Mechanics

Static

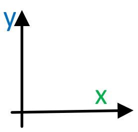
Dynamic

Kinematics

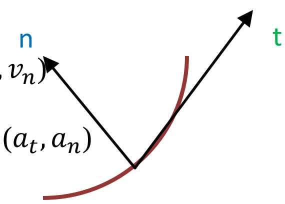
Kinetics

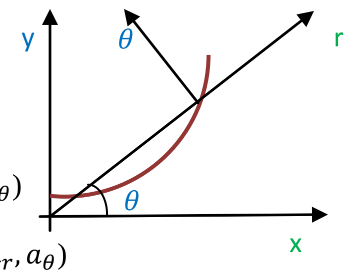
Rectilinear

Curvilinear



Rectangular Component	Tangential and Normal Component	Radial or Polar
Position (x)	Position (r)	Position (r)
Velocity (v_x, v_y)	Velocity (v_t , v_n)	Velocity (v_r , v_θ)
Acceleration (a)	Acceleration (a_t, a_n)	Acceleration (a_r, a_θ)



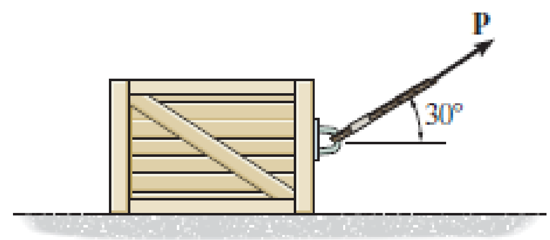


$\sum F_x = ma_x$	$\sum F_t = ma_t$	$\sum F_r = ma_r$
$\sum F_x = m\ddot{x}$	$\sum F_t = m\frac{dv}{dt}$	$\sum F_r = m(\ddot{r} - r\dot{\theta}^2)$
$\sum F_y = ma_y$	$\sum F_n = ma_n$	$\sum F_\theta = ma_\theta$
$\sum F_y = m\ddot{y}$	$\sum F_n = m\frac{v^2}{\rho}$	$\sum F_\theta = m(r\ddot{\theta} + 2\dot{r}\dot{\theta})$
$\sum F_z = ma_z$		
$\sum F_z = m\ddot{z}$		

Example (1)

If the coefficient of kinetic friction between the 50-kg crate and the ground is $u_k = 0.3$, determine the distance the crate travels and its velocity when t = 3 s. The crate starts from rest, and P = 200 N.

solution:



$F = u_k\, N\,,\ a_y = 0$

$+\uparrow \sum F_y = ma_y \longrightarrow \sum F_y = 0$

$N - 50(9.81) + 200 \sin 30 = 0$

N= 390.5 N

$+\rightarrow \sum F_x = ma_x$

$200 \cos 30 - 0.3(390.5) = 50a$

$a = 1.121\ m/s^2$

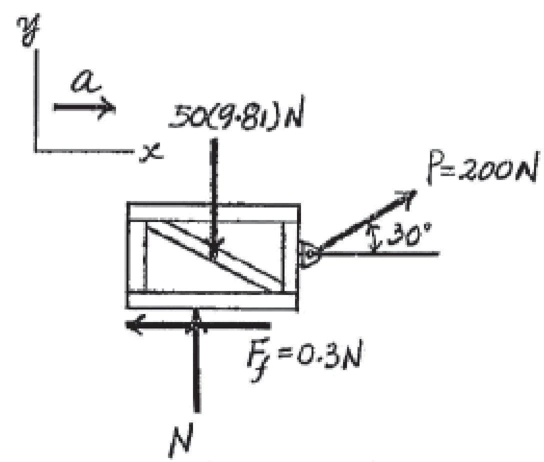
$v = v_o + a_c t$

$v = 0 + 1.21(3) = 3.36 \frac{m}{s}$ ….Ans.

$x = x_o + v_o t + \frac{1}{2} a_c t^2$

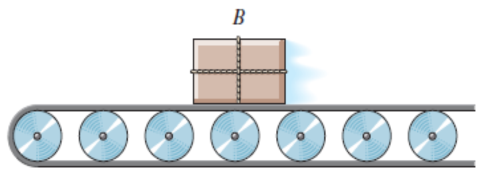
$x = 0 + 0 + \frac{1}{2}(1.121)(3)^2$

$x = 5.04\ m$ ….Ans.



Example (2)

The conveyor belt is moving at 4 m/s. If the coefficient of static friction between the conveyor and the 10-kg package B is u_k = 0.2, determine the shortest time the belt can stop so that the package does not slide on the belt. And determine the distance
the package will slide on the belt before coming to rest.



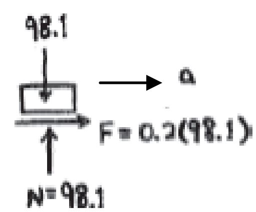
solution:

$F = 10 * 9.81 = 98.1\ N$

$+\rightarrow \sum F_x = ma_x$

$0.2 * 98.1 = 10\ a$

$a = 1.962\ m/s^2$



$v = v_o + a_c t$

$4 = 0 + 1.962(t)$

$t = 2.04\ s$ ....Ans.

$+\rightarrow v^2 = {v_o}^2 + 2a_c\,(x - x_o)$

$0 = 4^2 + 2(1.962)(x - 0)$

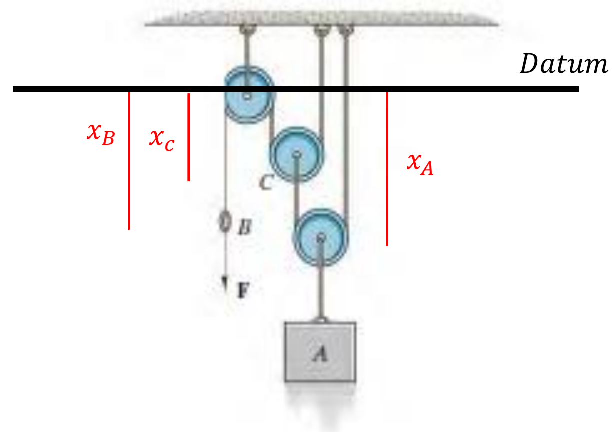
$x = -4.077m$

$x = 4.1\ m\ \leftarrow$

Example (3)

If the supplied force F = 150 N, determine the velocity of the 50-kg block A when it has risen 3 m, starting from rest.

solution:



from fig (a)

$+\uparrow \sum F_y = 0$

$150 + 150 - T = 0$

$T = 300\ \ N$

From fig (b)

$+\uparrow \sum F_y = ma_y$

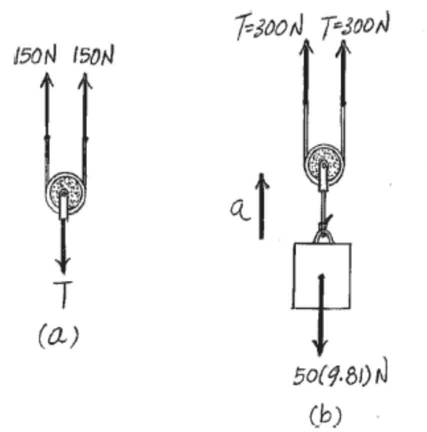
$300 + 300 - 50(9.81) = 50a$

$a = 2.19 \frac{m}{s^2} \uparrow$

$v^2 = {v_o}^2 + 2a_c\ (x - x_o)$

$v^2 = \ 0 + 2(2.19)\ (3 - 0)$

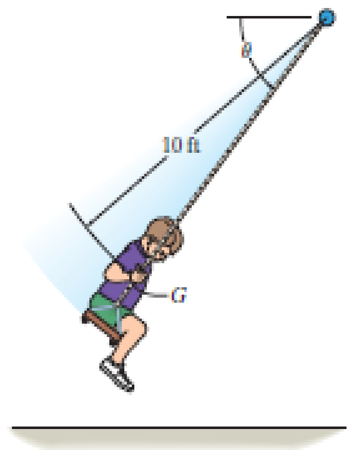
$v = 3.62\ m/s$ ...Ans.



Example (4)

At the instant θ = 60°, the boy's center of mass G is momentarily at rest. Determine his speed and the tension in each of the two supporting cords of the swing when θ = 90°. The boy has a weight of (60 lb). Neglect his size and the mass of the seat and cords.

solution:



$+\searrow \sum F_t = ma_t$

$60\cos\theta = \frac{60}{32.2}\, a_t$

$a_t = 32.2\cos\theta$ …..(1)

$+\nearrow \sum F_n = ma_n$

$2T - 60\sin\theta = \frac{60}{32.2}\left(\frac{v^2}{\rho}\right)$

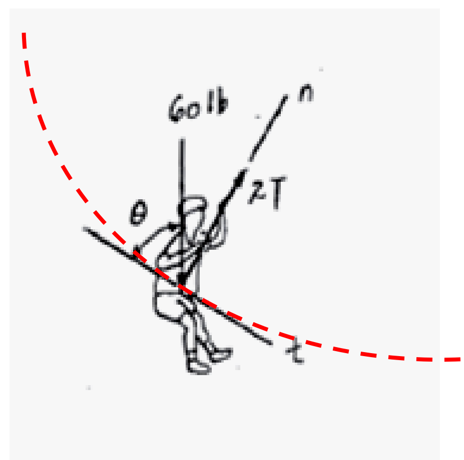
$2T - 60\sin\theta = \frac{60}{32.2}\left(\frac{v^2}{10}\right)$ …….(2)

$v\,dv = a_t\,dx \qquad , dx = 10d\theta$

$v\,dv = 32.2\cos\theta\,(10d\theta)$

$\int_0^v v\,dv = \int_{60}^{90} 322\cos\theta\,d\theta$

$v = 9.289\frac{ft}{s}$ ↘



Sub. V inot (2)

$2T - 60\sin 90 = \frac{60}{32.2}\left(\frac{9.289^2}{10}\right)$

$T = 38\ lb$

Example (5)

A girl having a mass of 25 kg sits at the edge of the merry-go-round so her center of mass *G* is at a distance of 1.5 m from the axis of rotation. If the angular motion of the platform is *slowly* increased so that the girl's tangential component of acceleration can be neglected, determine the maximum speed which she can have before she begins to slip off the merry-go-round. The coefficient of static friction between the girl and the merry-go-round is $u_k = 0.3$.

solution:

$+ \rightarrow \sum F_n = ma_n$

$F = 25 * 9.81 = 245.25N$

$0.3(245.25) = 25\left(\frac{v^2}{1.5}\right)$

$v = 2.1\ m/s$ ….Ans.