

PHYSICS

(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

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

1. (a) Which quantity associated with light wave sets the limit of ability to distinguish very close objects? 1
- (b) What is attenuation of signal in communication system? 1
- (c) ICs can be grouped in two categories. What are they? 1
- (d) What is impact parameter? 1
- (e) Which layer in our atmosphere protects us from ultra violet rays? 1
- (f) What is Current Sensitivity of a galvanometer? 1
- (g) Which experiment established the fact that electric charge is quantized? 1
- (h) How are eddy currents minimised in a transformer? 1

2. *(Attempt any ten of the following questions)*

- (a) A magnetic dipole is oscillating in a magnetic field obeying the following expression.

$$\frac{d^2\theta}{dt^2} = -\frac{mB}{I}\theta$$

What is the time period of oscillation and mention the nature of oscillation? 1½+½=2

- (b) You know that Ampere's circuital law is mathematically expressed as given below.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 i$$

Also you know that this law was corrected by Maxwell and which is known as Ampere-Maxwell law. Write the general form of the law and name the additional term. 1+1=2

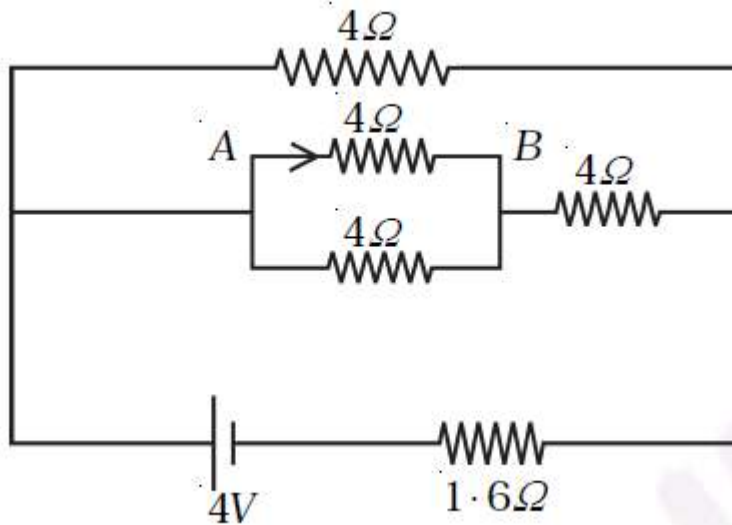
- (c) Explain in brief — "Infrared waves are sometimes referred to as heat waves." 2

- (d) Under what conditions Doppler effect is called (i) red shift and (ii) blue shift? 1+1=2

- (e) Draw a neat diagram to show lateral shift of a ray refracted through a parallel-sided slab. Indicate the lateral shift in the diagram by a double-headed arrow. 1½+½=2

- (f) Define one coulomb charge. Two point charges at a distance r in air exert a force F on each other. At what distance will these charges experience the same force F in a medium of dielectric constant k ? 1+1=2

- (g) Find the value of current I flowing from A to B in the following circuit. 2

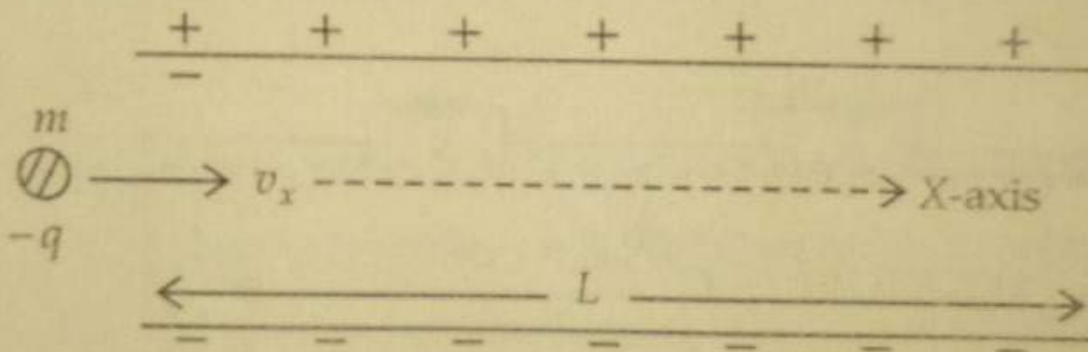


- (h) Explain Lenz's law from the principle of conservation of energy. 2
- (i) What is modulation index? If the maximum amplitude of an amplitude modulated wave is 10V and the minimum amplitude is 2V, what is the value of modulation index? 1+1=2
- (j) Obtain an expression for drift velocity of an electron in a conductor. 2
- (k) Establish the relation between the focal length (f) and radius of curvature (R) for a spherical mirror. 2

3. (a) A $600\mu\text{F}$ capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged $600\mu\text{F}$ capacitor. How much electrostatic energy is lost in the process?

3

OR / অথবা



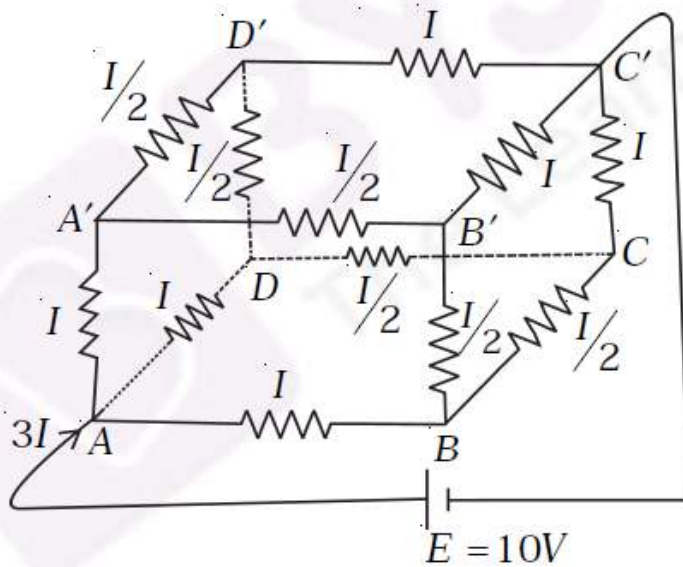
4. (Attempt any three of the following questions)

- (a) "The phenomenon of electro-magnetic induction has been technologically important application in the generation of alternating currents." Name the device which can generate alternating currents. Draw a neat diagram of it. A rectangular coil having area vector \vec{A} and number of turns N is rotating in a magnetic field \vec{B} with angular speed ω . If θ be the angle made by the area vector \vec{A} with the field \vec{B} at time t , derive an expression for alternating emf ε starting directly from Faraday's law. Draw a graph to show the generated emf at time $0, T/4, T/2, 3T/4$ and T .

$$\frac{1}{2} + 1\frac{1}{2} + 2 + 1 = 5$$

- (b) State Kirchhoff's (i) Junction rule and (ii) Loop rule. Determine the equivalent resistance of the network given below and the total current going out of the battery. Given, each resistor has resistance of 1Ω .

$$1+1+2+1=5$$



- (c) You know that the modulated signal in amplitude modulation (AM) is expressed as given below

$$C_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} \cos (\omega_c - \omega_m)t - \frac{\mu A_c}{2} \cos (\omega_c + \omega_m)t.$$

Plot the frequency spectrum of the signal i.e. a plot of amplitude versus ω . Write what will happen if the modulation index $\mu > 1$. What are sidebands? Write the full forms of PAM, PDM, PWM and PPM.

$$1+1+1+(4 \times \frac{1}{2})$$

- (d) A source of *emf*, $V_m \sin \omega t$ is connected in series with an inductor L , capacitor C and resistor R . Calculate the impedance and resonant frequency of the circuit. Also write an application of the resonant circuit.

3+1+1=5

- (e) For refraction at a convex spherical surface of radius of curvature R from a medium of refractive index n_1 to a medium of refractive index n_2 ($n_2 > n_1$), establish the relation

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

What will be the behaviour of a convex lens of refractive index 1.47 when it is immersed in a liquid of refractive index 1.47 ?

4+1=5

5.

- (c) Answer *any two* of the following :

$2 \times 2\frac{1}{2} = 5$

- (i) What determines the intensity of light in the photon picture of light ?
- (ii) "When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have same frequency as the incident frequency". Is this statement true ? If yes, why ? If you think it is not true, why ?

- (iii) What is the effect on the interference fringes in Young's double slit experiment when the monochromatic source is replaced by a source of white light ?
- (iv) "In between a fixed object and a fixed screen, a convex lens can cast two images at two different positions of the lens." Taking this to be a true statement show that product of the image sizes is equal to the square of the object size.
- (v) If you move the source slit closer to the double slit in Young's experiment, what will be effect on the fringes ?