Department of Electronics and Communication Engineering

University Institute of Engineering and Technology
CSJM University, Kanpur

Subject Name : Physics -1 **Subject Code : PHY-S101-ECE**

Semester : I, 2022-23 **Year : 1st year, (2K22)**

End Semester Examination

Time : 3 hours **Maximum Marks-50**

All questions are compulsory

Section - A
10 marks (10 questions of 1 mark each)

1. Write down the relations between the cartesian coordinates (x, y, z) and spherical polar coordinates (r, θ, ϕ).

2. Find the constant 'a'such that the vectors $2\hat{i} - \hat{j} + \hat{k}$, $\hat{i} + 2\hat{j} - 3\hat{k}$ and $3\hat{i} + a\hat{j} + 5\hat{k}$ are coplanar.

3. Using Taylor series expansion of the potential energy of a bound system, show that the bound system behaves like a harmonic oscillator for small oscillation.

4. Write down the potential energy of a teeter toy when it is given a tilt in vertical plane through a small angle θ. The length of each drooping arm is l, length of the peg is L and the angle between the drooping arm and the peg is α.

5. Show that torque of a particle in a central force field is zero.

6. Define the radius of gyration of a body about an axis.

7. Let $\phi = x^2y^3z^0$. (a) In what direction from the point $P(1,1,1)$ is the directional derivative of ϕ a maximum? (b) What is the magnitude of this maximum?

8. Prove that $\frac{d}{dt}\hat{e}_\rho = \dot{\phi}\hat{e}_\phi$ where $\hat{e}_\rho$ and $\hat{e}_\phi$ are the unit tangent vectors in cylindrical coordinate system.

9. What is the necessary and sufficient condition for an equilibrium to be a stable equilibrium?

10. What do understand by length contraction of a body in special theory of relativity?

Section B
20 marks (5 questions of 4 marks each)

1. Show by means of substitution $r = \frac{1}{u}$ that the differential equation for the path of a particle in a central field is $\frac{d^2u}{d\theta^2} + u = -\frac{f(\frac{1}{u})}{mh^2u^2}$.

2. Deduce the moment of inertia of a uniform solid cylinder about its axis.

3. The kinetic energy of a particle of rest mass m_0 is equal to its rest-mass energy. Find out its relativistic momentum p in the units of m_0c.

4. Find out the center of mass of a uniform semicircular wire of radius R.

5. What is a compound pendulum? Calculate the time period of oscillation of a compound pendulum.

Section C
20 marks (2 questions of 10 marks each)

1. a) Explain the concept of simultaneity in special theory of relativity with example.

1. b) A scientist observes that a certain atom $'A'$ moving relative to him with velocity $2 \times 10^8 m/sec$ emits a particle $'B'$ which moves with velocity $2.8 \times 10^8 m/sec$ w.r.t the atom $'A'$. Calculate the velocity of the emitted particle $'B'$ relative to the scientist. →

2. a) Consider a solid sphere of radius $'r'$ and radius of gyration $'k'$ about the axis through the center of mass is rolling down an inclined plane of angle of inclination θ. Find out the expression of its acceleration.

2. b) A rocket of mass $20kg$ has $180kg$ of fuel. The exhaust velocity of the fuel is $1.6km/sec$. Calculate the minimum rate of fuel consumption so that the rocket may rise from the ground. Also calculate the final velocity gained by the rocket when the rate of consumption of fuel is $2.0kg/sec$. →

Department of Electronics and Communication Engineering

UIET, CSJM University, Kanpur

Semester: 2022-23 (odd Semester), Year: 1st Year (2022)

Subject Name : Physics - I, Subject: Code : PHY-S101- ECE

2nd Mid Semester Examination

Time : 1.5 hours Maximum Marks-30

Note :

All questions are compulsory.

Section - A

9 marks (Each question carries 1 mark) (Fill in the blanks)

1. In symbols $\vec{F}$ is a central force field if and only if $\vec{F} =$ .....

2. Every planet moves in ..... orbit keeping sun at one of its foci.

3. If the equation of a conic is $r = \frac{12}{3+cos\theta}$, then the length of the semi major axis is .....

4. A system consists of two particles of masses m_1 and m_2 separated by a distance d. The center of mass of the system will be at $X_{cm} =$ ....., $Y_{cm} = 0$, $Z_{cm} = 0$.

5. If the initial and final masses of a rocket are M_0 and M_f respectively, then the final velocity of the rocket in free space is $\vec{V_f} = \vec{V_0} +$.....

6. The central force field is attractive if the magnitude of the force $f(r)$.....

7. A collision is said to be .....if the total kinetic energy of the system remains constant.

8. The total momenta of a system in center of mass frame is .....

9. The initial and final velocities in C-frame determine a plane which is known as .....

Section B

9 marks (Each question carries 3 marks)

1. Derive the expression of the final velocity of a rocket in presence of gravitational field taking initial velocity $\vec{V_0} = 0$.

2. Prove that if a planet is to revolve around the sun in an elliptical path with the sun at a focus, then the central force necessary varies inversely as the square of the distance of the planet from the sun.

3. An empty rocket weighs $5000kg$ and contains $40,000kg$ fuel. If the exhaust velocity of the fuel is $2km/sec$, find the maximum velocity gained by the rocket assuming $V_0 = 0$.

Section C

12 marks (Each question carries 6 marks)

1. Write down the three properties of a central force field. Prove that angular momentum is conserved in central force field.

2. A gun fires a bullet of mass m with horizontal velocity v into a block of wood of mass M which rests on horizontal frictionless plane. If the bullet becomes embedded in the wood then determine the subsequent velocity of the system and find out the loss in kinetic energy.

Department of Electronics and Communication Engineering

UIET, CSJM University, Kanpur

Semester: 2022-23 (Odd Semester), Year: 1st Year (2022)

Subject Name : Physics - I , Subject Code : PHY-S101

1st Mid Semester Examination

Time : 1.5 hours Maximum Marks-30

Note :

All questions are compulsory.

Section - A

9 marks (Each question carries 1 mark) (Fill in the blanks)

1. The component of $\vec{\nabla}\phi$ in the direction of a unit vector $\hat{a}$ is given by .....

2. $\vec{\nabla}.\vec{A}$ is a measure of how much the vector field ..... out from the point in question.

3. If $\vec{\nabla} \times \vec{A} = 0$, then $\vec{A}$ is called an.....vector.

4. If $\vec{r}$ is the position vector of a point P whose curvilinear coordinates are (u_1, u_2, u_3) then the unit tangent vector along u_1-curve is defined as $\hat{e_1}$ = ...

5. The values of $\frac{d\hat{r}}{dt}$ = ... and $\frac{d\hat{\theta}}{dt}$ = ... where $\hat{r}$ and $\hat{\theta}$ are two unit vectors in polar coordinate system.

6. The maximum magnitude of static friction is known as ..... friction.

7. The potential energy of a spring of spring constant k is given by $V(x) =$ .....

8. A necessary and sufficient condition that an equilibrium will be a stable equilibrium if the potential energy at the equilibrium point is .....

9. All bound systems behave like a ..... oscillator.

Section B

9 marks (Each question carries 3 marks)

1. What is the cause of friction at the atomic level?

2. A particle moves outward along a spiral. Its trajectory is given by $r = \frac{l_0\theta}{\pi}$. The angle θ increases as $\theta = \frac{1}{2}\alpha t^2$, where α is a constant. At what angle radial and transverse accelerations have equal magnitudes?

3. Show that $\vec{\nabla}\phi$ is a vector perpendicular to the surface $\phi(x, y, z) = C$ where C is a constant.

Section C

12 marks (Each question carries 6 marks)

1. Find out the three unit tangent vectors $\hat{e_\rho}$, $\hat{e_\phi}$ and $\hat{e_z}$ at point $P(\rho, \phi, z)$ in terms of $\hat{i}$, $\hat{j}$ and $\hat{k}$ for cylindrical coordinate system. Also show that cylindrical coordinate system is orthogonal.

2. Derive the expression of the potential energy of a teeter toy when it is given a tilt through a small angle θ and show that the stability is achieved only when $lcos\alpha > L$ where l, L and α are the length of the drooping arm, length of the peg and the angle between drooping arm and the peg of the teeter toy respectively.