



Engineering physics (2)

Question(1) :

(15 Marks)

- a. The position of a particle is given by

$$x(t) = 5 \cos(2\pi t + \pi) \quad m$$

Determine the velocity and acceleration of the particle at $t = 0.25 \text{ s}$

- b. An object with mass (m) attached to a spring with constant (k) moves without friction and is driven by an external force ($F_{ext} = F_o \sin \omega t$)
- Find the expression for the amplitude of the motion.
 - Determine the amplitude at ($m = 2 \text{ Kg}$), ($k = 20 \text{ N/m}$) and ($F_{ext} = 6 \sin 2\pi t$)

Question(2) :

(15 Marks)

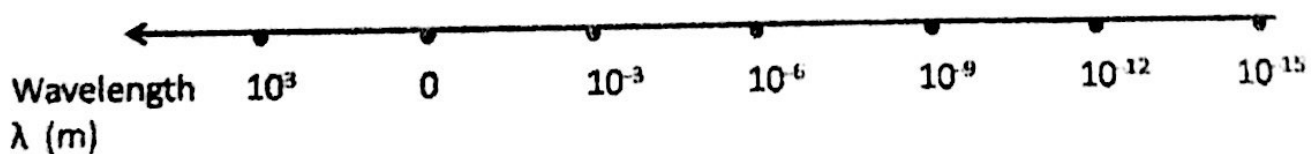
- a. A pulse moving to the right along the x -axis is represented by the wave function

$$y(x, t) = \frac{4}{(x - 5t)^2 + 1}$$

where x and y are measured in centimeters and t in seconds.

Draw the wave function at a $t = 0$ and $t = 1 \text{ s}$.

- b. A police car is traveling at (40 m/s) chases a motorist traveling at (30 m/s). The police siren is turned on and is heard by the policeman at a frequency of (600 Hz). What frequency does the motorist hear?
 (The speed of sound wave = 345 m/s)
- c. Write the (*Electromagnetic spectrum*) on the following (wavelength scale).



Question(3) :**(10 Marks)**

(a) In photosynthesis, pigments such as chlorophyll in plants capture the energy of sunlight to change CO_2 to useful carbohydrate. About nine photons are needed to transform one molecule of CO_2 to carbohydrate and O_2 . Assuming light of wavelength $\lambda = 670\text{nm}$ (chlorophyll absorbs most strongly in the range 650 nm to 700 nm), how efficient is the photosynthetic process? The reverse chemical reaction releases an energy of 4.9eV/molecule of CO_2 so 4.9 eV is needed to transform CO_2 to carbohydrate.

(b) In case of Compton scattering consider the electron initially at rest. Prove that $\Delta\lambda = \lambda' - \lambda = (h/m_e c) (1 - \cos\phi)$

(c) Discuss the blackbody radiation.

Question(4) :**(10 Marks)**

(a) What are the wave function and its interpretation?

(b) Solve Schrodinger equation for a particle in infinite quantum well.

(c) Discuss the quantum tunneling phenomena.

Question(5) :**(10 Marks)**

(a) Write down the eight quantum states allowed for electrons in the L -shell.

(b) An excited atom gives up its excess energy by emitting a photon of characteristic frequency. The average period that elapses between the excitation of an atom and the time it radiates is $1 \times 10^{-8}\text{ s}$. Find the inherent uncertainty in the frequency of the photon.

(c) The state of a free particle is described by the following wave function

$$\Psi(x) = 0 \text{ for } x < -3a$$

$$= c e^x \text{ for } -3a < x < a$$

$$= 0 \text{ for } x > a$$

(i) Determine c using the normalization condition

(ii) Find the probability of finding the particle in the interval $[0, a]$

Useful data: $m_e = 1.6022 \times 10^{-19}\text{C}$, $q_e = 9.1 \times 10^{-31}\text{kg}$ and $h = 6.62 \times 10^{-34}\text{J.s}$

Best Wishes**Dr. Ahmed Saeed****Dr. Demyana Adel Abdel Masieh**