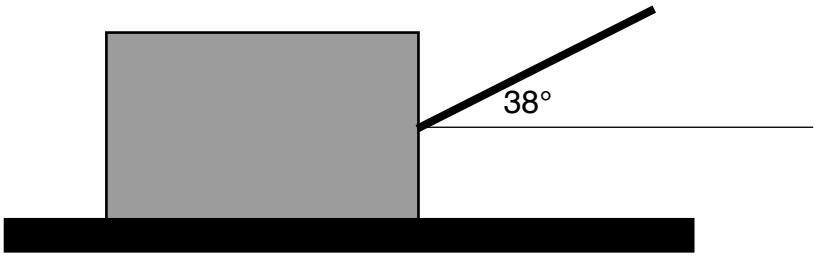
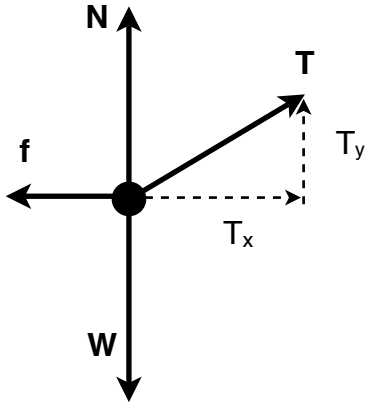
Dragging a crate

A worker drags a crate across a factory floor by pulling on a rope tied to the crate. The worker exerts a force of 450 N on the rope, which is inclined at 38° to the horizontal, and the floor exerts a horizontal friction of 125 N that opposes the motion. You can assume the crate doesn't leave the ground.

a) Calculate the acceleration of the crate (mass = 310 kg).

b) Calculate the normal force by the floor on the crate.





Solution: Resolve the tension force from the rope into horizontal and vertical components:

$T_y = T \sin 38° = 450 \sin 38° = 277$ N

$T_x = T \cos 38° = 450 \cos 38° = 355$ N

Now, there is no net force in the vertical direction, so

$$N + F_y - W = 0$$

so

$$N = W - F_y$$
$$= 310 \times 9.8 - 277 = 2761 \text{ N}$$

In the horizontal direction, there is a net force:

$$F_{net,x} = F_x - f$$
$$= 355 \text{ N} - 125 \text{ N} = 230 \text{ N}$$

From Newton's second law,

$$ma = F_{net}$$

so

$$a = F_{net,x} / m = 230 \text{ N} / 310 \text{ kg} = 0.74 \text{ ms}^{-2}$$

So the acceleration of the crate is 0.74 ms^{-2}, and the normal force is 2761 N.