Strictly Confidential: (For Internal and Restricted use only)
Senior School Certificate Examination-2020
Marking Scheme – PHYSICS THEORY (042)

(55/2/2)

General Instructions: -

1. You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully. **Evaluation is a 10-12 days mission for all of us. Hence, it is necessary that you put in your best efforts in this process.**
2. Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and marks be awarded to them.**
3. The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
4. Evaluators will mark(√) wherever answer is correct. For wrong answer 'X"be marked. Evaluators will not put right kind of mark while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
5. If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
6. If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
7. If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out.
8. No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
9. A full scale of marks 0-70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
10. Every examiner has to necessarily do evaluation work for full working hours i.e. 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).
11. Ensure that you do not make the following common types of errors committed by the Examiner in the past:-
    - Leaving answer or part thereof unassessed in an answer book.
    - Giving more marks for an answer than assigned to it.
    - Wrong totaling of marks awarded on a reply.
    - Wrong transfer of marks from the inside pages of the answer book to the title page.
    - Wrong question wise totaling on the title page.
    - Wrong totaling of marks of the two columns on the title page.

- Wrong grand total.
- Marks in words and figures not tallying.
- Wrong transfer of marks from the answer book to online award list.
- Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.)
- Half or a part of answer marked correct and the rest as wrong, but no marks awarded.

12. While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.

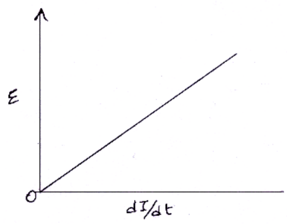
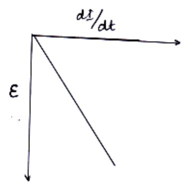
13. Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.

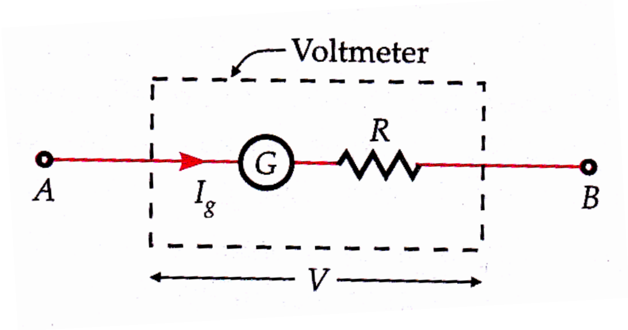
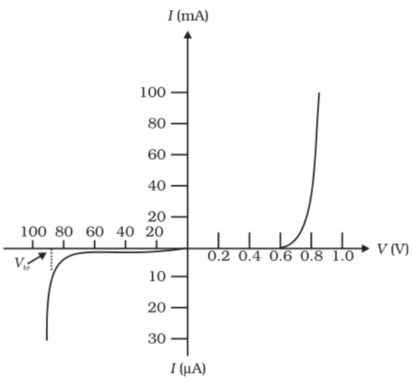
14. The Examiners should acquaint themselves with the guidelines given in the Guidelines for spot Evaluation before starting the actual evaluation.

15. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.

16. The Board permits candidates to obtain photocopy of the Answer Book on request in an RTI application and also separately as a part of the re-evaluation process on payment of the processing charges.

MARKING SCHEME: PHYSICS
QUESTION PAPER CODE: 55/2/2

Q.No.	Value Points/Expected Answer	Marks	Total Marks
	SECTION A		
1	(A) Temperature	1	1
2	(B) Conductivity	1	1
3	(A) neutron converts into a proton emitting antineutrino.	1	1
4	(C) Lead	1	1
5	(C) Ultraviolet rays	1	1
6	(B) just below the conduction band	1	1
7	(A) binding energy per nucleon increases	1	1
8	(A) X – rays	1	1
9	(C) zero as diffusion and drift current are equal and opposite.	1	1
10	(A) move in a straight line.	1	1
11	$\frac{q_2 - q_1}{\varepsilon_0}$	1	1
12	Blue	1	1
13	Large	1	1
14	$\frac{I_0}{2}$	1	1
15	Third OR $\frac{2\lambda}{a}$ [Alternatively, broader]	1	1
16	For a given photosensitive material, there exists a certain minimum cut-off frequency of the incident radiation, called the **threshold frequency**, below which no emission of photo electrons takes place, no matter how intense the incident light is.	1	1
17	Zero	1	1
18	$X_c = \frac{1}{2\pi\nu C}$ OR $Z = R$	1	1
19	$\lambda_2 : \lambda_1$	1	1
20	 Alternatively 	1	1
	SECTION B		
21	Identification of waves (a) & (b): ½ + ½ Uses: ½ + ½ (a) minimum wavelength: γ rays (b) minimum frequency: Microwaves γ rays are used to treat cancer Microwaves are used for communication [or any other correct use]	 ½ ½ ½ ½	2
22			

Q.No.	Value Points / Expected Points	Marks	Total Marks
	Figure and Formula — 1 Evaluation of resistance — 1  $R = \frac{V}{I_g} - G$ [If figure is not drawn, award full 1 mark for the formula] Here V = 3 V $I_g = 4\text{ mA} = 4 \times 10^{-3}\text{ A}$ $G = 16\ \Omega$ $R = \frac{3}{4 \times 10^{-3}} - 16$ $= \frac{3 \times 1000}{4} - 16$ $= 734\ \Omega$, in series with the galvanometer.	½ ½ ½ ½	2
23	V-I characteristics — 1 Explanation for voltage independence of reverse current — 1  Since reverse current is due to flow of minority charge carriers across the junction, it is limited due to the concentration of minority carriers on either side of the junction. It is therefore independent of the voltage applied.	1 1	2
24	Definition of mobility or formula — 1 Derivation of relationship — 1 Mobility is defined as the magnitude of drift velocity per unit electric field. $\mu = \frac{\lvert\vec{V}_d\rvert}{E}$ [Even if a student writes only the mathematical relation award ½ mark] Given $V_d = \frac{e\tau E}{m}$	1 ½	2

	Hence, $\mu = \frac{V_d}{E} = \frac{e\tau}{m}$	½	

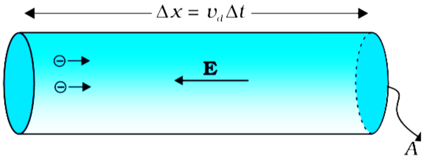
OR

Definition of drift velocity	1
Relation between current density and drift velocity	1

The average speed with which electrons move when an electric field or potential difference is applied is called drift velocity. — 1

$$\overrightarrow{V_d} = \frac{-e\vec{E}\tau}{m}$$

[Award 1/2mark if student writes the formulae]



The amount of charge crossing the area A in time Δt

$$I\Delta t = ne\,A\,|\overrightarrow{V_d}|\,\Delta t$$ — ½

Hence current density

$$j = \frac{I}{A} = ne\,V_d$$ — ½ — 2

25

Lens Maker's formula	½
Evaluation of refractive index	1
Condition for lens becoming converging	½

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ — ½

Given $f = \frac{3}{4}R$ $\quad R_1 = -R \quad R_2 = R$

$$\frac{-4}{3R} = (\mu - 1)\left[\frac{-1}{R} - \frac{1}{R}\right]$$ — ½

$$\Rightarrow \mu = 1 + \frac{2}{3} = \frac{5}{3}$$ — ½

If the lens is immersed in a medium of refractive index greater than 5/3 , it will behave like a converging lens. — ½ — 2

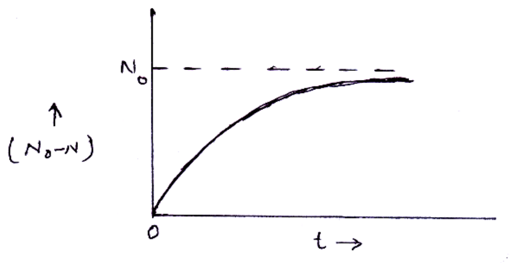
26.

(a) Graph	1
(b) Calculation of mass left undecayed	1

(a)

$N = N_0 e^{-\lambda t}$

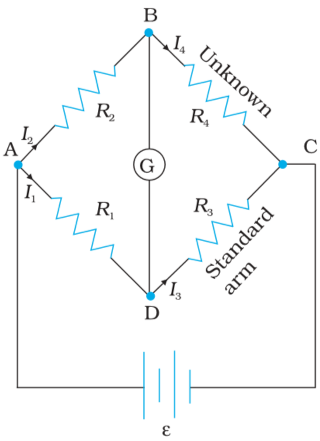
Total mass disintegrated $\quad N_0 - N = N_0(1 - e^{-\lambda t})$ — ½



½

	[If a student draws only the correct graph award full one mark] (b) $$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$ where t = total time T = half life $$N = 3.2\left(\frac{1}{2}\right)^{\frac{8}{4}}$$ $$= 3.2 \times \frac{1}{4} = 0.8\text{mg}$$ [Give full credit for this part even if a student calculates correct answer without using this formula]	½ ½	2
27	(a) Sharpness of resonance — 1 (b) Value of power factor — 1 (a) Sharpness of resonance is the sharpness of the peak of the resonance curve / a graph between I_m and ω. The sharper or narrower the curve the narrower is the resonance or the resonance lasts over a very small range of frequencies / Q factor or quality factor is the measure of sharpness of curve. (b) Z = R Hence Power factor $$\cos\phi = \frac{R}{Z}$$ $$\cos\phi = 1$$ Even if a student just writes power factor is 1, award full 1 mark	1 1	2
SECTION C			
28	(a) Reason for (i) Electric field lines not crossing — ½ (ii) Electric field form no closed loops — ½ (b) Evaluation of velocity — 2 (a) (i)Two electric field lines never cross each other because if they do so there will be two directions of electric field at the point of intersection which is not possible. (ii)Since the electric field lines start from positive charge and terminate at the negative charge hence closed loops are not possible. (b) $a = \frac{qE}{m}$ $= \frac{2\times10^{-6}\left(80\hat{i}+60j\right)}{1.6\times10^{-3}}$ $\because \vec{v} = \vec{u} + \vec{a}t$ $v = 4\hat{i} + \left(10\hat{i}+7.5j\right)\times10^{-2}\times5$ $v = 4.5\hat{i} + 0.375j$ m/s	½ ½ ½ ½ ½ ½	3

	OR (a) Equivalent capacitance — 1 (b) Maximum charge supplied — 1 (c) Total energy stored — 1 (a) Equivalent capacitance $C_{eq} = C_3 = 2\mu F$ (b) Max charge Q = CV $= 2 \times 10^{-6} \times 5$ V $= 10\ \mu$ C (c) Total energy $= \frac{1}{2} CV^2$ $= \frac{1}{2} \times 2 \times 10^{-6} \times 5^2$ $= 25\ \mu J$	1 ½ ½ ½ ½	 3
29	a) Differentiation between Half life and Average life — ½ + ½ b) Deduction of fraction of amount of the substance — 2 Half life is the time it takes for a radioactive sample, that has initially N_o radio nuclei, to reduce to $\frac{N_0}{2}$ $T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$ Mean life is obtained by adding the lives of all the nuclei over time 0 to infinity and dividing it by total number N_o of nuclei at t=0 $\tau = 1/\lambda$ [Even if a student writes only the relations for $T_{1/2}$ and τ award full marks for the definitions] $N = N_o e^{-\lambda t}$ At $t = \tau = 1/\lambda$ $N = N_0 e^{-\lambda \times \frac{1}{\lambda}}$ $\frac{N}{N_o} = \frac{1}{e}$	½ ½ ½ ½ 1	 3
30	Differences in construction — 1 mark Determination of position of object — 2 marks Aperture of telescope objective lens is large whereas aperture of microscope objective is small $f_o > f_e$ in telescope $f_o < f_e$ in microscope [Alternatively, focal length of telescope objective is large whereas focal length of microscope objective is very small] [Award full 1 mark even if a student writes only one difference] $m = m_o \times m_e$ $m_e = 1 + \frac{D}{f_e} = 1 + \frac{25}{5} = 6$ $\therefore m_o = \frac{30}{6} = -5$	½ ½ ½ ½	

	$m_o = \frac{v}{u} = -5$ $v = -5u$ $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ $\frac{1}{1.25} = \frac{1}{5u_o} + \frac{1}{u_0}$; $u = -u_0$ $u_0 = \frac{6}{5} \times 1.25 = 1.5\text{cm}$ [Alternatively, $m_o = \frac{v}{u} = \frac{f_o}{f_o + u_o}$ $-5 = \frac{1.25}{1.25 + u_o}$ $-7.5 = 5u_o$ $u_o = -1.5\text{cm}$ (for last ½ mark)]	½ ½	3
31	Deduction of expression for threshold wavelength — 2 marks Deduction of expression for work function — 1 mark $K_{max} = \frac{hc}{\lambda_1} - \phi_o = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_o}\right)$ when $\lambda = \lambda_2$ $2K_{max} = hc\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_o}\right)$ $\frac{K_{max}}{2K_{max}} = \frac{1}{2} = \frac{\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right)}{\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_0}\right)}$ $\lambda_o = \frac{\lambda_1\lambda_2}{2\lambda_2 - \lambda_1}$ = Threshold wavelength $\phi_o = \frac{hc}{\lambda_o} = \frac{hc(2\lambda_2 - \lambda_1)}{(\lambda_1\lambda_2)}$	½ ½ ½ ½ 1	3
32	(a) Derivation of balance condition — 2 (b) Circuit diagram — 1 (a) 	½	

In a balanced Wheatstone bridge $I_g = 0$

$$\therefore \; I_1 = I_3 \quad \text{and} \quad I_2 = I_4$$

Applying loop rule in ADBA

$$-I_1R_1 + 0 + I_2R_2 = 0$$ ½

$$\Rightarrow \frac{I_1}{I_2} = \frac{R_2}{R_1} \qquad \text{(i)}$$

And in loop CBDC

$$I_2R_4 + 0 - I_1R_3 = 0$$ ½

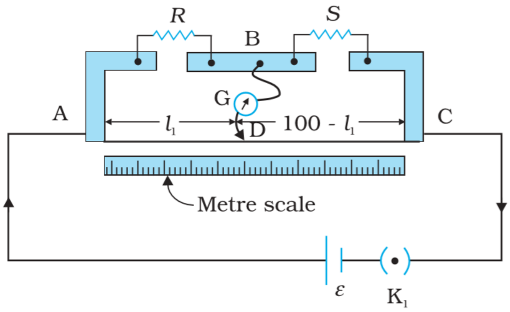
$$\Rightarrow \frac{I_1}{I_2} = \frac{R_4}{R_3} \qquad \text{(ii)}$$

From (i) and (ii) ½

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

Condition for balanced Wheatstone bridge

(b)



1

3

33

(a) Capacitance of the capacitor	1
(b) Value of induction	1
(c) Graph	1

(a) From graph $X_c = 6\,\Omega$ at $\upsilon = 100$ Hz ½

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi\upsilon C}$$

$$C = \frac{1}{2\pi\upsilon X_c} = \frac{1}{2\pi \times 600}$$

$$C = \frac{1}{1200\,\pi} = 0.265\text{mF} = 0.265 \times 10^{-3} f$$ ½

[Even if a student evaluates part(a) correctly using any other point on the graph, award full 1 mark.]

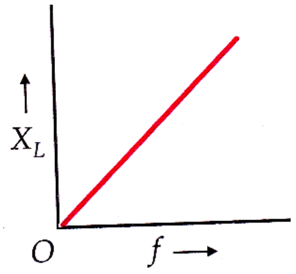
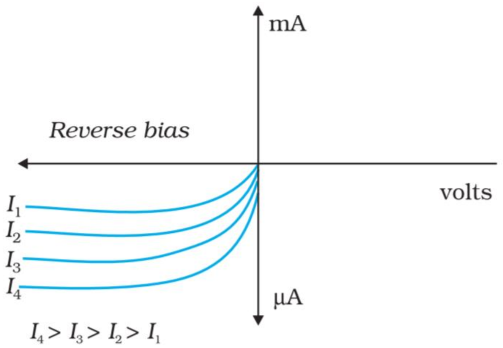
(b)

$$X_C = X_L = \omega L = 6 \quad \text{at 100 Hz}$$ ½

$$L = \frac{6}{2\pi\upsilon}$$

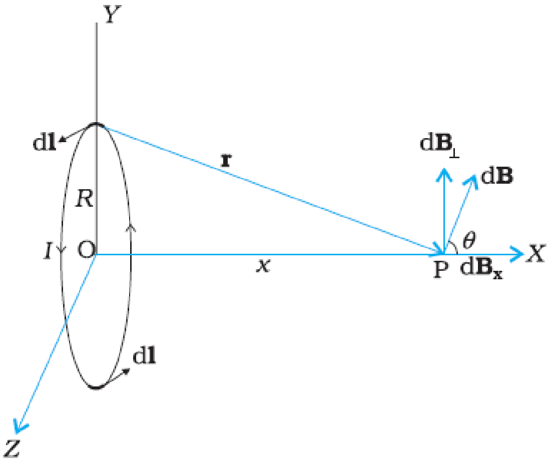
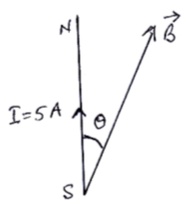
$$= \frac{6}{2\pi \times 100} = 0.955 \times 10^{-2}\text{H}$$ ½

(c)

		1	3
34	(a) V-I characteristics — 1 (b) Evaluation of series resistance — 2 (a)  (b) $I_L = 4\,mA = 4 \times 10^{-3}\,A$ $I_z = 4 \times 5 = 20\,mA = 20 \times 10^{-3}\,A$ $Total\ I = I_L + I_z$ $= (4 + 20) \times 10^{-3}\,A$ $\therefore Voltage\ drop\ across\ V_S = (10 - 6) = 4\,V$ $\therefore R_S = \frac{V_S}{I}$ $= \frac{4}{24 \times 10^{-3}} = \frac{4 \times 1000}{24}$ $R_s = \frac{500}{3} = 166.6\,\Omega \cong 167\,\Omega$	1 ½ ½ ½ ½	3

SECTION D

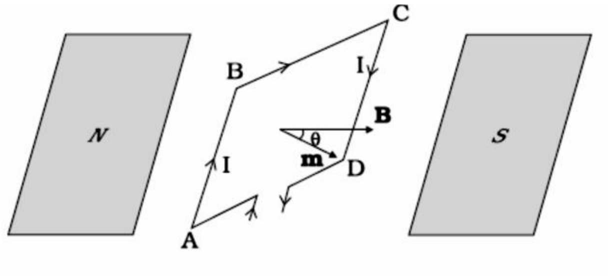
35	(a) Magnetic field at a point on the axis of the current loop — 3 (b)Magnitude and direction of the magnetic force — 2 (a)		

		½	
	$dB = \dfrac{\mu_0\, Idl}{4\pi(x^2 + R^2)}$	½	
	dB has two components dB_x *and* $dB_\perp$, perpendicular components from diametrically opposite elements dl cancel out, thus only dB_x components remain effective $dB_x = dB\cos\theta$	½	
	and $\cos\theta = \dfrac{R}{(x^2+R^2)^{\frac{1}{2}}}$ $\therefore B = \int dB_x$ $= \int_0^{2\pi R} \dfrac{\mu_0 IdlR}{4\pi(x^2+R^2)^{\frac{3}{2}}}$	½	
	$= \dfrac{\mu_0 IR^2}{2(x^2+R^2)^{\frac{3}{2}}}$ along the axis of the loop	1	
	(b) (i) 	½	
	$\vec{F} = I[\vec{l} \times \vec{B}]$	½	
	$F = IlB\sin\theta$ $= 5 \times 2 \times 0.6 \times 10^{-4} \times 0.5 = 3 \times 10^{-4}$N	½	5
	(ii) Towards east	½	

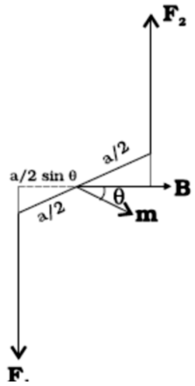
OR

(a) Derivation of torque	2
Reason of radial magnetic field	1
(b) Kinetic Energy of the particle	2

(a)



½



Arms AD and BC experience no net force whereas arm AB and CD experience forces which constitute torque ½

$F_1 = F_2 = IbB$

Therefore magnitude of torque ½

$$\tau = \left(F_1 \frac{a}{2} + F_2 \frac{a}{2} \right) \sin\theta$$

$$\tau = I(ab)\sin\theta$$

$$where\, ab = A(area\, of\ the\, loop)$$

$$\Rightarrow \tau = IAB\sin\theta$$ ½

for N number of turns

$$\tau = NIAB\sin\theta$$

$$\tau = \vec{M} \times \vec{B}$$

Where magnetic moment M=NIA

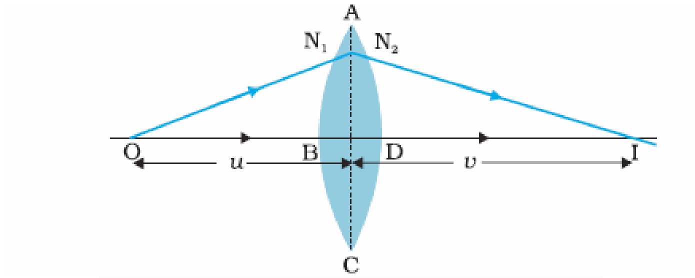
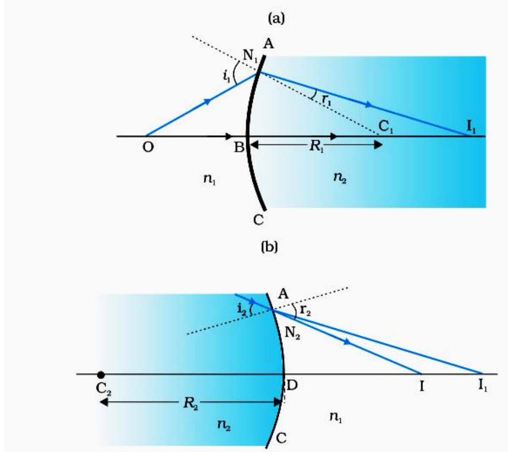
Galvanometer has Radial magnetic field to increase the field strength and to make torque independent of orientation θ/ it maximise the torque 1

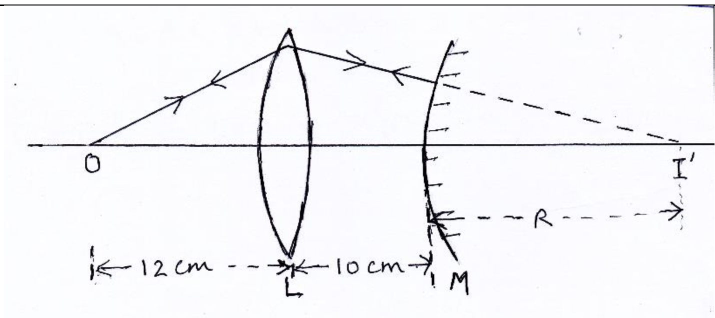
(b)

The kinetic energy $KE = \frac{1}{2}\frac{q^2B^2R^2}{m}$ ½

$$= \frac{1}{2} \times \frac{(1.6 \times 10^{-19})^2 \times (0.4)^2 \times (0.4)^2}{1.6 \times 10^{-27}} \; J$$ ½

$$= \frac{(1.6 \times 10^{-19})^2 \times (0.4)^2 \times (0.4)^2}{2 \times 1.6 \times 10^{-27} \times 1.6 \times 10^{-19}} \; eV$$ ½ 5

	$= 1.28\ MeV$	½	
36	(a) Derivation of the lens maker's formula 2½		
	(b) Ray diagram 1		
	(c) Focal length of the mirror 1½		
	(a)		
			
		½ ½	
	For first refracting surface		
	$\frac{\mu_2}{v_1} - \frac{\mu_1}{u} = \frac{\mu_2-\mu_1}{R_1}$ ----------------------------1	½	
	For second refracting surface ADC		
	$\frac{\mu_1}{v} - \frac{\mu_2}{v_1} = \frac{\mu_1-\mu_2}{R_2}$ ------------------------------2		
	Adding equations 1 and 2, we get		
	$\frac{\mu_1}{v} - \frac{\mu_1}{u} = (\mu_2 - \mu_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	½	
	$\Rightarrow \frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$		
	$\because \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$		
	$\therefore \frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	½	
	also		
	$\frac{\mu_2}{\mu_1} = \mu$		
	$\therefore \frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$		



1

$f_1 = 10\,cm$

$u = -12\,cm$

Aplying lens formula

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ ½

$\frac{1}{10} = \frac{1}{v} - \frac{1}{-12}$ ½

$\Rightarrow v = 60\,cm$

$\therefore$ *radius of curvature of the mirror*

$R = 60\,cm - 10\,cm = 50\,cm$

hence focal length of the morror $f_m = \frac{R}{2} = 25\,cm$ ½ 5

OR

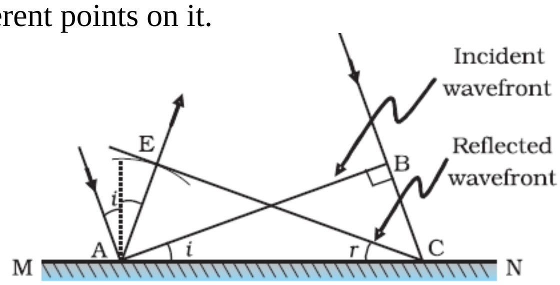
(a)	Definition of wavefront	½
	Propagation of wavefront	½
	Verification of law of refraction	2
(b)	(i) Determination of width of the slit	1
	(ii) Calculation of distance of secondary maxima	1

(a)

Wavefront is a surface of constant phase.

Alternatively, It is the locus of all those points which are in the same phase of disturbance. ½

The wave propagates in a direction perpendicular to the wavefront through secondary wavelets originating from different points on it. ½



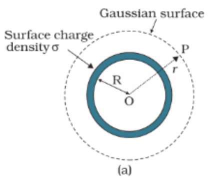
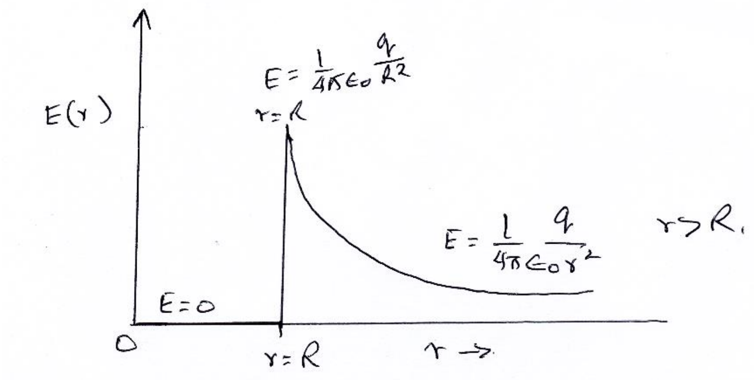
½

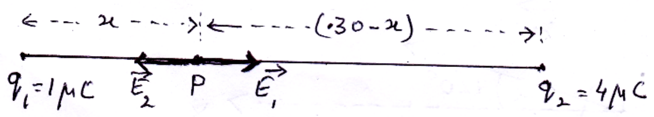
Consider a plane wave AB incident at an angle I with speed v on the surface MN in time τ

Therefore

$$BC = v\,\tau$$ ½

Using Huygen's principle, a sphere of radius v τ which has tangent plane CE is reflected at an angle r

	$\therefore AE = BC = v\tau$ $\because \Delta EAC$ and ΔBAC are congruent $\because \angle i = \angle r$ (b) (i) $x = \frac{\lambda D}{d}$ $\Rightarrow d = \frac{\lambda D}{x} = \frac{500 \times 10^{-9} \times 1}{2.5 \times 10^{-3}} = 2 \times 10^{-4} m$ (ii) For the first Secondary maxima $x = \frac{3\lambda D}{2d}$ $= \frac{3 \times 500 \times 10^{-9} \times 1}{2 \times 2 \times 10^{-4}}$ =3.75mm [Even if a student finds location of first secondary maxima by (2.5)+ ($\frac{1}{2} \times 2.5$) =3.75mm, award full 1 mark for b(ii)]	½ ½ ½ ½ ½ ½	5
37	(a) Expression for electric field outside a charged shell 2 Graph of E vs r 1 b) Location of point where field is zero 2 (a)  $\phi = \frac{q}{\epsilon_0}$ $E \times 4\pi r^2 = \frac{\sigma(4\pi R^2)}{\epsilon_0}$ $E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$ $[\therefore q = \sigma(4\pi R^2)]$ which is electric field due to a point charge q at a distance r from it  For r<R, E=0 because q=0 inside the shell (b)	 ½ ½ ½ ½ 1	

		½	
	$E_1 = E_2$		
	$$\frac{1}{4\pi\epsilon_o}\frac{1\times10^{-6}}{x^2} = \frac{1}{4\pi\epsilon_o}\frac{4\times10^{-6}}{(0.3-x)^2}$$	½	
	$$(0.3-x)^2 = 4x^2$$	½	
	$$0.3 - x = 2x$$		5
	$$x = 0.1m = 10\ cm\ (to\ the\ right\ of\ q_1)$$	½	
	OR		
	a) Work done in assembling the system — 2 b) (i) Evaluation of electric field — 1 ½ (ii) Electric flux through the cube — 1 ½		
	(a) The work done in bringing charge q_1 from infinity to r_1 is $W_1 = q_1V_1$	½	
	The work done in bringing charge q_2 from infinity to r_2 is $W_2 = q_2V_2$	½	
	Work done in moving q_2 against the field due to q_1 $W_3 = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r}$	½	
	Hence total work done is $W = W_1 + W_2 + W_3$ $W = q_1V_1 + q_2V_2 + \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r}$	½	
	[V_1 and V_2 are potentials at the two points in the electric field] (b) (i)		
	$E = \frac{-dV}{dx} = -\frac{d}{dx}(10x+5)$	1	
	$\therefore \vec{E} = -10\hat{i}\ N/C$	½	
	(ii) Electric flux through the cube, ϕ =sum of electric flux through 6 faces		
	Electric flux through faces perpendicular Y and Z axis = 0 $\because$ E is along x axis	½	
	Electric flux through faces perpendicular to x axis $= \phi_1 + \phi_2$	½	
	$= 10\times(0.2)^2 - 10\times(0.2)^2$		5
	=0	½	