# Friction and Angles – Two Examples

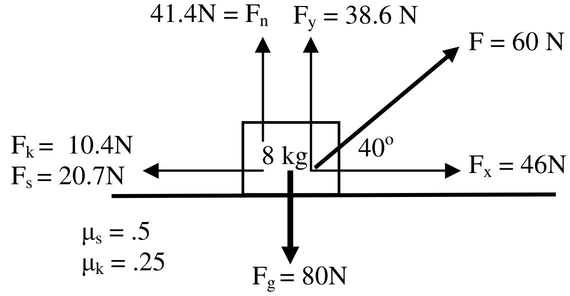
***This page assumes you have read and understood the notes on Normal Force and Friction.***

***Big Hints for Any Friction Problem with Angles***
***1) Draw accurate and neat diagrams.***
***2) Keep x and y directions separate.***

**Type 1: Object on a horizontal surface with a force applied at an angle.**
*Example: A 60 N force is applied at 40° to an 8 kg object. Will the object slide? If so, find its acceleration.*

Steps:

1) Find the weight of the object. (Remember that $F_w$ = mg, F is in Newtons, and that gravity always pulls straight down toward the earth.)
2) Resolve all vectors into their x and y components. Here $F_x = F(\cos\theta)$; $F_y = F(\sin\theta)$ (if a force is already along an axis, skip this step and put it in the x or y axis).
3) Find the normal force. Remember that $\Sigma F_{up} = \Sigma F_{down}$. (If there is a force pulling up in addition to $F_n$, $F_n$ will be less than Fg.)
4) Find $F_s$ and $F_k$. (Remember that $\mu_s = F_s/F_n$ and $\mu_k = F_k/F_n$.)
5) Is the object moving? (Is $F_x > F_s$?) (If no, you can stop here.)
6) Find "a" from ΣF = ma. (But because it is moving, you must use $F_k$, not $F_s$.) So $F_x - F_k$ = ma.




1) $F_g = mg = 8kg(-10m/s^2) = -80$ N (down)
2) $F_x = F(\cos\theta) = 60N(\cos 40^o) = 46$ N
   $F_y = F(\sin\theta) = 60N(\sin 40^o) = 38.6$ N
3) $\Sigma F_{up} = \Sigma F_{down}$
   $F_n + F_y = F_g$ $\quad F_n = F_g - F_y = 80N - 38.6N$
   $F_n = 41.4N$
4) $F_s = \mu_s F_n$ $\quad F_k = \mu_k F_n$
   $F_s = .5(41.4N)$ $\quad F_k = .25(41.4N)$
   $F_s = 20.7N$ $\quad F_k = 10.4N$
5) Is moving, because $F_x > F_s$ (46N > 20.7N)
6) ΣF = ma (but use $F_k$, not $F_s$)
   $F_x - F_k = ma$
   46N – 10.4N = (8 kg)a

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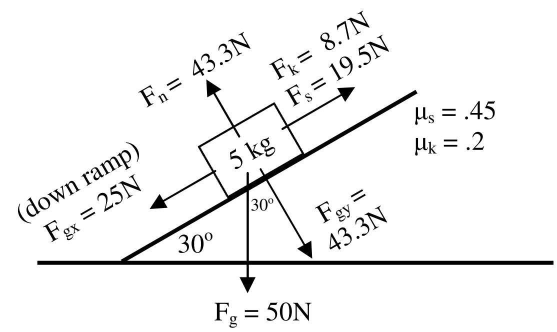
**Type 2: Object on a tilted ramp.**
*Example: A 5 kg object is on a 30° ramp. $\mu_s$ = .6 $\mu_k$ = .35 Will it slide? If so, find its acceleration.*

Steps:

1) Find the weight of the object. (Remember that $F_w$ = mg, F is in Newtons, and that gravity always pulls straight down toward the earth.)
2) Resolve $F_g$ into its components parallel and perpendicular to the ramp. Here $F_{gx} = Fg(\sin\theta)$; $F_{gy} = F_g(\cos\theta)$
3) Find the normal force. Remember that $\Sigma F_{up} = \Sigma F_{down}$ in the y-direction (perpendicular to the ramp) here Fn = Fgy.
4) Find $F_s$ and $F_k$.
5) Is the object moving? (Is $F_{gx} > F_s$?) (If no, you can stop here.)
6) Find "a" from ΣF = ma. (But because it is moving, you must use Fk, not Fs.) So $F_x - F_k$ = ma.




1) $F_g = mg = 5kg(-10m/s^2) = -50$ N (neg. means down)
2) $F_x = F(\sin\theta) = 50N(\sin 30^o) = 25$ N
   $F_y = F(\cos\theta) = 50N(\cos 30^o) = 43.3$ N
3) $\Sigma F_{up} = \Sigma F_{down}$
   $F_n = F_{gy}$ $\quad F_n = 43.3N$
4) $F_s = \mu_s F_n$ $\quad F_k = \mu_k F_n$
   $F_s = .45(43.3N)$ $\quad F_k = .2(43.3N)$
   $F_s = 19.5N$ $\quad F_k = 8.7N$
5) It is moving, because $F_x > F_s$ (25N > 19.5N)
6) ΣF = ma (but use $F_k$, not $F_s$)
   $F_x - F_k = ma$
   25N – 8.7N = (5 kg)a
   $a = 16.3N/5kg = 3.26\ m/s^2$