MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Sample Question Paper

Subjest: PHYSICS-I **Paper Code: BS-PH 101**

2022-23

***Time Allotted* : 3 Hours** ***Full Marks* : 70**

The figures in the margin indicate full marks

GROUP-A
(Multiple Choice Questions)

Answer any ten of the following ***10 × 1 = 10***

. 1. (i) The ratio of limiting friction and reaction is known as
a) Coefficient of friction b) Angle of friction
c) Angle of repose d) Sliding friction

(ii) The value of a for which $\vec{A} = \hat{\imath}2ax + \hat{\jmath}2y + \hat{k}4z$ is solenoidal is equal to
a) 2 b) 3 c) -3 d) 1

(iii) A body is resting on a plane inclined at an angle of 30^0 to horizontal. What force would be required to slide it down, if the coefficient of friction between body and plane is 0.3?
a) Zero b) 1 Kg c) 5 Kg
d) Would depend on weight of the body

(iv) When the frequency (p) of applied force and the natural frequency of vibration (ω) are equal then the value of maximum amplitude is
a) $\frac{f}{\sqrt{2kp}}$ b) $\frac{f}{2kp}$ c) $\frac{f}{2k}$ d) None of these

(v) The resolving power of a grating, having N number of total rulings, in nth order is
a) n/N b) nN
c) N/n d) none of these

(vi) A beam of unpolarised light of intensity I_o is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is:

a) $\frac{I_0}{2}$ b) $\frac{I_0}{4}$ c) $\frac{I_0}{8}$ d) I_o

(vii) Which of the following wave function is the solution of Schrödinger equation?

a) $A\sec x$, b) $A\tan x$, c) Ae^{-x^2} d) None of these

(viii) The operator corresponding to linear momentum (p) for a particle moving along the X- axis is

a) $\hat{p}_x = i\eta\frac{\partial}{\partial x}$, b) $\hat{p}_x = -i\eta\frac{\partial}{\partial x}$, c) $\hat{p}_x = \frac{1}{i\eta}\frac{\partial}{\partial x}$

(ix) Wien's displacement law could explain the distribution of thermal radiation in the spectrum of blackbody radiation in the region of

a) higher wavelength b) lower wavelength

c) middle wavelength d) none of these

(x) The Compton wavelength is

a) $\frac{h}{m_0 C}$ b) $\frac{h}{m_0 C^2}$ c) $\frac{h}{m_0 C^3}$ d) $\frac{h}{m_0 C^4}$

(xi) The number of macrostates for N particles in M-B distribution are

a) N+1 b) N c) N-1

(xii) The number of possible arrangements of two fermions in three cells is

a) 9 b) 6 c) 3 d) 1

(xiii) If the Fermi energy of a metal at thermal equilibrium is 15 eV then the average energy of the electron is

a) 9 eV b) 10 eV c) 5 eV

(xiv) The ferromagnetic susceptibility is given by

a) $\chi = \frac{C}{T+T_c}$ b) $\chi = C(T + T_c)$ c) $\chi = \frac{C}{T-T_c}$ d) $\chi = \frac{CT}{T+T_c}$

(xv) The relative permeability is related to magnetic susceptibility by

a) $\mu_r = 1 - \chi$ b) $\mu_r = \chi - 1$

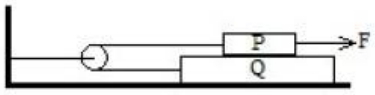
c) $\mu_r = \frac{1}{\chi}$ d) $\mu_r = \chi + 1$

Group B

(Short Answer Type Questions)

Answer any three of the following **3 × 5 = 15**

2. Two masses P and Q equal to m_1 and m_2 respectively are connected to one another via a mass less string passing over a pulley as shown in the figure. Mass Q rests on a fixed horizontal surface. If μ is the coefficient of friction between any two surfaces, show that the minimum force F needed to keep P and Q moving with uniform speed is $\mu(3m_1 + m_2)$ g. 5



3. (a) How Fraunhofer diffraction differs from Fresnel diffraction? 2
(b)Write the expression for intensity due to Fraunhofer diffraction at double slit and hence find the conditions for maxima and minima. 3

4. (a) Find the directional derivative of $\phi = x^2yz + 4xz^2$ at (1, -2, -1) in the direction $(2\hat{\imath} - \hat{\jmath} - 2\hat{k})$. 3

(b) Prove curl(gradϕ) = 0 2

5. Obtain the differential equation of SHM and hence solve it for a situation, when the motion is started by giving some initial displacement. 5

6. (a) Explain why an electron cannot be scattered at an angle greater than 90° in Compton scattering. 2
(b) Find the change in wavelength of an X-ray photon when it is scattered through an angle of 135° by a free electron. Use approximate value of the constants. 3

Group C

(Long Answer Type Questions)

Answer any three of the following **3 × 15 = 45**

7. (a) Determine the moment of inertia of a disc having uniform mass density, with total mass M and radius R, about an axis passing through the center and perpendicular to its plane. 3
(b) Two identical discs each of mass 2 kg and radius 20 cm are revolving about their axis one with angular speed 10 radian/sec and another with 5 radian/sec. If one of the disc is

gently placed on other having same axis, then find the final angular speed with which both will rotate after some time. 3

(c) What is the physical significance of the logarithmic decrement of a damped oscillatory system? 2

(d) In damped harmonic motion, calculate the time in which the energy of the system falls to $\frac{1}{e}$ times of its initial value. 3

(e) The equation for displacement of a point of a damped oscillator is given by, $x = 5e^{-0.25t}\sin\left(\frac{\pi}{2}\right)t$ m. Find the velocity of the oscillating point at $t = \frac{T}{4}$ and T, where T is the time period of oscillator. 4

8. (a) Write three basic differences between interference and diffraction. 2

(b) State and explain Brewester's law of polarization by clearly indicating the nature of polarization of the reflected and refracted rays. 3

(c) What is population inversion in case of LASER. Explain briefly the various ways by which population inversion is achieved. 1+2

(d) What is the minimum number of lines of a grating which resolve the 3rd order spectrum of two lines having wavelengths of 6000 ´ and 6004 ´. 3

(e) A tube of 10cm length filled with a solution of cane sugar with concentration 0.2g/cc is placed in the path of a polarised light. If the specific rotation of cane sugar is 65^o, then find the angle of rotation of the plane of polarization. 4

9. (a) Show that $K = (1 + \chi_e)$, where K and χ_e are the dielectric constant and electric susceptibility of the medium respectively. 3

(b) A dielectric slab of flat surface with relative permittivity (or dielectric constant) 3 is disposed with its surface normal to a uniform field of flux density 1.6 $C.m^{-2}$. The slab occupies a volume of 0.08 m^3 and is uniformly polarized. Determine: (i) the polarization in the slab and (ii) the total dipole moment of slab. 3

(c) What do you mean by hysteresis, remanence and coercivity of ferromagnetism? 3

(d) Distinguish among dia-magnetism, para-magnetism, and ferromagnetism. 3

(e) In hydrogen atom an electron 'e' revolves round the nucleus at the distance r meter with an angular velocity 'ω' radians. Obtain magnetic moment associated with it due to its orbital motion. 3

10. (a) State Rayleigh-Jeans law of black body radiation. What is ultraviolet catastrophe? 1+2

(b) Explain the phenomenon of Compton effect. Show that it is impossible for a photon to give all of its energy to the electron. 1+2

(c) An x-ray photon is found to have its wavelength doubled on being scattered through 90^0. Find the wavelength and energy of the incident photon. 2+2

(d) What do you mean by matter wave? State de Broglie`s Hypothesis. Prove that de Broglie

wavelength of a gas molecule at temperature T is $\frac{h}{\sqrt{3mkT}}$. 1+1+3

11. (a) Define canonical and micro-canonical ensemble. 2

(b) Draw the Fermi distribution function at (i) $T = 0$ K and (ii) $T_1 > T_2 > 0$ K. 2

(c) Show that both F-D and B-E statistics approach M-B statistics at a certain limit. 3

(d) Show that the average energy of an electron in a metal at $T = 0$ is $\frac{3}{5}\varepsilon_F$ where ε_F is the Fermi energy. 3

(e) There are two particles in three quantum states g_i = 1, 2, 3. Distribute the particles according to MB, BE and FD statistics. 2+2+1