Lecture 3 - Newton's 3rd Law

What is my Weight?

Weight is the force exerted on a body by gravity $F = mg$.

Gravity acts vertically so consider only vertical component $F_w = F_y = ma_y$.

In free fall, acceleration $g = 9.8 \text{ ms}^{-2}$.

$F_w = mg$

:. my weight is $84 \text{ kg} \times 9.8 \text{ ms}^{-2} = 820 \text{ N}$

(downwards! Always give vector's direction) 2 sig figs!

Newton's Third Law

For every action (force) there is an equal and opposite reaction (counter-force).

\[ \mathbf{F}_{BA} = -\mathbf{F}_{AB} \]

So, why does anything move at all?

Remember:

Although all forces are paired, the Action (force) and the Reaction (force) are NOT exerted on the same object.

But what about rockets?

Problem

An oppressed worker subject to John Howard's new industrial relations laws drags a crate across a factory floor by pulling on a rope tied to the crate. The worker exerts a force of $450 \text{ N}$ on the rope, which is inclined at $38^\circ$ to the horizontal, and the floor exerts a horizontal friction of $125 \text{ N}$ that opposes the motion. You can assume the crate doesn't leave the ground.

a) Calculate the acceleration of the crate (mass = $310 \text{ kg}$).

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

[0.74 ms$^{-2}$, 2.7 kN]

Another Problem

A 50 kg skier is pulled up a frictionless ski slope that makes an angle of $8^\circ$ with the horizontal, by holding onto a ski rope that moves parallel to the slope. Determine the magnitude of the force of the rope on the skier at an instant when:

a) the rope is moving with constant speed of $2.0 \text{ ms}^{-1}$, and

b) the rope is moving with a speed of $2.0 \text{ ms}^{-1}$, but that speed is increasing at a rate of $0.10 \text{ ms}^{-2}$.

[68N, 73N]

And yet more.. similar to Hecht Example 4.8

A problem with pulley, weights and string:

a) Find the magnitude of acceleration of the blocks

b) Find the tension in the string

Note: for an ideal string* the magnitudes of $\mathbf{T}$ & $\mathbf{w}$ (along the string direction) are the same at both ends

*inextensible, with negligible mass & stiffness

[1.8 kg, 10.2 kg]