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1 SEM TDC PHYH (CBCS) C 2

2021

(Held in January/February, 2022)

PHYSICS

(Core)

Paper : C–2

(Mechanics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×5=5

(a) The angle of projection for a projectile whose equation of motion represented by $y = \frac{x}{\sqrt{3}} - \frac{g}{20}x^2$ is given by

(i) 59°

(ii) 60°

(iii) 30°

(iv) 65°

(b) In case of perfectly inelastic collision

(i) momentum is not conserved, KE is conserved

(ii) momentum is conserved, KE is not conserved

(iii) both momentum and KE are conserved

(iv) both momentum and KE are not conserved

(c) Mass of a body measured by a spring balance is

(i) inertial mass

(ii) gravitational mass

(iii) both gravitational and inertial mass

(iv) None of the above

(d) If the displacement of a particle executing SHM is represented by

$$y = 10\sin\left(10t - \frac{\pi}{6}\right)$$

then maximum velocity of the particle is

(i) 10

(ii) 100

(iii) 60

(iv) 600

(e) A photon is moving with a velocity c in frame S' and S' is moving with velocity c relative to frame S, then the velocity of the photon as measured by an observer in frame S is

(i) $2c$

(ii) c

(iii) c^2

(iv) None of the above

2. *(a)* Prove that the change in kinetic energy of a particle is equal to the work done on it. 2

(b) The position vector of a particle of mass m and angular velocity ω at any instant t is given by $\vec{r} = A\cos\omega t\,\hat{i} + A\sin\omega t\,\hat{j}$, where A is a constant. Prove that the force acting on it is conservative in nature. 2

Or

Show that the angular momentum of a body moving under the central force is a constant of motion.

(c) Two bodies of masses 10 gm and 5 gm have position vectors $(2\hat{i} + 3\hat{j} - \hat{k})$ and $(\hat{i} - \hat{j} + 3\hat{k})$ respectively. Determine the distance of the centre of mass from the origin. 2

Or

Show that for a simple harmonic oscillator the total mechanical energy is constant.

(d) Show that the moment of inertia of a body rotating about an axis with unit angular velocity is equal to twice the kinetic energy of rotation about that axis. 2

(e) What is Poisson's ratio? Explain why its practical value cannot be negative. 1+1=2

3. Obtain the expression for the final velocity of a rocket moving in a constant gravitational field. 4

4. *(a)* Obtain the expression for the moment of inertia of a hollow cylinder about an axis passing through its centre and perpendicular to its own axis. 4

Or

State the general theorems on moment of inertia. Assuming earth to be a sphere of uniform density ρ and radius R, determine the moment of inertia of the earth about its axis of rotation. 2+2=4

(b) Prove that the acceleration of a body of circular symmetry rolling down in an inclined plane without slipping is independent of mass of the body. 3

5. Write the main assumptions in deriving the Poiseuille's formula. Why this formula fails in the case of a tube of wide bore? 2+1=3

6. *(a)* Find an expression for the gravitational potential due to a solid sphere at the centre of the sphere. 4

Or

What is gravitational potential? Describe how the gravitational potential and field due to a spherical shell vary with distance graphically. 1+3=4

(b) What are geostationary and polar satellites? Which satellite can be used for remote sensing? 2+1=3

7. What is forced vibration? Obtain the steady-state function for such vibration. 1+4=5

8. Obtain an expression for Coriolis force for a particle moving with respect to a rotating frame. 4

9. *(a)* Describe the Michelson-Morley experiment and explain the physical significance of negative results. 4

(Continued)

Or

Deduce the formula for relativistic variation of mass with velocity. 4

(b) Show that the rest mass of a photon is zero. 2

(c) Find an expression for the relativistic length contraction. 2

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