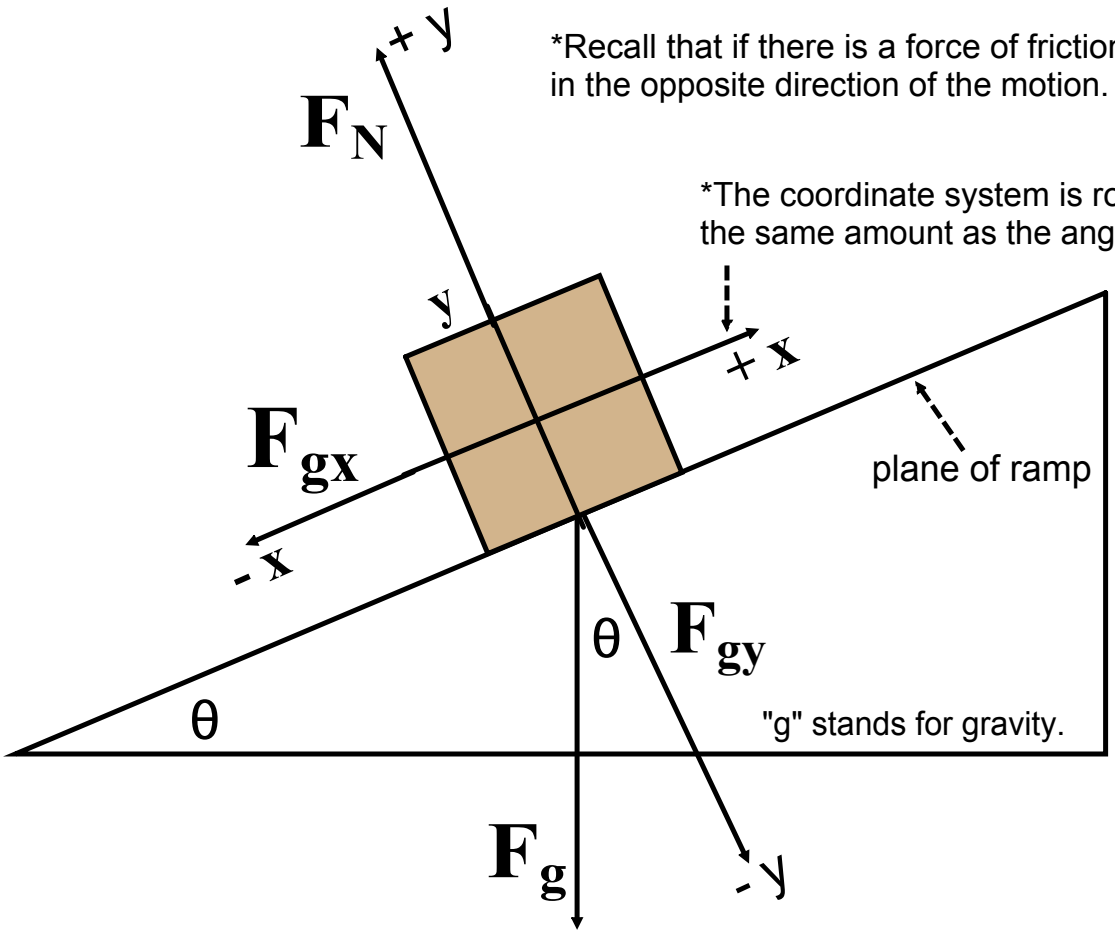
# Type III - Inclined Planes, Hills, Ramps

(printed copy for students)

*Recall that if there is a force of friction it acts in the opposite direction of the motion.

*The coordinate system is rotated the same amount as the angle θ.




$F_{gy}$ and $F_g$ are separated by θ because of two similar triangles.

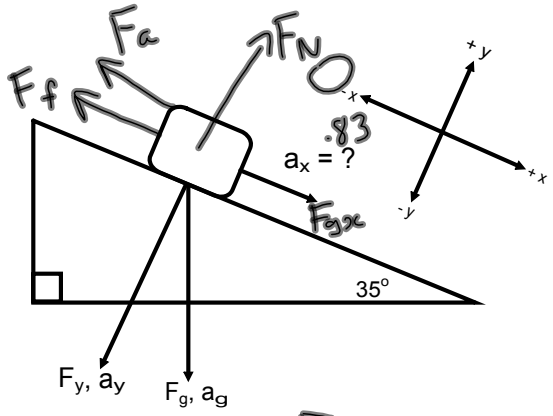
$F_{gx} = F_g \sin \theta$ ⟵ component parallel to the plane.

$F_{gy} = F_g \cos \theta$ ⟵ component perpendicular to the plane.

**NOTE**! The *sin* and *cos* have switched places. This will only happen when dealing with objects on a ramp.

**NOTE FURTHER**! Every ***F*** in the above diagram can be replaced with an ***a*** for acceleration.

1. A 55 kg block is sliding down an incline. The coefficient of kinetic friction is 0.13 and the incline makes an angle of 35° with the ground. What applied force up the ramp is necessary so the block accelerates with a magnitude of 0.83 m/s$^2$? down the ramp?




$F_{netx} = F_{gx} + F_f + F_a$

$F_{netx} = ma_x$

$F_{netx} = 55(0.83)$

$= 45.7\ N$

$F_f = \mu F_N$

Ramp $\rightarrow |F_N| = |F_{gy}|$

$F_f = 0.13\ F_{gy} = (0.13)(F_g \cos 35)$

$F_f = (55)(9.81)\cos 35^\circ \times 0.13$

($F_g$)

$F_f = 57.5\ N$

$F_{gx} = F_g \sin 35^\circ$

$= (55)(9.81)\sin 35$

$= 309\ N$

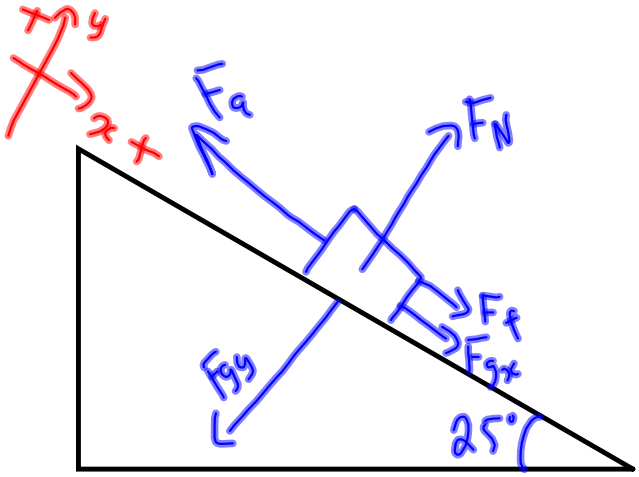
$F_{netx} = F_{gx} + F_f + F_a$

$45.7 = 309 + (-57.5) + F_a$

$-206\ N = F_a$

↑ up the ramp

2. What applied force is necessary for a person to pull a 30 kg object up a ramp at a constant velocity? The ramp makes an angle of 25° with the ground and the coefficient of kinetic friction is 0.12.




$F_{netx} = F_a + F_f + F_{gx}$

$F_{netx} = 0$

$F_f = \mu F_N$

$F_f = 0.12(30)(9.81)\cos 25$

$= 32\ N$

$F_{gx} = F_g \sin\theta$

$= (30)(9.81)\sin 25$

$= 124\ N$

$F_{netx} = F_{gx} + F_f + F_a$

$0 = 124\ N + 32\ N + F_a$

$-156\ N = F_a$

up the ramp