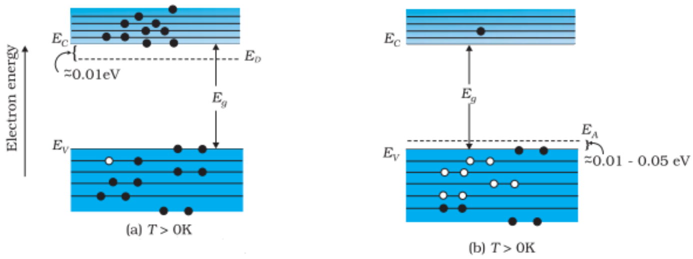
SOLUTIONS : PHYSICS (042)			
CODE: 55/7/2			
Q.NO.	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION- A		
1.	(B) E = 0, V= V_0 (a constant)	1	1
2.	(D) $\left[ML^2T^{-2}A^{-2}\right]$	1	1
3.	(B) zero	1	1
4.	(B) 3.20×10^{14} Hz	1	1
5.	(B) 0.2 mV	1	1
6.	(C) holes and few electrons	1	1
7.	(C) 16/3 Ω	1	1
8.	(C) capacitive and inductive respectively	1	1
9.	(A) 1/200 s	1	1
10.	(D) 3/4	1	1
11.	(C) same neutron number, but different atomic number.	1	1
12.	(A) both the potential barrier height and width of depletion layer decrease.	1	1
13.	(C) Assertion(A) is true and Reason(R) is false.	1	1
14.	(D) Both Assertion (A) and Reason (R) are false	1	1
15.	(B) Both Assertion(A) and Reason (R) are true but Reason (R) is **not** the correct explanation of Assertion(A).	1	1
16.	(B) Both Assertion(A) and Reason (R) are true but Reason (R) is **not** the correct explanation of Assertion(A).	1	1
	SECTION- B		
17.	Finding the ratio of drift velocities when joined in (i) Series 1 (ii) Parallel 1 (i) Series $I = neAv_d$ $\frac{v_{d_1}}{v_{d_2}} = \frac{A_2}{A_1}$ (ii) Parallel $v_d = \frac{V}{RneA} = \frac{V}{\rho l ne}$ $\frac{v_{d_1}}{v_{d_2}} = \frac{1}{1}$	 ½ ½ ½ ½	 2
18.	Drawing Energy band diagram of n type semiconductor ½ p type semiconductor ½ Showing donor/acceptor energy level ½+½		

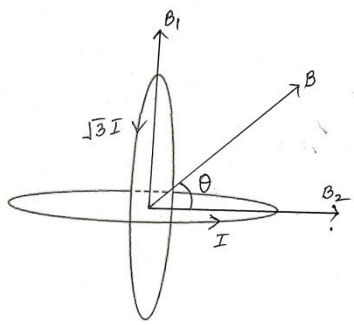
	 	1+1	2
19.	Calculating the ratio of intensities 2 Given, $\frac{I_{max}}{I_{min}} = \frac{25}{9}$ $\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{25}{9}$ $3(a_1 + a_2) = 5(a_1 - a_2)$ $\frac{a_1}{a_2} = \frac{4}{1}$ $\frac{I_1}{I_1} = \frac{16}{1}$	½ ½ ½ ½	2
20.	(a) Deducing for (a)Size 1 (b)Location of the image produced by convex mirror 1 Let, u= nf From the Mirror formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$ $= \frac{1}{f} + \frac{1}{nf}$ $v = \frac{nf}{n+1}$ $n = +ve \quad \therefore v < f$ $m = \frac{-v}{u} = \frac{1}{n+1}$ m is always positive & less than 1. **(Note: Please award full credit if correctly concluded by any other method)** **OR**	½ ½ ½ ½	

	(b) Finding the nature & focal length of lens 1½ Stating answer for changing thickness ½ $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$ $\frac{1}{12} = \frac{1}{10} - \frac{1}{15} + \frac{1}{f_3}$ $\frac{1}{f_3} = \frac{5-6+4}{60}$ $f_3 = 20\,\text{cm}$ Nature: Convex Yes	½ ½ ½ ½	2
21.	Calculating Binding Energy per nucleon 2 $\Delta m = (2m_n + 2m_H) - m({}_2^4He)$ $= 2\times1.008665 + 2\times1.007825 - 4.002603$ $= 0.0303774u$ $BE = \Delta mc^2$ $= 0.030377\times931$ $= 28.2962\,\text{MeV}$ $\frac{\text{BE}}{\text{nucleon}} = \frac{28.2962}{4} = 7.07\,\text{MeV}$	½ ½ ½ ½	2
	SECTION- C		
22.	Writing the mathematical form of postulates of Bohr's Theory 1½ Proving, (a) radius of the orbit is proportional to n^2 1 (b) total energy of the atom is proportional to $1/n^2$ ½ Mathematical form of postulates of Bohr's Theory (i) $E_n = \frac{-13.6}{n^2}\,\text{eV}$ **Alternatively** : Electron revolve in stable orbits with definite energy called stationary orbits. (ii) $L = mvr = \frac{nh}{2\pi}$ (iii) $h\nu = E_f - E_i$	½ ½ ½	

	(a) $\frac{mv^2}{r}=\frac{Ze^2}{r^2}$ -----(1) $mvr=\frac{nh}{2\pi}$ -----(2) Solving (1) & (2) $r=n^2\left(\frac{h}{2\pi}\right)^2\frac{4\pi\varepsilon_0}{me^2}$ ----(3) Since energy in the orbit $E_n = \frac{-e^2}{8\pi\varepsilon_0 r}$ Using eq (3) $E_n = \frac{-me^4}{8n^2\varepsilon_0{}^2h^2}$ or $E_n \propto \frac{1}{n^2}$	½ ½ ½	3
23.	(a) Explaining Einstein's photoelectric equation 1 (b) Determining which metal will not show photoelectric emission 1½ Reason when source is brought closer ½ (a) $h\nu=\phi_0+K_{max}$ $h\nu$ = Energy of incident radiation ϕ_0 = Work function or minimum energy required to emit an electron from metal surface K_{max} = maximum kinetic energy of emitted electron **Alternatively:** The energy of incident radiation E (> ϕ_0) incident on a metal surface, a part of it is used to overcome the work function & remaining energy provides maximum kinetic energy to the electrons. (b) $\lambda=330\,nm$ $E=\frac{hc}{\lambda}=\frac{6.63\times10^{-34}\times3\times10^{8}}{330\times10^{-9}\times1.6\times10^{-19}}$ $=3.77\,eV$ Mo and Ni will not show photoelectric emission. No change.	1 ½ ½ ½ ½	3
24.	(a) (i)Writing Biot-Savart's Law in vector form 1 (ii)Finding magnitude & direction of net magnetic field at centre of two current carrying coils 2 (i) $\vec{dB}=\frac{\mu_0}{4\pi}\frac{I(\vec{dl}\times\vec{r})}{r^3}$	1	

(ii) $B_1 = \frac{\mu_0 I}{2R}$ ½

$B_2 = \frac{\mu_0 \sqrt{3} I}{2R}$



$B = \sqrt{B_1^2 + B_2^2}$

$\therefore B = \frac{\mu_0 I}{2R}\sqrt{1+3}$ ½

$B = \frac{\mu_0 I}{R}$ ½

$\tan\theta = \frac{B_1}{B_2} = \frac{1}{\sqrt{3}}$ ½

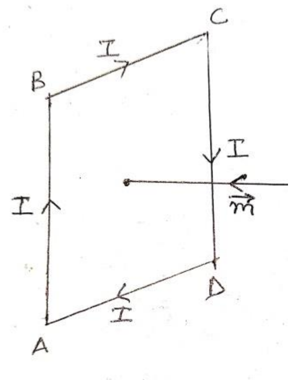
Direction of net magnetic field is 30° with direction of B_2/ 60° with the direction of B_1.

OR

(b)

Writing the expression for magnetic moment & showing its direction	1
Proving no net force	1
Torque $(\vec{\tau}) = \vec{m} \times \vec{B}$	1

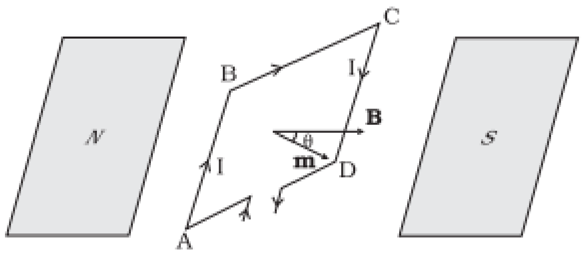
(i) $\vec{m} = I\vec{A}$ ½



½

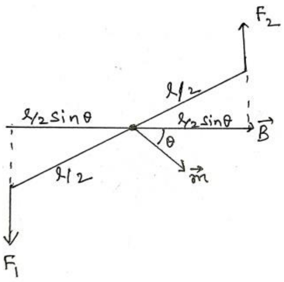
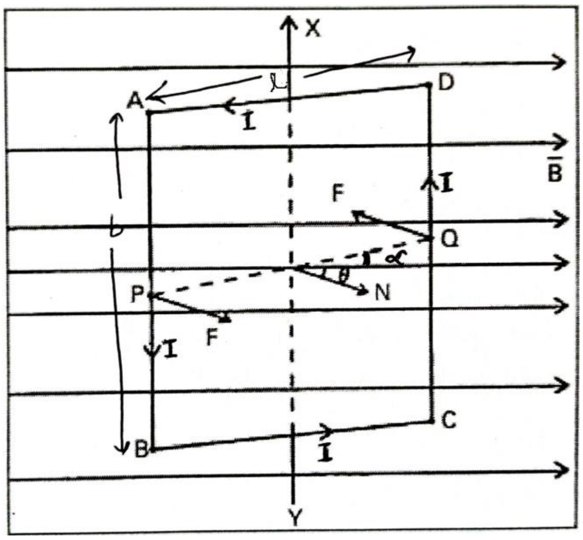
(ii) $F_1 = F_2 = IbB$ $F_1 = \text{Force on AB into the plane}$

$F_2 = \text{Force on CD out of the plane}$ ½

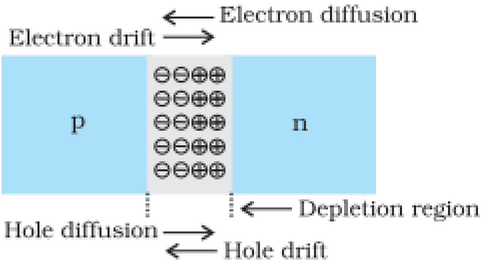


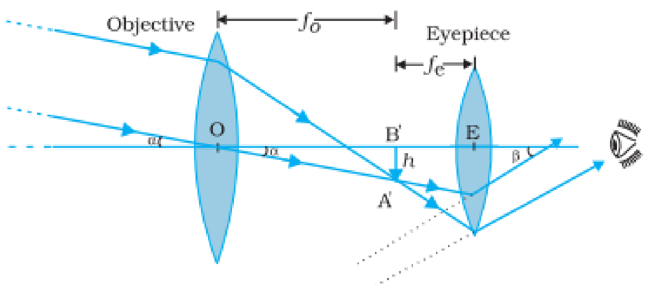
Since forces are equal & opposite so net force = 0 ½

Both forces form a couple, magnitude of torque acting on the coil is

	$\therefore \tau = F_1 \frac{l}{2}\sin\theta + F_2 \frac{l}{2}\sin\theta$ $= I\,b\,B\,l\sin\theta$ $= I\,A\,B\,\sin\theta$ $= m\,B\sin\theta$ $\vec{\tau} = \vec{m}\times\vec{B}$  **Alternatively**:  If the plane of the current carrying coil makes an angle ∝ with the magnetic field $\vec{F}_{DA} = -\vec{F}_{Bc}$ (cancel each other) Force on the arm BC is into the plane of the paper $\lvert F_{DC}\rvert = IbB$ Force on the arm DA is out of the plane of the paper. $\lvert F_{AB}\rvert = IbB$ Since forces are equal & opposite so net force = 0 Both of them form a couple and magnitude of torque acting on the coil is τ=either force ×perpendicular distance between the two forces. $\tau = IbB \times a\sin\theta$ $= IAB\sin\theta$ $\vec{\tau} = I\vec{A}\times\vec{B}$ $\vec{\tau} = \vec{m}\times\vec{B}$	½ ½ ½ ½ ½ ½	3
25.	(a) Production of em waves 1 (b) Writing the wavelength & use of (i) Microwaves 1 (ii) Ultraviolet waves 1 (a) Electromagnetic waves are produced by an oscillating or accelerated charge.	1	

	Alternatively: An oscillating charge produces an oscillating electric field which produces an oscillating magnetic field which in turn is a source of oscillating electric field & so on. (b) (i) **Microwaves** **Wavelength**: 0.1 m to 1 mm **Use** : Radar used in aircraft navigation. Microwave ovens. **(Any one)** (ii) **Ultraviolet waves** **Wavelength**: 400 nm to 1 nm **Use** : Kill germs in UV purifiers. LASIK eye surgery. **(Any one)**	½ ½ ½ ½	3
26**.**	(a) Obtaining expression for mutual inductance of two concentric coils 2 (b) Finding self-inductance of the solenoid 1 (a) Magnetic field at centre of outer coil S_2 $B_2 = \frac{\mu_0 I_2}{2r_2}$ Flux linked with inner coil S_1 is $\phi_1 = B_2 A_1$ $= \frac{\mu_0 I_2}{2r_2} . \pi r_1^2$ Also, $\phi_1 = M_{12} I_2$ $\therefore M_{12} = \frac{\mu_0}{2r_2} . \pi r_1^2$ (b) $\varepsilon = -L\frac{dI}{dt}$ $L = \frac{0.4 \times 50 \times 10^{-3}}{4 \times 10^{-3}}$ $= 5H$	½ ½ ½ ½ ½ ½	3
27**.**	Explaining the formation of depletion layer and potential barrier 1+1 Feature of junction diode for its use as rectifier 1 When an electron diffuses from n-side to p-side, it leaves behind an ionized donor on n side. Similarly when a hole diffuses from p-side to n-side, it leaves behind an ionized acceptor on p side. This space charge region consisting of immobile ions on either side of the junction is known as depletion layer.	1	

	As diffusion process continues, width of depletion layer increases and consequently strength of electric field increases across the junction and thus the drift current. The potential that prevents the movement of electron from n region into p region is called potential barrier.  **(<u>Note</u> : Award full credit of formation of depletion layer even if a student draws above diagram)** Diode allows current to pass only when it is forward biased as resistance is small whereas in reverse bias, its resistance is very large. **Alternatively**: Diode is unidirectional.	1 1	3
28.	(a) Calculating work done to separate two charges 1 (b) Calculating electrostatic potential energy 2 (a) $U=\frac{kq_1q_2}{r}$ $=\frac{9\times10^9\times(-5\times10^{-6})\times(2\times10^{-6})}{10\times10^{-2}}$ $=-0.9\,J$ W = U(infinity) – U(r) = 0.9J (b) $E=\frac{-dV}{dr}$ $dV=\frac{-A}{r^2}dr$ $V=\frac{A}{r}$ $U=q_1V_1+q_2V_2+\frac{kq_1q_2}{r}$ $=(-5\times10^{-6})\left(\frac{8\times10^4}{4\times10^{-2}}\right)+(2\times10^{-6})\left(\frac{8\times10^4}{6\times10^{-2}}\right)-0.9$ $=-10+2.67-0.9$ $=-8.24\,J$	½ ½ ½ ½ ½ ½	3
	SECTION -D		
29.	(i) (A) $1/\sqrt{n^2-1}$ (ii) (a) (B) 1.4 **OR** (b) (D) increase by 19%	1 1	

	(iii) (C) First real and then virtual (iv) (A) 10cm	1 1	4
30.	(i) (D) 1 (ii) (C) 3.75×10^{6} (iii) (B) 500^{0} C (iv) (a) (D) I decreases and II is almost constant **OR** (b) (D) All I, II and III change	1 1 1 1	4
	SECTION- E		
31.	(a) (i) Drawing labeled Diagram 1½ Explanation ½ Writing expression of Magnifying power 1 (ii) Calculating the focal length of objective & eye piece 2  **(Note: Deduct ½ mark, for not showing arrows with the rays)** Light from distant object enters the objective lens & forms a real image A'B' at f_o . This image A'B' acts as an object for eye piece and eye piece forms a magnified image at infinity. Magnifying Power = f_o / f_e (ii) Image is formed at least distance of distinct vision $20 = m_o \times m_e$ $m_o = \frac{20}{5} = 4$ $m_e = 1 + \frac{D}{f_e}$ $f_e = \frac{25}{4} cm$ $\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$ $\frac{1}{-25} - \frac{1}{u_e} = \frac{4}{25}$ $u_e = -5cm$	1½ ½ 1 ½ ½	

$L = v_0 + |u_e|$

$v_0 = 9\,cm$ ½

Given, $\frac{v_0}{u_0} = 4$

$$\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$$

$$\frac{1}{f_0} = \frac{1}{9} - \left(-\frac{4}{9}\right)$$

$$f_0 = \frac{9}{5}\,cm$$ ½

OR

(b)

(i) Obtaining the expression for resultant intensity of interference pattern	2
Writing maximum & minimum values of resultant intensity	1
(ii) Calculating the distance of	
(I) First order minimum	1
(II) Second order maximum from centre of screen	1

(i) $y_1 = a\cos\omega t$ ½

$y_2 = a\cos(\omega t + \phi)$

According to Principle of Superposition

$$y = y_1 + y_2$$

$$= a\left[\cos\omega t + \cos(\omega t + \phi)\right]$$ ½

$$= 2a\cos\phi/2\,\cos(\omega t + \phi/2)$$

$$y = A\cos\left(\omega t + \phi/2\right)$$ ½

where, $A = 2a\cos\phi/2$

$$I = kA^2$$

$$I = k\left(4a^2\cos^2\phi/2\right)$$

$$I = 4I_0\cos^2\phi/2$$ ½

<u>Alternatively</u>: If student writes

$I = I_1 + I_1 + 2\sqrt{I_1 I_1}\cos\phi$ **(award one mark)**

Maximum value $I = 4I_0$ ½

Minimum value $I = 0$ ½

(ii) **(I)** Position of first order minimum

	$y=\frac{n\lambda D}{a}$ $y_1=\frac{\lambda D}{a}$ $=\frac{600\times10^{-9}\times1.5}{3\times10^{-3}}=3\times10^{-4}\text{m}$ **(II)** Position of second order maximum $y_n=(2n+1)\frac{\lambda D}{2a}$ $n=2,\quad y_2=\frac{5\lambda D}{2a}$ $=\frac{5\times600\times10^{-9}\times1.5}{2\times3\times10^{-3}}=7.5\times10^{-4}\text{ m}$	½ ½ ½ ½	5
32.	(a) (i) Finding the value of capacitance 3 (ii) Finding the number of capacitors 2 (i) $C_0=\frac{\varepsilon_0 A}{d}$ $C=\frac{\varepsilon_0 A}{(d-t)+\frac{t}{K}}$ $t=d/4$ $C=\frac{\varepsilon_0 A}{\left(d-\frac{d}{4}\right)+\frac{d}{4K}}=\frac{\varepsilon_0 A}{d\left(\frac{3}{4}+\frac{1}{4K}\right)}$ $=C_0\frac{4K}{(3K+1)}$ **Alternatively**: When dielectric is inserted, the electric field between the plates is $E=E_0/K$ The potential difference will be $V=E_0\left(\frac{3d}{4}\right)+E\left(\frac{d}{4}\right)$ $=E_0\left(\frac{3d}{4}\right)+\frac{E_0}{K}\left(\frac{d}{4}\right)$ $=V_0\left(\frac{3}{4}+\frac{1}{4K}\right)$ $V=V_0\left(\frac{3K+1}{4K}\right)$ $C=\frac{Q_0}{V}=\left(\frac{4K}{3K+1}\right)\frac{Q_0}{V_0}$ $C=C_0\left(\frac{4K}{3K+1}\right)$ (ii) Each capacitance can withstand 200V	½ ½ 1 1 ½ ½ 1 1 ½	

No. of capacitors in each row = $\frac{1200}{200} = 6$

Net capacitance of each row= 1/6 μF ½

Number of rows = n

$C_{eq} = C_1 + C_2 + \_\_\_\_\_\_ + C_n$

$C_{eq} = \frac{1}{6} + \frac{1}{6} + - - - - - - n$

$2 = \frac{n}{6}$ ½

$\therefore n = 12$

Total no. of capacitors in the arrangement = 6 × 12 ½

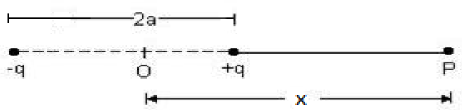
= 72

OR

(b)

(i) Deriving the expression of electric potential due to dipole	
I. along its axis	1½
II. along its bisector line	1½
(ii) Calculating the torque	2

I. Along its axis



$V_- = \frac{-kq}{x+a}$

$V_+ = \frac{kq}{x-a}$ ½

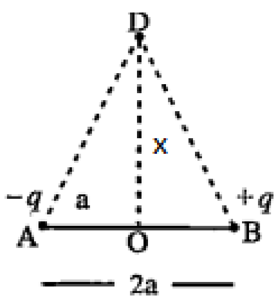
$V = V_- + V_+$

$= kq\left(\frac{-1}{x+a} + \frac{1}{x-a}\right)$

$= kq\frac{2a}{(x^2-a^2)} = \frac{kp}{x^2-a^2}$ ½

$x \gg a \quad \therefore V = \frac{kp}{x^2}$ ½

II. Along the bisector line



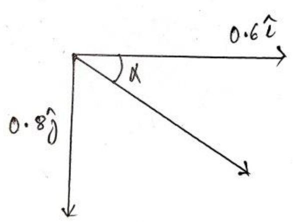
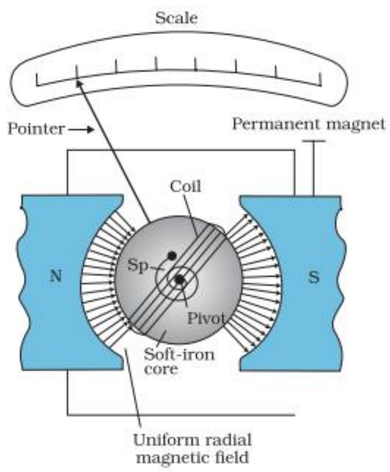
$V_- = \frac{kq}{\sqrt{x^2 + a^2}}$ ½

$V_+ = \frac{-kq}{\sqrt{x^2 + a^2}}$ ½

$V = V_- + V_+$

$= 0$ ½

(ii) $\vec{\tau} = \vec{p} \times \vec{E}$ ½

	$=(0.8\hat{i}+0.6\,\hat{j})\times10^{-29}\times(1\times10^{7})\,\hat{k}$ $=\left[0.8\left(-\hat{j}\right)+0.6\hat{i}\,\right]\times10^{-22}$ $\tau=\left[\sqrt{(0.8)^2+(0.6)^2}\,\right]\times10^{-22}$ $=10^{-22}\ Nm$ $\tan\alpha=\frac{\lvert0.8\rvert}{0.6}$ $\alpha=\tan^{-1}\left(\frac{4}{3}\right)$ $\alpha=53^0$  	½ ½ ½	5
33.	(a) (i) Labelled diagram 1 Working principle of moving coil galvanometer 1 Use of (i) Radial magnetic field ½ (ii) Soft iron core ½ (ii) Defining current sensitivity 1 Reason 1  **Principle**: A current carrying coil placed in uniform magnetic field experiences a torque. (i) Radial magnetic field makes the scale linear **Alternatively**: Radial magnetic field provides maximum Torque. (ii) Use of soft iron core is to increase the strength of magnetic field/ increase sensitivity of the galvanometer. (ii) **Current sensitivity** is defined as deflection per unit current. **Alternatively**:	1 1 ½ ½ 1	

	$I_s = \frac{\Phi}{I} = \frac{NAB}{k}$		
	Voltage sensitivity $V_s = \frac{\Phi}{V} = \left(\frac{NAB}{k}\right)\frac{I}{V} = \left(\frac{NAB}{k}\right)\frac{1}{R}$	½	
	Increase in number of turns, increases the current sensitivity and resistance of the galvanometer in the same proportion of current sensitivity therefore Voltage sensitivity remains unchanged.	½	
	OR		
	(b) (i) (I) Writing Ampere circuital law & explaining the terms. 1 (II) Reason for magnetic field outside long solenoid approaching zero 1 (III) Reason for irregular shaped loop changing to circular loop in uniform magnetic field 1 (ii) Finding the value of Resistance R_3 2		
	(i) **(I)** $\oint \vec{B}.\vec{dl} = \mu_0 I_e$	½	
	I_e= Total current through the surface B= Magnetic field dl = length of small element	½	
	(II) As length of solenoid increases, it appears like a long cylindrical metal sheet so field outside approaches zero.	1	
	(III). For a given perimeter, a circle encloses greater area than any other shape, which maximizes the flux.	1	
	(ii) $R_1 = \frac{V}{I_g} - G \quad \Rightarrow \frac{V}{I_g} = R_1 + G$ -----(1)	½	
	$R_2 = \frac{V}{2I_g} - G \quad \Rightarrow \frac{V}{2I_g} = R_2 + G$ -----(2)	½	
	Solving (1) & (2) $G = R_1 - 2R_2$	½	
	$R_3 = \frac{2V}{I_g} - G$ -----(3)	½	
	Solving using eq (1) & (3) $R_3 = 3R_1 - 2R_2$	½	5