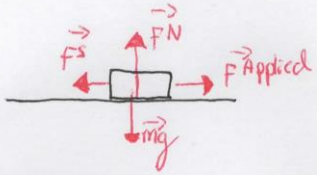
A 25.0-kg box is sitting on a plane floor in a warehouse. The coefficients of static and kinetic friction are 0.548 and 0.321 respectively. What is the horizontal force required to (a) just get the box moving and (b) slide the box across the warehouse with constant velocity?

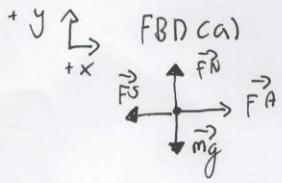
Solution

a) To make the box move from sitting still, the force applied has to be as large as the maximum value of static friction.



Known values

mass - 25.0kg
μ_s - 0.548
μ_k - 0.321



equations

from formula of static friction

eq1 - $\vec{F}_{S\,max} = \mu_s F_N$

from FBD

eq2 $\Sigma \vec{F}_y = \vec{F}_N - \vec{mg} = m\vec{a}^{\,0}$

$\vec{F}_N = \vec{mg}$

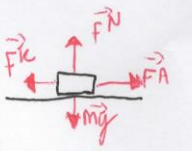
Using both equations find $\vec{F}_{S\,max}$

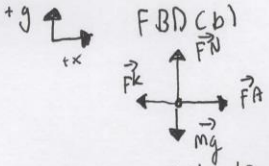
$\vec{F}_{S\,max} = \mu_s \vec{mg}$

$\vec{F}_{S\,max} = (0.548)(25.0\,kg)(9.8\,m/s^2)$

$\boxed{\vec{F}_{S\,max} = 134.3\,N}$

b) The box is moving at a constant speed. so, there is no acceleration in horizontal direction.





To answer this question it is easiest to start by summing your forces

$\Sigma \vec{F}_y = \vec{F}_N - \vec{mg} = m\vec{a}^{\,0}$

eq1 $\vec{F}_N = \vec{mg}$

$\Sigma \vec{F}_x = \vec{F}_A - \vec{F}_k = m\vec{a}^{\,0}$

$\vec{F}_A = \vec{F}_k$

e2 $\vec{F}_A = \mu_k \vec{F}_N$

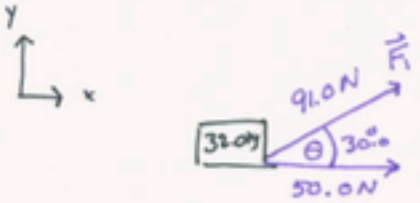
Combine eq1 & eq2

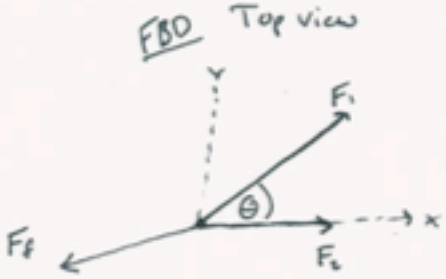
$\vec{F}_A = \mu_k \vec{mg}$

$\vec{F}_A = (0.321)(25.0\,kg)(9.8\,m/s^2)$

$\boxed{\vec{F}_A = 78.65\,N}$

There is a 32.0 kg brick that is initially at rest. Looking down on the brick, two forces, F_1 *and* F_2 are applied to the , it begins to move. The coefficient of kinetic friction between the brick and the ground is $\mu_k = 0.280$. F_1 has a force of 91.0 N at 30.0° relative to the x-axis and F_2 has a magnitude of 50.0 N in the same direction as the x-axis. The coefficient of kinetic friction between the crate and the floor is $\mu_k = 0.280$. Determine the magnitude and direction (relative to the x- axis) of the acceleration of the brick.





K
m
F_1
$\vec{F}_2$
θ
g
μ_k

UK
$\vec{a}$ ← want

$F_f = \mu_k F^N$
$F^N = F^g$

① Find Resultant Vector of F_1 & F_2

$\Sigma F_x = \vec{F}_2 + \vec{F}_1 \cos\theta$
$= 50.0 + 91.0\cos\theta$
$= 128.81\ N$

$\Sigma F_y = \vec{F}_1 \sin\theta$
$= 91 \sin 30$
$= 45.5\ N$

use pythagorean theorem
$a^2 + b^2 = c^2$

$F_{resultant} = \sqrt{(128.81)^2 + (45.5)^2}$
$F_r = 136.609\ N$

② Find direction

$\tan\theta = \frac{y}{x}$
$\tan\theta = \frac{F_y}{F_x}$
$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$
$\theta = 19.455°$

③ Find acceleration

$F_{total} = Force_{Resultant} - F_{friction} = F_{resultant} - \mu_k F^N$
$= 136.609 - 87.808N$
$= 48.801N$ → $F = ma$

$a = \frac{F}{m}$

$\vec{a} = 1.525\ m/s^2$ @ 19.455°