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

(55/4/3)

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.

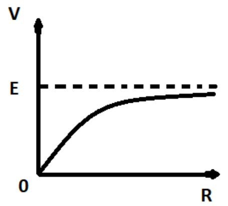
14. The Examiners should acquaint themselves with the guidelines given in the Guidelines for spot Evaluation before starting the actual evaluation.

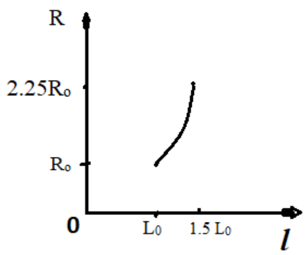
15. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.

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.

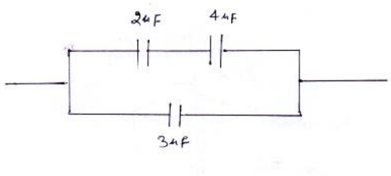
MARKING SCHEME: PHYSICS

QUESTION PAPER CODE: 55/4/3

Q.No.	Value Points/Expected Answer	Marks	Total Marks
	SECTION-A		
1.	(b) $\frac{I}{4}$	1	1
2.	(c) helical with its axis parallel to x-axis	1	1
3.	(b) Zero	1	1
4.	(b)  	1	1
5.	(b) 2×10^{-5} T, acting towards north	1	1
6.	(b) R	1	1
7.	(a) Only on impact parameter	1	1
8.	(a) Infra red region	1	1
9.	(b) 1:1	1	1
10.	(c) π	1	1
11.	Middle/mid point /center OR Decrease	1	1
12.	90^0 or $\frac{\pi}{2}$	1	1
13.	${}^{7}_{3}Li$ / ${}^{7}_{3}X$	1	1
14.	Decreasing/Lower	1	1
15.	Zero	1	1
16.	The displacement current will decrease. $Hint: -\left(I_C = \frac{V}{X_C} = \frac{V}{\left(\frac{1}{\omega c}\right)} = \omega CV\right)$ / the rate of change of electric flux/electric field will decrease	1	1
17.	No As there will be discontinuity for the flow of charge carriers / no contact at atomic level. (Any One Justification) OR The forward current is large due to majority charge carriers which are very large in number. Hence resistance in forward bias is low. Alternatively: Depletion region decreases or barrier potential decreases.	½ ½ 1	1
18.	Reflecting type telescope Reason/Justification :- Mirror have large aperture/high resolving power/ free from chromatic aberration /free from spherical aberration. (Any one)	½ ½	1
19.	It increases form 0° to 90°	1	1
20.	Increases	1	1

SECTION - B			
21.	Explanation of set up of potential barrier 2 Diffusion current is set up across the junction due to the concentration difference of the majority charge carriers on the two sides of the junction. This diffusion develops an electric field from n- side to p- side across the junction which creates a drift current in the opposite direction. When diffusion and drift current become equal in magnitude the potential difference across the junction is the barrier potential.	1 ½ ½	2
22.	(a) Comparison of frequencies 1 (b) Justification 1 (a) Let υ_{0A} , υ_{0B} and υ_{0C} be their threshold frequencies for the surfaces A,B and C Therefore $\upsilon_{0A} > \upsilon_{0B} > \upsilon_{0C}$ (b) Justification :- If the frequency of incident light/photon is υ $h\upsilon = h\upsilon_0 + E_k$ Therefore $\upsilon_{0A} > \upsilon , \upsilon_{0B} = \upsilon$ and $\upsilon_{0C} < \upsilon$ OR (i) Effect on the energy of the photo electrons 1 (ii) Effect on photoelectric current 1 (i) The energy of the emitted photoelectrons increases As $E_k = h\upsilon - \phi_0$ As υ increases, **E_k** also increases (ii) Photo current will not be affected As, increase of υ, **E_k** will increase but not the number of photoelectrons [Alternatively photocurrent depends upon intensity of light and not on frequency]	1 ½ ½ ½ ½ ½ ½	2 2
23.	a) Plotting graph of R vs l 1 b) Finding final resistance 1 a)  	1	

<table>
<tr><td></td><td>(b) Resistance becomes 4 R_0
(Hint :- As $R = \frac{\rho l}{A} = \frac{\rho l^2}{Al} = \frac{\rho l^2}{V}$) (V= Volume)
$R \propto l^2$</td><td>1</td><td>2</td></tr>
<tr><td>24.</td><td>a) Formation of combination 1
b) Maximum and minimum value of equivalent capacitance 1

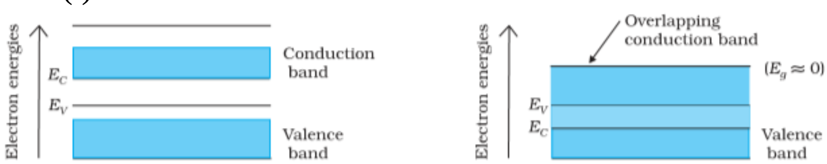
a)


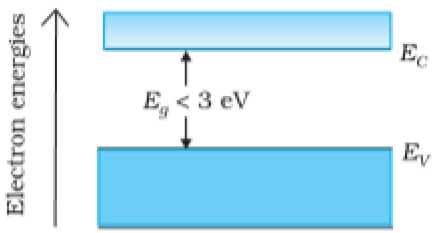
$\left[\begin{array}{c} if\ the\ student\ explains\ the\ formation\ of\ this \\ combination\ without\ diagram\ award\ him\ 1\ mark \end{array}\right]$
b) $C_{max} = 2 + 3 + 4 = 9\ \mu F$
$\frac{1}{C_{min}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{4} = \frac{12}{13}\ \mu F$</td><td>1

½

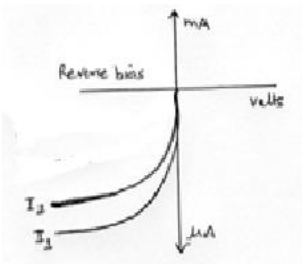
½</td><td>2</td></tr>
<tr><td>25</td><td>(a) Energy bands in solids 1
(b) Drawing energy band diagram
(i) Metal ; (ii) Semiconductor ½ + ½
(a) Note: Out of syllabus; marks are distributed in part(b)

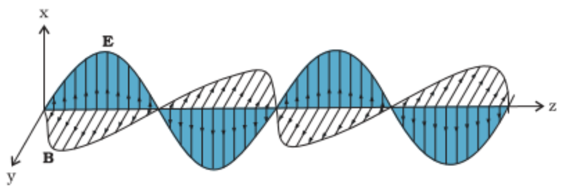
(b) [A student may draw both or any one]

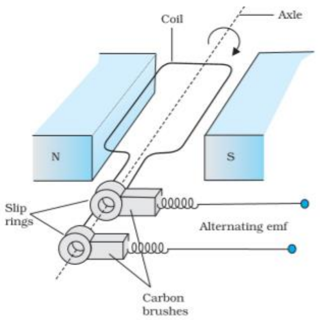
(i)


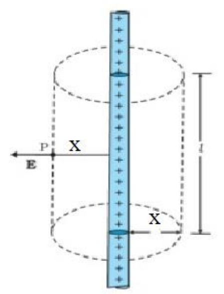
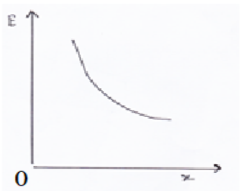
(ii)

</td><td>1

1</td><td>2</td></tr>
</table>

26.	(i) Finding average power dissipated 1 (ii) Finding instantaneous current 1 (i) Average power dissipated $P_1 = I_{eff} \times V_{eff} \times \cos 0^0$ $= I_{eff} \times I_{eff} \times R \times 1 = I_{eff}^2 R = \frac{V_0{}^2}{R}$ (ii) Instantaneous Current $I = \frac{V}{R} = \frac{V_0}{R} \sin \omega t = I_0 \sin \omega t$	½ ½ ½+ ½	2
27	(a) Photo diode in reverse biasing 1 (b) V-I Characteristics of photodiode 1 (a) Because the fractional change in the minority carriers dominated very weak reverse current is more easily measurable than fractional change in forward biased large current (b)  $I_1 > I_2$ OR (a) Level of doping and biasing in LED 1 (b) Any two advantages of LED 1 (a) It is a heavily doped p-n junction. It operates in forward biasing (b) Advantages Low operational voltage/less power /fast action / nearly monochromatic / long life (Any two)	1 1 ½ ½ ½ + ½	 2 2
SECTION C			
28	(a) Phase difference between the waves 1 (b) Resultant intensity at the point 1 (c) Resultant intensity in terms of intensity at maximum 1		

	(a) Phase difference $\emptyset = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$ (b) $I_1 = I_2 + I_3 + 2\sqrt{I_3 I_2} \cos \emptyset$ $= I + I + 2\,I \times \frac{1}{2} = 3\,I$ $= 15 \times 10^{-2}\, Wm^{-2}$ (c) $I_{max} = 4I$ $I_1 = \frac{3I}{4I} \times 4I = \frac{3}{4} I_{max}$	½+ ½ ½+ ½ ½+ ½	3
29.	(a) Production of electromagnetic waves 1 (b) Depiction of electromagnetic waves 1 (c) Two characteristics of electromagnetic waves 1 a) Electromagnetic waves are produced by accelerated (oscillating) charges  b) i) An e.m.wave consists of oscillating $\vec{E}$ and $\vec{B}$ mutually perpendicular and also perpendicular to the direction of propagation of the wave. ii) They carry energy and momentum. (or any other two characteristics)	1 1 1	3
30.	Finding the focal length of the mirror 3 $m = \frac{f}{f-u}$ In first case: u =-9 cm $m_1 = \frac{f}{f+9}$ In second case: u = -15 cm $m_2 = \frac{f}{f+15}$ but $m_1 = 4m_2$ $\frac{f}{f+9} = 4\frac{f}{f+15}$ f+15 = 4f + 36 f= -7cm	½ ½ ½ ½ ½ ½	3
31.	(a) Difference between self-inductance and mutual inductance 1 (b) Finding (i) Change in magnetic flux 1 (ii) EMF induced 1		

	(a) Self inductance is the response of the coil/ solenoid to the charge in current in the coil/ solenoid itself (or definition of self inductance) Mutual inductance is the response of a coil to the charge of current in a neighbouring coil (or definition of mutual inductance) Alternatively Self-inductance is the property of given coil/solenoid Mutual inductance is the property of given pair of coils /solenoids (b) (i) $\Delta\phi = M\Delta I = 2 \times 0.5 = 1Wb$ (ii) $e = -\frac{d\phi}{dt} = \frac{1}{100\times10^{-3}} = 10V$	½ ½ ½ + ½ ½+ ½	3
32.	a) Labelled diagram of A.C. generator 1 b) Working 1 c) Obtaining expression for EMF 1 (a) Labelled diagram  (b) Working :- When a coil is rotated in a magnetic field; the magnetic flux linked with it changes; hence an EMF is induced which lasts so long as the coil rotates. (c) Let initially the plane of coil is perpendicular to the direction of magnetic field ($\overrightarrow{B}$).After time t , the normal to the plane of the coil makes an angle θ,when the coil is rotated with a constant angular speed ω $\theta = \omega t$ $E = \frac{-d\phi}{dt} = -\frac{d(\overrightarrow{B}.dS)}{dt}$ $= -\frac{d(BANcos\omega t)}{dt}$ $= BAN\omega \sin \omega t$ $E = E_0 \sin \omega t$	1 1 ½ ½	3
33	(a) Giving the value of surface charge density of (i) Inner surface (ii) Outer Surface ½ + ½ (b) Deriving expression for electric field 2		

	(a) Surface charge density on the inner surface= $\frac{q}{4\pi r_1^2}$	½	
	On the outer surface= $\frac{Q-q}{4\pi r_2^2}$	½	
	(b) For a spherical Gaussian surface $x > r_2$		
	$\oint \vec{E}\vec{ds} = \frac{Q-q}{\epsilon_0}$	1	
	$E \times 4\pi x^2 = \frac{Q-q}{\epsilon_0}$	½	
	$E = \frac{1}{4\pi\epsilon_0}\frac{Q-q}{x^2}$	½	3
	OR		
	(a) Derivation for electric field due to a uniformly charged straight wire 2 (b) Graph showing variation of electric field E vs distance x 1		
	(a)		
		½	
	$\oint \vec{E}.\vec{dS} = \frac{q}{\epsilon_0}$		
	$\int \vec{E}\,.\vec{dS_1} + \int \vec{E}\,.\vec{dS_2} + \int \vec{E}\,.\vec{dS_3} = \frac{\lambda l}{\epsilon_0}$		
	$E\,dS_1 \cos 90^0 + EdS_2 \cos 90^0 + EdS_3 \cos 0^0 = \frac{\lambda l}{\epsilon_0}$	½	
	$0 + 0 + E \times 2\pi x l = \frac{\lambda l}{\epsilon_0}$	½	
	$E = \frac{\lambda}{2\pi\epsilon_0 x}$	½	
	(b)		
		1	3
34	(a) Principle of working of potentiometer 1 (b) Finding emf of two cells 1+1		

(a) For a steady current flowing through a uniform wire , the potential difference between any two points is directly proportional to the length of the wire between the two points — 1

(b) Potential gradient = $\frac{5}{1000}\ V cm^{-1}$ — ½

$E_1 + E_2 = 700 \times \frac{5}{1000} = 3.5\ V$ (i) — ½

$E_1 - E_2 = 100 \times \frac{5}{1000} = 0.5\ V$ (ii) — ½

Solving these two equations, we get

E_1=2V and E_2 = 1.5 V — ½ — 3

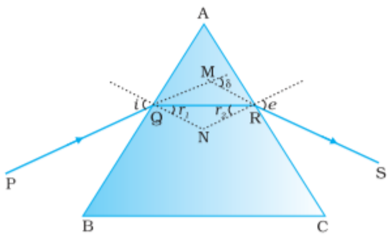
SECTION D

35

(a) (i) Ray diagram showing refraction in a prism	1
(ii) Derivation $\mu = \frac{\sin\left(A+\delta_m\right)/2}{\sin\frac{A}{2}}$	2
(b) (i)Tracing the path of the ray	1
(ii) Effect on path of the ray	1

(a)

(i)



— 1

(ii) Derivation

From the figure

$\angle A + \angle QNR = 180^0$ (i)

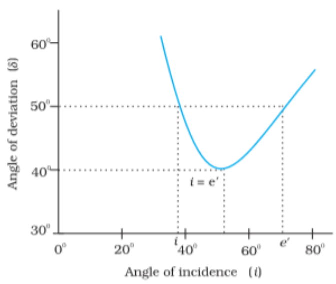
In $\Delta\, QNR \quad r_1 + r_2 + \angle QNR = 180^0$ (ii) — ½

Comparing equation (i) and (ii) we get

$r_1 + r_2 = A$ (iii)

Total deviation produced $\delta = (i - r_1) + (e - r_2)$

$\delta = i + e - (r_1 + r_2) = i + e - A$ (iv) — ½



From the graph δ vs i we find that when δ becomes minimum i.e. δ_m

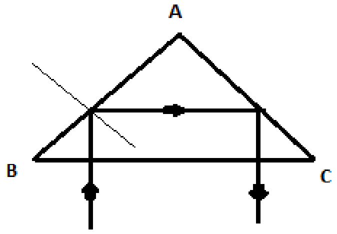
i = e and $r_1 = r_2$ — ½

From (iv) $i = \frac{(A + \delta_m)}{2}$

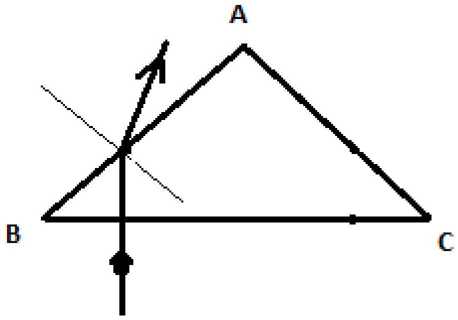
and from (iii) $r = \frac{A}{2}$

$\mu = \frac{\sin i}{\sin r} = \frac{\sin^{(A+\delta_m)}/_2}{\sin\frac{A}{2}}$ ½

(a) (i) 1



(ii) If $\mu = 1.4$ Total Internal Reflection will not occur as shown in the figure

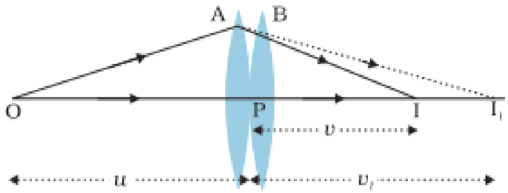


(Note: Award this last one mark if student does not draw the diagram and conclude correctly.) 1 5

OR

(a)	Expression for focal length of combination with labelled diagram	3
(b)	Finding refractive index of the liquid	2

(a)



½

For lens A

$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1}$ (i)

½

For lens B :

virtual image I_1 formed by A acting as object

$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2}$ (ii)

½

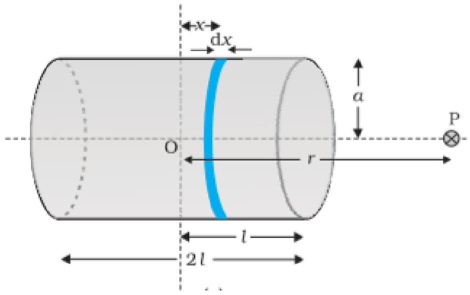
Adding equations (i) and (ii)

$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v} - \frac{1}{u}$ ½

	Hence $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ Therefore $\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F}$ (b) In air $P_1 = \frac{1}{f_1} = ({}_a\mu_g - 1)(\frac{1}{R_1} - \frac{1}{R_2})$ (i) For Liquid $P_2 = \frac{1}{f_2} = ({}_l\mu_g - 1)(\frac{1}{R_1} - \frac{1}{R_2})$ (ii) From (i) and (ii) $\frac{P_1}{P_2} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$ $\frac{10}{-2} = \frac{(1.5-1)}{(\frac{1.5}{\mu_l} - 1)}$ $\mu_l = \frac{5}{3}$	½ ½ ½ ½ ½ ½	5
36	(a) Derivation for decay law 2 ½ (b) Calculation of mean life 1 ½ (c) Calculation of fraction of initial mass 1 (a) Let N_0 be the initial (t =0) number of radioactive substance and N be the number of radioactive substance at interval t = t Hence rate of radioactive decay = $-\frac{dN}{dt} \propto N$ $\frac{dN}{dt} = -\lambda N$ $\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda\, dt$ $\ln N - \ln N_0 = -\lambda t$ $\frac{N}{N_0} = e^{-\lambda t}$ $N = N_0 e^{-\lambda t}$ (b) $\tau = \frac{T_{\frac{1}{2}}}{\log 2}$ $= \frac{4.5 \times 10^9}{0.693}$ $\tau = 6.493 \times 10^9\ years$ (c) $\frac{N}{N_0} = \frac{1}{2^n}$ $\frac{N}{N_0} = (\frac{1}{2})^5$ $\frac{N}{N_0} = \frac{1}{32}$ therefore fraction decaying= (1-$\frac{1}{32}$)= $\frac{31}{32}$ OR	 ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	 5

	(a) Bohr's Postulate and Derivation of expression 3 (b) Finding ratio of wavelengths 2		
	(a) Bohr's Postulates:-		
	1) An electron in an atom could revolve in certain stable orbits without the emission of radiant energy	½	
	2) The electron revolves around the nucleus only in those orbits for which the angular momentum is some integral multiple of h/2π where h is the Planck's constant	½	
	3) The frequency of the emitted photon when an electron makes a transition from higher orbit to lower energy orbit is given by $h\nu = E_2 - E_1$	½	
	$L_n = mv_nr_n = \frac{nh}{2\pi}$ (i)		
	$\frac{mv_n^2}{r_n} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r_n^2}$	½	
	$v_n = \frac{e}{\sqrt{4\pi\epsilon_0 m r_n}}$	½	
	Combining wit h equation (i) $v_n = \frac{1}{n}\frac{e^2}{4\pi\epsilon_0}\frac{1}{(h/\pi)}$ $r_n = \left(\frac{n^2}{m}\right)\left(\frac{h}{2\pi}\right)^2\left(\frac{4\pi\epsilon_0}{e^2}\right)$	½	
	(b) For shortest wave length $\frac{1}{\lambda_S} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$ $\frac{1}{\lambda_S} = \frac{R}{4}$ (i)	½	
	For longest wave length $\frac{1}{\lambda_L} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$ $= R\left(\frac{1}{4} - \frac{1}{9}\right)$ $= R\left(\frac{5}{36}\right)$ (ii)	½	
	Dividing equation (i) by equation (ii) we get $\frac{(1/\lambda_S)}{(1/\lambda_L)} = \frac{(R/4)}{(5R/36)}$	½	
	$\frac{\lambda_L}{\lambda_S} = \frac{9}{5}$ OR $\lambda_L : \lambda_S = 9:5$	½	5
37	(a) Solenoid as a small bar magnet 1 Expression for magnitude of magnetic field 2 (b) Magnitude of magnetic dipole moment 1 ½ Direction ½		
	(a) A solenoid may be regarded as a combination of large number of identical circular current loops in which each behaves like a magnetic dipole. Hence, the current carrying solenoid will behave like a small bar magnet.	½	

Expression for magnetic field :-



½

Figure shows a solenoid consisting of n turns per unit length Consider a circular element of thickness dx at a distance x from the centre of the solenoid

Therefore magnetic field at point P due to this circular element

$$dB = \frac{\mu_0 n dx I a^2}{2[(r-x)^2 + a^2]^{\frac{3}{2}}}$$ ½

$$B = \frac{\mu_0 n\, I a^2}{2} \int_{-l}^{+l} \frac{dx}{[(r-x)^2 + a^2]^{\frac{3}{2}}}$$ ½

For point P, r >> a and $r \gg l$

$$B = \frac{\mu_0 n\, I a^2}{2\, r^3} \int_{-l}^{+l} dx = \frac{\mu_0 n I 2 l a^2}{2 r^3}$$ ½

$$B = \frac{\mu_0}{4\pi} \frac{2m}{r^3}$$ ½

(b) $M = NI\pi a^2$ ½

$= 5 \times 2 \times \frac{22}{7} \times 49 \times 10^{-4}$ ½

$= 154 \times 10^{-3}$

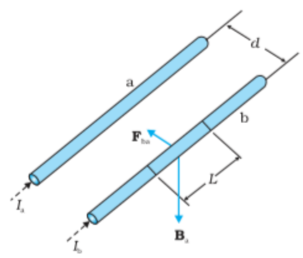
$= 0.154\ Am^2$ ½

$\vec{M}$ *will be perpendicular to* $x - y$ *plane or parallel to Z axis* ½ 5

OR

(a) Derivation for the force between two current carrying wires	2
Definition of 1 A	1
(b) Calculation of value of F	1 ½
Effect on equilibrium if F is withdrawn	½

(a)



½

Magnetic field due to the current I_a flowing in conductor 'a' at any point on conductor 'b'

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$ ½

	(Acting perpendicular downward) Therefore force on conductor 'b' due to field B_a $\vec{F} = I_b\,(\vec{l_b} \times \vec{B_a})$ $\lvert\vec{F_{ba}}\rvert = I_b l_b \times \frac{\mu_0\, I_a}{2\pi d}$ $= \frac{\mu_0\, I_a I_b\, l_b}{2\pi d}$ $\frac{\lvert\vec{F_{ba}}\rvert}{l_b} = \frac{\mu_0\, I_a I_b}{2\pi d}$ Definition of 1 A : Two straight infinitely long parallel conductors are said to carry 1 A current each when they interact each other with a force of $2 \times 10^{-7}\, Nm^{-1}$, when kept 1m apart in vacuum (b) In equilibrium Restoring Torque = Deflecting Torque $F \times r = m\,B\,\sin\theta$ $F \times 10 \times 10^{-2} = 3 \times 0.25 \times \sin 30^0$ $F = \frac{3 \times 0.25 \times 1}{10 \times 10^{-2} \times 2}$ = 3.75 N The magnet oscillates for sometime but finally aligns along the original direction of the external magnetic field.	½ ½ 1 ½ ½ ½ ½	5