ANNAI WOMEN'S COLLEGE

(Arts & Science)

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DEPARTMENT OF PHYSICS

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COURSE: B.SC., (PHYSICS)

SEMESTER: VI

TITLE OF THE PAPER: THEORETICAL PHYSICS

SUBJECT CODE :16SCCPH9

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2- MARK QUESTIONS

1. **What are generalized co-ordinates?**

The set of independent co-ordinates sufficient to describe completely the state of configuration of the system is called generalized co-ordinates.

it denoted by($q_1, q_2, q_3, \ldots q_k \ldots, q_f$)

where q_f is the total number of generalized co-ordinates.

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2. **Define constraints.**

A motion that cannot proceed orbitary in any manner is called constrain motion.The limitations or geometrical restrictions on the motion of a particle or system of particle are generally know as constrain.

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3 **How constraints are classified?**

Constraints are classified as

(i)Holonomic and non- holonomic: If conditions of all the constraints are expressed as equations of the form are said to be *holonomic.*

$$f(r_1, r_2, r_3, \ldots, r_n, t) = 0$$

If the constraints are not so expressed, they are called *non-holonomic constraints.*

***(ii)*Scleronomic and rheonomic constraints.** If the constraints are independent of time, they are called *scleronomic*. If they contain time explicitly are rheonomic.

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3. **State the principle of virtual work.**

$$\sum_i fia.\delta r_i = 0$$

A system of particles is in equilibrium only if the total work of the actual or applied forces is zero.

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4. **State D'Alembert's principle.**

$$\sum_i (F_i - \dot{p}_i) . \delta r_i = 0$$

The D'Alembert's principle states that the sum of the difference between the force acting on a system of mass particles and the time derivatives of the momenta of the system itself projected on to any virtual

Displacement consistent with the contraints of the system is zero. dynamical system is zero.

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5. **State Hamilton's principle.**

The path actually traversed in a conservative holonomic dynamical system from time t_1 and t_2 is one over which the integral of the Lagrangian between limits t_1 and t_2 is stationary (*i.e.*, the time integral of the Lagrangian is extremum.

$$\dot{q_k} - \frac{\partial H}{\partial p_k} = 0 \; and \; \dot{p_k} + \frac{\partial H}{\partial q_k} = 0$$

$$\frac{\partial H}{\partial p_k} = \dot{q_k} \; and \; \frac{\partial H}{\partial q_k} = -\dot{p_k}$$

These are the required Hamilton's equations.

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6. **Give the Lagrange's equation for a conservative system.**

The Lagrange's equation for a conservative system is

$$\frac{d}{dt}\frac{\partial}{\partial \dot{q}_k}(T - V) - \frac{\partial}{\partial q_k}(T - V) = 0.$$

Where L = T – V and L is known as Lagrangian function.

The above equation becomes,

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_k}\right)-\frac{\partial L}{\partial q_k}=0.$$

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7. **Write the Lagrange's equation for a system containing dissipative force.**

The Lagrange's equation for a system containing dissipative force is given by

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_k}\right)-\frac{\partial L}{\partial q_k}+\frac{\partial R}{\partial \dot{q}_k}=0.$$

Here, the term $\frac{\partial R}{\partial \dot{q}_k}$ taken into account for the dissipative forces.

Thus, if dissipative forces are acting on the system, we must specify two scalar functions – the Lagrange's function L and Rayleigh's dissipation function R – to derive the equations of motions.

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UNIT II

8. **Write Hamilton's equations.**

$$\left.\begin{aligned}\dot{q}_k&=\frac{\partial H}{\partial p_k},\\ -\dot{p}_k&=\frac{\partial H}{\partial q_k},\end{aligned}\right\}$$

These equations are called Hamilton's equations or Hamilton's canonical equations of motion.

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9. **State the principle of least action.**

The principle of least action states that the variation of action along the actual path between given time interval is least *i.e.*

$$\Delta\int_{t_1}^{t_2} 2T\,dt = 0\ \dots(1)$$

But in system for which Hamiltonian H remains constant,

$$2T=\sum_k p_k\dot{q}_k$$

Therefore for such system, the principle of least action may be written as

$$\Delta \int_{t_1}^{t_2} \sum_k p_k q_k \, dt = 0 \ldots (2)$$

Where Δ represents a new type of variation of the path which allows time as well as position co-ordinates to vary.

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10. **What are cyclic coordinates?**

The Langrangian L is written as function of q_i and q_i. If the Lagrangian of a system does not contain a given coordinate, say q_k, then the coordinate is said to be *cyclic*. Since the coordinates q_k is absent in the expression for the Lagragian L, the partial derivative of L with respect to q_k will vanish, *i.e.*, $\frac{\partial L}{\partial q_k} = 0$.

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11. **Define generalized momentum**.

The generalized momentum conjugate to the generalized co-ordinates q_k is defined as the quantity $\frac{\partial L}{\partial q_k}$.

It is represent by p_k. *i.e.*, $p_k = \frac{\partial L}{\partial q_k}$.

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12. **Define phase space.**

A single particle in phase space is specified by six co-ordinates; three position coordinates and three momentum co-ordinates. This six dimensional space is sometimes called the μ space. *The phase space is a superposition of μ spaces.*

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13. **State conservation theorem for generalized momemtum.**

If a given component of the total applied force vanishes, the corresponding component of the linear momentum is conserved.

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14. **State conservation theorem for energy.**

If the Lagrangian function does not contain the time explicitly, the total energy of the conservative system is conserved.

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UNIT III

15. **State de Broglie hypothesis.**

According to de Broglie, a *moving particle, whatever its nature, sometimes acting as a particle and sometimes acting as a wave*. He proposed that the wavelength λ associated with any moving particle of momentum *p* (mass *m* and velocity *v*) is given by

$$\lambda = \frac{h}{p} = \frac{h}{mv},$$ Where *h* is planck's constant.

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16. **Define group velocity.**

The velocity v_g of the wave group is

$$v_g = \frac{\Delta\omega}{\Delta k}$$

When ω and k have continuous spreads, the group velocity is given by

$$v_g = \frac{d\omega}{dk}$$

This is the expression for the group velocity, the ratio of change in frequency and change in wave number.

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17. **What is meant by de Broglie waves?**

A photos of light of frequency *v* has the momentum P=h *v/c* but *v*=**c**/*λ*

The momentum of the photons can be expressed in terms of wavelength λ as P = h/ λ

λ=h/p then P = mv and its de Broglie wavelength is accordingly *λ*=h/mv

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18. **Write the relation connecting group velocity and phase velocity.**

The relation between group velocity and phase velocity is given by

$$v_g = v_p - \lambda \frac{dv_p}{d\lambda}$$

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19. **What is meant by wave velocity?**

A wave of angular frequency ω and wave number *k*, then the de Broglie wave velocity is $v_p = \frac{\omega}{k}$

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20. **State Heisenberg's uncertainty principle.**

Heisenberg's uncertainty principles states that it is impossible to know simultaneously the exact position and momentum of a particle, that is the more exactly the position is determined, the less known the momentum and vice versa

$$\Delta x.\ \Delta y \geq \hbar/2$$

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21. **State the principle of electron microscope.**

An electron microscope uses an 'electron beam' to produce the image of the object and magnification is obtained by 'electromagnetic fields'; unlike light or optical microscopes, in which 'light waves' are used to produce the image and magnification is obtained by a system of 'optical lenses'.

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UNIT IV

23. **State the postulates of wave mechanics.**

(i) Each dynamical variable relating to the motion of a particle can be represented by a linear operator.

(ii) A linear eigenvalue equation can be always linked with each operator.

(iii) In general, when a measurement of a dynamical quantity *a* is made on a particle for which the wave function is ψ, we get *different* values of a during different trials. This is in conformity with the uncertainty principle. The most *probable value* of *a* is given by $< a > = \int_0^{\infty} \psi * \hat{A}\, \psi\, dV$

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24. **what is an operator?**

An operator tells us what operations to carry out on the quantity that follows it.

The operator $i\left(\frac{h}{2\pi}\right)\frac{\partial}{\partial t}$ instructs us to take the partial derivative of what comes after it with respect to *t* and multiply the result by $i\left(\frac{h}{2\pi}\right)$.

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25. **Define eigen value and eigen function.**

An eigen function of an operation F_{op} is a function ψ such that the application of $F_{op} on\, \psi$ gives times a constant

In general, we can write an eigen value equation as $F_{op}\,\psi = f\psi$

ψ is then called an *eigen function* of the operator F_{op},

f is called the *eigen value*.

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26. **Define normalized wave function.**

The probability of finding a particle in a volume *dx, dy, dz* is $|\psi^2|\ dx\ dy\ dz$. further, since the particle is certainly to be found somewhere in space

$$\iiint |\psi^2|\,dx.dy.dz = 1$$

The trial integral extending over all possible values of *x, y, z* .

A wave function (ψ) satisfying this relation is called a *normalized wave function*.

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27. **Write any two applications of Schrodinger's wave equation.**

(i) Particle in a box.

(ii) The barrier penetration problem.

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28. **What are quantum operators for angular momentum and kinetic energy.**

For angular momentum of the particle, the operator is $-i\left(\frac{h}{2\pi}\right)(\boldsymbol{r}\times\nabla)$.

The operator for kinetic energy of a particle is $-(h^2/8\pi^2 m)\,\nabla^2$

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29. **State Ehrenfest theorem**

It states that the quantum mechanics is same result as classical mechanics for a particles for which the operation values of any dynamical quantities are involves.

d/dt <x>, <Px>/m   d/dt <Px> = - dv/dx

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UNIT V

30. **What is called a rigid rotator?**

The system consisting of two spherical particles attached together, separated by finite fixed distance and capable of rotating about an axis, passing through the centre of mass and normal to the plane containing the two particles, constitutes, a rigid rotator.

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31. What is zero point energy in harmonic oscillator?

Zero point energy or ground state energy is the lowest possible energy that quantum mechanical system may have

$$E=(n+1/2)\,\hbar\omega \quad , \text{ when } n=0$$

$$E= \tfrac{1}{2}\,\hbar\omega$$

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32.what is Tunnel effect?

The Probability that a particle incident on the barrier from one side will appear other side. such a probability is zero classically, but a finite quantity in quantum mechanics. we thus conclude that if a particle with energy E is incident on a thin energy barrier of height greater than ,there is a finite probability if the particle penetrating the barrier. This phenomenon is called tunnel effect.

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