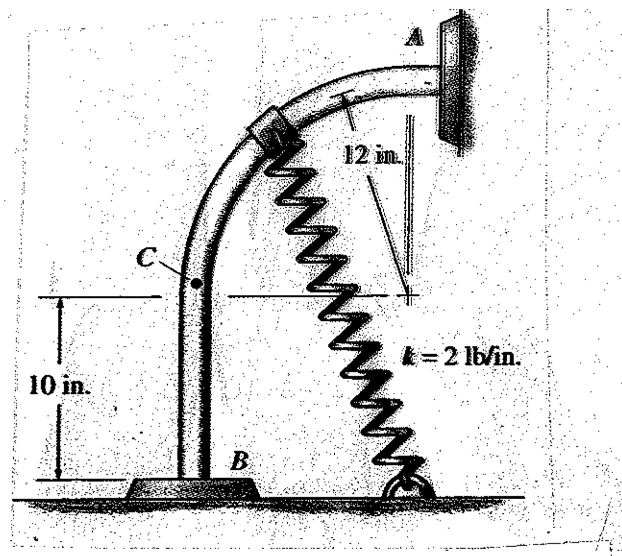
Problem 14.77 (Page 200)

A 5-lb collar is released from rest at A and travels along a smooth guide. Determine a) its speed when its center reaches point C, and b) the normal force it exerts on the rod at this point. The spring has an unstretched length of 12 inches, and point C is located just before the end of the curved portion of the rod.

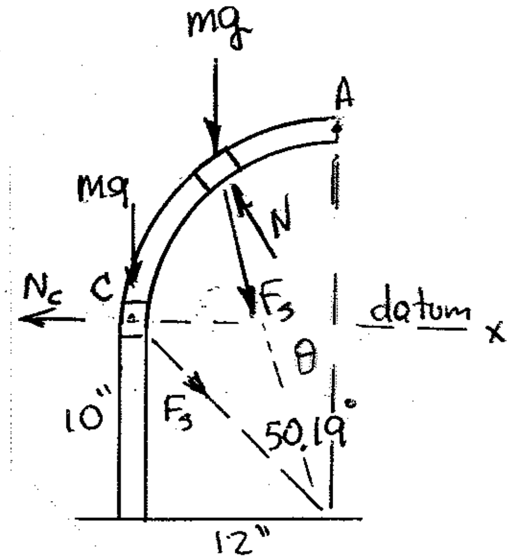


$$T_A + V_A = T_C + V_C \qquad U_{A-C} = 0$$

$$0 + 0 + \frac{1}{2}(2)(12)\left(\frac{10}{12}\right)^2 + 5\left(\frac{12}{12}\right)$$

$$= \frac{1}{2}\left(\frac{5}{32.2}\right)v^2 + \frac{1}{2}(24)\left[\sqrt{1+\left(\frac{10}{12}\right)^2} - \frac{12}{12}\right]^2$$

$$v_C = 12.556 \text{ f/sec}$$



$$\overset{+}{\rightarrow} \sum F_x = -N_C + F_s \sin 50.19^\circ = \left(\frac{5}{32.2}\right)\frac{(12.556)^2}{1}$$

$$F_s = ks = 2(12)\left[\sqrt{1+\left(\frac{10}{12}\right)^2} - \frac{12}{12}\right]$$

$$F_s = 7.24 \text{ lbs} \searrow$$

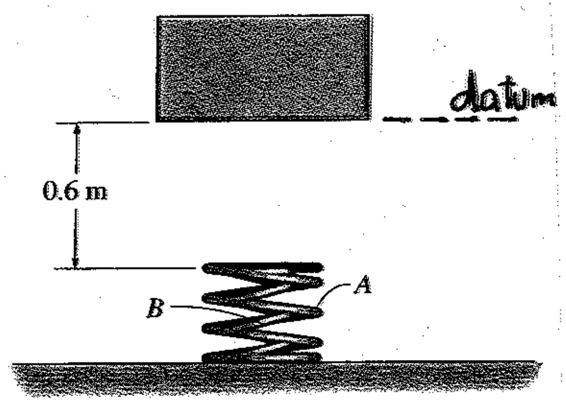
$$N_C = 18.9 \text{ lbs} \leftarrow$$

Just before the straight section

On the straight section at C $\quad N_C = 7.24 \text{ lb} \leftarrow$

Problem 14.84 (Page 202)

Two equal-length springs having a stiffness $k_A = 300$ N/m and $k_B = 200$ N/m are nested together in order to form a shock absorber. If a 2-kg block is dropped from an at-rest position of 0.6 m above the top of the springs, determine their deformation when the block momentarily stops.



$$T_1 + V_1 + U_{1-2} = T_2 + V_2$$

$$0 + 0 + 0 = 0 - 2(9.81)(.6)$$

$$- 2(9.81)Y_{max} + \frac{1}{2}(300)Y_{max}^2$$

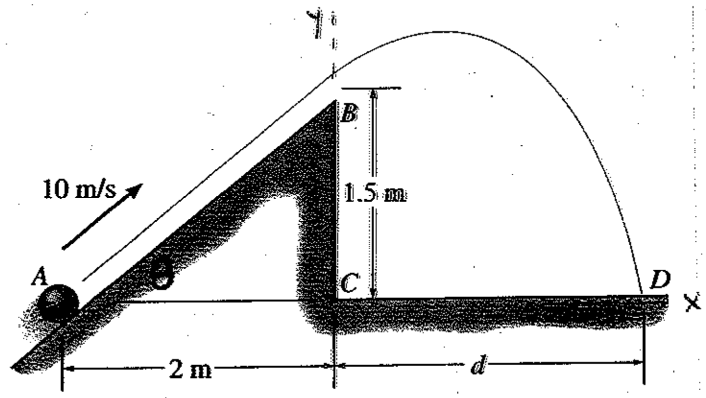
$$+ \frac{1}{2}(200)Y_{max}^2$$

$$250\,Y_{max}^2 - 19.62\,Y_{max} - 11.77 = 0$$

$$Y_{max} = .26 \text{ m}$$

Problem 14.89 (Page 203)

A 2-kg ball of negligible size is fired from a point A with an initial velocity of 10 m/s up a smooth inclined plane. Use the energy method to determine a) the velocity of the ball at B, b) the distance from point C to where it hits the horizontal surface at D, and c) its velocity when it strikes the surface.



$$T_A + V_A + U_{A-B} = T_B + V_B$$

$$\frac{1}{2}(2)(10)^2 + 0 + 0 = \frac{1}{2}(2)V_B^2 + 2(9.81)(1.5)$$

$$V_B = 8.4 \text{ m/s}$$

$$\theta = \tan^{-1}\frac{1.5}{2.0} = 36.87^\circ$$

$$V_{Bx} = 8.4\cos 36.87^\circ = \frac{dx}{dt}$$

$$d = 6.72\,t$$

$$a_y = -9.81 = \frac{dV_y}{dt} \qquad V_y = 8.4\sin 36.87^\circ - 9.81\,t = \frac{dy}{dt}$$

$$-1.5 = 0 + 5.04\,t - 4.905\,t^2$$

$t = 1.269$ sec (From B to D)

$$d = 6.72(1.269) = 8.53 \text{ m}$$

For datum through A: $U_{A-D} = 0$

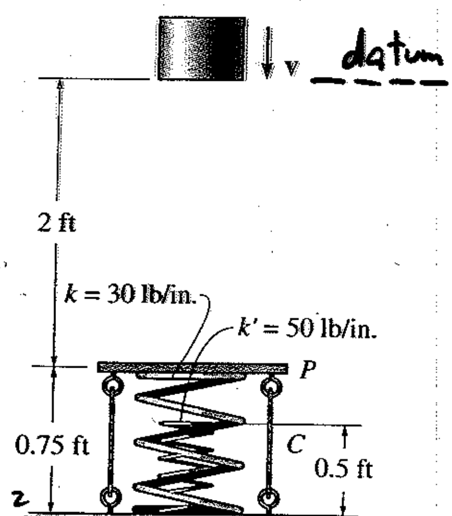
$$T_A + V_A = T_D + V_D$$

$$\frac{1}{2}(2)(10)^2 + 0 = \frac{1}{2}(2)V_D^2 + 0$$

$V_D = 10$ m/s at 47.8°

Problem 14.93 (Page 203)

Four inelastic cables C are attached to a plate P and hold the 1-ft long spring 0.25 ft in compression when no weight is on the plate. There is also an undeformed spring nested within this compressed spring. If the 10-lb block is moving downward at 4 ft/sec, when it is 2 ft above the plate, determine the maximum compression in each spring after it strikes the plate. Neglect the mass of the plate and spring and any energy lost in the collision.



$K = 30(12) = 360 \text{ lb/ft}$

$K' = 50(12) = 600 \text{ lb/ft}$

$T_1 + V_1 = T_2 + V_2$

$\frac{1}{2}\left(\frac{10}{32.2}\right)4^2 + 0 + \frac{1}{2}(360)(.25)^2$

$= 0 + \frac{1}{2}(360)(s+.25)^2 + \frac{1}{2}(600)(s-.25)^2$

$- 10(s+2)$

$480s^2 - 70s - 3.73 = 0 \qquad s = 0.1873 \text{ ft} < .25 \text{ ft}$

The nested spring does not deform

Equation becomes:

$180s^2 + 80s - 22.48 = 0$

$s = 0.195 \text{ ft}$