The Open University of Sri Lanka

B.Sc /B.Ed Degree Programme

Applied Mathematics - Level 04

APU 2142 – Newtonian Mechanics I

Open Book Test (OBT) - 2010/2011

Duration :- One and half hours

Date:- 15. 03. 2011 **Time:- 4.00 p.m. - 5.30 p.m.**

Answer All Questions.

1. A particle moving in a straight line, is subject to a retardation of kv^n where v is the speed at time t. Find v as a function of t. Show that, if $n<1$, particle will come to rest at a distance $\frac{u^{2-n}}{k(2-n)}$ from the point of projection at a time $\frac{u^{1-n}}{k(1-n)}$ where u is the initial speed.

What happens when

(i) $1<n<2$ (ii) $n>2$.

2. A particle A, of mass m, is held at rest on a smooth horizontal table. One end of a light inextensible string is attached to A. The string passes through a small smooth hole H in the table, and carries at the other end a particle B, also of mass m, hanging freely. Initially $AH = a$ and the particle A is moving horizontally with speed $\sqrt{2gh}$, where $h > \frac{a}{2}$, in a direction perpendicular to the string.

If r is the distance AH after time t, show that $\dot{r}^2 = gh\left(1-\frac{a^2}{r^2}\right)+g(a-r)$.

Show also that if the particle B reaches the table, then the total length of the string cannot exceed $\frac{1}{2}\left[h + \sqrt{h^2 + 4ah}\right]$.

3. A smooth wire is bent into the form of an arch of a cycloid with intrinsic equation: $s = 4a\sin\psi$, $-\frac{\pi}{2} \le \psi \le \frac{\pi}{2}$, where a is a positive constant. The wire is fixed in a vertical plane with its axis vertical and its vertex O at its lowest point. A bead P, of mass m, moves under gravity on this wire. Given that the bead is projected from the vertex O with speed $2\sqrt{ga}$, show that when P reaches the point at which the tangent is inclined at an angle θ to the horizontal:

(a) its speed is $2\sqrt{ga}\cos\theta$,

(b) the normal contact force exerted by the wire on the bead is $2mg\cos\theta$.