CBSE **Class** 12 Physics Question Paper 2020
Set 55/4/1

Series : HMJ/4

SET – 1

n
the title page of the answer-book.

NOTE

(I) Please check that this question paper contains 15 printed pages.

(II) Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.

(III) Please check that this question paper contains 37 questions.

(IV) Please write down the Serial Number of the question in the answer-book before attempting it.

(V) 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

CBSE Physics Class 12 Question Paper 2020

PHYSICS (Theory)

collegedunia

Time allowed : 3 hours

Maximum Marks : 70

.55/4/1.

308A

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) This question paper comprises four sections – A, B, C and D.

(ii) There are 37 questions in the question paper. All questions are compulsory.

(iii) Section A : Q. no. 1 to 20 are very short-answer type questions carrying 1 mark each.

(iv) Section B : Q. no. 21 to 27 are short-answer type questions carrying 2 marks each.

(v) Section C : Q. no. 28 to 34 are long-answer type questions carrying 3 marks each.

(vi) Section D : Q. no. 35 to 37 are also long answer type questions carrying 5 marks each.

(vii) There is no overall choice in the question paper. However, an internal choice has been provided in two questions of one mark, two questions of two marks, one question of three marks and all the three questions five marks. You have to attempt only one of the choices in such questions.

(viii) However, separate instructions are given with each section and question, wherever necessary.

(ix) Use of calculators and log tables is not permitted.

(x) You may use the following values of physical constants wherever necessary :

$c = 3 \quad 10^{8}$ m/s

$h = 6.63 \quad 10^{-34}$ Js

$e = 1.6 \quad 10^{-19}$ C

$_{0} = 4 \quad 10^{-7}$ T m A^{-1}

$_{0} = 8.854 \times 10^{-12}\ C^{2} N^{-1} m^{-2}$

$\frac{1}{4 \quad _{0}} = 9 \quad 10^{9}\ N m^{2} C^{-2}$

Mass of electron (m_e) = $9.1 \quad 10^{-31}$ kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

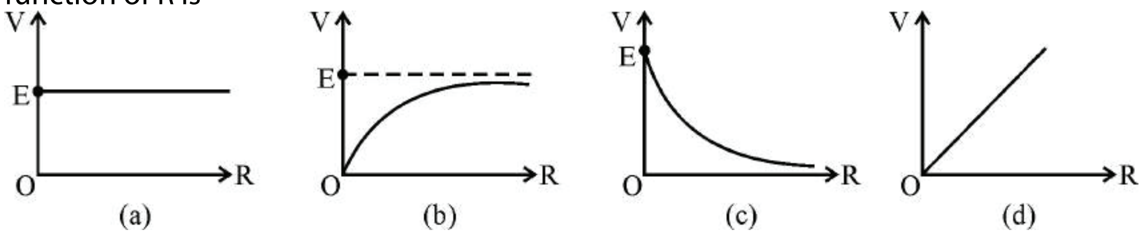
Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = $1.38 \times 10^{-23}\ JK^{-1}$

SECTION – A

Select the most appropriate option from those given below each question.

1. A cell of emf (E) and internal resistance r is connected across a variable external resistance R. The graph of terminal potential difference V as a function of R is –

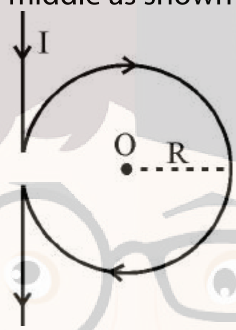


1

2. A uniform wire of resistance 2R is bent in the form of a circle. The effective resistance between the ends of any diameter of the circle is :

(a) 2R (b) R (c) $\frac{R}{2}$ (d) $\frac{R}{4}$ 1

3. A current I flows through a long straight conductor which is bent into a circular loop of radius R in the middle as shown in the figure.



The magnitude of the net magnetic field at point O will be

(a) Zero (b) $\frac{{}_0 I}{2R}(1 + \quad)$ (c) $\frac{{}_0 I}{4 \quad R}$ (d) $\frac{{}_0 I}{2R}\left(1 - \frac{1}{\quad}\right)$ 1

4. A circular loop of radius r, carrying a current I lies in y-z plane with its centre at the origin. The net magnetic flux through the loop is :
(a) directly proportional to r (b) zero
(c) inversely proportional to r (d) directly proportional to I 1

5. The kinetic energy of a proton and that of an -particle are 4 eV and 1 eV, respectively. The ratio of the de-Broglie wavelengths associated with them, will be
(a) 2:1 (b) 1:1 (c) 1:2 (d) 4:1 1

6. A photocell connected in an electrical circuit is placed at a distance 'd' from a source of light. As a result, current I flows in the circuit. What will be the current in the circuit when the distance is reduced to 'd/2' ?
(a) I (b) 2I (c) 4I (d) I/2 1

7. A current of 10A is flowing from east to west in a long straight wire kept on a horizontal table. The magnetic field developed at a distance of 10 cm due north on the table is :

(a) 2×10^{-5} T, acting downwards (b) 2×10^{-5} T, acting upwards

(c) 4×10^{-5} T, acting downwards (d) 4×10^{-5} T, acting upwards 1

8. When a wave undergoes reflection at an interface from rarer to denser medium, adhoc change in its phase is :

(a) $\frac{}{2}$ (b) 0 (c) (d) $\frac{}{4}$ 1

9. Paschen series of atomic spectrum of hydrogen gas lies in :

(a) Infrared region

(b) Ultraviolet region

(c) Visible region

(d) Partly in ultraviolet and partly in visible region 1

10. In the particle scattering experiment, the shape of the trajectory of the scattered particles depend upon :

(a) only on impact parameter.

(b) only on the source of particles.

(c) both impact parameter and source of particles.

(d) impact parameter and the screen material of the detector. 1

Note : Fill in the blanks with appropriate answer.

11. Torque acting on an electric dipole placed in an electric field is maximum when the angle between the electric field and the dipole moment is ________. 1

12. A proton released from rest in an electric field, will start moving towards a region of ________ potential in the field. 1

13. To minimize the percentage error in the determination of unknown resistance of a conductor in meter bridge experiment, the balance point is adjusted near ________ of the wire. 1

OR

In potentiometer, a long uniform wire is used to ________ potential gradient along the wire. 1

14. Unpolarised light of intensity I_o is incident on two crossed polaroids. The intensity of light transmitted by the combination will be ________. 1

15. Name the particle emitted spontaneously in the following nuclear reaction :

$^{32}_{15}P \quad\quad ^{32}_{16}S + \bar{v} +$ ________ 1

Answer the following :

16. The work done in moving a charge particle between two points in an uniform electric field, does not depend on the path followed by the particle. Why ? 1

17. Define 'magnetic declination' at a place on earth. 1

18. An A.C. source with variable frequency is connected to a parallel plate capacitor. How will the displacement current be affected with the decrease in frequency of the source ? 1

19. An astronomical telescope may be a refracting type or a reflecting type. Which of the two produces image of better quality ? Justify your answer. 1

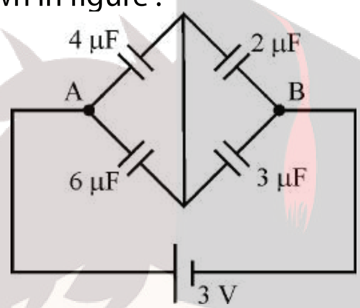
20. Can a slab of p-type semi-conductor be physically joined to another n-type semiconductor slab to form p-n junction ? Justify your answer. 1

OR

In a p-n junction diode the forward bias resistance is low as compared to the reverse bias resistance. Give reason. 1

SECTION : B

21. Find the total charge stored in the network of capacitors connected between A and B as shown in figure :



2

22. A wire of length L_o has a resistance R_o. It is gradually stretched till its length becomes $2L_o$.

(a) Plot a graph showing variation of its resistance R with its length l during stretching.

(b) What will be its resistance when its length becomes $2L_o$? 2

23. A resistor R and an inductor L are connected in series to a source of voltage $V = V_o \sin$ t. The voltage is found to lead current in phase by /4. If the inductor is replaced by a capacitor C, the voltage lags behind current in phase by /4. When L, C and R are connected in series with the same source,

Find the :

(i) average power dissipated and

(ii) instantaneous current in the circuit. 2

24. Light of same wavelength is incident on three photo-sensitive surfaces A, B and C. The following observations are recorded.

(i) From surface A, photo electrons are not emitted.

(ii) From surface B, photo electrons are just emitted.

(iii) From surface C, photo electrons with some kinetic energy are emitted.

Compare the threshold frequencies of the three surfaces and justify your answer. 2

OR

If the frequency of light incident on the cathode of a photo-cell is increased, how will the following be affected ? Justify your answer.

(i) Energy of the photo electrons.

(ii) Photo current. 2

25. Briefly explain how a potential barrier is set up across a p-n junction as a result of diffusion and drift of the charge carriers. 2

26. (a) Why is a photo diode operated under reverse bias condition ?

(b) Draw V-I characteristic curves of photo diode for incident light of intensities I_1 and I_2 ($I_1 > I_2$). 2

OR

(a) State the level of doping and biasing condition used in light emitting diode (LED).

(b) Write any two advantages of LED over the conventional low power lamps. 2

27. (a) Explain the formation of energy bands in crystalline solids.

(b) Draw the energy band diagrams of (i) a metal and (ii) a semiconductor. 2

SECTION – C

28. A hollow conducting sphere of inner radius r_1 and outer radius r_2 has a charge Q on its surface. A point charge –q is also placed at the centre of the sphere.

(a) What is the surface charge density on the (i) inner and (ii) outer surface of the sphere ?

(b) Use Gauss' law of electrostatics to obtain the expression for the electric field at a point lying outside the sphere. 3

OR

(a) An infinitely long thin straight wire has a uniform linear charge density . Obtain the expression for the electric field (E) at a point lying at a distance x from the wire, using Gauss' law.

(b) Show graphically the variation of this electric field E as a function of distance x from the wire. 3

29. (a) Explain the principle of working of a potentiometer.

(b) In a potentiometer, a standard source of emf 5V and negligible internal resistance maintains a steady current through the potentiometer wire of length 10m. Two primary cells of emf E_1 and E_2 are joined together in a series with (i) same polarity and (ii) opposite polarity. The combination is connected to the potentiometer circuit in each case. The balancing length of the wire in the two cases are found to be 700 cm and 100 cm, respectively.

Find the values of emf of the two cells. 3

30. (a) Differentiate between self inductance and mutual inductance.
    (b) The mutual inductance of two coaxial coils is 2H. The current in one coil is changed uniformly from zero to 0.5A in 100 ms. Find the :
        (i) change in magnetic flux through the other coil.
        (ii) emf induced in the other coil during the change. 3

31. Explain with the help of a diagram, the working of a step-down transformer. Why is a laminated iron core used in a transformer ? 3

32. Name the electro-magnetic waves with their frequency range, produced in
    (a) some radioactive decay
    (b) sparks during electric welding
    (c) TV remote 3

33. Two coherent light waves of intensity 5×10^{-2} Wm^{-2} each super-impose and produce the interference pattern on a screen. At a point where the path difference between the waves is /6, being wavelength of the wave, find the
    (a) phase difference between the waves.
    (b) resultant intensity at the point.
    (c) resultant intensity in terms of the intensity at the maximum. 3

34. Two objects P and Q when placed at different positions in front of a concave mirror of focal length 20 cm, form real images of equal size. Size of object P is three times size of object Q. If the distance of P is 50 cm from the mirror, find the distance of Q from the mirror. 3

SECTION-D

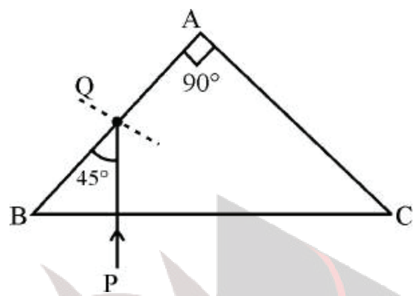
35. (a) Show that a current carrying solenoid behaves like a small bar magnet. Obtain the expression for the magnetic field at an external point lying on its axis.
    (b) A steady current of 2A flows through a circular coil having 5 turns of radius 7 cm. The coil lies in X-Y plane with its centre at the origin. Find the magnitude and direction of the magnetic dipole moment of the coil. 5

OR

    (a) Derive the expression for the force acting between two long parallel current carrying conductors. Hence, define 1 A current.
    (b) A bar magnet of dipole moment 3 Am^2 rests with its centre on a frictionless pivot. A force F is applied at right angles to the axis of the magnet, 10 cm from the pivot. It is observed that an external magnetic field of 0.25 T is required to hold the magnet in equilibrium at an angle of 30° with the field.
    Calculate the value of F.
    How will the equilibrium be effected if F is withdrawn ? 5

36. (a) Draw the ray diagram showing refraction of ray of light through a glass prism. Derive the expression for the refractive index of the material of prism in terms of the angle of prism A and angle of minimum deviation $_{m}$.

(b) A ray of light PQ enters an isosceles right angled prism ABC of refractive index 1.5 as shown in figure.



(i) Trace the path of the ray through the prism.

(ii) What will be the effect on the path of the ray if the refractive index of the prism is 1 ·4 ? 5

OR

(a) Two thin lenses are placed coaxially in contact. Obtain the expression for the focal length of this combination in terms of the focal lengths of the two lenses.

(b) A converging lens of refractive index 1.5 has a power of 10 D. When it is completely immersed in a liquid, it behaves as a diverging lens of focal length 50 cm. Find the refractive index of the liquid. 5

37. (a) Derive the law of radioactive decay $N = N_o e^{- t}$

(b) The half life of $^{238}_{92}U$ undergoing -decay is 4.5×10^{9} years. Find its mean life.

(c) What fraction of the initial mass of a radioactive substance will decay in five half – life periods ? 5

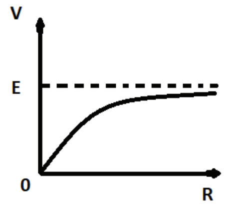
OR

(a) State the postulates of Bohr's model of hydrogen atom and derive the expression for Bohr radius.

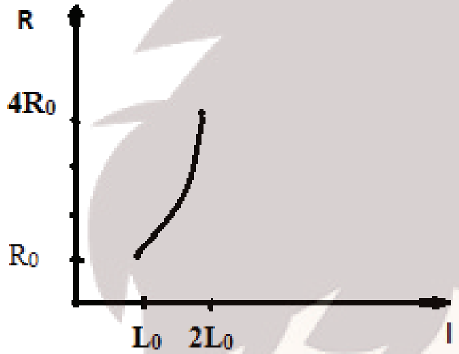
(b) Find the ratio of the longest and the shortest wavelengths amongst the spectral lines of Balmer series in the spectrum of hydrogen atom. 5

MARKING SCHEME: PHYSICS

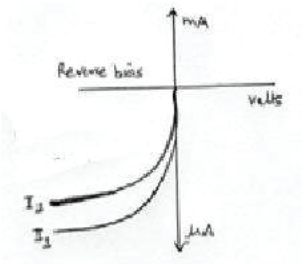
QUESTION PAPER CODE: 55/4/1

Q.No.	Value Points/Expected Answer	Marks	Total Marks
	SECTION A		
1	(b)  	1	1
2	(c) $\frac{R}{2}$	1	1
3	(d) $\frac{\mu_0 I}{2R} \times (1 - \frac{1}{\pi})$	1	1
4	(b) Zero	1	1
5	(b) 1:1	1	1
6	(c) 4 I	1	1
7	(a) 2×10^{-5} T acting downwards	1	1
8	(c) π	1	1
9	(a) Infra red region	1	1
10	(a) Only on impact parameter	1	1
11	90^0 or $\frac{\pi}{2}$	1	1
12	Decreasing/Lower	1	1
13	Middle/mid point /center OR Decrease	1	1
14	Zero	1	1
15	$\beta^- / e^{-1} / electron$	1	1
16	Because the electrostatic force is conservative in nature **Alternatively:-** Electric field is conservative in nature / work done by or against the electric field does not depend upon the path followed.	1	1
17	Magnetic declination is the angle between the magnetic meridian and the geographic meridian at a place on the earth.	1	1
18	The displacement current will decrease. $Hint \quad -(I_C = \frac{V}{X_C} = \frac{V}{(\frac{1}{\omega C})} = \omega CV)$ / the rate of change of electric flux/electric field will decrease	1	1
19	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
20	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

SECTION B

21	(i) Net capacitance of the combination 1 (ii) Total Charge stored in the network 1 (i) Net Capacitance => $\frac{1}{C_{net}} = \frac{1}{10} + \frac{1}{5}$ $C_{net} = \frac{10}{3} \mu F$ (ii) $q = C_{net} V = \frac{10}{3} \times 3 = 10\ \mu C$	½ ½ ½+ ½	2
22	(a) Graph 1 (b) Final resistance 1 (a) $R = S\frac{l}{A} = S\frac{l^2}{V}$  [Note if a student draws only the graph correctly, award full 1 mark] (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) $R \quad l^2$	½ ½ 1	2
23	(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

24	(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 $\upsilon = \upsilon_0 + E_k$ Therefore $\upsilon_{0A} > \upsilon , \upsilon_{0B} = \upsilon$ and $\upsilon_{0C} < \upsilon$	1 ½ ½	2
	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 $E_k = \upsilon - \phi_0$ As υ increases, $\mathbf{E_k}$ also increases (ii) Photo current will not be affected As, increase of υ, $\mathbf{E_k}$ will increase but not the number of photoelectrons [Alternatively photocurrent depends upon intensity of light and not on frequency]	½ ½ ½ ½	2
25	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
26	(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	1	

	(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 ½ ½ ½ + ½	2 2
27	(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)  	1 1	2

SECTION C

28

(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 $x > r_2$

$$Eds = \frac{Q-q}{\epsilon_0}$$ 1

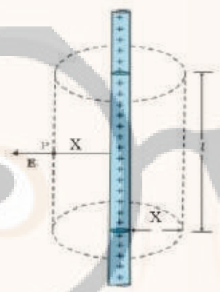
$$E \times 4\pi x^2 = \frac{Q-q}{\epsilon_0}$$ ½

$$E = \frac{1}{4\pi\epsilon_0}\frac{Q-q}{x^2}$$ 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

$$E.dS = \frac{q}{\epsilon_0}$$

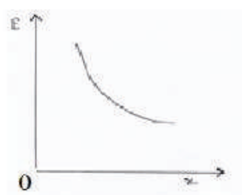
$$\int E.dS_1 + \int E.dS_2 + \int E.dS_3 = \frac{\lambda l}{\epsilon_0}$$

$$E\, dS_1 \cos 90^0 + EdS_2 \cos 90^0 + EdS_3 \cos 0^0 = \frac{\lambda l}{\epsilon_0}$$ ½

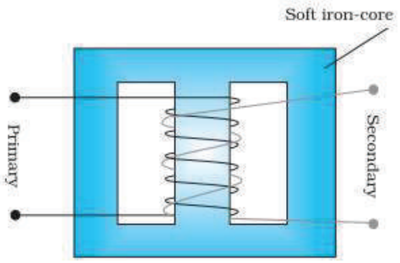
$$0 + 0 + E \times 2\pi x l = \frac{\lambda l}{\epsilon_0}$$ ½

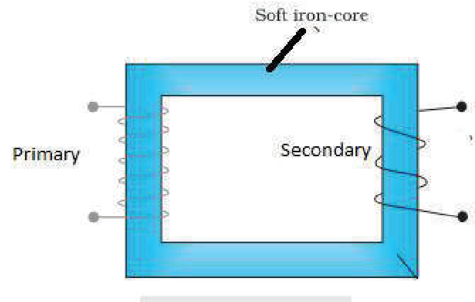
$$E = \frac{\lambda}{2\pi\epsilon_0 x}$$ ½

(b)



1 3

29	(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 (b) Potential gradient = $\frac{5}{1000}\ Vcm^{-1}$ $E_1 + E_2 = 700 \times \frac{5}{1000} = 3.5\ V$ (i) $E_1 - E_2 = 100 \times \frac{5}{1000} = 0.5\ V$ (ii) Solving these two equations, we get E_1=2V and E_2 = 1.5 V	1 ½ ½ ½ ½	3
30	(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
31	Diagram of step down transformer 1 Working 1 Use of laminated core 1 (a)  Alternatively	1	

	 (b) When an a.c. voltage is applied across the primary coil, the resulting a.c. current in the primary coil changes the magnetic flux linked with the secondary coil, as a result an emf is induced across the secondary coil. As the number of turns in the secondary coil is less than that in the primary coil in the step down transformer, the output voltage is less than the input voltage. (c) Use of laminated core :- Use of laminated sheets minimizes the eddy currents, hence the energy loss.	1 1	3
32	(i) Naming electromagnetic waves 1½ (ii) Their frequency range 1 ½ (a) Gamma rays, frequency range 10^{19} to 10^{24} Hz (a) UV rays, frequency range 10^{15} to 10^{17} Hz (b) Infrared rays, frequency range 10^{12} to 10^{14} Hz	½+ ½ ½+ ½ ½+ ½	3
33	(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 $= \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$ (b) $I_1 = I_2 + I_3 + 2\sqrt{I_3 I_2}cos$ $= I + I + 2I \times \frac{1}{2} = 3I$ $= 15 \times 10^{-2}\ Wm^{-2}$ (c) $I_{max} = 4I$ $I_1 = \frac{3I}{4I} \times 4I = \frac{3}{4} I_{max}$	½+ ½ ½+ ½ ½+ ½	3
34	Calculating the distance of Q from the mirror formula 1 Calculation and result 2 For object P $m = \frac{2}{1} = \frac{f}{f - u_1}$ For Object Q $m = \frac{2}{1} = \frac{f}{f - u_2}$	½ ½	

<table>
<tr><td></td><td>Now $_{1} = 3\ _{1}$; $_{2} = \ _{2}$; $f = -20\ cm$; $u_1 = -50\ cm$
$$\frac{m}{m} = \frac{2}{1} \times \frac{1}{2} = \frac{f-u_2}{f-u_1}$$
$$\frac{m}{m} = \frac{1}{3} = \frac{-20-u_2}{-20+50}$$
$$10 = -20 - u_2 = \quad u_2 = -30\ cm$$</td><td>½

1

½</td><td>

3</td></tr>
<tr><td colspan="4">SECTION D</td></tr>
<tr><td>35</td><td>

(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.

Expression for magnetic field :-

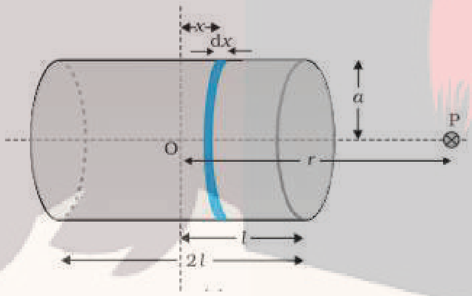


Figure shows a solenoid consisting of n turns per unit length Consider a circular element of thickness dx at a distance x from the centre of the solenoid
Therefore magnetic field at point P due to this circular element

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

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

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

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

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

(b) $M = NI\pi a^2$
$= 5 \times 2 \times \frac{22}{7} \times 49 \times 10^{-4}$
$= 154 \times 10^{-3}$
$= 0.154\ Am^2$
M will be perpendicular to x − y plane or parallel to Z axis
</td><td>

½

½

½
½

½
½
½
½

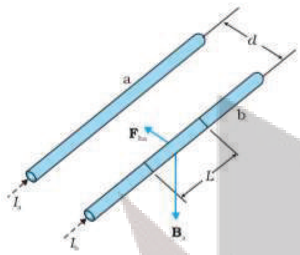
½
½</td><td>

5</td></tr>
</table>

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

$$F = I_b (l_b \times B_a)$$ ½

$$|F_{ba}| = I_b l_b \times \frac{\mu_0 I_a}{2\pi d}$$

$$= \frac{\mu_0 I_a I_b l_b}{2\pi d}$$

$$\frac{|F_{ba}|}{l_b} = \frac{\mu_0 I_a I_b}{2\pi d}$$ ½

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 1

(b) In equilibrium

Restoring Torque = Deflecting Torque ½

$$F \times r = m B \sin\theta$$

$$F \times 10 \times 10^{-2} = 3 \times 0.25 \times \sin 30^0$$ ½

$$F = \frac{3 \times 0.25 \times 1}{10 \times 10^{-2} \times 2}$$ ½

= 3.75 N

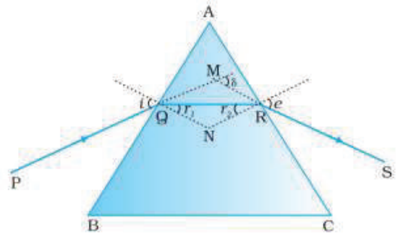
The magnet oscillates for sometime but finally aligns along the original direction of the external magnetic field. ½ 5

36

(a) (i) Ray diagram showing refraction in a prism	1
(ii) Derivation $\mu = \frac{\sin{(A+\delta_m)}/_2}{\sin\frac{A}{2}}$	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

$A + \quad QNR = 180^0$ (i) ½

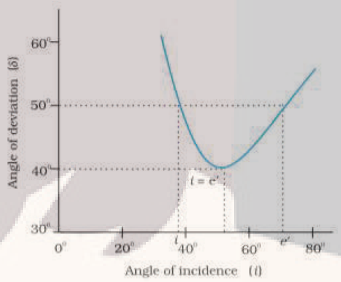
In $\Delta\, QNR \quad r_1 + r_2 + \quad QNR = 180^0$ (ii)

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

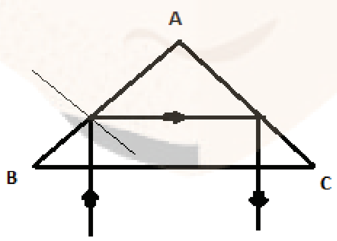
i = e and $r_1 = r_2$ ½

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

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

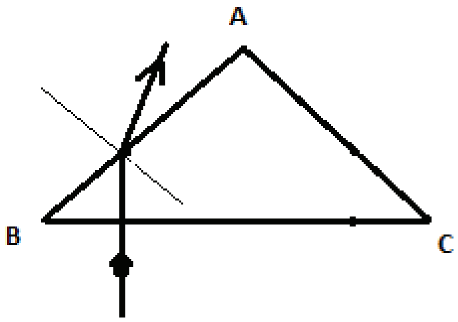
$\mu = \frac{\sin i}{\sin r} = \frac{\sin {(A+\delta_m)}/{2}}{\sin \frac{A}{2}}$ ½

(a) (i)



1

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



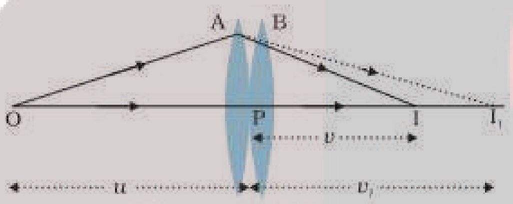
1 | 5

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

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

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

½

For lens B

virtual image I_1 formed by A acting as object

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

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 $\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F}$

½

(b) ½

In air $P_1 = \frac{1}{f_1} = ({}_a\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (i)

For Liquid ½

$$P_2 = \frac{1}{f_2} = ({}_l\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{(ii)}$$

From (i) and (ii) ½

$$\frac{P_1}{P_2} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$$

½

$$\frac{10}{-2} = \frac{(1.5 - 1)}{\left(\frac{1.5}{\mu_l} - 1\right)}$$

	$\mu_l = \frac{5}{3}$	½	5
37	(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 = $-\frac{dN}{dt} \quad N$ $\frac{dN}{dt} = -\lambda N$ $\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda\, dt$ $\ln N - \ln N_0 = -\lambda t$ $\frac{N}{N_0} = e^{-\lambda t}$ $N = N_0 e^{-\lambda t}$ (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 (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 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 3) The frequency of the emitted photon when an electron makes a transition from higher orbit to lower energy orbit is given by $h\nu = E_2 - E_1$ $L_n = mv_n r_n = \frac{n}{2\pi}$ (i)	½ ½ ½ ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	5

	$\frac{mv_n^2}{r_n} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r_n^2}$ $v_n = \frac{e}{\sqrt{4\pi\epsilon_0 m r_n}}$ Combining wit h equation (i) $v_n = \frac{1}{n}\frac{e^2}{4\pi\epsilon_0}\frac{1}{(\ /\pi)}$ $r_n = \left(\frac{n^2}{m}\right)\left(\frac{}{2\pi}\right)^2\left(\frac{4\pi\epsilon_0}{e^2}\right)$ (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) 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) Dividing equation (i) by equation (ii) we get $\frac{(1/\lambda_S)}{(1/\lambda_L)} = \frac{(R/4)}{(5R/36)}$ $\frac{\lambda_L}{\lambda_S} = \frac{9}{5}$ OR $\lambda_L : \lambda_S = 9:5$	½ ½ ½ ½ ½ ½ ½	5