ET-105(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) / BTCLEVI / BTMEVI / BTELVI / BTECVI / BTCSVI

00770

Term-End Examination
June, 2015

ET-105(A) : PHYSICS

Time : 3 hours   *Maximum Marks : 70*

Note : *Attempt **all** questions. Internal choices are provided. Assume missing data suitably, if any. Symbols have their usual meanings.*

1. (a)   State and explain Newton's laws of motion. When two bodies collide, show that their total momentum is conserved.   **4**

OR

State Kepler's laws. Illustrate the Second law. Show that the Second law is a consequence of the conservation of angular momentum.

(b)   Show that the equation of a harmonic wave
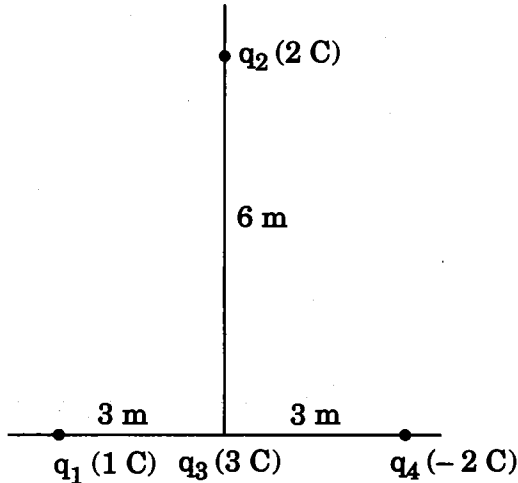
$$u(x, t) = u_0 \sin \frac{2\pi}{\lambda} (x - vt)$$

has the property that

$$u(x + \lambda, t) = u(x, t).$$ **6**

(c) Four charges are arranged as shown. Distances between the charges and their magnitudes are given. Find the potential energy of charge q_3 in the field of other charges.   4

q_2 (2 C)

6 m

3 m   3 m

q_1 (1 C) q_3 (3 C) q_4 (– 2 C)

OR

An electric field is given by $\vec{E} = \hat{i} y + \hat{j} x$. Calculate its flux through the entire surface of a cube of side a.

2. (a) Distinguish between inertial and non-inertial frames of reference. Are Newton's laws valid in non-inertial frames ? Explain with the help of two examples.   6

OR

Define centre of mass of a system of particles. Show that its definition is independent of the choice of the origin of coordinates.

(b) When a stationary nucleus of mass 242 u emits an α-particle of mass 4 u, it is observed to recoil with a speed of 10^4 m/s. What is the speed with which the α-particle is emitted ?   *4*

(c) Discuss the elastic collisions between two particles in one dimension. If the masses of the two particles are equal, show that the effect of elastic collision between them is that they merely exchange their velocities.   *4*

OR

An Atwood's machine has a frictionless pulley of mass M and radius R. Two masses m_1 and m_2 are suspended by a massless string which goes over the pulley. Calculate the acceleration of the masses.

3. (a) Show that the potential energy of a spring of mass m executing simple harmonic motion, averaged over one cycle, is $1/4\ m\omega^2A^2$, where A is the amplitude and ω is the angular frequency of the SHM. Would the kinetic energy averaged over a cycle, also be the same ?   *6*

OR

Calculate the power loss of a system executing damped oscillations. Define Quality Factor of an oscillator.

(b)   A rope of length L and mass M hangs freely from a ceiling. Show that the velocity of transverse waves along the rope is $\sqrt{gz}$ and the time the wave takes to travel the entire length of the rope is $2\sqrt{L/g}$, where g is the acceleration due to gravity.   *4*

(c)   Calculate the equivalent resistance between A and B of the network shown below. The resistances are expressed in Ω.   *4*
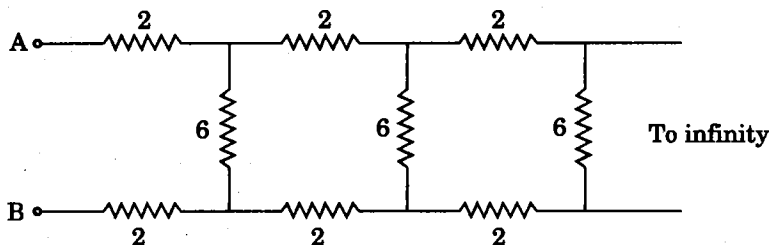
OR

State the relationship between the current density and drift velocity. The drift velocity of electrons in copper is 7.4×10^{-6} m/s. If the current density through a copper wire is 10^5 A/m², what is the number density of electrons in copper ?

4. (a) Derive an expression for the capacitance of a cylindrical capacitor. State any assumption that you make. *6*

OR

Calculate and sketch the electric field at points inside and outside a charged spherical shell.

(b) A ray of light is incident from air on the surface of a medium of refractive index 1·5. Find the angle of incidence so that the reflected ray is completely linearly polarized. *4*
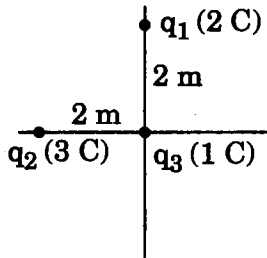
(c) Show that in a single slit diffraction experiment, the intensity on the screen varies as $\sin^2 \alpha / \alpha^2$, where $\alpha = \dfrac{\pi a \sin \theta}{\lambda}$, where a is the slit width and λ is the wavelength of light. *4*

OR

A distribution of charges is shown below. The magnitudes of charges are given. Calculate the magnitude and directon of the force felt by charge q_3 due to charges q_1 and q_2.

5. (a) Describe the structure and working of a cyclotron. **6**

OR

What is displacement current ? Explain why it was introduced into the Maxwell's equations.

(b) Define $\vec{B}$ field. Examine if

$$\vec{A} = \hat{i}\, x^2 y + \hat{j}\, xy^2 - \hat{k}\, 4xyz$$ can be a $\vec{B}$ field. **4**

(c)   Evaluate the line integral of the vector field $\vec{A} = \dfrac{xy}{a^2} (\hat{i} + \hat{j})$.   4

OR

A bulb, marked 100 W and 240 V, is connected to an outlet which gives 210 d.c. How much power would the bulb give ?

Physical Constant :

$$\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ C^2/(Nm^2)$$

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