EASTERN UNIVERSITY, SRI LANKA

FIRST EXAMINATION IN SCIENCE - 2002/2003

FIRST SEMESTER

(JUNE/JULY 2003)

PH 101 Mechanics I

Time: 01 hour.

Answer ALL Questions

1. (a) A particle has the position function

$$\mathbf{r}(t) = (t^3 + 1)\mathbf{i} + (t^3 - 6t^2 + 12t)\mathbf{j}$$

where r is in meter t is in sec.

(i) Find the general expression for the velocity and the acceleration of the particle

(ii) At what time the velocity in the Y direction a mimimum?

(b) A particle is moving in two dimension and its position is given by the polar coordinates (r, θ). Show that the velocity $\mathbf{v}$ and the acceleration $\mathbf{a}$ of the particle are given by

$$\mathbf{v} = \dot{r}\mathbf{e}_r + r\dot{\theta}\mathbf{e}_\theta$$

$$\mathbf{a} = \left(\ddot{r} - r\dot{\theta}^2\right)\mathbf{e}_r + \left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\mathbf{e}_\theta$$

where $\mathbf{e}_r$ and $\mathbf{e}_\theta$ are the unit vectors along and perpendicular to the radial direction respectively.

A particle moves in two dimension $r = 2\theta$ where θ varies with time t as $\theta = t^2$. Show that the acceleration of the particle is

$$\mathbf{a} = 4(1 - 2t^4)\mathbf{e}_r + 20t^2\mathbf{e}_\theta$$

2. What do you mean by work done by a force? A force $\mathbf{F}(t)$ is acting on a particle moving with velocity $\mathbf{v}(t)$. Show that the work done W by the force between the time interval t_1 and t_2 is

$$W = \int_{t_1}^{t_2} (\mathbf{F}.\mathbf{v})dt$$

A force given by $F = (4\mathbf{i} + 8\mathbf{j} + 12t\mathbf{k})N$, where N is Newton and t is in sec, acts on a particle of mass $2Kg$. Assume that when $t = 0$ the position vector and the velocity of the particle are zero.

(i) Find the velocity and the position vector of the particle when $t = 1$ sec.

(ii) Find the work done by the force in the time interval $t = 0$ sec and $t = 1$ sec.

(iii) Find the power of the force at any time t sec.

(iv) Calculate the kinetic energy of the particle when $t = 1$ sec and verify the Work-Energy Theorem.