Techno India Batanagar
Basic Science and Humanities

Model Questions

Subject Name: Physics **Subject Code:** PH 201

Multiple Choice Questions

1) Lissajous figure obtained by superposition of two mutually perpendicular SHMs having phase difference$\frac{\pi}{2}$, and same amplitude should be
(a) Elliptical, (b) Circular, (c) Straight linear, (d) Hyperbolic

2) $\frac{d^2x}{dt^2} = \mu x$is an example of equation of motion of a
(a) SHM, (b) Object under friction, (c) Projectile motion, (d) can be any of these

3)Time period in a gravity free atmosphere for a SHM should be
(a) Zero, (b) One, (c) Infinite, (d) Undefined

4) Three springs of force constant 3K each are joined forming a single spring, its spring constant is (a) 9K, (b) 27K (c) 3K, (d) K

5) Time period of a SHM having solution $x = 15\ Sin\ \left(\frac{\pi}{3}t + \frac{\pi}{15}\right)$ cm is
(a)30s (b) 1s (c) 6s, (d) 3s

6) The natural frequency of a SHM having differential equation $\frac{d^2x}{dt^2} + \omega^2 x = 0$ is given by
(a) ω^2 (b)$\frac{\omega^2}{2\pi}$(c)$\frac{\omega}{2\pi}$(d)$\frac{\omega}{\pi}$

7) The maximum velocity of a body of 2g mass in SHM having solution$x = 10Sin\ \left(\frac{\pi}{3}t + \frac{\pi}{15}\right)$ is
(a) 10.5 cm/s, (b) 0 cm/s (c) 5.25 cm/s (d) 2 cm/s

8) The phase difference between velocity and displacement in case of SHM is
(a)0^o (b) 90^o (c)180^o(d)-90^o

9) The total mechanical energy that can be obtained by a particle of mass m, amplitude a and angular frequency ω is given by
(a)$\frac{1}{2}m\omega^2$ (b)$\frac{1}{2}ma^2\omega^2$ (c)$\frac{1}{2}ma\omega^2$ (d)$\frac{1}{2}mv^2\omega^2$

*(10)*In SHM of a simple pendulum, component of weight which is directed towards mean position is
(a) mgcosθ, (b) mg sinθ (c) mg tanθ (d) mg cotθ

*(11)*In Hooke's Law, F = -k x, constant *k*is the
(a) velocity, (b) speed constant(c) spring constant (d) time

*(12)*In SHM, velocity at equilibrium position is
(a) minimum (b)constant (c)maximum (d)zero

*(13)*For SHM, maximum speed is proportional to
(a)wavelength (b)acceleration (c)time (d)frequency

*(14)*Magnitude of gradient of a-x graph is
(a)ω (b)ω^2 (c)$\omega/2$ (d)ω^3

*(15)*In SHM, object's acceleration depends upon
(a)displacement from equilibrium position
(b)magnitude of restoring force
(c)both A and B
(d)force exerted on it

*(16)*If time period of an oscillation is 0.40 s, then it's frequency is
(a)2 Hz (b)2.5 Hz (c)3 Hz (d)3.5 Hz

*(17)*An object moving in a circle of radius ‘r’ with a constant speed ‘v’ has a constant acceleration towards center equal to
(a)v^2/r (b)v/r (c)$v^2 \times r$ (d)$v \times r$

*(18)*Equation of a simple harmonic motion is given as $x = 3 \sin 20\pi t + 4 \cos 20 \pi t$. The amplitude is:
(a) 7 cm (b) 4 cm (c) 5 cm (d) 3 cm

*(19)*14. A particle at the end of a spring executes simple harmonic motion with a period t1, while the corresponding period for another spring is t2. If the period of oscillation with the two springs in series is T, then

(a) $T = t1 + t2$ (b) $T^2 = t1^2 + t2^2$(c) $T^{-1} = t1^{-1} + t2^{-1}$ (d) $T^{-2} = t1^{-2} + t1^{-2}$

*(20)*A particle is subjected to two mutually perpendicular SHM such that x = 2 sin ωt and y = 2 sin [ωt + (π/4). The path of the particle will be:

(a) An ellipse (b) A straight line (c) A parabola (d) A circle

21) Oscillations become damped due to

(a) Normal force (b)friction (c)tangential force (d) parallel force

22) As amplitude of resonant vibrations decreases, degree of damping

(a) increases (b)remains same (c) decreases (d)varies

23) In which type of vibrations, amplitude of vibration goes on decreasing every cycle?

a) Damped vibrations b) Undammed vibrations c) SHM d) each of the above

24) calculate logarithmic decrement if damping factor is 0.33.

(a) 1.36 (b) 3.23 (c) 5.16 (d) 2.19

25) Determine logarithmic decrement, if the amplitude of a vibrating body reduces to 1/6th in two cycles.

(a) 0.223 (b) 0.8958 (c) 0.3890 (d) None of the above

26) For low damping when the frequency of the applied periodic force is equal to the natural angular frequency of the body then the phase difference between the displacement and applied force is given by

(a) π (b) 2π (c) π/2 (d) 0

27) In case of velocity resonance, the maximum velocity is

(a) $v_{max} = \frac{2f}{\omega k}$, (b) $v_{max} = \frac{f}{2k}$, (c) $v_{max} = \frac{2f}{\omega}$, (d) $v_{max} = \frac{\omega}{2k}$

28) Restoring constant ω is related to quality factor Q by

(a) $\omega = \frac{Q}{\tau}$, (b) ω = Qτ, (c) τ = Qω, (d) Q = τ + ω

29) The differencein phase between the driver and driven system at velocity resonance is

(a) 2π, (b) π/2, (c) 0, (d) π.

30) The equation of motion for a vibrating system with viscous damping is $\frac{d^2x}{dt^2} + \frac{c}{m}\frac{dx}{dt} + \frac{s}{m}x = 0$

If the roots of this equation are real, then the system will be

a) over damped b) under damped c) critically damped d) none of the mentioned

31) In under damped vibrating system, if x_1 and x_2 are the successive values of the amplitude on the same side of the mean position, then the logarithmic decrement is equal to
a)x_1/x_2 b)$\log(x_1/x_2)$ c)$\log_e(x_1/x_2)$ d) $\log(x_1.x_2)$

32) Two waves having intensities in the ratio of 9:1 produce interference. The ratio of maximum intensity to minimum intensity is equal to
(a) 10:8, (b) 9:1, (c) 16:9, (d) 4:1.

33) In Fraunhofer diffraction the incident wavefront is
(a) plane, (b) circular, (c) cylindrical, (d)spherical.

34) The resolving power of a grating, having N number of total rulings, in the n^{th} order is
(a) n/N, (b) nN, (c) n+N, (d) none of these.

35) Fringe width of interference pattern is (where symbols have their usual meaning)
(a)$\frac{d\lambda}{D}$, (b) $\frac{\lambda}{dD}$, (c) $\frac{\lambda D}{d^2}$, (d) $v_{max} = \frac{D\lambda}{d}$

36) Intensity at a point in Fraunhofer diffraction by a single slit is given by (where symbols have their usual meaning)
(a) $I = I_0 \frac{\sin^2\alpha}{\alpha^4}$ (b) $I_0 = I \frac{\sin^2\alpha}{\alpha^2}$ (c) $I = I_0 \frac{\sin^2\alpha}{\alpha^2}$ (d) $I = I_0 \frac{\sin^4\alpha}{\alpha^4}$

37) If the wavelength of the light used in single slit Fraunhofer diffraction experiment is increased then the width of the central maximum-
(a) Remains same, (b) Decreases in constant fraction, (c)Increases in constant fraction, (d)Increases in the ratio of the wavelengths

38) Two sinusoidal waves of same frequency and having amplitudes A_1 and A_2 respectively superpose coherently. The ratio of the maximum intensity and the minimum intensity of the resultant wave is
(a) $\frac{A_1^2 + A_2^2}{A_1^2 - A_2^2}$ (b) $\frac{A_1^2 - A_2^2}{A_1^2 + A_2^2}$ (c) 1 (d) $\frac{(A_1 + A_2)^2}{(A_1 - A_2)^2}$

39) Constructive interference happens when two waves are
(a)out of phase (b)zero amplitude (c)in phase (d)in front

40) Two waves with phase difference 180° have resultant of amplitude
(a)one (b)zero (c)same as single wave (d)doubles single wave

41) Extra distance travelled by one of waves compared with other is called
(a) path (b)displacement (c)phase difference (d)path difference

42) For destructive interference, path difference is
(a)odd number of half wavelengths (b)even number of half wavelengths
(c)whole number of wavelengths (d)even whole number of wavelengths

43) Interference of light is evidence that:
a) the speed of light is very large b) light is a transverse wave c) light is electromagnetic in character d) light is a wave phenomenon

44) In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:
a) a fourth of a wavelength b) a half a wavelength c) a wavelength d) three-fourths of a wavelength

45) In a Young's double-slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to:
a) D/2 b) $D/\sqrt{2}$ c) $D\sqrt{2}$ d) 2D

46) When a light wave is reflected at the surface of an optically denser medium, then the change in the phase difference is
a) $\pi/4$ b) $\pi/2$ (c)2π (d) 4π

47) Interference due to reflected light is also called _____ law
a) sine law b) cosine law c) Tangent law c) Cotangent law

48)If a1 and a2 are the amplitudes of light coming from two slits in Young's double slit experiment, then the maximum intensity of interference fringe is
a) (a1 + a2) b) 2(a1 + a2) c) $(a1 + a2)^2$ d) $(a1 – a2)^2$

49) The fringe width (β) of the interference pattern in the Young's double slit experiment increases _____ distance between the slits and the screen.
a) With increase in b) With decrease in c) independent of d) with both increase and decrease in

50) Correlation between the field at a point and field at the same point at later time is known as
a) Temporal coherence b) coherence c) Spatial coherence d) none of these

Short answer type questions

51) Express the differential equation of a series LCR circuit driven by a sinusoidal voltage. Explain each term.

52) Show that the motion of a particle represented by $y = \sin \omega t - \cos \omega t$ is simple harmonic with a period of $2\pi/\omega$.

53) Find the displacement of a simple harmonic oscillator at which its P.E. is half of the maximum energy of the oscillator.

54) A body of mass m is situated in a potential field $U(x) = U(1-\cos \alpha x)$ when U and α are constants. Find the time period of small oscillations.

55) Consider a pair of identical pendulums, which oscillate with equal amplitude independently such that when one pendulum is at its extreme position making an angle of 2° to the right with the vertical, the other pendulum makes an angle of 1° to the left of the vertical. What is the phase difference between the pendulums?

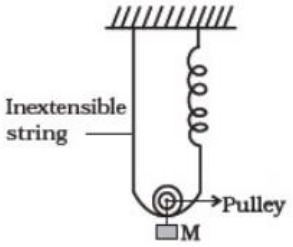
56) What is the ratio between the distance travelled by the oscillator in one time period and amplitude?

57) The length of a second's pendulum on the surface of Earth is 1m. What will be the length of a second's pendulum on the moon?

58) Calculate the relaxation time of a damped oscillator having energy E_0=100 joule and damping coefficient b =$2s^{-1}$. Write down differential equations for an oscillator executing free, damped and forced vibration

59) A mass of 2 kg is attached to the spring of spring constant 50 Nm. The block is pulled to a distance of 5cm from its equilibrium position at x = 0 on a horizontal frictionless surface from rest at t = 0. Write the expression for its displacement at any time t.

60) Find the time period of mass M when displaced from its equilibrium position and then released for the system shown in figure below



61) What is temporal coherence? If diameters of 4^{th} and 7^{th} Newton's dark rings are 0.42 cm and 0.58 cm, and the radius of curvature of the lens is 80 cm, determine the wavelength of the light used.

62) Distinguish between Fresnel and Fraunhoffer diffraction?

63) Due to interference of two waves, the energy becomes zero at some points, Is this energy is dissipated? Explain in short.

64) What are the differences between Newton's ring and Wedge-film fringes?

65) Two light waves of equal intensity interfere. How many times is the intensity at a bright fringe as compared to the intensity of other wave?

66) Write down the expression for the area of a half period zone for- a) plane wave front b) spherical wave front? Explain the meaning of the symbols used.

67) Explain the statement 'Newton's rings are the fringes of equal thickness.'

68) What is meant by interference of light? State the fundamental conditions for the production of interference fringes.

69) Discuss the phase change on reflection of light on the basis of stokes treatment?

70) Prove the relation $\lambda = [D_m^2 - D_n^2] / 4(m - n)R$, where the symbol have their usual meaning.

71) In a Newton's ring experiment the diameter of the 10th ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate? Calculate the refractive index of the liquid.

72) A grating has 20,000 lines per cm. Can it be used to measure the wavelength of X- rays? Give a reason to your answer.

73) Two waves of amplitudes 3 mm and 4 mm respectively travel in the same medium and in the same direction. If the phase difference between these waves at a point in their path is $\pi/2$, what will be the resultant amplitude at that point due to these waves?

74) Write down only the conditions for the constructive and destructive interference in the reflected and transmitted parts due to a film of thickness t and refractive index μ?

75) What will be the order of spectrum for normal incidence ($\theta = 90^o$) of parallel beam of light of wavelength 5000 A0 on a grating having 7000 lines per cm?

76) What is polarizing angle? Does it depend upon the wavelength of light ?
77) What is polarizer and analyzer?
78) Define Brewster's law with a diagram. The critical angle of water is 48^o. What is the polarizing angle?
79) What is polarization?. What is double refraction in crystals?
80) What is Nicol prism? What are ordinary and extra-ordinary rays? Define optic axis and principal section of the crystal
81) What is the requirement to produce laser beam? What do you understand by population inversion? What are the various techniques of optical pumping?
82) Distinguish between spontaneous and stimulated emissions?
83) What are transition probabilities?
84) What are the characteristic of laser radiation?
85) Write down some applications of LASER.
86) Express the energy of the scattered photon in terms of energy of the incident photon and the scattering angle.
87) What is maximum possible Compton shift for scattering of gamma rays from free electrons?
88) For a Compton scattering experiment, estimate the lowest energy that an incident photon may have, if it transfers half of its energy to an electron initially at rest.
89) Compute kinetic energy of the recoiling electron in Compton scattering if the wavelength of the incident photon is 3 angstrom and the scattering angle is 90 degree.
90) In a Compton scattering experiment, the wavelength of scattered X-rays for scattering angle of 45 degree is found to be 0.024 angstrom. (a) What is the wavelength of the incident photon? (b) What is the percentage change in the wavelength on Compton scattering?
91) Calculate the maximum change in the wavelength of an incident photon of wavelength 0.1 nm in a Compton scattering experiment.
92) In a Compton scattering experiment with X-rays, the Compton shift at scattering angle 90 degree is found to be 0.0242 angstrom. Assume that the Planck's constant and speed of light in vacuum is known. Estimate the rest mass of an electron.
93) Find de Broglie wavelength of an electron of kinetic energy (a) 1 keV; (b) 1 MeV.
94) The kinetic energy of an electron is 1GeV. What is its de Broglie wavelength?
95) A thermal neutron has speed corresponding to the average thermal energy at the temperature T= 300 K. Compute its de Broglie wavelength.
96) What is a Crystal? (or) What are crystalline materials? Give examples?
97) Define space lattice (or) crystal lattice
98) What do you mean by crystallographic axis? Define unit cell and lattice planes
99) Define Atomic packing factor (or) Packing density (or) density of packing
100) State the condition imposed on the coll parameter for systems having the largest number of bravais lattices the least number of nearest neighbors.

Long answer type questions

101) Establish the differential equation for damped harmonic motion. Show graphically, the variation of amplitude of forced vibration with respect to frequency for different values of damping factors. What is quality factor?

102) Show that the time period of oscillation of a liquid in a 'U' shaped tube is independent of mass of the liquid. Find time period if the mass of liquid is 9g and density is 13.6 g/cc and the internal diameter of the U tube is 1.2 mm.

103) If an LCR circuit is driven by an e.m.f. of $E = E_0 e^{ipt}$ (symbols having usual meaning), find out the solution for the charge in the circuit comparing with mechanical vibration. What are velocity and amplitude resonance?

104) A body of mass m is attached to one end of a massless spring which is suspended vertically from a fixed point. The mass is held in hand so that the spring is neither stretched nor compressed. Suddenly the support of the hand is removed. The lowest position attained by the mass during oscillation is 4cm below the point, where it was held in hand.
(a) What is the amplitude of oscillation?
(b) Find the frequency of oscillation?

105) A cylindrical log of wood of height h and area of cross-section A floats in water. It is pressed and then released. Show that the log would execute S.H.M. with a time period $T = 2\pi\sqrt{\frac{m}{A\rho g}}$

106) A tunnel is dug through the centre of the Earth. Show that a body of mass 'm' when dropped from rest from one end of the tunnel will execute simple harmonic motion.

107) A mass of 0.1 kg is suspended by a light spring of spring constant 120 $N.m^{-1}$. If the spring oscillates under a retarding force per unit velocity of 2 $N.m^{-1}.s$ and a driving force of $F = 4\cos 50t$ N find the amplitude of oscillation.

108) A cylindrical block of length l, radius r and density ρ is floating in a liquid of density σ (σ > ρ).The block is slightly depressed and released. Show that it will execute simple harmonic motion and hence determine the frequency of oscillation.

109) Write down the differential equation of a series LCR circuit driven by a sinusoidal voltage. Identify the natural frequency of the circuit. Find out the condition that this circuit will show an oscillatory decay.

110) A person normally weighing 50 kg stands on a massless platform which oscillates up and down harmonically at a frequency of 2.0 s –1 and an amplitude 5.0 cm. A weighing machine on the platform gives the persons weight against time.
(a) Will there be any change in weight of the body, during the oscillation?
(b) If answer to part (a) is yes, what will be the maximum and minimum reading in the machine and at which position?
111) Discuss the formation of Newton's ring by i) reflected light ii) transmitted light.
112) Give the theory of Fraunhoffer diffraction due to single slit and discuss the intensity distribution on the screen.
113) Derive the expression for the resultant intensity in a single slit Fraunhofer diffraction process.Hence show that the intensity of the 1st order secondary maxima is nearly 4.5% of the principal maxima.
114) How will you determine refractive index of a transparent liquid using Newton's ring experiment? A diffraction grating, 2 cm width is just able to resolve sodium D-lines (having wavelengths 589 nm & 589.6 nm) in second order. Find the number of rulings per mm.
115) Graphically show the intensity curves for Fraunhofer single slit diffraction and show that intensities of maxima(s) decrease with order number.
116) State the conditions for sustained interference in Young's double slit experiment. Find the missing orders for double slit diffraction if the slits of width 0.012 cm are separated by 0.48 mm.
117) Give the theory of plane transmission grating.
118) Describe the method for determination of- Wavelength of light & Refractive index of liquid, using Newton's ring.
119) Obtain the condition $2\mu t\cos(\beta + \gamma) = n\lambda$ for destructive interference in a thin 68 wedge shaped film?
120) A diffraction grating, 2 cm width is just able to resolve sodium D-lines (having wavelengths 589 nm & 589.6 nm) in second order. Find the number of rulings per mm.
121) State the Rayleigh's criterion. What is the minimum number of lines a grating should require to just resolve 4^{th} order spectrum of two lines having wavelengths 6000Å and 5996Å.
122) What do mean by the following terms. a) Population inversion b) Pumping c) Metastable state. Explain in detail the process of stimulated emission? Draw a neat diagram of ruby laser. Explain its operation.

123) Explain in detail the process of stimulated emission. Draw a neat diagram of ruby laser. Explain its operation

124) Explain the operation of He-Ne gas laser. Draw its schematic diagram. Describe how stimulated emission takes place with the exchange of energy between the Helium and Neon atoms.
125) Write notes on Ruby LASER? Compare spontaneous emission and stimulated emission.
126) Derive the relation between Einstein's A-B coefficient in LASER.

127) Describe the construction, action of Nicol prism as polarizer and analyzer.
128) Find the speed of an electron whose de Broglie wavelength is 2 pm.

129) Derive Wien's displacement law from Planck's radiation law. Write down de Broglie Hypotheis explaining each term.

130) Derive Rayleigh Jeans law from Planck's radiation law. Write down de Broglie Hypotheis explaining each term.

131) Derive Stefan's law from Planck's radiation law. Write down de Broglie Hypotheis explaining each term.

132)What is Compton effect? Derive an expression for change in wavelength of scatterec photon during Compton scattering.

133) Explain Ultraviolet Catastrophe and derive Planck's Black body Radiation formula.

134) A 200 MeV photon strikes a stationary proton (rest mass 931 MeV) and is back scattered. Find the kinetic energy of the proton after the scattering

135) Is Compton effect easier to observe with I.R., visible, UV or X-rays ? In a Compton scattering experiment the scattered electron moves in the same direction as that of the incident photon. In which direction does the photon scatter?

136) A photon scatters from a proton, initially at rest. After the collision, the proton is found to scatter at an angle of 30 with the original direction of the incident photon with a kinetic energy of 100 MeV. Find (i) the initial energy of the photon and (ii) the angle through it is scattered

137) A photon has the same wavelength as the Compton wavelength of an electron. What is the energy of the photon in eV?

138) What is phase velocity and Particle velocity? Using the Heisenberg uncertainty principle find the zero-point energy of a simple harmonic oscillator.

139) Show that in a cubic crystal of side L, the interplaner spacing between consecutive parallel planes of Miller indices (hkl) is

$$d_{hkl} = \frac{L}{\sqrt{h^2 + k^2 + l^2}}$$

Find the atomic packing factor for body centered cubic crystals. Calculate the lattice constant of a substance having *fcc*lattice, molecular weight 60·2 and density 6250 kg/m^3. Avogadro

number = $6{\cdot}02 \times 10^{23}$

140) Deduce the formula for interplanar spacing of a simple cubic lattice
141) A beam of x-ray having wavelength 0.084 nm is diffracted by a crystal at an angle of 8.35o and cause first order diffraction, calculate the angle of third order diffraction.
142) What is Bremsstrahlung? Is bremsstrahlung radiation (braking radiation) also in the electromagnetic spectrum? If so, does it have a higher or lower frequency than X-ray? How is it similar to X-ray?

143) How are X-rays obtained from an accelerator?
144) What is characteristic x-ray? Describe its origin
145) How are the characteristic X-ray spectra generated? If an X-ray tube is subjected to a potential difference of 50 kV, then find out the minimum wavelength of the X-ray produced.
146) What is reciprocal lattice? Show that the reciprocal lattice of a body centered cubic (BCC) lattice is also a face centered cubic (FCC) lattice. How many Bravais lattices are there in Cubic system?
147) Deduce the relation between group velocity and phase velocity for a de-Broglie wave. The minimum uncertainty in position measurement of an electron in a nucleus is 2.5×10-21 Kg.m.s^{-1}. Find the maximum uncertainty in the position measurement.
148) What is Miller indices, explain with example, describe its utilities.
149) A metal having FCC structure and atomic radius 0.13 nm. Calculate its interplanar spacing for (111) plane.
150) Determine Miller indices of a plane having intercepts of a, b/2 and ∞ on the a,b,c axes respectively.