DAY — 05 SEAT NUMBER | | | | | | |

2016	II	24	1100	J-731	(E)

PHYSICS (54)

(Mechanics, Properties of Matter, Sound and Heat)

Time : 3 Hrs. **(8 Pages)** **Max. 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.

(vi) Answers to both sections must be written in the same answerbook.

(vii) Answer to every question must be written on a new page.

SECTION – I

Q. 1. Attempt Any Six : **[12]**

(i) In U. C. M. (Uniform Circular Motion), prove the relation $\vec{v} = \vec{w} \times \vec{r}$, where symbols have their usual meanings.

(ii) Derive an expression for critical velocity of a satellite revolving around the earth in a circular orbit.

(iii) Obtain an expression for total kinetic energy of a rolling body in the form $\frac{1}{2}MV^2\left[1+\frac{K^2}{R^2}\right]$.

(iv) Define 'emissive power' and 'coefficient of emission of a body'.

(v) A coin kept at a distance of 5cm from the centre of a turntable of radius 1·5m just begins to slip when the turntable rotates at a speed of 90 r.p.m. Calculate the coefficient of static friction between the coin and the turntable. [$g = 9{\cdot}8\ m/s^2$].

(vi) The fundamental frequency of an air column in a pipe closed at one end is in unison with the third overtone of an open pipe. Calculate the ratio of lengths of their air columns.

(vii) A particle performing linear S.H.M. has a period of 6·28 seconds and a pathlength of 20cm. What is the velocity when its displacement is 6 cm from mean position?

(viii) The energy of the free surface of a liquid drop is 5π times the surface tension of the liquid. Find the diameter of the drop in C.G.S. system.

Q. 2. Select and write the most appropriate answer from the given alternatives for each sub-question : **[7]**

(i) A particle rotates in U.C.M. with tangential velocity 'v' along a horizontal circle of diameter 'D'. Total angular displacement of the particle in time 't' is .....

(a) vt (b) $\left(\frac{v}{D}\right) - t$

(c) $\frac{vt}{2D}$ (d) $\frac{2vt}{D}$

(ii) Two springs of force constants K_1 and K_2 ($K_1 > K_2$) are stretched by same force. If W_1 and W_2 be the work done stretching the springs then .....

(a) $W_1 = W_2$ (b) $W_1 < W_2$

(c) $W_1 > W_2$ (d) $W_1 = W_2 = 0$

(iii) A and B are two steel wires and the radius of A is twice that of B. If they are stretched by the same load, then the stress on B is .....

(a) four times that of A. (b) two times that of A.

(c) three times that of A. (d) same as that of A.

(iv) If sound waves are reflected from surface of denser medium, there is phase change of .....

(a) 0 rad (b) $\frac{\pi}{4}$ rad

(c) $\frac{\pi}{2}$ rad (d) π rad

(v) A sonometer wire vibrates with frequency n_1 in air under suitable load of specific gravity 'σ'. When the load is immersed in water, the frequency of vibration of wire n_2 will be .....

(a) $n_1\sqrt{\frac{\sigma+1}{\sigma}}$ (b) $n_1\sqrt{\frac{\sigma-1}{\sigma}}$

(c) $n_1\sqrt{\frac{\sigma}{\sigma+1}}$ (d) $n_1\sqrt{\frac{\sigma}{\sigma-1}}$

(vi) For polyatomic molecules having 'f' vibrational modes, the ratio of two specific heats, $\frac{C_P}{C_V}$ is ____.

(a) $\frac{1+f}{2+f}$ (b) $\frac{2+f}{3+f}$

(c) $\frac{4+f}{3+f}$ (d) $\frac{5+f}{4+f}$

(vii) A body of moment of inertia 5 kgm^2 rotating with an angular velocity 6 rad/s has the same kinetic energy as a mass of 20 kg moving with a velocity of ____.

(a) 5 m/s (b) 4 m/s

(c) 3 m/s (d) 2 m/s

Q. 3. Define linear S.H.M. Show that S.H.M. is a projection of U.C.M. on any diameter. **[7]**

A metal sphere cools at the rate of 4°C / min. when its temperature is 50°C. Find its rate of cooling at 45°C if the temperature of surroundings is 25°C.

OR

Explain analytically how the stationary waves are formed. Hence show that the distance between node and adjacent antinode is $\frac{\lambda}{4}$.

A set of 48 tuning forks is arranged in a series of descending frequencies such that each fork gives 4 beats per second with preceding one. The frequency of first fork is 1·5 times the frequency of the last fork, find the frequency of the first and 42^{nd} tuning fork.

Q. 4. Attempt any THREE : **[9]**

(i) What is the decrease in weight of a body of mass 600 kg when it is taken in a mine of depth 5000 m?

[Radius of earth = 6400 km, g = 9·8 m/s^2]

(ii) State and prove theorem of parallel axes about moment of inertia.

(iii) Derive Laplace's law for spherical membrane of bubble due to surface tension.

(iv) A steel wire having cross sectional area $1 \cdot 5$ mm^2 when stretched by a load produces a lateral strain $1 \cdot 5 \times 10^{-5}$. Calculate the mass attached to the wire.

($Y_{steel} = 2 \times 10^{11}$ N/m^2, Poisson's ratio $\sigma = 0 \cdot 291$, $g = 9 \cdot 8$ m/s^2)

SECTION – II

Q. 5. Attempt any SIX : **[12]**

(i) What is 'diffraction of light'? Explain its two types.

(ii) Draw a neat labelled diagram for the construction of 'cyclotron'.

(iii) Distinguish between 'paramagnetic' and 'ferromagnetic' substances.

(iv) Write a short note on surface wave propagation of electromagnetic waves.

(v) The combined resistance of a galvanometer of resistance 500Ω and its shunt is 21Ω. Calculate the value of shunt.

(vi) The susceptibility of magnesium at 200 K is $1 \cdot 8 \times 10^{-5}$. At what temperature will the susceptibility decrease by 6×10^{-6} ?

(vii) The co-efficient of mutual induction between primary and secondary coil is 2H. Calculate induced e.m.f. if current of 4A is cut off in $2 \cdot 5 \times 10^{-4}$ seconds.

(viii) The decay constant of radioactive substance is $4 \cdot 33 \times 10^{-4}$ per year. Calculate its half life period.

Q. 6. Select and write the most appropriate answer from the given alternatives for each sub-question : [7]

(i) If the polarising angle for a given medium is 60°, then the refractive index of the medium is .....

(a) $\frac{1}{\sqrt{3}}$ (b) $\sqrt{\frac{3}{2}}$

(c) 1 (d) $\sqrt{3}$

(ii) The resolving power of a telescope depends upon the .....

(a) length of the telescope

(b) focal length of an objective

(c) diameter of an objective

(d) focal length of an eyepiece

(iii) Electric intensity due to a charged sphere at a point outside the sphere decreases with .....

(a) increase in charge on sphere.

(b) increase in dielectric constant.

(c) decrease in the distance from the centre of sphere.

(d) decrease in square of distance from the centre of sphere.

(iv) In potentiometer experiment, if l_1 is the balancing length for e.m.f. of cell of internal resistance r and l_2 is the balancing length for its terminal potential difference when shunted with resistance R then :

(a) $l_1 = l_2\left(\frac{R+r}{R}\right)$ (b) $l_1 = l_2\left(\frac{R}{R+r}\right)$

(c) $l_1 = l_2\left(\frac{R}{R-r}\right)$ (d) $l_1 = l_2\left(\frac{R-r}{R}\right)$

(v) The energy of photon of wavelength λ is _____.
[h = Planck's constant, c = speed of light in vacuum]

(a) $hc\lambda$ (b) $\frac{h\lambda}{c}$

(c) $\frac{\lambda}{hc}$ (d) $\frac{hc}{\lambda}$

(vi) Which logic gate corresponds to the truth table given below?

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(a) AND (b) NOR
(c) OR (d) NAND

(vii) The process of superimposing a low frequency signal on a high frequency wave is _____ .
(a) detection (b) mixing
(c) modulation (d) attenuation

Q. 7. State the principle on which transformer works. Explain its working with construction. Derive an expression for ratio of e.m.f.s and currents in terms of number of turns in primary and secondary coil. **[7]**

A conductor of any shape, having area $40\,cm^2$ placed in air is uniformly charged with a charge $0\cdot2\mu C$. Determine the electric intensity at a point just outside its surface. Also, find the mechanical force per unit area of the charged conductor.

$[\epsilon_0 = 8\cdot85\times10^{-12}$ S.I. units]

OR

With the help of a neat labelled diagram, describe the Geiger-Marsden experiment. What is mass defect?

The photoelectric work function for a metal surface is 2·3 eV. If the light of wavelength 6800Å is incident on the surface of metal, find threshold frequency and incident frequency. Will there be an emission of photoelectrons or not?

[Velocity of light $c = 3 \times 10^8$ m/s,

Planck's constant, $h = 6{\cdot}63 \times 10^{-34}$ Js]

Q. 8. Attempt any THREE : **[9]**

(i) Determine the change in wavelength of light during its passage from air to glass. If the refractive index of glass with respect to air is 1·5 and the frequency of light is $3{\cdot}5 \times 10^{14}$ Hz, find the wave number of light in glass.
[Velocity of light in air ($c = 3 \times 10^8$ m/s]

(ii) In biprism experiment, 10th dark band is observed at 2·09 mm from the central bright point on the screen with red light of wavelength 6400 Å. By how much will fringe width change if blue light of wavelength 4800Å is used with the same setting?

(iii) Describe Kelvin's method to determine the resistance of galvanometer by using metre bridge.

(iv) Explain the elementary idea of an oscillator with the help of block diagram.

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