COLLEGE OF ENGINEERING & TECHNOLOGY
Department of Electronics and Communications
Course: Solid State Electronics (EC210)
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Sheet 1: Particles and Waves

Useful information:

The speed of light $c = 3 \times 10^8$ m/s
The rest mass of the electron $m_o = 9.1 \times 10^{-31}$ kg
1 eV $= 1.6 \times 10^{-19}$

1. Calculate the momentum of two electrons having velocities of $0.08\ c$ *and* $0.8\ c$ respectively.
2. Calculate the rest energy of an electron in joules and in electron volts.
3. An electron was accelerated to energy of 2 GeV. What is the ratio of the electron's mass to its rest mass?
4. Show that the kinetic energy of the particle reduces to $\frac{1}{2}\ m_o v^2$ when $v/c \ll 1$.
   [Hint: $(1 + x)^n = 1 + n\,x + n\,(n\text{-}1)/2!\ x^2 + \ldots$]
5. A sinusoidal wave is described by $y = (0.25$ m$)\sin(0.30x - 40t)$ where x and y are in meters and t is in seconds. Determine for this wave the (a) amplitude, (b) angular frequency, (c) angular wave number, (d) wavelength, (e) wave speed, and (f) direction of motion.
6. If the amplitude of the wave of problem 5 is doubled, how much its intensity is increased?
7. For the wave of problem 5, (a) determine the smallest distance at which the wave displacement reaches absolute maximum at time $t = 0$, (b) determine the times at which it will reach absolute maximum again at the same point found in (a)?

Indicate whether each of the following statements is true or false *(give reasons)*

1. The rate of change of kinetic energy of a particle equals the force acting on it.

2. Assuming the force F, mass m, and acceleration a, the rule F = m a can be used for only constant mass particles.

3. The more the velocity of a particle, the less is its mass.

4. The velocity of a particle can not exceed the velocity of light.

5. The difference between the mass of a particle and its rest mass is apparent for velocities sufficiently smaller than the velocity of light.

6. The change of the mass of a particle is proportional to the change in its energy.

7. A particle of rest mass m_o is accelerated to a velocity v. The kinetic energy gained by the particle can be taken as $\frac{1}{2}mv^2$ provided that v is much greater than the velocity of light.

8. A particle with zero rest mass and moving with a velocity smaller than the velocity of light can have nonzero momentum.

9. The wavelength of a wave is proportional to its angular wave number.

10. The angular frequency of a wave is proportional to its wavelength.

Choose the correct answer justifying your choice:

1. In the diagram shown beside, the interval PQ represents the ……….. of a wave.

displacement

time

P   Q
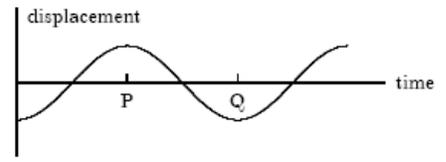
(a) wavelength   (b) half periodic time
(c) frequency   (d) angular wave number
(e) Amplitude

2. A sinusoidal wave is traveling toward the right as shown. The amplitude of the wave is represented by the distance …….

A

E

$\vec{v}$

B

D

C
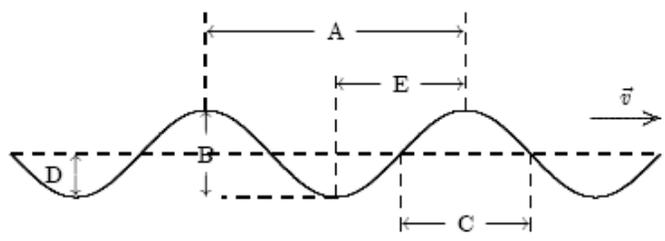
(a) A   (b) B   (c) C   (d) D   (e) E

3. The intensity of a wave has the units of ……..
(a) W/m   (b) J.s/m^2 (c) W/m^2 (d) J/m^2 (e) J/m