This question paper contains 4 printed pages] 13.12.18 (M)

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 103

Unique Paper Code : 32221102 I

Name of the Paper : Mechanics

Name of the Course : B.Sc. (Hons.) Physics (CBCS)

Semester : I

Duration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *five* questions in all.

Q. No. 1 is compulsory.

Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following : 5×3=15

   (*a*) Prove that the radius vector sweeps out equal areas in equal intervals of time for any elliptical orbit under central force motion.

   (*b*) Explain the theory of expanding universe using Doppler effect in light.

   (*c*) What are the effects of Coriolis force due to Earth's rotation.

P.T.O.

(*d*) Show that the ratio of rotational to translational kinetic energy for a solid cylinder rolling down a plane without slipping is 1 : 2.

(*e*) Compare gravitational mass with inertial mass of the body.

(*f*) Show that $E^2 - c^2p^2$ is invariant to Lorentz transformations.

(*g*) Show that damping has little or no effect on the frequency of a harmonic oscillator if its quality factor is large.

(*h*) Explain how a hollow cylinder is stronger than a solid cylinder having same material, mass and length.

2. (*a*) State and prove Work-Energy theorem. 7

(*b*) Show that in an elastic collision of two particles in centre of mass frame of reference, the magnitude of the velocity remains unchanged before and after the collision. 8

3. (*a*) Find the centre of mass of a uniform solid hemisphere of mass M and radius R w.r.t. its geometrical centre. 7

(*b*) Determine the moment of inertia of a uniform hollow sphere of mass M, and radius R about its diameter and tangent. 8

4. (*a*) Derive the expression for the gravitational potential due to a solid sphere of radius R and mass M at a point outside the shell and also at a point inside the shell. 10

(*b*) Show graphically the variation of both gravitational potential and gravitational field as a function of radial distance from the centre of the sphere. 5

5. (*a*) State and prove theorem of perpendicular axes of moment of inertia for a three-dimensional rigid body. 7

(*b*) Establish the relation between Y, K and *n* where Y is the Young's modulus, K is the bulk modulus and *n* is the modulus of rigidity of the material. 8

6. (*a*) Deduce the differential equation of a damped harmonic oscillator and discuss in detail the cases of overdamped, critical and underdamped oscillators. 12

(*b*) A condenser of capacity 1 microF, an inductance of 0.2 Henry and a resistance of 800 ohm are connected in series. Is the circuit oscillatory ? If yes, calculate the frequency and quality factor of the circuit. What do you understand by Quality factor of an oscillator ? 3

P.T.O.

7. (*a*) What is Coriolis force ? Show that the total Coriolis force acting on a body of mass m in a rotating frame is $-2m\ \vec{\omega} \times \vec{v}_{rot}$, where $\vec{\omega}$ is the angular velocity of rotating frame and $\vec{v}_{rot}$ is the velocity of the body in rotating frame. 9

(*b*) Calculate the values of the centrifugal and Coriolis forces on a mass of 20 g placed at a distance of 10 cm from the axis of a rotating frame of reference, if the angular speed of rotation of the frame be 10 radians per second. 4

(*c*) Calculate the effective weight of an astronaut ordinarily weighing 60 kg when his rocket moves vertically upward with 5 g acceleration. 2

8. (*a*) Describe Michelson-Morley experiment and explain the significance of the null result. State the postulates of special theory of relativity. 6,2,2

(*b*) The proper mean life time of pi meson is 2.5×10^{-8} sec. Calculate :

(i) the mean life time of pi meson travelling with velocity 2.4×10^{10}cm/sec.

(*ii*) distance travelled by it before disintegrating. 3,2