Mahindra University Hyderabad

École Centrale School of Engineering

Minor-I exam

Program: B. Tech. **Branch: All** **Year: 1** **Semester: 2**

Subject: Physics 1 (PH1201)

Date: 18.04.24 **Start Time: 10 am**

Time Duration: 1.5 Hours **Max. Marks: 60**

Instructions:

1) **All the questions are compulsory**
2) **Calculator is allowed**
3) **Values of useful constants are given at the end of the question paper.**

Q1 (10 + 10)

(a) A block of mass 10 kg is attached to a spring with spring constant k = 10 N/m? What is Block's period of oscillation?

The block is held at rest at a position that is $X_0 = 5.00$ cm from the equilibrium position and then released. i) Find the maximum energy of the block. ii) Express the position as a function of time; assume no damping.

(b) i) Equation of a damped harmonic oscillator is given by $\ddot{x} + \Upsilon\dot{x} + \omega_0^2 x = 0$. Here Υ and other symbols having usual meaning. If $e^{-t/2}\cos 3t$ is a solution of the above equation, what are the values of Υ and ω_0?

ii) What is the value of the quality factor (Q) for this oscillator? Assume it is a lightly damped oscillator.

Q2 (10 + 5 + 5)

(a) In the context of photoelectric effect the work function for tungsten metal is 4.52 eV.

(i) What is the cutoff wavelength λ_C for tungsten?

(ii) What is the maximum kinetic energy of the ejected electrons when an incident radiation of wavelength 200 nm is used?

(iii) What is the stopping potential in this case?

(b) A 500 W radio transmitter operates at a frequency of 1 kHz. How many photons per second does it emit?

(c) The distance between two successive atomic planes of a calcite crystal is 0.3 nm. Find the smallest angle for Bragg scattering of X-rays of 0.03 nm wavelength by the Calcite crystal.

Q3 (10 + 5 + 5)

(a) An X-ray photon of initial frequency 3.0×10^{19}Hz collides with an electron and is scattered through 90 degrees. Find the frequency of the scattered photon. How much energy is transferred to the electron in this collision?

(b) What voltage must be applied to an X-ray tube for it to emit X-rays with a minimum wavelength of 40 pm? (1 pm = 10^{-12} m)

(c) What is the minimum energy (in eV) that a photon must have to produce a proton-antiproton pair in the presence of matter?
Note that the rest mass energy of a particle of mass m_0 is given by m_0c^2. Also, mass of a proton = mass of an antiproton

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Useful constants:

$c = 3 \times 10^8$ m/s

mass of an electron $= 9 \times 10^{-31}$ kg

mass of a proton $= 1.67 \times 10^{-27}$ kg

$h = 6.6 \times 10^{-34}$ J.s

Or

$h = 4.1 \times 10^{-15}$ eV.s