Force of Gravity, Normal Force and Centripetal Force

Goal:

- to become familiar with different types of forces
- to be able to calculate different types of forces

What is gravity?

↳ force that pulls (towards a planet, star, actually anything) between any objects with matter.

Remember weight = force of gravity

$F = mg$

g: gravitational field strength (N/kg)

on Earth:

$g = 9.8\ N/kg$

Law of Universal Gravitation

$$F_G = \frac{G m_1 m_2}{r^2}$$

m_1 : mass of object 1 (kg)

m_2 : mass of object 2 (kg)

r : distance between objects (m)

$G : 6.67 \times 10^{-11} \ N m^2/kg^2$

↑ Newton's universal gravitation constant

Determine the force of gravity between you and the person sitting next to you.

$$F_G = \frac{6.67 \times 10^{-11} \ N m^2/kg^2 \ (50 kg)(50 kg)}{(0.4 m)^2}$$

$$= 1.04 \times 10^{-6} \ N$$

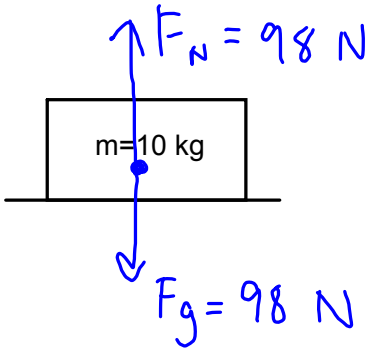
Normal Force

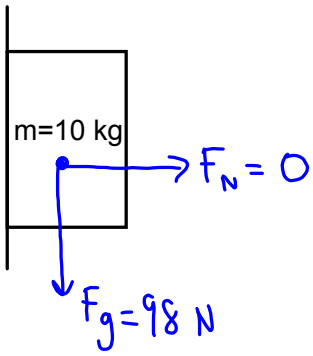
↳ geometric sense means perpendicular

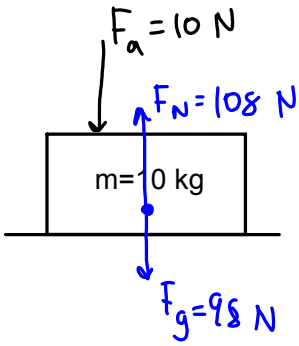
Normal force is contact force generated by surfaces, always acting at 90° to the surface.

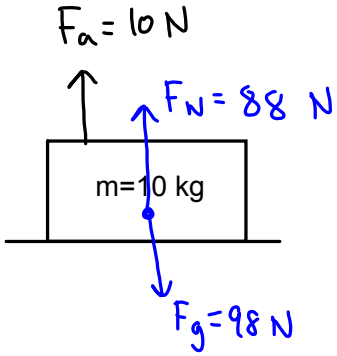
$\vec{F}_N$: normal force

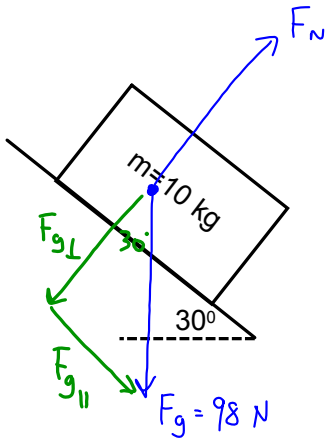
Determine the normal force in the following situations:











$F_{g\parallel} = F_g \sin 30^\circ = 49$ N

$F_{g\perp} = F_g \cos 30^\circ = 84.9$ N

$F_N = F_{g\perp} = 84.9$ N

Elevator problems

when elevator is accelerating upwards you feel...

heavier

$F_N > F_g$

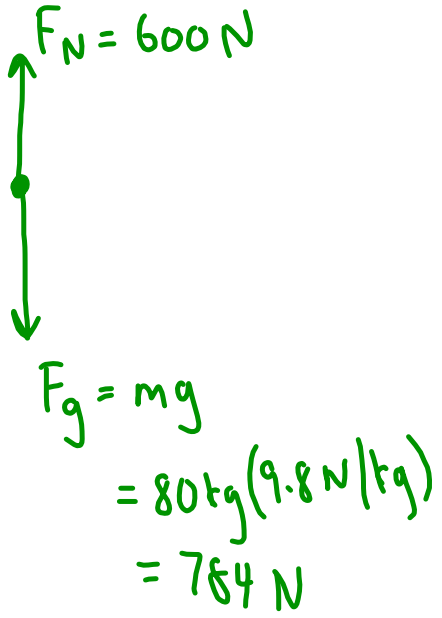
when elevator is accelerating downwards you feel...

lighter

$F_N < F_g$

A person with a mass of 80 kg is in an elevator. The normal force exerted on the person is 600 N. What is the acceleration of the elevator?

FBD :



$\vec{F}_{net} = 600\ N\ [up] + 784\ N\ (down)$

$= 184\ N\ [down]$

$m\vec{a} = 184\ N\ [down]$

$(80kg)\vec{a} = 184N\ (down)$

$\vec{a} = 2.3\ m/s^2\ [down]$

A person with a mass of 60 kg is traveling in an elevator that is accelerating at 1.5 m/s^2 [up].

a) What is the normal force acting on the person?

$\vec{F}_{net} = m\vec{a}$

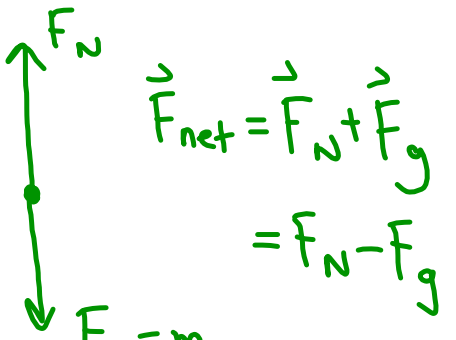
$= (60\,kg)(1.5\,m/s^2)$

$= 90\,N\,[up]$

$F_N - F_g = 90\,N$

$F_N - 588 = 90$

$F_N = 678\,N$



b) What is their apparent mass?

$678\,N = mg$

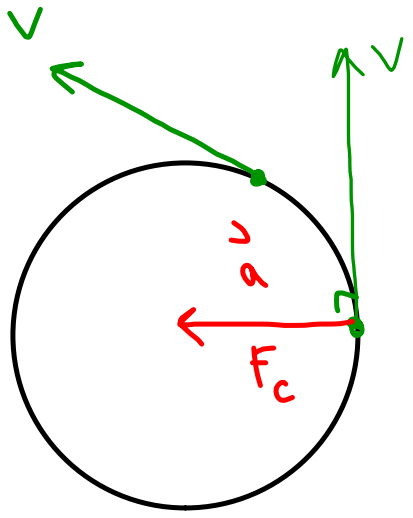
$678\,N = m(9.8\,N/kg)$

$m = 69.2\,kg$

Centripetal Force is a centre-seeking force.

It must exist for objects to travel in a circle.

$$\vec{F}_c = \frac{mv^2}{r}$$



Centripetal acceleration