EASTERN UNIVERSITY, SRI LANKA

FIRST EXAMINATION IN SCIENCE - 2010/2011

FIRST SEMESTER (PROPER/REPEAT)

(October/November 2012)

PH 101 MECHANICS I

Time: 01 hour.

Answer ALL Questions

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1. (a) Distinguish between average velocity, instantaneous velocity Kinetic energy and Potential energy.

(b) A particle is moving in two dimensions and its position is given by the polar coordinates (r, θ). Show that the velocity v and the acceleration a of the particle are given by:

$$v = \dot{r}e_r + r\dot{\theta}e_\theta$$
$$a = (\ddot{r} - r\dot{\theta}^2)e_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})e_\theta$$

where e_r and e_θ are the unit vectors along and perpendicular to the radial direction respectively.

(c) Show that the potential energy of a spring when it is compressed through a distance x from its original length is given by $\frac{1}{2}kx^2$, where k is the spring constant.

(d) The spring attached to a wall is compressed to a distance of 2 cm from its relaxed state, and a small ball of mass 10 g is placed in touch with the spring. What is the speed of the ball if the spring is released? The spring constant k is 5.5 N cm^{-1}. Assume the motion occurred in a horizontal plane and no friction associated with the motion. Also assume that the ball left the spring and the spring stopped when it reached its relaxed length.

2. (a) Describe what is meant by work done, conservative force and Work-Energy principle.

(b) A particle is moving with a velocity $v(t)$ under the influence of a force $F(t)$. Show that the work done W by the force between the time interval t_1 and t_2 is,

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

(c) A force $\vec{F} = (3t^2\vec{i} + 2t\vec{j} + 2\vec{k})$ acts on a particle of mass $2\ kg$ where F is in Newton and t is in second. 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" principle.