INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date: **.11.2011 ( )** Time: **3 Hrs.** Full Marks: **80** Deptt: **Physics & Meteo.**

No. of Students____**630**_____, End Autumn Semester Examination

Sub. No. _____**PH_11001**_____ Sub. Name____**Physics-I**_____

The paper contains 11 questions in one page. Each question carries10 marks. ***Answer ANY EIGHT (8).***

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1. A grating has 800 lines/cm. Calculate the minimum width of the grating required to resolve the components of Sodium D-lines of wavelengths 5890 Å and 5896 Å respectively in the 2nd order.
2. For oblique incidence, the grating equation is $d(\sin\theta_i+\sin\theta_m) = m\lambda$, where θ_i and θ_m are respectively the angles of incidence and m^{th} order diffraction. What is the angle of minimum deviation for m^{th} order diffraction? If the angle of minimum deviation in the 1st order spectrum is 20^0 for mercury blue line of λ= 4358 Å, determine the number of lines per cm of the grating.
3. Write down the Schrodinger's equation for a free electron. Obtain the solution that describes the wavefunction for the free electron. Determine the electron's de Broglie wavelength and momentum (in terms of c) when k =50 nm^{-1}.
4. Explain how a Michelson interferometer is used to find the difference in wavelengths of D_1 and D_2 lines in Na-spectrum. The displacement of the movable mirror between two consecutive positions of maximum distinctness for D_1 and D_2 lines is found as 2.89×10^{-5} cm. Calculate $\Delta\lambda$.
5. Consider a plane wave of λ=0.60 μm incident normally on a long narrow slit of width 0.02 cm. The Fraunhofer diffraction pattern is observed on the focal plane of a lens of focal length 20 cm. Determine the positions and relative (as compared with the central maxima) intensities of the 1st and 2nd maxima.
6. A Compton collision occurs in which the photon is back-scattered *i.e.*, making an angle of 180^0 with the direction of incident photon. The scattered photon has **half** the energy of the incident photon. Find the wavelength of scattered photon in terms of Compton wavelength λ_c= h/m_0c. Calculate the de Broglie wavelength of the scattered electron.
7. Consider a double-slit diffraction pattern with a = 0.008 cm and b = 0.07 cm and λ = 0.6328 μm. Determine the number of minima between the two 1st order diffraction minima on either side of the principal maxima.
8. A thermal neutron has a speed v at temperature T=300K and kinetic energy given by ½ mv^2 =3kT/2. Calculate its de-Broglie wavelength. What should be the inter-planar separation of a crystal for this beam of neutrons to be used for carrying out diffraction experiment? Assume m =1.67 x 10^{-27} kg and k=1.38 x 10^{-28} $m^2kgs^{-2}K^{-1}$.
9. A particle is in the ground state of an infinite potential well with length L. Calculate the probability that this particle will be found in the middle-half of the well, that is between x = L/4 to x = 3L/4.
10. Using Heisenberg's uncertainty principle estimate the minimum energy of a particle in one-dimensional simple harmonic potential, $V(x)$= ½ kx^2 such that total energy is E= K.E.+P.E.= ½ p_x^2/m + ½ kx^2.
11. The reflection coefficient of the two mirrors of a Fabry-Perot interferometer is r = 0.8 and the mirror separation is d = 2.5 cm. What are the nearest wavelengths on either side of λ = 5000 Å that can be resolved by this etalon?
