**PH3151-ENGINEERING PHYSICS**

**PART-A**

**UNIT I: MECHANICS**

**1. Define center of mass.**

Ans: The center of mass of a body is defined as a point where the entire mass of the body appears to be concentrated.

**2. Define torque and mention its unit.**

Ans: Torque is defined as the moment of the external applied force about a point or axis of rotation. The expression for torque is,

τ⃗ = r⃗ x F⃗

**3. What are the conditions in which force cannot produce torque?**

Ans: The forces intersect (or) passing through the axis of rotation cannot produce torque as the

perpendicular distance between the forces is 0 i.e. r = 0.

∴ τ⃗ = r⃗ x F⃗ = 0

**4. What is the relation between torque and angular momentum?**

Ans: We have the expression for magnitude of angular momentum of a rigid body as, L = I ω. The expression for magnitude of torque on a rigid body is, τ = I α. We can further write the expression for torque as,

τ = I dω/dt (∴ α = dω/dt)

where, ω is angular velocity and α is angular acceleration. We can also write equation,

τ = d(Iω)/dt

τ = dL/dt

**5. What is equilibrium?**

Ans: A rigid body is said to be in mechanical equilibrium where both its linear momentum and angular momentum remain constant.

**6. Define angular momentum.**

Ans: Angular momentum of a particle is defined as its moment of linear momentum it is given by the product of linear momentum and perpendicular distance of its line of action from the axis of rotation.

**7. What is the theorem of moment?**

Ans: The Principle of Moments, also known as Varignon’s Theorem, states that the moment of any force is equal to the algebraic sum of the moments of the components of that force.

**8. What is moment of inertia?**

Ans: Moment of inertia is defined as the quantity expressed by the body resisting angular acceleration which is the sum of the product of the mass of every particle with its square of a distance from the axis of rotation. Moment of Inertia is also known as the angular mass or rotational inertia.

**9. Define couple.**

Ans: A pair of forces which are equal in magnitude but opposite in direction and separated by a

perpendicular distance so that their lines of action do not coincide that causes a turning effect is called a couple.

**10. Define center of gravity.**

Ans: The center of gravity of a body is the point at which the entire weight of the body acts, irrespective of the position and orientation of the body.

**UNIT 2 – ELECTROMAGNETIC WAVES**

**1. Define electromagnetic wave?**

Ans: Electromagnetic waves are waves that are created as a result of vibrations between an electric field and magnetic field. In other words, EM waves are composed of oscillating magnetic and electric fields.

**2. Write one dimension wave equations**

Ans: The center of gravity of a body is the point at which the entire weight of the body acts, irrespective of the position and orientation of the body.

**3. Write Maxwell’s equations before electrodynamics.**

Ans: 1. ∇.E = ; 2. ∇.B = 0 ; 3. ∇XB=μ J; 4. ∇XE = −

∂Bs00 ∂t

**4. Write Maxwell’s equations after electrodynamics.**

Ans: 1) ∇.E = ; 2) ∇. B = 0 ; 3) ∇XB − μ ε ∂E = μ

**5. Write electromagnetic wave equations in vacuum**

Ans: 1) ∇. E = 0 ; 2.) ∇. B = 0 ; 3) ∇XB=μ ε

∂E ∂B

; 4) ∇XE = −

0 0 ∂t ∂t

**6. Write Electromagnetic waves speed in vacuum or empty space**

Ans: Electromagnetic waves are travelling in free space at a speed is P =1

√μ0s0

= 3 X 10

8m/s.

**7. What is electromagnetic wave amplitude?**

Ans: In electromagnetic waves, the amplitude is the maximum field strength of the electric and magnetic fields.

**8. Define-Polarization**

Ans: Polarization is a property applying to transverse waves that specifies the geometrical orientation of the oscillations. In a transverse wave, the direction of the oscillation is perpendicular to the direction of motion of the wave is called polarization.

**9. Write three-dimension wave equations.**

Ans: ∇2f =0

**10. Write range of electromagnetic spectrum.**

Ans: The electromagnetic spectrum (EMS) is the general name given to the known range of

electromagnetic radiation. Wavelengths increase from approximately 10 -18 m to 100 km, and this corresponds to frequencies decreasing from 3 × 10

26 Hz to 3 ×10

3 Hz.

**UNIT 3 – OSCILLATIONS, OPTICS & LASERS**

**1. What is periodic motion? Give its example.**

Ans: Any motion that repeats itself after regular intervals of time is known as periodic motion or harmonic motion. Eg: The motion of the hands of a clock is periodic.

**2. What is oscillatory (or) Harmonic motion? Give example.**

Ans: If a body moves back and forth repeatedly about its mean position, then the motion is said to be oscillatory (or) vibratory (or) harmonic motion. Eg: The vibrations of the string of a guitar.

**3. What is meant by Simple Harmonic Motion (SHM)? Give its types and examples.**

* Ans: A particle is said to execute Simple Harmonic Motion (SHM) if its acceleration is directly

proportional to the displacement from the mean position and is always directed towards the mean position.

Eg: Vibrations of a tuning fork.

* Linear simple harmonic motion: Here the displacement of the particle executing simple harmonic motion is linear. Eg: i) Motion of simple pendulum, ii) Motion of point mass suspended with a spring. etc.
* Angular simple harmonic motion: Here the displacement of the particle executing simple harmonic motion is angular. Eg: Oscillations of a compound pendulum, torsional oscillations. etc.

**4. What are free, damped and forced oscillations? (Jan 2018)**

Ans: A system (or) body which vibrates freely without any resistance (even air) (or) Frictional force is

called as free vibrations or oscillations. In general, if a body sets into oscillations or vibrations, the amplitude keeps on decreasing due to air frictional resistance hence after some time the vibrations or oscillations will die. This type of oscillations is called as damped oscillations. The body vibrates at natural frequency.

**Forced oscillations**

If a body is continuously accelerated with external periodic force then the body continues to oscillate under the influence of such external forces. Such oscillations of the body which vibrate with a frequency other than the natural frequency are called forced oscillations.

**5. Distinguish between forced oscillation and resonant oscillations.**

Forced oscillations Resonant oscillations The body vibrates under the influence of external force

which possesses frequency other than natural frequency.

The body vibrates under the influence of external

force which vibrates at natural frequency.The amplitude of the oscillations is moderate. The amplitude of the oscillations is high.Eg: oscillations of simple pendulum, vibrating tuning

fork.

Eg: Pushing a person in a swing, buildings are wrecked during earthquake.

**6. Why army troops not allowed to march in steps while crossing a bridge?**

Ans: Army troops are not allowed to march in steps while crossing a bridge because it is quite likely that the frequency of the footsteps may match with the natural frequency of the bridge, and due to resonance the bridge may pick up large amplitude and break.

**7. What are the types of motion? Give examples.**

Ans: Based on the motion of the physical bodies, it can be classified into two types:

i) Linear motion, in which the motion of the body moves linearly with time. Eg: Train moving in a track, Rocket launching etc.

ii) Rotational or Oscillatory motion, in which the motion of the body repeat itself after regular interval of time. Eg: i) Bob moving in a pendulum clock ii) Beating of Heart iii) Movement of earth around the sun.

**8. Define amplitude and phase.**

Ans: Amplitude: The maximum distance covered by the body on either side of its mean position is called its amplitude.

Phase: It is a physical quantity that expresses the instantaneous position and direction of motion of an oscillating system.

**9. What is meant by critical damped motion? Give examples.**

Ans: During oscillatory motion, when the displacement decreases to zero rapidly, then it is called critical damped motion. Eg: i) Movement of pointer in voltmeter, ammeter etc. ii) Sensitive galvanometer.

**10. What is meant by resonance? Give examples.**

Ans: When the driving frequency (ω) coincides with the natural frequency (ω0), resonance occurs. Eg: i) Collapse of bridges and roads due to earthquake, ii) Shattering of glass due to sound waves.

**UNIT 4 – BASIC QUANTUM MECHANICS**

**1. Write any two drawbacks of classical theory.**

Ans: i) It fails to explain the micro concepts like stability of atoms, photoelectric effect, Compton effect and black body radiation.

ii) According to classical theory the hydrogen spectrum which is assumed to be continuous, is found as discrete experimentally.

**2. What are the merits of quantum theory?**

Ans:

 Specific heat of solids at low temperature can be explained.

 Theory of atomic structure and spectrum of hydrogen can be explained.

 Photoelectric effect, Compton Effect and black body radiation can be explained by this theory.

**3. Define Compton Effect, Compton wavelength and Compton shift. (May 2017 & Jan 2019)**

Ans: When a photon of energy hν collides with a scattering element, the scattered beam has two components, one of the same wavelength as that of the incident radiation and the other has higher wavelength compared to incident wavelength. This phenomenon is called Compton effect and the change in wavelength is called Compton shift.

**4. Explain the variations of Compton shift with respect to the scattering angle.**

Ans: The Compton shift in wavelength increases with the increase in scattering angle as shown below.

Case i) when θ = 0, dλ = 0; scattering is absent,

Case ii) when θ = 45

, dλ = 0.0071 Å; shift in wavelength is minimum,

Case iii)when θ = 90

,dλ = 0.02424 Å; good agreement with the experimental results,

Case iv) when θ = 180

, dλ = 0.0472 Å; shift in wavelength is maximum.

**5. X-rays of wavelength 0.124 Å are scattered by a carbon block. Find the wavelength of scattered beam for a scattering angle of 180**

Ans

= (0.124 × 10−10) + 4.848 × 10−12 = 0.1725 Å

**6. In a Compton scattering experiment, the incident photons have a wavelength of 3× 10**

**-10 m. Calculate the wavelength of scattered photons if they are viewed at an angle of 60**

**to the direction of incidence.(c = 3×10 8 ms -1 ) (Apr 2003)**

Ans:

=(3 × 10−10) + 1.212 × 10−12 = 3.0121 Å

**7. In a Compton experiment, the wavelength of the incident photon is 1A and that of the scattered photon is 1.02 A. Calculate the kinetic energy of the recoiling electron. (Dec 2019)**

Ans: K.E of the recoiling electron = hP − hP′ = hc −

= 6.626x10

**8. What are matter waves?**

= 3.9x10

-17 J

1×10

−10 1.02×10

−10

Ans: The waves associated with the matter particles (electrons, photons) are known as matter waves.

2mE

2meV

3mKBT

**9. What is meant by Photon? Give any two properties.**

Ans:

Definition: The quanta packet of discrete energy of definite frequency (or) wavelength is known as

photon.

 They do not have any charge and they will not ionize gases.

 The energy and momentum of the photon is given as E = hν and p = mc.

**10. State de – Broglie’s hypothesis and how he justified.**

Ans:

 Our universe is fully composed of light and matter.

 Nature loves symmetry. If radiation like light can act as wave and particle, then material particles can

also act like particle and a wave.

 Every moving particle is associated with a wave.

**UNIT 5 – APPLIED QUANTUM MECHANICS**

**1. What is mean by harmonic oscillator in quantum mechanics?**

Ans: A harmonic oscillator (quantum or classical) is a particle in a potential energy well given

by V(x)=1⁄2kx2. k is called the force constant. It can be seen as the motion of a small mass attached to a string, or a particle oscillating in a well-shaped as a parabola.

**2. What do u mean by zero point energy?**

Ans: unlike the classical harmonic oscillator, not only are there discrete levels but the ground state does not have zero energy, rather a finite amount (1⁄2ħω). This minimal amount of energy is known as the zero point energy.

**3. A macroscopic pendulum has ω=1 s -1 , m=1 kg and total energy 0.1J. What would be its quantum number if described quantum mechanically?**

Ans: EV = (1⁄2 + v) ħω → v = Ev ÷ ħω - 1⁄2 = 0.2 ÷ (1.05 x 10 -34 x 1) - 1⁄2

≈ 1.90 x 10

33(i.e very large).

4**. Is there a zero point energy for the particle in the box & free particle?**

Ans:

 Yes for a particle in the box.

 No for free boundaries because quantization derives from the boundary condition. Without

boundaries, there is no quantization and E = 0 is allowed.

**5. Give an expression for the energy levels of the quantum harmonic oscillator.**

Ans: The energy levels of the quantum harmonic oscillator are

**6. Can we simultaneously measure position and energy of a quantum oscillator? Why? Why not?**

Ans: Yes, within the constraints of the uncertainty principle. If the oscillating particle is localized, the momentum and therefore energy of the oscillator are distributed.

**7. Can a quantum particle ‘escape’ from an infinite potential well like that in a box? Why? Why not?**

Ans: No, the restoring force on the particle at the walls of an infinite square well is infinity.

**8. What decreases the tunneling probability most: doubling the barrier width or halving the kinetic energy of the incident particle?**

Ans: Doubling the barrier width

**9. Describe tunneling effect.**

Ans: In Quantum mechanics a particle having lesser energy (E) then the barrier potential (V) can easily cross the potential barrier having a finite width ‘L’ even without climbing over the barrier by tunneling through the barrier. This process is called tunneling.

**10.What is the principle of Scanning Tunneling Microscope (STM)?**

Ans: When a conducting tip is brought very near to the surface to be examined, a bias (voltage difference) applied between the two can allow electrons to tunnel through the vacuum between them.