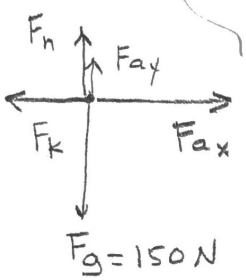
$\Sigma F = ma$ $F_g = mg$ $F_k = \mu_k F_n$ Name_____

Forces Problem Set # 7: Pulling/Pushing at an Angle

Draw a complete FBD (x and y forces) and write the ΣFy and ΣFx for each problem to get full credit.

Ex: A passenger is pulling on the strap of a 15.0 kg suitcase with a force of 69.0 N. The strap makes an angle of 37.5 ° with the horizontal. The coefficient of friction μ_k= 0.25. Find the normal force and the acceleration of the suitcase.

FBD



ΣFy

$F_n + F_{ay} = F_g$

$F_n = F_g - F_{ay}$

$= 150N - 69N(\sin 37.5°)$

$= 108N$

ΣFx

$F_{ax} - F_k = ma$

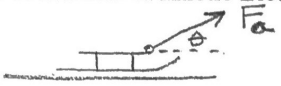
$a = \frac{F_{ax} - F_k}{m}$

$= \frac{69N(\cos 37.5) - 0.25(108N)}{15kg}$

$= \frac{54.7N - 27N}{15kg}$

$= \boxed{1.85\ m/s^2\ right}$

1. A 15 kg sled is being pulled across a horizontal surface at a constant velocity. The pulling force Fa has a magnitude of 83.5 N and is directed at an angle of 30 ° above the horizontal. Find the normal force and the coefficient of kinetic friction. (Note: just as in the example, Fn is not equal to Fg; you have to use the ΣFy equation first.)



FBD

ΣFy

$F_n + F_{ay} = F_g$

$F_n = F_g - F_{ay}$

$= 150N - 83.5N(\sin 30)$

$= 108N$

ΣFx

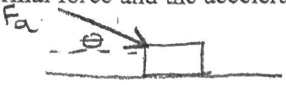
$F_{ax} = F_k$

$F_k = 83.5N \cos 30$

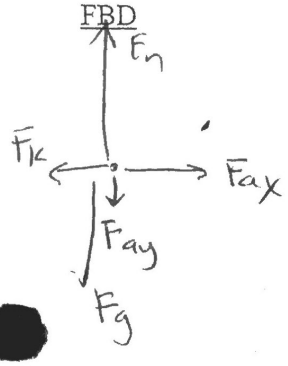
$= 72N$

$\mu_k = \frac{F_k}{F_n} = \frac{72N}{108N} = .67$

2. A box of books weighing 325 N accelerates across the floor when the box is pushed with a force of 425 N exerted **downward** at an angle of 35 ° below the horizontal. The coefficient of friction μ_k= 0.35. Find the normal force and the acceleration of the box.



FBD



ΣFy

$F_n = F_g + F_{ay}$

$F_n = 325N + 425N \sin 35$

$= 569N$

ΣFx

$F_{ax} - F_k = ma$

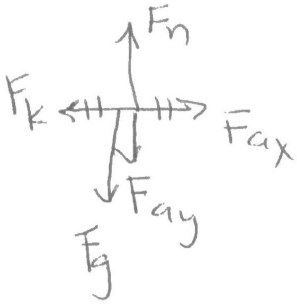
$348N - .35(569N) = ma$

$348N - 199N = ma$

$a = \frac{149N}{32.5kg} = 4.6 m/s^2$

3. A person pushes a 14.0 kg lawn mower at constant speed with a force of Fa = 88.0 N directed along the handle, which is at an angle of 45 degrees to the horizontal. Find Fk, Fn, and μ_k.

FBD



ΣFy

$F_{ax} = F_k$

ΣFx

$F_{ax} = F_a \cos\theta$

$= 62\,N = F_k$

$F_n = F_g + F_{ay}$

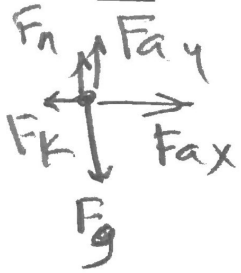
$= 140\,N + 88\,N(\sin 45)$

$= \boxed{202\,N}$

$\mu_k = \frac{F_k}{F_n} = .31$

4. A 10.0 kg box is pulled along a horizontal surface a Fa = 40.0 N applied at a 30 degree angle above the horizontal. $\mu_k = 0.3$. Calculate the acceleration.

FBD



ΣFy

$F_{ay} + F_n - F_g = 0$

$F_n = F_g - F_{ay}$

$= 100\,N - 20\,N$

$\boxed{F_n = 80\,N}$

ΣFx

$F_{ax} - F_k = ma$

$F_k = \mu_k F_n$

$= 24\,N$

$a = \frac{\Sigma F}{m} = \frac{34.6\,N - 24\,N}{10\,kg}$

$F_k = 24\,N$

$F_n = 80\,N$

$a = 1.06\,m/s^2$

Stuart's desk