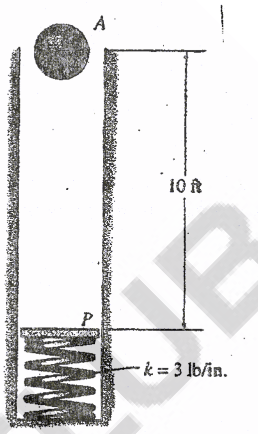
***15-72.** The 8-lb ball is released from rest 10 ft from the surface of a flat plate P which weighs 6 lb. Determine the maximum compression in the spring if the impact is perfectly elastic.



Datum at lowest point :

$T_1 + V_1 = T_2 + V_2$

$0 + (8)(10) = \frac{1}{2}\left(\frac{8}{32.2}\right)(v_A)_1^2 + 0$

$(v_A)_1 = 25.377$ ft/s

$(+\downarrow) \qquad \Sigma m v_1 = \Sigma m v_2$

$\frac{8}{32.2}(25.377) + 0 = \frac{8}{32.2}(v_A)_2 + \frac{6}{32.2}(v_P)_2$

$e = \frac{(v_P)_2 - (v_A)_2}{(v_A)_1 - (v_P)_1}$

$1 = \frac{(v_P)_2 - (v_A)_2}{25.377 - 0}$

Solving,

$(v_A)_2 = 3.625$ ft/s

$(v_P)_2 = 29.00$ ft/s

Initially the plate is compressed

$F_s = kx; \qquad 6 = (3)x, \qquad x = 2 \text{ in.} = \frac{1}{6}$ ft

Datum at final plate position :

$T_2 + V_2 = T_3 + V_3$

$\frac{1}{2}\left(\frac{6}{32.2}\right)(29.00)^2 + \frac{1}{2}(3)(12)\left(\frac{1}{6}\right)^2 + 6x = 0 + \frac{1}{2}(3)(12)\left(x + \frac{1}{6}\right)^2$

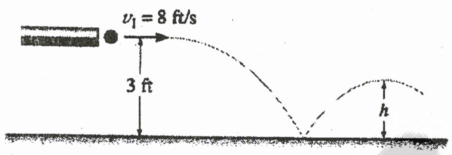
$18x^2 - 78.367 = 0$

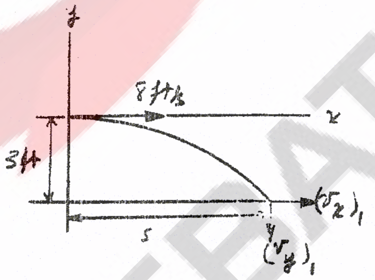
$x = 2.087$ ft

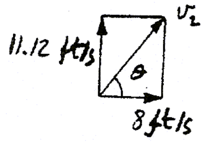
Maximum spring compression is

$x_{max} = 2.087 + \frac{1}{6} = 2.25$ ft **Ans**

***15-76.** The ball is ejected from the tube with a horizontal velocity of $v_1 = 8$ ft/s as shown. If the coefficient of restitution between the ball and the ground is $e = 0.8$, determine (a) the velocity of the ball just after it rebounds from the ground and (b) the maximum height to which the ball rises after the first bounce.







$(+\uparrow)$ $\quad v^2 = v_0^2 + 2a_c(s - s_0)$

$$(v_y)_1^2 = 0 + 2(-32.2)(-3-0)$$

$$(v_y)_1 = 13.90 \text{ ft/s} \downarrow$$

In y direction :

$(+\uparrow)$ $\quad e = \dfrac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1}; \qquad 0.8 = \dfrac{(v_y)_2 - 0}{0-(-13.90)}$

$(v_y)_2 = 11.12$ ft/s $\uparrow$

$(v_x)_2 = 8$ ft/s $\rightarrow$

$v_2 = \sqrt{(8)^2 + (11.12)^2} = 13.7$ ft/s $\qquad$ Ans

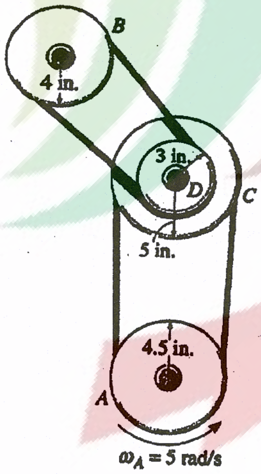
$\theta = \tan^{-1}\left(\dfrac{11.12}{8}\right) = 54.3°$ $\qquad$ Ans

$(+\uparrow)$ $\quad v^2 = v_0^2 + 2a_c(s - s_0)$

$$0 = (11.12)^2 + 2(-32.2)(h-0)$$

$h = 1.92$ ft $\qquad$ **Ans**

16-30. A mill in a textile plant uses the belt-and-pulley arrangement shown to transmit power. When $t = 0$ an electric motor is turning pulley A with an angular velocity of $\omega_A = 5$ rad/s. If this pulley is subjected to a constant angular acceleration $2\ \text{rad/s}^2$, determine the angular velocity of pulley B after B turns 6 revolutions. The hub at D is rigidly *connected* to pulley C and turns with it.



$\omega_A = 5\,\text{rad/s}$

$\alpha = 2\,\text{rad/s}^2$

$\theta_B = 6\,\text{rev} \cdot \frac{2\pi\,\text{rad}}{1\,\text{rev}} = 37.69$

$\theta_B r_B = \theta_C r_C$

$6(4) = \theta_C (5)$

$\theta_C = 8$

$8(5) = \theta_A\, 4.5$

$\theta_A = 8.889\,\text{rad}$

$\omega_A^2 = \omega_{A0}^2 + 2\alpha(\theta_1 - \theta_0)$

$\omega_B^2 = (5)^2 + 2(2)(55.85)$

$\omega_A = 15.76$

$\omega_A r_A = \omega_C r_C$

$\omega_C =$

$\omega_C r_C = \omega_B r_B$

$\omega_B =$

When $\theta_B = 6$ rev ;

$4(6) = 3\,\theta_C$

$\theta_C = 8$ rev

$8(5) = 4.5(\theta_A)$

$\theta_A = 8.889$ rev

$(\omega_A)_2^2 = (\omega_A)_1^2 + 2\alpha_C[(\theta_A)_2 - (\theta_A)_1]$

$(\omega_A)_2^2 = (5)^2 + 2(2)[(8.889)(2\pi) - 0]$

$(\omega_A)_2 = 15.76$ rad/s

$15.76(4.5) = 5\omega_C$

$\omega_C = 14.18$ rad/s

$14.18(3) = 4(\omega_B)_2$

$(\omega_B)_2 = 10.6$ rad/s **Ans**