55 (B)

MARKING SCHEME

Q. NO.	Expected Answer / Value Points	Marks	Total Marks
	SECTION – A		
Q. 1	RMS current is the equivalent dc current that would produce the same average power loss as the alternating current $I_{rms} = \frac{I_0}{\sqrt{2}}$	½ ½	 1
Q. 2	$\lambda = \frac{h}{\sqrt{2mK}}$ Or $\lambda \, \alpha \sqrt{\frac{1}{m}}$ (For Same K) Electron has greater de-Broglie wavelength because its mass is smaller. (Note: Award full 1 mark even if student just writes "electron" as the answer)	½ ½	 1
Q. 3	Number of nuclei undergoing decay per unit time at any instant is proportional to the total number of nuclei in the sample at that instant. (Alternatively : $\frac{dN}{dt} = -\lambda N$)	1	1
Q. 4	Electrical resistivity of a material is the resistance of a wire of that material of unit length and unit area of cross section.	1	1
Q. 5	Zero	1	1
	SECTION – B		
Q. 6	a) Processes responsible for β^+, β^- decay $\frac{1}{2}+\frac{1}{2}$ b) Reason 1 a) In β^- decay a neutron converts to proton and an antineutrino $(\bar{\nu})$ is emitted. In β^+ decay a proton converts into a neutron and a neutrino (v) is emitted. b) It is difficult to detect neutrinos because they have very weak interaction with other particles and can penetrate large quantity of matter without any interaction	 ½ ½ 1	 2

*These answers are meant to be used by evaluators

OR

Formula for radius of nucleus	1
Explanation of constancy of Nuclear Density	1

Radius of Nucleus = $R_0 A^{1/3}$ — 1

Volume of nucleus $V = 4/3\ \Pi r^3 = 4/3\ \Pi R_0^3\ A$ — ½

Nuclear Density = A / V $= \frac{3}{4\pi R_0^3}$ = Constant — ½

2

7.

Formula for magnetic field	½
Expressions for magnetic fields in the two cases	½ +½
Ratio B_1 / B_2	½

Case-i :

$B = \frac{\mu_0}{2}\frac{I}{R}$ — ½

$l = 2\pi R \rightarrow R = \frac{l}{2\pi}$

$B_1 = \frac{\mu_0}{2}\frac{I}{R} = \frac{\mu_0 \pi I}{l}$ ……………………………(i) — ½

Case-ii

$l = n \times 2\pi r \rightarrow r = \frac{l}{2\pi n}$

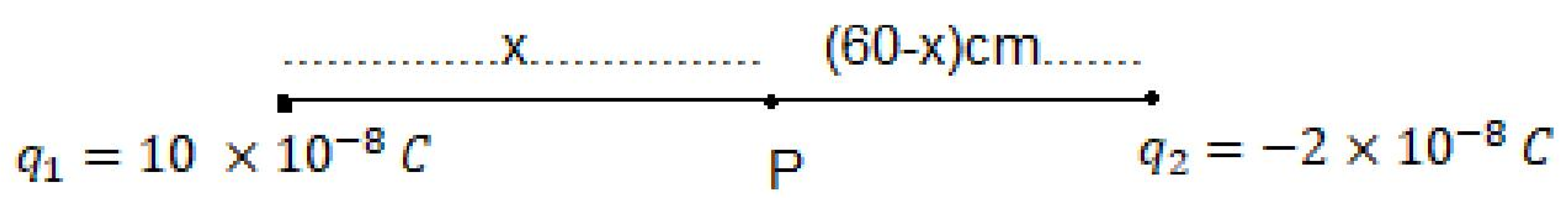
$B_2 = \frac{\mu_0}{2}\frac{nI}{r} = \frac{\mu_0 n^2 I}{l}$ ……………………………(ii) — ½

$\therefore \frac{B_1}{B_2} = \frac{1}{n^2}$ — ½

2

8.

Formula for Potential	½
Equation for zero potential …………………………	1
Evaluation of distance……………………………	½



We have $V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$ — ½

*These answers are meant to be used by evaluators

	$$\frac{1}{4\pi\epsilon_0}\left[\frac{10\ \times 10^{-8}}{x \times 10^{-2}} + \frac{-2\ \times 10^{-8}}{(60-x)\times 10^{-2}}\right] = 0$$ $$\frac{5}{x} = \frac{1}{(60-x)}$$ $6x = 300$ $x = 50\ cm$ (from q_1)	½ ½ ½	2
9.	Principal of LED ……………………………………………………1 Two advantages……………………………………………………1/2 +1/2 <u>Principal of Working of LED</u> When LED is forward biased, electrons are sent from n to p side and holes from p to n side . At the junction boundary minority carriers recombine with majority carriers. On recombination, the energy is released in the form of photons of energy equal to , or less than, the band gap energy. <u>Advantages of LED</u> (i) Low operational voltage and less power (ii) Long life and ruggedness (or any two other advantages)	1 ½ ½	2
10.	Two factors……………………………………………… 1+1 Any two of the following: (i) Size of Antenna: The antenna should have a size comparable to the wavelength of the signal. For e.m. waves of frequency 20 Hz, λ is 15 km. Such a long antenna is not possible to construct, therefore there is a need to translate baseband signal to high frequency by modulation. (ii) Effective Power radiated by antenna: Power radiated is proportional to l / λ^2. Therefore, for the same antenna length, the power radiated increases with decreasing λ. For a good transmission we need high power and hence need of high frequency transmission. (iii) Mixing up of signals from different transmitters: If many transmitters are transmitting base signals (in the audio frequency range) simultaneously they will get mixed up and there is no way to distinguish between them. By using high frequency, and allotting a band of frequencies to each signal, such mixing can be avoided.	1+1	2

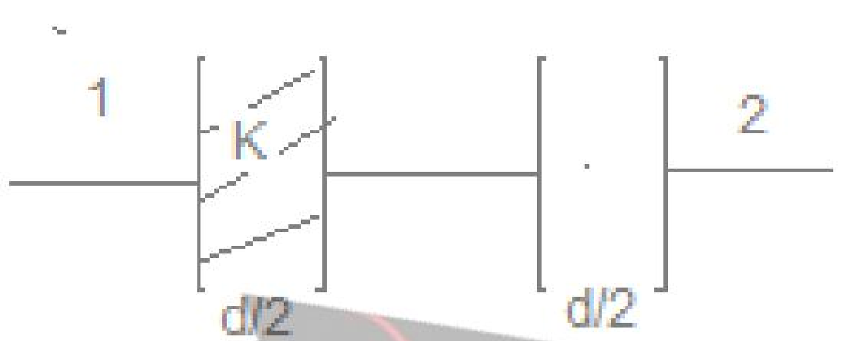
SECTION C

11.

(a) Effect on the electric field inside a dielectric	1
(b) Formulae for capacitance	1/2+1/2
Net capacitance	1

(a) The net Electric field gets reduced — 1

(b) It is like two capacitors connected in series



$$C_1 = \frac{\epsilon_0 AK}{\frac{d}{2}},$$ ½

$$C_2 = \frac{\epsilon_0 A}{\frac{d}{2}}$$ ½

$$\Rightarrow C_1 = KC_2$$

Net Capacitance in series combination

$$C = \frac{C_1 C_2}{C_1 + C_2}$$ ½

$$= \frac{KC_2C_2}{kC_2+C_2}$$

$$= \frac{KC_2}{K+1}$$

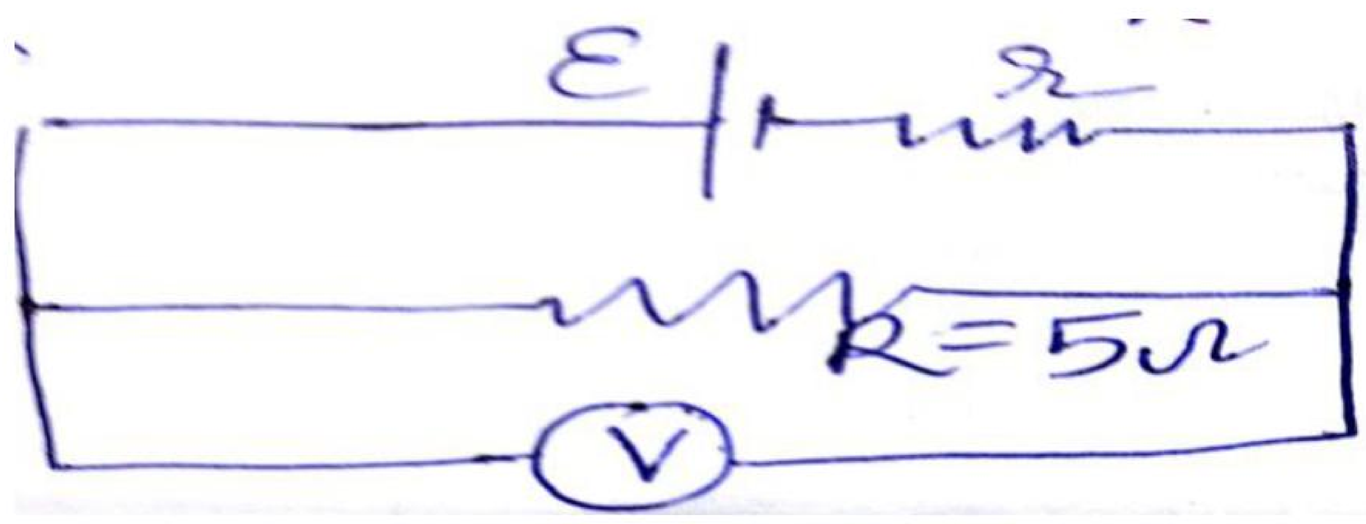
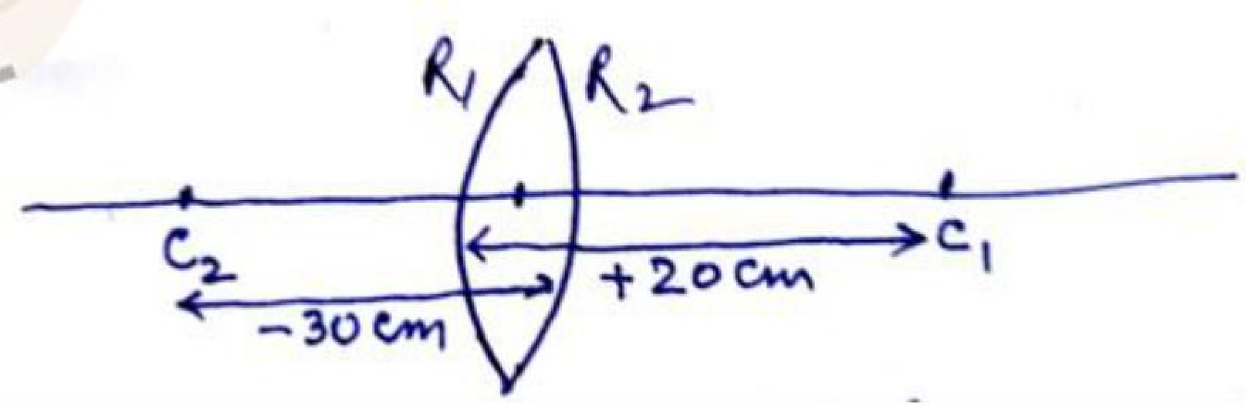
$$C = \left(\frac{2K}{K+1}\right)\frac{\epsilon_0 A}{d}$$ ½

3

12.

Identifying e.m.f.	1
Calculation if r	2

As resistance of voltmeter is high, no current flows through it.
Hence emf of the cell $\epsilon = 2.2\,V$ — 1

	When 5Ω resistance is connected across the terminals of the cell (as shown in the diagram), we have		
			
	$V = \frac{E\,R}{r + R}$	1	
	$r = \frac{(E - V)R}{V} = \frac{(2.2 - 1.8)5}{1.8}\ \Omega$	½	
	$r = \frac{0.4 \times 5}{1.8} = \frac{2}{1.8} = 1.11\Omega$	½	3
13.	(i) Definition 1 Writing Yes/No ½ (ii) Lens Makers Formula and Calculation ½+1		
	(i) The Power of a lens is defined as the reciprocal of its focal length (in meters)	1	
	Yes, it can be negative	½	
	(ii) 		
	R_1 = + 20 cm, R_2 = - 30 cm From Lens Maker's Formula		
	$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	
	$\frac{1}{f} = (1.6 - 1)\left(\frac{1}{20} + \frac{1}{30}\right)$	½	
	$\frac{1}{f} = 0.6 \times \frac{1}{12} = \frac{1}{20}$ f = 20 cm = 0.2 m $P = \frac{1}{0.2}$ D = 5D	½	3

14.	(a) Difference — 1Mark (b) Function of Transmitter — 1Mark Function of Transducer — 1Mark (a) Analog Signals are smooth and continuous. Digital Signals are stepping – Square, and directive (b) (i) Transmitter processes the incoming message signal so as to make it suitable for transmission (ii) Transducer converts one form of energy into the other.	1 1 1	3
15.	(a) Relation $2\pi r = \lambda$ — 1 Mark (b) (i) Einstein Equation — 1 Mark (ii) Stating the features — 1 Mark (a) $2\pi r = \lambda$ (b) $K_{max} = h\nu - h\nu_0$ Features (any two): (1) Maximum energy of the emitted electrons does not depend upon the intensity of incident radiation. (2) There exists a threshold frequency for each photosensitive surface. (3) Photoemission is an instantaneous phenomenon.	1 1 ½+½	3
16.	• Definition — 1/2 Mark • Vector/Scalar nature — 1/2 Mark • Numerical — 1 Mark • Dependence on radius — ½ Mark • Explanation — 1/2 Mark • Electric flux: It is defined as the number of electric filed lines passing through a surface placed perpendicular to the direction of electric field lines • It is a Scalar Quantity • $\Phi = -1 \times 10^3 \frac{Nm^2}{C}$ $\Phi = \frac{q_{Enclosed}}{\epsilon_0}$ $q_{Enclosed} = \Phi \epsilon_0$	½ ½ ½	

*These answers are meant to be used by evaluators

$= -1\times10^{3}\times8.854\times10^{-12}\,C$

$= -8.854\times10^{-9}\,C$

Or $q_{Enclosed} = -8.854\,nC$ ½

- No, it does not depend the on radius of the Gaussian surface. ½

Justification: As According to Gauss Theorem

$\Phi = \dfrac{q_{Enclosed}}{\epsilon_0}$ ½

Hence flux does not depend on radius. 3

OR

• Definition	1 Mark
• Numerical Problem	2 Mark

Definition: Dipole moment of an electric dipole, equals the product of the magnitude of either of its charges and the distance between the two charges.

(Alternatively: $\vec{p} = q\ 2a\ \hat{r}$

Where $\hat{r}$ is unit vector directed from the negative to the positive charge.) 1

Numerical: 1

p = $3\times10^{-8}\,C\,m$

$W = -\,p\,E\,(\cos\theta_2 - \cos\theta_1)$ ½

$W = -\,3\times10^{-8}\times10^{4}\,(\cos180° - \cos0°)$

$W = 6\times\ 10^{-4}\ Joules$ ½ 3

17.

(i) Definition of Magnifying Power	1 Mark
(ii) Reason for large Focal Length and aperture of objective	½+1/2Mark
(iii) Two advantages of reflecting telescope	½+1/2 Mark

(i) Magnifying Power of telescope is the ratio of angle β subtended at the eye by the final image to the angle α which the object directly subtends at the lens / the eye. 1

(ii) Focal length of the objective is kept large to have higher magnifying power ½

Aperture of objective is large for getting high resolution/collecting more light from the distant object. ½

(iii) Two advantages of Reflecting telescopes (any two) ½+½

(a) No Chromatic aberration

(b) No Spherical abberation

(c) Easier to assemble. 3

18.	(i) Expression for λ_{max} 1 Mark (ii) Expression for λ_{min} 1 Mark (iii) Ratio $\lambda_{max} : \lambda_{min}$ 1 Mark		
	Maximum Wavelength, λ_{max} is emitted in the transition (n =3) to (n = 2) $\Delta E_{32} = E_3 - E_2$ $\frac{hc}{\lambda_{max}} = -\frac{E_0}{9} + \frac{E_0}{4} = \frac{5}{36}E_0$ .... (i)	1	
	Minimum Wavelength, λ_{min} is emitted in the transition (n =3) to (n = 1) $\frac{hc}{\lambda_{min}} = -\frac{E_0}{9} + \frac{E_0}{1} = \frac{8}{9}E_0$ .... (ii)	1	
	Dividing (ii) by (i) $\frac{\lambda max}{\lambda min} = \frac{8}{9} \Big/ \frac{5}{36} = \frac{32}{5}$	1	3
19.	(i) Definition of drift velocity 1 Mark (ii) Ratio of Drift Velocities 2 Mark		
(i)	Drift velocity equals the average velocity of free electrons in a conductor when an external field is applied across .	1	
(ii)	$I_x = I_y$	½	
	$n_x e A v_x = n_y e A v_y$	½	
	$\frac{v_x}{v_y} = \frac{n_y}{n_x}$	½	
	$\frac{n_y}{2n_y} = \frac{1}{2}$	½	3
20.	(a) Calculation of angle of incidence 1 Mark Calculation of minimum deviation 1 Mark (b) Reason for no interference 1 Mark		
(a)	$r = 120^0 - 90^0 = 30°$	½	
	$\frac{\sin i}{\sin r} = \mu$ sin i = $\sqrt{3} \times \frac{1}{2}$ i = 60°	½	
	$D_{min} = 2i - A$	½	

*These answers are meant to be used by evaluators

	$D_{min} = 120^0 - 60^0 = 60^\circ$	½	
	(b) Two sodium lamps are two independent sources with no fixed phase difference between them. Therefore, no sustained interference pattern is observed on the screen. **(Alternatively** Two independent sodium lamps are not coherent sources.)	1	3
21	(a) (i) Name of em wave and frequency range — 1 Mark (ii) Name of em wave and frequency — 1 Mark (b) production of em waves — 1 Mark		
(a)	(i) Gamma rays Frequency range 10^{18} Hz to 10^{22}Hz (or greater than 10^{18} Hz) (ii) Infrared waves Frequency range 10^{12}Hz to 10^{14} Hz	½ ½ ½ ½	
(b)	An oscillating charge produces an oscillating electric field in space, which in turn produces an oscillating magnetic field, which in turn is a source of oscillating electric field and so on. Hence the oscillating charge can produce an em wave propagating through space.	1	3
22	Definition of self inductance — 1 Mark Change in brightness on reducing C — 1 Mark Change in brightness on reducing f — 1 Mark		
	Self inductance of a coil of is equal in magnitude to the magnetic flux linked with the coil when a unit current flows in the coil.	1	3
	(Alternatively : Self inductance of a coil is equal in magnitude to the emf induced in it, if current in the coil changes at the rate of 1 ampere per second.)	1	
	(i) Brightness decreases	½	
	On reducing the capacitance C, impedence of the circuit $\left(\frac{1}{\varpi c}\right)$ increases. Hence, current flowing and the brighenss of lamp would decrease.	½	
	(ii) Brightness decreases	½	
	When frequency decreases, impedance of the circuit $\left(\frac{1}{\varpi c}\right)$ increases. Hence, current flowing and the brightness of lamp would decrease.	½	3

*These answers are meant to be used by evaluators

23	SECTION - D a) Reason for oscillations to stop — 1 Mark b) Method of reducing the effect — 1 Mark c) Two values displayed by each — 1 + 1 Mark a) Eddy currents produced in the metallic plate oppose the motion (oscillations) b) Effect can be reduced by cutting holes or slots in the plate. c) Values of Lata : Inquisitive, Scientific temperament (or any other) Values of Teacher : caring, responsible (or any other)	1 1 1 + 1	4
24	SECTION - E Working of amplifier - 3 Mark Expression for voltage gain – 2 Mark We make a circuit in which the input side (Base –emitter) is forward biased While the output side (collector- emitter) is revers biased. When no signal is applied to the base, to the input current almost completely flows into the output (Collector- emitter) Circuit. When a signal varying voltage is added to the biased voltage of the input circuit, its amplified form appears in the output circuit. We thus get an amplified form of given input signal ∴ Voltage gain, $A_v = \frac{V_0}{V_i} = \frac{\Delta V_{CE}}{r \Delta I_B}$ $A_v = -\beta_{ac} \frac{R_C}{r}$ OR a) Reason for diffusion — 2 Mark b) Fabrication of photodiode — 1 Mark Working – 1 Mark Reason for operating in reverse bias – 1 Mark a) There is high concentration of holes in the region and comparatively very low concentration of holes in the n – region.	1 1 ½ ½ 1 1 1	5

*These answers are meant to be used by evaluators

Q. No.	Answer	Marks	Total
	Because of the concentration gradient holes diffuse from p to the n – region. b) A photodiode is fabricated with a transparent window to allow light to fall on the diode. When the photodiode is illuminated with light protons of energy greater than the energy gap, election-hole pairs are generated due to the absorption of protons in or near the depletion region. Due to junction field, election and holes are separated before they recombine. Elections reach n-side and holes reach p-side giving rise to an emf. This is proportional to the intensity of the incident light. (c) It is operated in the reverse bias as it can then detect changes in the light intensity more easily. (Alternatively : Photodiode is operated in reverse is because fractional change in majority carriers ($\Delta {}^{n}/_{n}$) would be much less than the fractional change in minority carriers ($\frac{\Delta p}{p}$). Therefore, change in reverse bias current is more easily measurable.)	1 1 1 1	
25	Definition — 1 Mark Reason for Polarization when passes through a Polaroid — 2 Mark Reason for two maxima and minima in a 2π rotation — 2 Mark Light is said to be linearly polarized when the oscillations of its electric field vector are confined to a plane containing its direction of propagation. When passed through a polaroid, the electric filed vibrations along the direction of aligned molecules get absorbed Hence light gets linearly polarized with the electric vector oscillating along a direction perpendicular to the aligned molecules. When linearly polarized light is viewed through a polaroid, the transmitted intensely is $I = I_o \cos^2 \theta$ (θ is the angle between the pass axes of the two polaroid (polarizer and analyzer)) If $\theta = 0^0$ or π, I = I_o (Maxima) and if $\theta = \frac{\pi}{2}$ or $\frac{3\pi}{2}$, I = 0 (Minima) Hence, two maxima and two minima are obtained in a 2π rotation.	1 1 1 ½ ½ ½ ½	5

OR

a)	Explanation of single slit diffraction	2 Mark
b)	Variation of angular width of maxima with	
i.	slit width	1 Mark
ii.	distance	1 Mark
iii.	wavelength	1 Mark

a) A parallel beam of light falls normally on a single slit of width 'a'; Dividing the slit into different parts and treating each part as source of light with all the parts in phase,

Path difference between the edges of the slit = a $\sin\theta$ ½

At the central point on the screen $\theta = 0$, hence all path differences are zero and a maxima is formed. ½

Minima are formed on the screen in the direction 'θ'for which aθ = nλ It can be explained by divining the slit into even number of parts with path difference $\frac{\lambda}{2}$ between successive parts. ½

Secondary maxima are formed on the screen in the direction 'θ' for which a$\theta = (n + \frac{1}{2})\lambda$ It can be explained by dividing the slit into odd number of parts with path difference $\frac{\lambda}{2}$ between successive parts. ½

b) Angular width of central maxima = $2\theta = \frac{2\lambda}{a}$. Hence

i. If 'a' decreases, angular width increases 1

ii. No change in angular width when the given distance is increased 1

iii. If λ decreases, angular width decrease. 1

5

26

Principle	1 Mark
Working	1 Mark
Importance of radial field	1 Mark
Production of radial field	1 Mark
Current sensitivity	1 Mark

Principle – A current carrying coil experiences a torque in a magnetic field. 1

Working – Galvanometer consists of a coil with many turns, free to rotate about a fixed axis in a uniform radial magnetic field. When current flows through the coil, a torque, τ acts on it which is expressed as,

$$\tau = NIAB$$

A spring provides counter torque, kØ that balances the magnetic torque, τ

*These answers are meant to be used by evaluators

	$\therefore k\emptyset = NIAB$ $\emptyset = \frac{NAB}{k} I$ Radial field makes the magnetic field same for all orientations of the coil. This makes the scale of current linear with deflection ∅. Radial field is produced by using cylindrical pole pieces for the magnet. Current sensitivity is deflection per unit current, ($I_s = \frac{\emptyset}{I} = \frac{NAB}{k}$) Current sensitivity can be increased by increasing the number of turns N and decreasing, k, the torsional constant of the spring.	½ ½ 1 1 ½ ½	5
	OR Principal of cyclotron — 1 Mark Working — 1 Mark Cyclotron frequency — 2 Mark Two uses — 1 Mark Principal – A charged particle acquires kinetic energy when it passes through a potential difference of V volt (or an electric field). A magnetic field is used to make the particle accelerate through the same alternating electric field again and again. Working – Cyclotron uses crossed electric and magnetic fields. Every time particle moves from one dee to another, electric field acts on it and accelerate it. Inside the dee there is no electric field but only the magnetic field, this makes the particle move in circular path and brings it back to the edge of the dee to face the accelerating field again. The electric field is produced by connecting dee's to a high frequency AC source. Expression for Cyclotron frequency $\frac{mv^2}{r} = qvB$ $\Rightarrow v = \frac{qBr}{m}$ Frequency, $v_c = \frac{1}{T} = \frac{v}{2\pi r}$ $\therefore v_c = \frac{qB}{2\pi m}$ Uses – i) used to accelerate charged particles or ions to high energies. ii) used in hospitals to produce radioactive substances (or any other use)	 1 1 ½ ½ ½ ½ ½ + ½	5

*These answers are meant to be used by evaluators