PHYSICS (Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

The figures in the margin indicate full marks for the questions.

***Q.** No. **1** carries **1** mark each*	1x8 = 8
Q. No. **2** *carries 2 marks each*	2x10 = 20
Q. No. 3 carries 3 marks each	3x9 = 27
Q. No. 4 carries 5 marks each	5x3 = 15
	Total = 70

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1 (a) How did Coulomb measure the electrostatic force between two charged particles ?

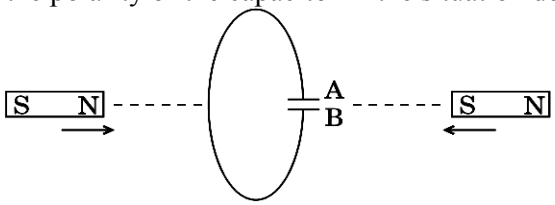
(b) With the positive ions of the metal , what types of paths followed by electrons between successive collisions in a conductor with

(i) absence of electric field,

(ii) presence of electric field?

(c) What is Bohr magneton ?

(d) Predict the polarity of the capacitor in the situation described below :



(e) What is dimensional formula of mobility ?

(f) What is the smallest unit of energy in modern physics ? Give its value .

(g) If magnetic monopoles existed, how would the Gauss's law of magnetism be modified?

(h) How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced by red light ? Give reason.

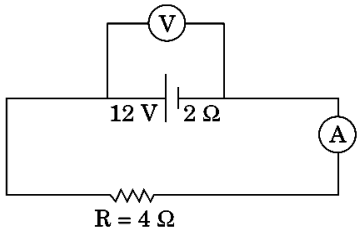
2. (Attempt any ten of the following questions)

(a) A system has two charges $q_A = 2.5\times10^{-7}$ C and $q_B = -2.5\times10^{-7}$C located at points A: (0, 0, –15 cm) and B: (0,0, +15 cm), respectively. What are the total charge and the electric dipole moment of the system? 2

(b) What is electric polarisation vector ? Define the term electric susceptibility. 2

(c) Establish the relation between electric intensity and electric potential at a point in an electric field. 2

(d) In the figure below , an ammeter A and a resistor of 4Ω are connected to the terminals of the source. The emf of the source is 12 V having an internal resistance of 2 Ω. Calculate the voltmeter and ammeter readings.



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(e) Draw a labelled diagram of a moving coil galvanometer.
What is the function of radial magnetic field in the iron core of the galvanometer ? 2

(f) Write down the Faraday's laws of electromagnetic induction 2

(g) An object is placed at 10 cm in front of a concave mirror of radius of curvature 15 cm. Find the position and magnification of the image . 2

(h) The photoelectric threshold for a certain metal surface is 330**Å** . What is the maximum kinetic energy of the photoelectrons released , if radiations of wavelength 100**Å** are used? 2

(i) The magnetic flux through a loop of resistance R = 0.2 Ω is varying according to the relation $\phi = 6t^2 + 7t + 1$ where ϕ is in milliwebers and t is sec. What is the magnitude of current induced in the loop at t=2s ? 2

(j) A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm . If the current carried is 8.0A, estimate the magnitude of B inside the solenoid near its centre. 2

(k) Draw the ray diagram for the formation of image by a compound microscope.
What is its magnification. 2

3. (Attempt any nine of the following questions)

(a) Obtain the formula for the electric field due to a long thin wire of uniform linear charge density λ using Coulomb's law . 3

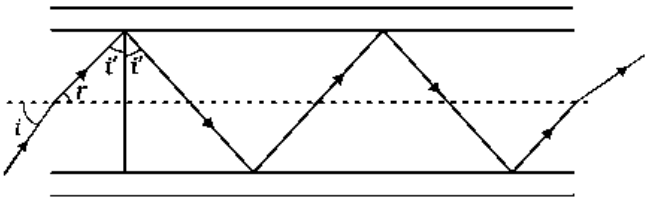
(b) A uniform magnetic field of 6.5×10^{-4} T is maintained in a chamber. An electron enters into the field with a speed of 4.8×10^{6} m/s normal to the field.

What type of path will be followed by the electron and why ?

Determine its frequency of revolution in the circular orbit. 3

(c) A metallic rod of length L is rotating with an angular frequency ω with one end hinged at the centre and other end at the circumference of a circular metallic ring of radius L about an axis passing through the centre and perpendicular to the plane of rotation . A uniform magnetic field of B is perpendicular to the plane of rotation every where . Find the emf between the centre and the metallic ring . 3

(d) Following figure shows a cross-section of a 'light pipe' made of a glass fibre of refractive index 1.68. The outer covering of the pipe is made of a material of refractive index 1.44. What is the range of the angles of the incident rays with the axis of the pipe for which total reflections inside the pipe take place .



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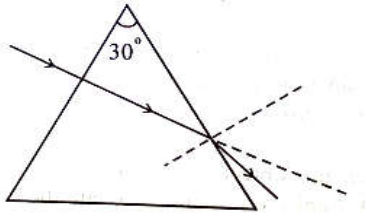
(e) Establish the relation ,

$$\mu_{21} = \frac{Sin\left(\frac{A+\delta_m}{2}\right)}{Sin\frac{A}{2}}$$, where symbols are having usual meanings. 3

(f) A ray of light is incident normally on one the refracting surfaces a prism .The angle of the prism is 30°. Find the angle of deviation for the ray of light. [$\mu = \sqrt{2}$]



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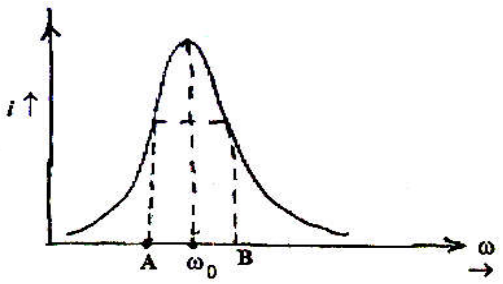
(g) In deriving the single slit diffraction pattern, it was stated that the intensity is zero at angle of $n\lambda/a$. Justify this by suitably dividing the slit to bring out the cancellation. 3

(h) What is fresnel distance ?

Estimate the distance for which ray optics is good approximation for an aperture of 4 mm and wavelength of 400 nm. 1+2=3

(i) Using Ampere's Circuital law, find an expression for the magnetic field due to a solenoid. 3

(k) Define bandwidth and sharpness of resonant curve of the LCR circuit
If ω_A=95 rad/sec and ω_B=105 rad/sec , find the value of R for which the current response is drawn.
[L=10mH and ω_0 = 100 rad/sec]



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4 . . (Attempt any three of the following questions)

(a) Find the expression for magnetic potential energy stored in a bar magnet in a uniform magnetic field.

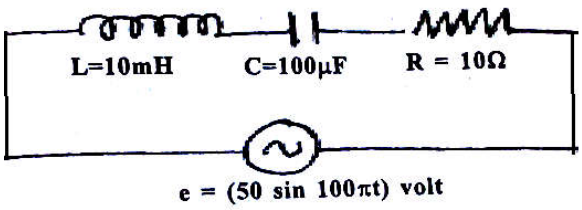
Magnetic field arises due to charges in motion. Can a system have magnetic moments even though its net charge is zero? 3+2=5

(b) Deduce Lens Makers formula

Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20 cm? 3+2 = 5

(c) At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work?

Find out power in the following LCR circiut



2+3 = 5

(d) In Young's double slit experiment, the ratio of intensity at the maximum and minimum in the interference experiment is 25:9. What is the ratio of widths of two slits?

In a Young's double slit experiment, the slits are 2mm apart and are illuminated with a mixture of two wave lengths λ_1 = 750nm and λ_2 = 900nm. At what minimum distance from the common central bright fringe on a screen 2m from the slits will a bright fringe from one interference pattern coincide with a bright fringe from the other? 2 +3=5