

~~Your Name _____ Section _____~~

~~**HOMEWORK #6 - 8.01 MIT - Prof. Kowalski**~~

~~**Due 4:00PM Thursday Oct. 16, 2003**~~

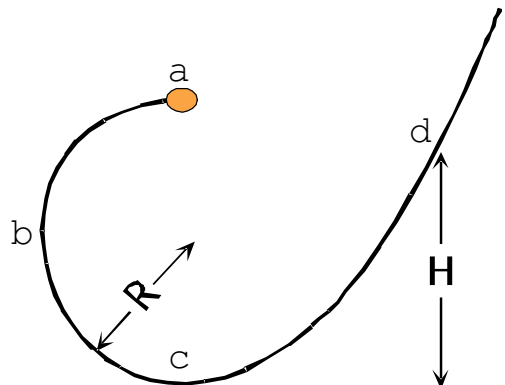
~~**Topics: Potential Energy and Mechanical Energy Conservation**~~

~~Any following problems designated with a bold number indicate problems from Young and Freedman 11th edition.~~

- ~~1. **7.42** (Assume that the curve at the base of the incline is smooth enough so that no energy is lost in rounding it.)~~
- ~~2. **7.58**~~
- ~~3. **7.72**~~

4. Bead Slides Around and Up Wire – 5 points

A bead of mass M slides on a smooth wire that is bent in a circle of radius R . It is released at the top of the circular part of the wire (point a in the figure) with a negligibly small velocity.



- a) Find the normal force of the wire on the bead at point b (even with the center of the circle)
- b) Find the normal force at point c (at the bottom of the circle).
- c) Find the height H of point d where the mass will reverse direction.

~~The other solution:~~

$$\frac{1}{2}kd_{\max} - mg = 0 \quad (28)$$

$$d_{\max_2} = d_{\max} = \frac{2mg}{k} \quad (29)$$

~~Replacing k from equation (21) we get:~~

$$d_{\max} = \frac{2mg}{\frac{mg}{d}} \quad (30)$$

$$\therefore d_{\max} = 2d \quad (31)$$

~~This is not surprising - the fish oscillates symmetrically about its equilibrium position.~~

4) *Bead Slides Around and Up Wire*

Please refer to the figure in the problem set.

There is no non-conservative forces, so mechanical energy is conserved. The thing to remember is that for a circular motion acceleration is *radial* and is equal in magnitude to $\frac{v^2}{R}$.

Our first job is to obtain v at different points and look carefully what radial at that point means and use the component of Newton's law $\sum \vec{F} = m\vec{a}$ in the radial direction. As for convention I choose the horizontal line shown at the bottom of the loop in the figure as the $\mathbf{0}$ of potential energy.

a)

$$\frac{1}{2}mv_a^2 + mgy_a = E_a = E_b = \frac{1}{2}mv_b^2 + mgy_b \quad (32)$$

$$v_a = 0 \quad y_a = 2R \quad (33)$$

$$y_b = R \quad (34)$$

$$0 + mg(2R) = \frac{1}{2}mv_b^2 + mgR \quad (35)$$

$$\therefore v_b = \sqrt{2gR} \quad (36)$$

Radial at point **b** is the \mathbf{x} direction:

$$\sum F_{bx} = N_b = m\frac{v_b^2}{R} = m\frac{2gR}{R} = 2mg \quad (37)$$

(This is twice the weight)

b)

$$\frac{1}{2}mv_a^2 + mgy_a = E_a = E_c = \frac{1}{2}mv_c^2 + mgy_c \quad (38)$$

$$v_a = 0 \quad y_a = 2R \quad (39)$$

$$y_c = 0 \quad (40)$$

$$0 + mg(2R) = \frac{1}{2}mv_c^2 + 0 \quad (41)$$

$$\therefore v_c = 2\sqrt{gR} \quad (42)$$

Radial at point **c** means the \mathbf{y} direction:

$$\sum F_{cy} = N_c - mg = m\frac{v_c^2}{R} = m\frac{4gR}{R} = 4mg \Rightarrow N_c = 5mg \quad (43)$$

c) At point d which the mass reverse its direction: $v_d = 0$.

$$\frac{1}{2}mv_a^2 + mgy_a = \frac{1}{2}mv_d^2 + mgy_d \quad (44)$$

$$v_a = 0 \quad y_a = 2R \quad v_d = 0 \quad y_d = H \quad (45)$$

$$0 + mg(2R) = 0 + mgH \quad (46)$$

$$\therefore H = 2R \quad (47)$$

This is not surprising- in the absence of dissipation it rises to the same height from which it was released.

You could have chosen any two points you want between which to apply energy conservation since energy is conserved along the entire path. Let's do this part by comparing points d and c:

$$\frac{1}{2}mv_c^2 + mgy_c = \frac{1}{2}mv_d^2 + mgy_d \quad (48)$$

$$v_c = 2\sqrt{gR} \quad y_c = 0 \quad v_d = 0 \quad y_d = H \quad (49)$$

$$\frac{1}{2}m(4gR) + 0 = 0 + mgH \quad (50)$$

which gives again

$$H = 2R. \quad (51)$$