

# BOARD QUESTION PAPER: MARCH 2014

## PHYSICS

Time: 3 Hours

Total Marks: 70

Note:

- i. All questions are compulsory.
- ii. Neat diagrams must be drawn wherever necessary.
- iii. Figures to the right indicate full marks.
- iv. Use of only logarithmic table is allowed.
- v. All symbols have their usual meaning unless otherwise stated.

### SECTION – I

**Q.1. Attempt any SIX :**

[12]

- i. Explain the rise of liquid in the capillary on the basis of pressure difference.
- ii. Show graphical representation of energy distribution spectrum of perfectly black body.
- iii. The escape velocity of a body from the surface of the earth is 11.2 km/s. If a satellite were to orbit close to the surface, what would be its critical velocity?
- iv. A pipe which is open at both ends is 47 cm long and has an inner diameter 5 cm. If the speed of sound in air is 348 m/s, calculate the fundamental frequency of air column in that pipe.
- v. Show that R.M.S. velocity of gas molecules is directly proportional to square root of its absolute temperature.
- vi. For a particle performing uniform circular motion  $\vec{v} = \vec{\omega} \times \vec{r}$  obtain an expression for linear acceleration of the particle performing non-uniform circular motion.
- vii. A stone of mass 1 kg is whirled in horizontal circle attached at the end of a 1 m long string. If the string makes an angle of  $30^\circ$  with vertical, calculate the centripetal force acting on the stone. ( $g = 9.8 \text{ m/s}^2$ ).
- viii. A solid cylinder of uniform density of radius 2 cm has mass of 50 g. If its length is 12 cm, calculate its moment of inertia about an axis passing through its centre and perpendicular to its length.

**Q.2. Attempt any THREE:**

[9]

- i. Derive an expression for acceleration due to gravity at depth 'd' below the earth's surface.
- ii. A copper metal cube has each side of length 1 m. The bottom edge of the cube is fixed and tangential force  $4.2 \times 10^8 \text{ N}$  is applied to a top surface. Calculate the lateral displacement of the top surface if modulus of rigidity of copper is  $14 \times 10^{10} \text{ N/m}^2$ .
- iii. State an expression for K.E. (kinetic energy) and P.E. (potential energy) at displacement 'x' for a particle performing linear S.H.M. Represent them graphically. Find the displacement at which K.E. is equal to P.E.
- iv. The equation of simple harmonic progressive wave is given by  $y = 0.05 \sin \pi \left[ 20t - \frac{x}{6} \right]$ , where all quantities are in S. I. units. Calculate the displacement of a particle at 5 m from origin and at the instant 0.1 second.

**Q.3.** State and prove the theorem of 'parallel axes'.

Calculate the density of paraffin oil, if glass capillary of diameter 0.25 mm dipped in paraffin oil of surface tension 0.0245 N/m rises to a height of 4 cm.

(Angle of contact of paraffin with glass =  $28^\circ$  and acceleration due to gravity =  $9.8 \text{ m/s}^2$ .)

[7]

**OR**

**Q.3.** A wire of density ' $\rho$ ' and Young's modulus ' $Y$ ' is stretched between two rigid supports separated by a distance ' $L$ ' under tension ' $T$ '. Derive an expression for its frequency in fundamental mode.

Hence show that  $n = \frac{1}{2L} \sqrt{\frac{YT}{\rho L}}$ , where symbols have their usual meanings.

When the length of a simple pendulum is decreased by 20 cm, the period changes by 10%. Find the original length of the pendulum.

[7]

**Q.4. Select and write the most appropriate answer from the given alternatives for each sub-question:**

[7]

i. The bulging of earth at the equator and flattening at the poles is due to \_\_\_\_\_.

- (A) centripetal force (B) centrifugal force  
(C) gravitational force (D) electrostatic force

ii. Young's modulus of material of wire is ' $Y$ ' and strain energy per unit volume is ' $E$ ', then the strain is

- (A)  $\sqrt{\frac{Y}{2E}}$  (B)  $\sqrt{\frac{E}{Y}}$  (C)  $\sqrt{\frac{2E}{Y}}$  (D)  $\sqrt{2EY}$

iii. The wavelength range of thermal radiation is

- (A) from  $4000 \text{ \AA}$  to  $7000 \text{ \AA}$  (B) from  $7700 \text{ \AA}$  to  $4 \times 10^6 \text{ \AA}$   
(C) from  $10^6 \text{ \AA}$  to  $10^8 \text{ \AA}$  (D) from  $4 \times 10^{-12} \text{ \AA}$  to  $4 \times 10^8 \text{ \AA}$

iv. A pipe open at both ends resonates to a frequency ' $n_1$ ' and a pipe closed at one end resonates to a frequency ' $n_2$ '. If they are joined to form a pipe closed at one end, then the fundamental frequency will be \_\_\_\_\_.

- (A)  $\frac{n_1 n_2}{2n_2 + n_1}$  (B)  $\frac{2n_2 n_1}{2n_2 + n_1}$   
(C)  $\frac{2n_2 n_1}{n_1 + n_2}$  (D)  $\frac{n_2 + 2n_1}{n_1 n_2}$

v. The phase difference between displacement and acceleration of a particle performing S.H.M. is \_\_\_\_\_.

- (A)  $\frac{\pi}{2}$  rad (B)  $\pi$  rad (C)  $2\pi$  rad (D)  $\frac{3\pi}{2}$  rad

vi. Let  $n_1$  and  $n_2$  be the two slightly different frequencies of two sound waves. The time interval between waxing and immediate next waning is \_\_\_\_\_.

- (A)  $\frac{1}{n_1 - n_2}$  (B)  $\frac{2}{n_1 - n_2}$  (C)  $\frac{n_1 - n_2}{2}$  (D)  $\frac{1}{2(n_1 - n_2)}$

vii. A metal ball cools from  $64^\circ \text{C}$  to  $50^\circ \text{C}$  in 10 minutes and to  $42^\circ \text{C}$  in next 10 minutes. The ratio of rates of fall of temperature during the two intervals is \_\_\_\_\_.

- (A)  $\frac{4}{7}$  (B)  $\frac{7}{4}$   
(C) 2 (D) 2.5

## SECTION – II

**Q.5. Attempt any SIX :**

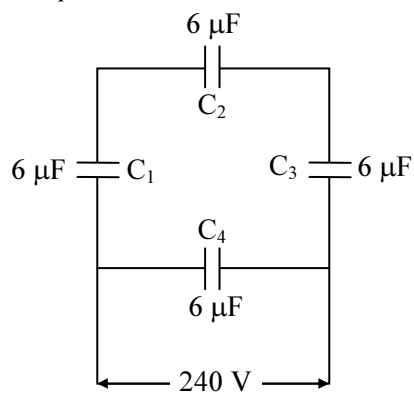
[12]

- i. Show that the orbital magnetic dipole moment of a revolving electron is  $\frac{evr}{2}$ .
- ii. Describe the construction of photoelectric cell.
- iii. For a glass plate as a polariser with refractive index 1.633, calculate the angle of incidence at which light is polarised.
- iv. The susceptibility of magnesium at 300 K is  $2.4 \times 10^{-5}$ . At what temperature will the susceptibility increase to  $3.6 \times 10^{-5}$ ?
- v. Draw a neat labelled diagram for Davisson and Germer experiment, for diffraction of electron wave.
- vi. Explain the terms : (a) Transmitter and (b) receiver in communication system.
- vii. A metal rod  $\frac{1}{\sqrt{\pi}}$  m long rotates about one of its ends perpendicular to a plane whose magnetic induction is  $4 \times 10^{-3}$  T. Calculate the number of revolutions made by the rod per second if the e.m.f. induced between the ends of the rod is 16 mV.
- viii. Find the wave number of a photon having energy of 2.072 eV.  
 Given : Charge on electron =  $1.6 \times 10^{-19}$  C,  
 Velocity of light in air =  $3 \times 10^8$  m/s,  
 Planck's constant =  $6.63 \times 10^{-34}$  J-s.

**Q.6. Attempt any THREE :**

[9]

- i. State Ampere's circuital law. Obtain an expression for magnetic induction along the axis of toroid.
- ii. Calculate the radius of second Bohr orbit in hydrogen atom from the given data.  
 Mass of electron =  $9.1 \times 10^{-31}$  kg  
 Charge on the electron =  $1.6 \times 10^{-19}$  C  
 Planck's constant =  $6.63 \times 10^{-34}$  J-s.  
 Permittivity of free space =  $8.85 \times 10^{-12}$  C<sup>2</sup>/Nm<sup>2</sup>
- iii. Explain the working of P-N junction diode in forward and reverse biased mode.
- iv. A network of four capacitors of 6  $\mu$ F each is connected to a 240 V supply. Determine the charge on each capacitor.



**Q.7.** Describe biprism experiment to find the wavelength of monochromatic light. Draw the necessary ray diagram for magnified and diminished images of virtual sources.

If the difference in velocities of light in glass and water is  $2.7 \times 10^7$  m/s, find the velocity of light in air.

(Refractive index of glass = 1.5, Refractive index of water = 1.333)

[7]

**OR**

**Q.7.** State the principle of a transformer. Explain its construction and working. Derive an expression for the ratio of e.m.f.s in terms of number of turns in primary and secondary coil.

Two diametrically opposite points of a metal ring are connected to two terminals of the left gap of metre bridge. The resistance of  $11 \Omega$  is connected in right gap. If null point is obtained at a distance of 45 cm from the left end, find the resistance of metal ring.

[7]

**Q.8. Select and write the most appropriate answer from the given alternatives for each sub-question:**

[7]

i. Intensity of electric field at a point close to and outside a charged conducting cylinder is proportional to \_\_\_\_\_.

(r is the distance of a point from the axis of cylinder)

(A)  $\frac{1}{r}$  (B)  $\frac{1}{r^2}$

(C)  $\frac{1}{r^3}$  (D)  $r^3$

ii. When a hole is produced in P-type semiconductor, there is \_\_\_\_\_.

- (A) extra electron in valence band  
(B) extra electron in conduction band  
(C) missing electron in valence band  
(D) missing electron in conduction band

iii. The outermost layer of the earth's atmosphere is \_\_\_\_\_.

- (A) stratosphere (B) mesosphere  
(C) troposphere (D) ionosphere

iv. Accuracy of potentiometer can be easily increased by \_\_\_\_\_.

- (A) increasing resistance of wire (B) decreasing resistance of wire  
(C) increasing the length of wire (D) decreasing the length of wire

v. When electron in hydrogen atom jumps from second orbit to first orbit, the wavelength of radiation emitted is  $\lambda$ . When electron jumps from third orbit to first orbit, the wavelength of emitted radiation would be \_\_\_\_\_.

(A)  $\frac{27}{32}\lambda$  (B)  $\frac{32}{27}\lambda$

(C)  $\frac{2}{3}\lambda$  (D)  $\frac{3}{2}\lambda$

vi. An ideal voltmeter has \_\_\_\_\_.

- (A) low resistance (B) high resistance  
(C) infinite resistance (D) zero resistance

vii. The resolving power of telescope of aperture 100 cm for light of wavelength  $5.5 \times 10^{-7}$  m is \_\_\_\_\_.

(A)  $0.149 \times 10^{+7}$  (B)  $1.49 \times 10^{+7}$   
(C)  $14.9 \times 10^{+7}$  (D)  $149 \times 10^{+7}$