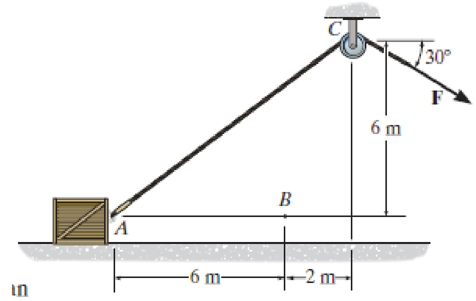
Example (1)

If the 75-kg crate starts from rest at A, determine its speed when it reaches point B. The cable is subjected to a constant force of F = 300N .Neglect friction and the size of the pulley.



Solution:

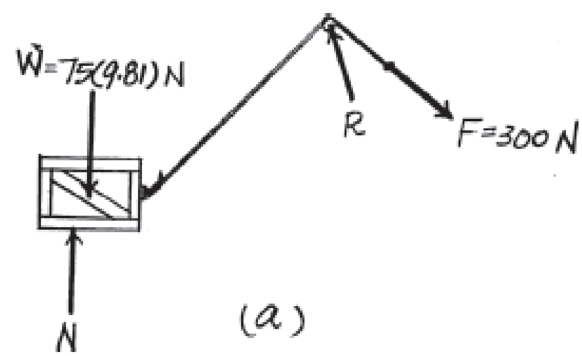
$x = AC - BC$

$x = \sqrt{8^2 + 6^2} - \sqrt{2^2 + 6^2} = 3.675\ m$

$T_1 + \sum U_{1-2} = T_2$

$0 + 300(3.675) = \frac{1}{2}(75)(v_B{}^2)$

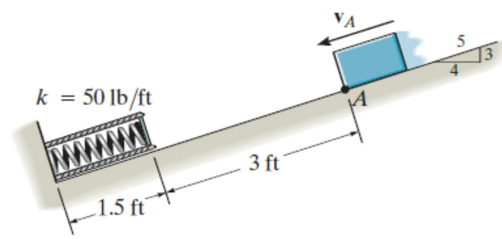
$v_B = 5.42\ m/s$ ....**Ans.**



Example (2)

The spring has a stiffness k = 50 lb/ft and an *unstretched length* of 2 ft. As shown, it is confined by the plate and wall using cables so that its length is 1.5 ft. A 4-lb block is given a speed v_A when it is at *A*, and it slides down the incline having a coefficient of kinetic friction u_k = 0.2. If it strikes the plate and pushes it forward 0.25 ft before stopping, determine its speed at *A*. Neglect the mass of the plate and spring.

Solution:



$+\nwarrow \sum f_y = 0$

$N_B - 4\left(\frac{4}{5}\right) = 0$

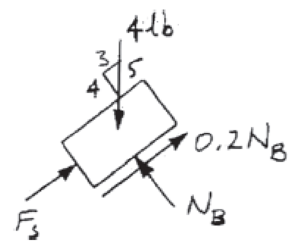
$N_B = 3.2\ lb$

$T_1 + \sum U_{1-2} = T_2$

$\frac{1}{2}\left(\frac{4}{32.2}\right) v_a{}^2 + (3 + 0.25)\left(\frac{3}{5}\right) 4 - 0.2(3.2)(3 + 0.25) - [\frac{1}{2}(50)(0.75)^2 -$

$\frac{1}{2}(50)(0.5)^2] = 0$

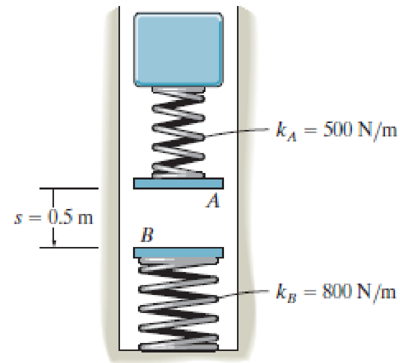
$v_a = 5.8\ lb/ft$ ...Ans.



Example (3)

The block has a mass of 20 kg and is released from rest when *s* = 0.5 m. If the mass of the bumpers *A* and *B* can be neglected, determine the maximum deformation of each spring due to the collision.

Solution:



$T_1 + v_1 = T_2 + v_2$

$0 + 0 = 0 + \frac{1}{2}(500){s_A}^2 + \frac{1}{2}(800){s_B}^2 + 2(9.81)[-(s_A + s_B) - 0.5]$ …. (1)

Also

$F_s = 500\ s_A = 800\ s_B$

$s_A = 1.6\ s_B$ …..(2)

Sub. (2) into (1)

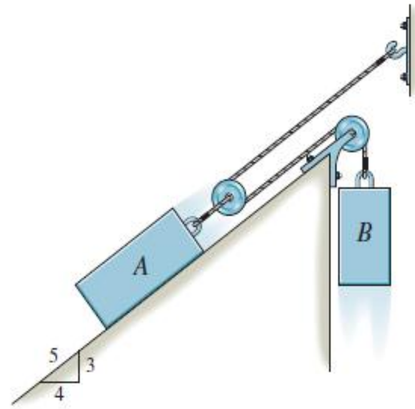
$0 = \frac{1}{2}(500)(1.6\ s_B)^2 + \frac{1}{2}(800){s_B}^2 + 2(9.81)[-(1.6\ s_B + s_B) - 0.5]$

$s_B = 0.638\ m$

$s_A = 1.02\ m$

Example (4)

Block *A* has a weight of 60 lb and block *B* has a weight of 10 lb. Determine the speed of block *A* after it moves 5 ft down the plane, starting from rest. Neglect friction and the mass of the cord and pulleys.



Solution:

$$2x_A + x_B = l$$

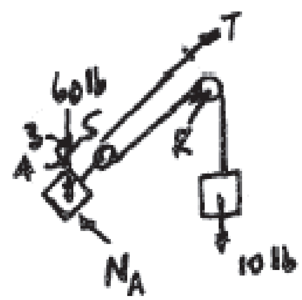
By deriving

$$2v_A + v_B = 0$$

$$2T_1 + \sum U_{1-2} = T_2$$

$$0 + 60\left(\frac{3}{5}\right)5 - 10(10) = \frac{1}{2}\left(\frac{60}{32.2}\right)v_A^2 + \frac{1}{2}\left(\frac{10}{32.2}\right)(v_A)^2$$

$v_A = 7.18\frac{ft}{s}$ **…Ans.**



Example (5)

A 20-lb block slides down a 30° inclined plane with an initial velocity of 2 ft/s. Determine the velocity of the block in 3 s if the coefficient of kinetic friction between the block and the plane is u_k = 0.25.

solution:

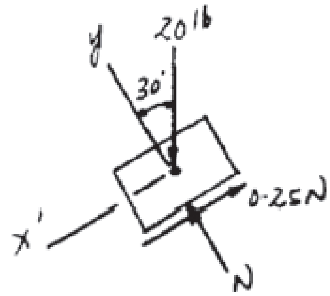
$$+\nwarrow\ mv_{y1} + \sum \int_{t1}^{t2} F_y\, dt = mv_{y2}$$

$$0 + N(3) - 20 \cos 30\ (3) = 0$$

$$N = 17.32\ lb$$

$$+\swarrow\ mv_{x1} + \sum \int_{t1}^{t2} F_x\, dt = mv_{x2}$$

$$\frac{20}{32.2}(2) - 20 \sin 30\ (3) - 0.25(7.32)(3) = \frac{20}{32.2} v$$



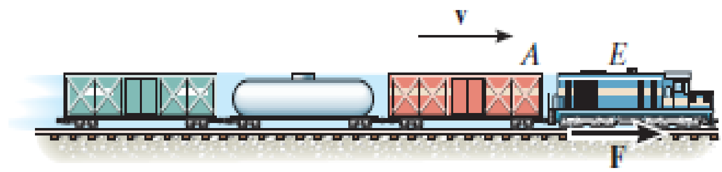
$v = \ 29.4\ ft/s$ ….Ans.

Example (6)

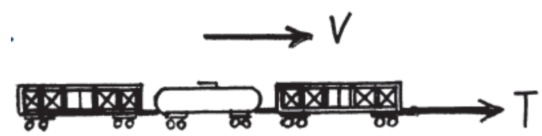
A train consists of a 50-Mg engine and three cars, each having a mass of 30 Mg. If it takes 80 s for the train to increase its speed uniformly to 40 km/h, starting from rest, determine the force *T* developed at the coupling between the engine *E* and the first car *A*. The wheels of the engine provide a resultant frictional attractive force **F** which gives the train forward motion, whereas the car wheels roll freely. Also, determine *F* acting on the engine wheels.

solution:

$$v_{x2} = 40\frac{km}{h} * \frac{\frac{10^3}{3600}m}{s} = 11.11\, m/s$$



For three cars only

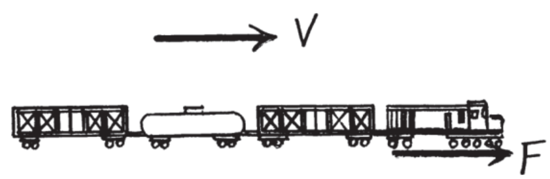


$$+\rightarrow\ mv_{x1} + \sum \int_{t1}^{t2} F_x\, dt = mv_{x2}$$

$$0 + T(80) = 3(30)(10^3)(11.11)$$

$T = 15.2\, Kn$ **….Ans.**

For all the train



$$+\rightarrow\ mv_{x1} + \sum \int_{t1}^{t2} F_x\, dt = mv_{x2}$$

$$0 + F(80) = [50 + 3(30)](10^3)(11.11)$$

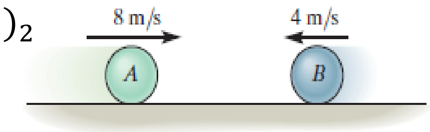
$F = 19.4\, Kn$ **….Ans.**

Example (7)

Ball A has a mass of 3 kg and is moving with a velocity of 8 m/s when it makes a direct collision with ball B, which has a mass of 2 kg and is moving with a velocity of 4 m/s. If e = 0.7, determine the velocity of each ball just after the collision. Neglect the size of the balls.

solution:

$\xrightarrow{+}\ m_A(v_A)_1 + m_B(v_B)_1 = m_A(v_A)_2 + m_B(v_B)_2$



$3(8) + 2(-4) = 3v_A + 2(v_B)$

$3v_A + 2v_B = 16$ …..(1)

$\xrightarrow{+}\ e = \frac{(v_B)_2-(v_A)_2}{(v_A)_1-(v_B)_1}$

$0.7 = \frac{(v_B)_2-(v_A)_2}{8-(-4)}$

$v_B - v_A = 8.4$ …..(2)

Solving (1) & (2)

$v_A = 0.16\ \frac{m}{s}\ \leftarrow$

$v_B = 8.24\frac{m}{s} \rightarrow$