 10^{-5}$ T The resultant magnetic flux density $B_R = \left(B_C^2 + B_H^2\right)^{\frac{1}{2}} = \sqrt{\left(1.6 \times 10^{-5}\right)^2 + \left(1.8 \times 10^{-6}\right)^2}$ $= \mathbf{1.61 \times 10^{-5}\ T}$ The direction is $\theta = \tan^{-1}\left(\frac{1.6 \times 10^{-5}}{1.8 \times 10^{-6}}\right)$ = **83.6°** to B_H	½ 1 1 ½ 1 ½ ½
(d)	(ii) Radial magnetic field: This ensures that the plane of the coil is always parallel to the magnetic field in whatever angular position. ⇒ this results in the scale being linear. Fine hair springs: This provides the counter torque; and the weaker it is the more sensitive the galvanometer is. Large number of turns: This also ensures high sensitivity since the torque on the coil increases directly with the number of turns. A conducting former: This allows eddy currents to flow in it whenever the coil is moving. This results in damping of the oscillations of the coil, which is necessary.	1 1 1 1 1
Total =20		

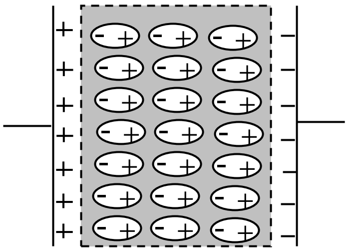
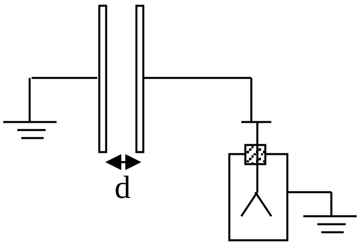
6. (a)	(i) …the development of an emf in a coil due to variations of current flowing in the coil itself.	1
	(ii) … the development of an emf in a coil as a result of variation of current in a nearby coil.	1
(b)	(i) Lenz's Law: The induced emf is in such a direction as to oppose the flux change causing it. Faraday's Law: The magnitude of the induced emf is directly proportional to the rate of change of flux linkage.	1 1
	(ii)  Consider a magnetic pole thrust towards a coil connected to a sensitive galvanometer. When the north pole is approaching, the coil repels it; When the north pole is retreating from the coil, it attracts it. The induced current in the coil sets up a force, which the agent moving the magnet must overcome; The work done in overcoming this force provides the electrical energy of the current. Hence, mechanical energy supplied by the agent moving the magnet is converted into electrical energy of the coil.	½ ½ ½ ½ ½ ½ 1
(c)	(i) **Ohmic Loss:** This is energy lost in form of heat in the resistance of the coil. It is minimised a low-resistance material for the coil – copper is used. **Eddy Current Loss:** This is due to circulation of current induced in the core. It is minimised by using a laminated core. **Hysteresis Loss:** This is energy lost due to forcing the magnetic field to reverse repeatedly and rapidly in the core. It is minimised by using a magnetically soft material for the core, i.e soft iron. **Flux Leakage:** This loss is brought due to some magnetic field lines failing to go through the space enclosed by the secondary coil.	½ ½ ½ ½ ½ ½ ½ ½
	(ii) $V_p = 240V$, $V_s = 20V$	

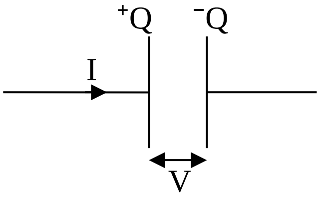
	$0.8 = \frac{V_s^2/R}{I_pV_p} = \frac{20^2/40}{I_p \times 240}$ $\therefore \quad I_p = \frac{10}{0.8 \times 240} = \mathbf{0.0521\ A}$	1 2
(d)	(i) When the switch is first closed, the rate of change of current from the battery is high. This gives to a very large back emf in the coil. Hence very little current flows through it; so most current flows through the ammeter. As the current in the circuit increases o maximum, its rate of change decreases, and the induced back emf in the coil decreases. Nearly all the current flows through the coil The current through the ammeter therefore tends to zero ∴ The ammeter reading gradually decays from maximum to nearly zero.	½ ½ ½ ½ ½ ½
	(ii) When K is opened, the large rate of decay of the current leads to a great induced emf in the coil. This tends to maintain a great current in the upper circuit. Hence current flows in the ammeter in the opposite direction and this current decays to zero as the magnetic flux of the coil decays to zero.	½ ½ ½ ½
	Total = 20	
7. (a)	(i) The r.m.s value of an alternating voltage is that value of steady voltage which would dissipate heat at the same rate in a given resistor as the alternating voltage.	1
	(ii) The peak value is the maximum value of the voltage in a cycle	1
(b)	(i) Let $I_{d.c}$ be the steady current equivalent to the alternating current, i.e. $I_{r.m.s}$ Then $\quad I_{d.c}^2R = (\text{Mean value of } I^2) \times R$ $\therefore \quad I_{d.c} = I_{r.m.s} = \sqrt{\text{mean value of } I^2}$ If the alternating current is sinusoidal, then $I = I_o \sin \omega t$ and $I_{r.m.s} = \sqrt{\text{mean value of } I_0^2 \sin^2 \omega t}$ $= I_o\sqrt{\text{mean value of } \sin^2 \omega t}$ Now, over a full cycle, the mean value of $\sin^2\omega t = ½$ $\therefore \quad I_{r.m.s} = I_o\sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}}I_o = 0.707\ I_o$	1 1 1 1
(c)		½ ½ ½

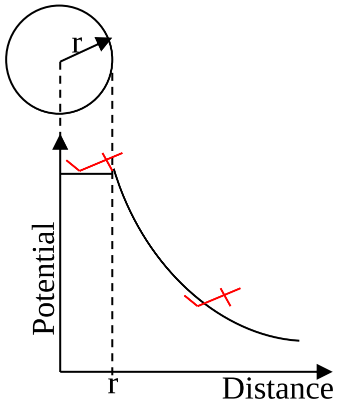
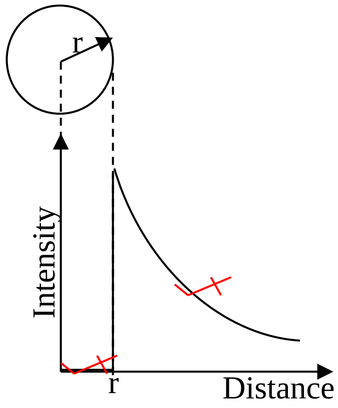
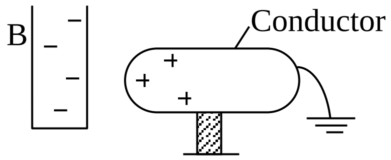
	- The current to be measured flows round the coil and magnetises the two soft iron rods with like poles side by side. - Since like poles repel, the soft iron rods repel each other with the result that the movable one moves away thereby turning the pointer fixed to it. - The pointer turns until the counter torque developed in the control spring is enough to stop it. - The repulsion force, and therefore the angle turned through by the pointer, depends on the current flowing in the coil (but not linearly).	½ 1 1 ½ ½
(d)	 Assume the resistance of the coil is zero. If a current I is flowing through the coil at an instant t, then $I = I_o\sin\omega t$ The back emf, E = $-L\frac{dI}{dt} = -\omega LI_o\cos\omega t$ For the current to flow, the applied voltage in the inductor must be equal and opposite the back emf i.e $V = \omega LI_o\cos\omega t$ Thus, the applied voltage 'leads' the current. Peak voltage, $V_o = \omega LI_o$ $\therefore \frac{V_o}{I_o} = \frac{V_{r.m.s}}{I_{r.m.s}} = \omega L = 2\pi fL$ And the quantity $2\pi fL$ is termed the ***inductive reactance***, X_L $\therefore$ $\mathbf{X_L = 2\pi fL}$ At the start, the rate of increase of current from zero is greatest, leading to maximum induced emf $\Rightarrow$ V is maximum. When the current is maximum its rate of change is zero leading to the back emf and hence the applied voltage to zero. This explains why V is maximum when I = 0 and why V is zero when I is maximum.	1 ½ ½ ½ ½ 1 ½ ½
(e)		

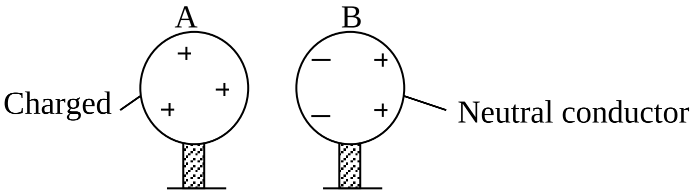
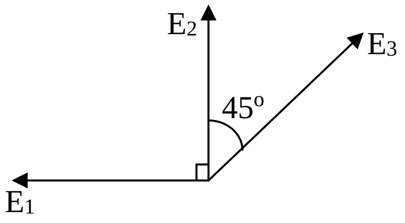
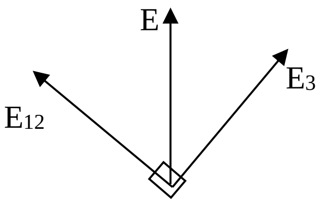
	$X_L = 2\pi \times 50 \times 2 = 200\pi$ ✓ $Z = \sqrt{500^2 + (200\pi)^2} = 803\ \Omega$ ✓ $I = \frac{V}{Z} = \frac{240}{803} = 0.3\ A$ ✓ $V_R = IR = 0.3 \times 500 =$ **150 V** ✓	1 1 1 1
	Total = 20	
8. (a)	 A source has internal resistance. ✓ Let r = internal resistance When a current I is drawn from the source there is a “lost” voltage, Ir, ✓ across r i.e. the terminal p.d, V = E – Ir, where E is the emf of the source. ✓ If I increases, Ir increases. So the terminal p.d, V, drops ✓	1 1 ½ ½
(b)	  (i) Let R_v = resistance of the voltmeter Then $\frac{400R_v}{(400+R_v)R} = \frac{4}{8} = \frac{1}{2}$ …………..……. (1) ✓ and $\frac{RR_v}{(R+R_v)400} = \frac{6}{6} = 1$ ………..………. (2) ✓ From (1) $800R_v = 400R + RR_v$ ∴ $800\frac{R_v}{R} = 400 + R_v$ …………………..(3) ✓ From (2) $RR_v = 400R + 400R_v$ ∴ $R_v = 400 + 400\frac{R_v}{R}$ ………..……….. (4) ✓	1 1 1 1

	Eq(4) x 2: $2R_v = 800 + 800\frac{R_v}{R}$ .... (5) Eq(3) + Eq(5): $2R_v = 1200 + R_v$ ∴ $R_v = \mathbf{1200\ \Omega}$	 1 1
	(ii) From (1): $R = \frac{2 \times 400R_v}{(500 + R_v)} = \frac{2 \times 400 \times 1200}{(400 + 1200)} = \mathbf{600\ \Omega}$	1
(c)	 A circuit is set up as shown, in which R is a standard resistor. 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. Now, $\frac{V}{E} = \frac{R}{R + r}$ But $\frac{V}{E} = \frac{l}{l_E}$ ∴ $\frac{l}{l_E} = \frac{R}{R + r}$ ∴ $\mathbf{r} = \mathbf{R}\left(\frac{l_E}{l} - \mathbf{1}\right)$	1 1 1 ½ 1 ½
(d)	(i) $V_{AB} = \frac{10}{12} \times 3 = 2.5\text{ V}$ $V_{eff} = \frac{80}{100} \times 2.5 = 2.0\text{ V}$ Considering cell Y, the p.d across the internal resistance is 2.2 - V_{eff} If I is the current flowing in the resistor Then $1.0 \times I = 2.2 - 2.0 = 0.2$ ∴ $I = \mathbf{0.2\ A}$	½ ½ 1 1
	(ii) $0.2R_1 = \frac{45}{100} \times 2.5$ $R_1 = \frac{0.45 \times 2.5}{0.2} = \mathbf{5.625\ \Omega}$	1

	$0.2(R_1 + R_2) = 2.0$ $\therefore \quad R_2 = \frac{2.0}{0.2} - R_1 = 10 - 5.625 = \mathbf{4.375\ \Omega}$	1
	Total = 20	
9. (a)	(i) …the ratio of the magnitude of charge on either plate to the potential difference between the plates.	1
	(ii) …the highest electric intensity the dielectric can be subjected to without breaking its insulation	1
(b)		1
	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.	½
	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.	½
	This arrangement reduces the positive potential of the positive plate and does the same on the negative potential of the negative plate.	½
	So the potential difference between the plates is lowered.	½
	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.	½
	This way the dielectric assists the plates to store charge.	½
(c)		1
	- A parallel- plate capacitor is set up as shown, one being earthed and the other connected to a gold leaf electroscope.	½
	- The plate connected to the gold-leaf electroscope is given a charge.	½
	- The divergence of the leaf is observed for various distances, d, of separation of the plates.	1
	- It is observed that the divergence increases with the distance, d, implying that the p.d between the plates increases.	½
	- Since the charge on the plates is constant, it means that the capacitance decreases with the increase in thickness of the dielectric.	½

(d)	(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. ✓	1
		
	Then the rate at which work is being done to charge the capacitor is the electrical power,	1
	$P = IV = I\frac{Q}{C}$ ✓	
	Now, the current, I $= \frac{dQ}{dt}$ (rate of flow of charge to the capacitor plates)	1
	∴ $P = \frac{Q}{C}\frac{dQ}{dt}$ ✓	
	The total work done in accumulating the charge from zero to a quantity, say Q_o, is	1
	$W = \int Pdt = \int_0^{Q_o} \frac{Q}{C}\frac{dQ}{dt}dt = \int_0^{Q_o} \frac{QdQ}{C} = \frac{Q_o^2}{2C}$ ✓	1
	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. ✓ Then the work done in transferring the charge δQ is $\delta W = V.\delta Q$ (from the definition of p.d). But $V = Q/V$ ✓ ∴ $\delta W = \frac{Q\delta Q}{C}$ ✓ 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	
(e)	Originally $Q_A = C_AV_A = 10 \times 10^{-6} \times 25 = 250 \times 10^{-6}$ $Q_B = C_BV_B = 10 \times 10^{-6} \times 25 = 300 \times 10^{-6}$ Let V be the final common p.d. Since total charge remains the same. $(C_A + C_B)V = C_AV_A + C_BV_B$ $\therefore \quad V = \frac{C_AV_A + C_BV_B}{C_A + C_B} = \frac{250 + 300}{25} = 22 \text{ V}$ The charge that flows so as to equalise the p.d is $C_BV - C_BV_B = C_B(V - V_B)$ $= 15 \times 10^{-6}(22 - 20) = 30 \times 10^{-6}$ C This is the charge that flows through G $\therefore$ the throw = 2 x 30 = **60 divisions**	1 1 1 1 1
	Total = 20	
10.(a)	(i) The force between two point charges is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between the charges.	1
	(ii) The electric intensity at a point in an electric field is the force experienced by a positive charge of one coulomb placed at that point. 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 1
(b)	(i)  	½ 1 ½
	(ii) 	1

	A negatively charged body, B, is brought near a conductor. The conductor is then earthed in the presence of B. Electrostatic induction occurs, and when the conductor is earthed, electrons are repelled to the earth, leaving the conductor positively charged but at zero potential.	½ ½ 1
	(iii)  When a positively charged sphere, A, is brought near a neutral conductor B, electrostatic induction occurs in the conductor with the negative charge residing on the side near A. The negative charge near the charged sphere A reduces the potential of A.	1 1 1
(d)	(i) $V_p = \left(\frac{-1}{0.2}+\frac{1}{0.2}+\frac{\sqrt{8}}{0.2\sqrt{2}}\right) \text{x}\,10^{-6}\ \text{x}\,9\ \text{x}\,10^{9}$ $= \mathbf{9.0\ x\ 10^4\ V}$	3 1
	(ii)   $E_1 = \frac{1}{0.2^2}\ \text{x}\,10^{-6}\ \text{x}\,9\ \text{x}\,10^{9} = 2.25\ \text{x}\ 10^5\ NC^{-1}$ $E_2 = \frac{1}{0.2^2}\ \text{x}\,10^{-6}\ \text{x}\,9\ \text{x}\,10^{9} = 2.25\ \text{x}\ 10^5\ NC^{-1}$ $E_3 = \frac{\sqrt{8}}{(0.2\sqrt{2})^2}\ \text{x}\,10^{-6}\ \text{x}\,9\ \text{x}\,10^{9} = 3.18\ \text{x}\ 10^5\ NC^{-1}$ $E^2 = E_1^2 + E_2^2 + E_3^2$ $= (2.25^2 + 2.25^2 + 3.18^2)\ \text{x}\ 10^{10}$ $= 20.25\ \text{x}\ 10^{10}$ $\therefore\ E = \mathbf{4{,}5\ x\ 10^5\ NC^{-1}}$	1 1 1 1 1
Total = 20		