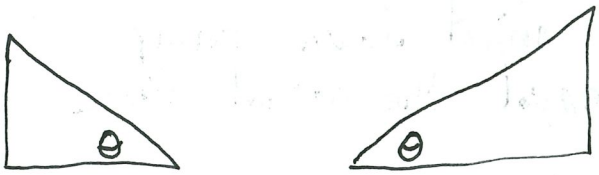
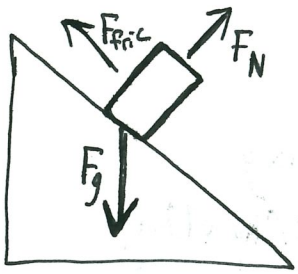
Inclines

Draw an incline which makes an angle of θ with the horizontal.

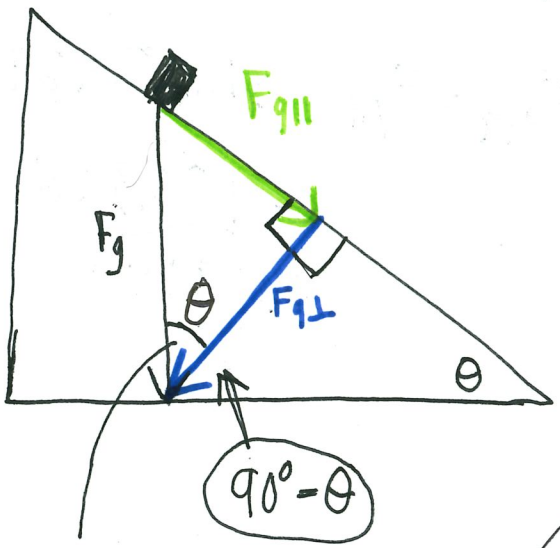


Consider a block placed on the incline. Gravity pulls the block straight downwards while the Normal force acts perpendicular to the incline.



We can resolve the force of gravity into two perpendicular components:

Force parallel to the incline ($F_{g\parallel}$) and the force perpendicular to the incline ($F_{g\perp}$)



$$\sin\theta = \frac{F_{g\parallel}}{F_g}$$

$$\cos\theta = \frac{F_{g\perp}}{F_g}$$

$90^\circ - (90^\circ - \theta)$

$90^\circ - 90^\circ - (-\theta)$

θ

$$F_{g\parallel} = \sin\theta \cdot F_g$$

$$F_{g\perp} = \cos\theta \cdot F_g$$

Key finding:

The parallel component of gravity will pull object down ramp

The perpendicular component of gravity will equal the normal force

Example 1: A 8.0 kg block is placed on a frictionless 35° incline. What is the force acting to pull the block down the incline? What is the acceleration of the block?

$F_{g||} = \sin 35 \times F_g = \sin 35 \times m \times g$

$= \sin 35 \times 8.0\,kg \times 9.8\,m/s^2$

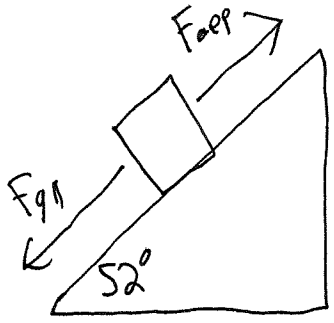
$= 44.97\,N$

$\approx 45\,N$

$a = \frac{F_{net}}{m} = \frac{44.97\,N}{8.0\,kg}$

$= 5.6\,m/s^2$

Example 2: How much force is required to push a 24 kg block up a 52° incline at a constant velocity?



Since it has constant velocity

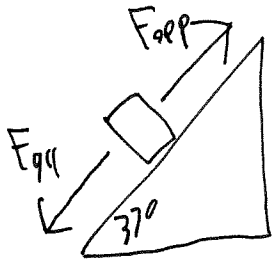
$F_{app} = F_{g||} = \sin 52 \times 24\,kg \times 9.8\,m/s^2$

$= 185.34\,N$

$\approx 190\,N$

Example 3: How much force is required to push a 16 kg block up a 37° incline so that it accelerates at 1.2m/s^2?

$$F_{net} = ma = 16kg \times 1.2m/s^2 = 19.2N$$



$$F_{g\parallel} = \sin 37° \times F_g$$
$$= \sin 37° \times 16kg \times 9.8m/s^2$$
$$= 94.4N$$

$$F_{app} = 94.4N + 19.2N$$
$$= \boxed{110N}$$

Example 4: What is the normal force acting on a 29 kg block on a 26° incline?

$$F_N = F_{g\perp} = \cos 26° \times F_g$$
$$= \cos 26° \times 29kg \times 9.8m/s^2$$
$$= 255N$$
$$\approx \boxed{260N}$$