Inertial Mass

The more mass an object has the greater its resistance to change in velocity. For example, to decrease the velocity of a 500 kg object 1 m/s requires 100 times more force than to decrease the velocity of a 5kg object the same amount.

How much force is required to change the velocity of a 2.0 kg object from rest to 5.0 m/s in 1.0 second?

$a = 5 m/s^2$

$F_{net} = ma = 2.0kg \times 5.0 m/s^2$

$= 10 N$

How much force is required to change the velocity of a 2.0 kg object from 45.0 m/s to 50.0 m/s in 1.0 second?

$a = 5 m/s^2$

$F_{net} =$ same $= 10N$

How much force is required to change the velocity of a 2.0 kg from 5.0 m/s to rest in 1.0 second?

$-10 N$

How much force is required to accelerate a 20.0 kg object at 5.0 m/s^2?

100N

How much force is required to accelerate a 200.0 kg object 5.0 m/s^2?

1000N

Force of Gravity

The force of gravity attracts all matter to all other matter

The more mass the more the force of gravity acts on the object. This is called gravitational mass and is the same as inertial mass.

Mass is the amount of stuff in an object (kg)

Weight is the force of gravity affecting an object (N)

Mass is constant but weight changes depending where in the universe something is.

Force of gravity is determined using the equation: $F_g = mg$

Where m = mass

g = gravitational field strength

On Earth g= $9.8 \frac{m}{s^2}$ on the moon it is g= $1.6 \frac{m}{s^2}$ on Jupiter g = $24.8 \frac{m}{s^2}$

Determine the force of gravity acting on each of the following on Earth, then use Newton's second law to determine the acceleration due to gravity of each object.

A 86 kg man

$F_g = mg$

$= 86\,kg \times 9.8\,\frac{m}{s^2}$

$= 842.8\,N \approx 840\,N$

$F_{net} = ma$

$\frac{F_{net}}{m} = a$

$\frac{842.8\,N}{86\,kg} = 9.8\,m/s^2$

A 0.25 kg coffee cup

$2.45\,N$

$\approx 2.5\,N$

$9.8\,m/s^2$

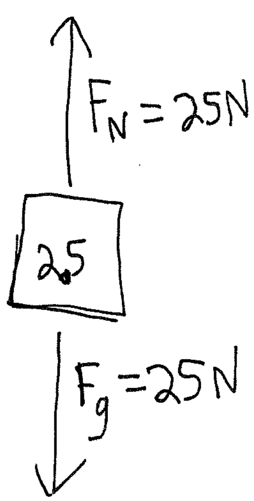
A 5800 kg elephant

$56840\,N$

$\approx 57000\,N$

$9.8\,m/s^2$

Draw a FBD with magnitude of forces labelled for a 2.5 kg block which is sitting on a table.



$F_g = mg$

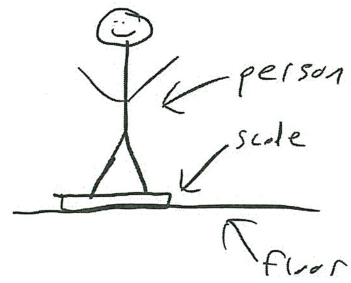
$= 2.5\,kg \times 9.8\,\frac{m}{s^2}$

$= 24.5\,N$

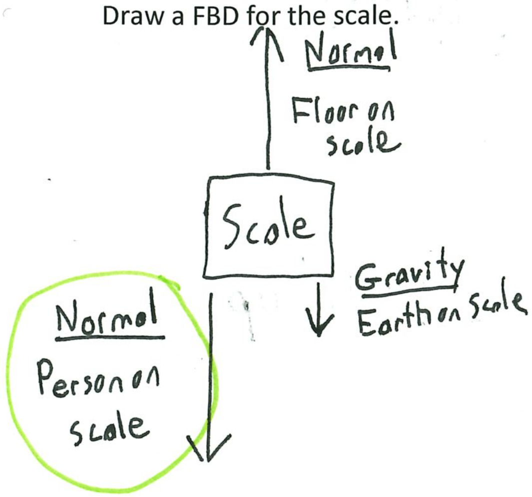
$\approx 25\,N$

Scales, Weight and Mass

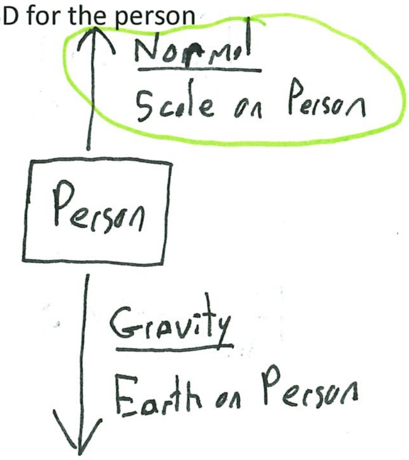
A person stands on a bathroom scale to determine their mass.



Draw a FBD for the scale.



Draw a FBD for the person



The scale does not measure the mass of the person, rather it will show Normal force between scale & person which will be equal to the Grav force on person which is proportional to mass.

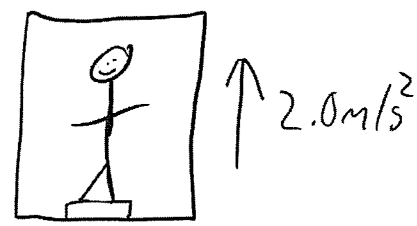
Example: If the normal force between the person and the scale is 627 N

Weight of person is 627N

$$\frac{F_g}{g} = m \rightarrow \frac{627\,N}{9.8\,m/s^2} = \boxed{64\,kg}$$

The normal force from the person onto the scale is called apparent weight

A 50.0 kg person stands on a scale in an elevator which is accelerating upwards at 2.0 m/s². It could be speeding up going upwards, or slowing down going downwards, either is the same for our purposes.



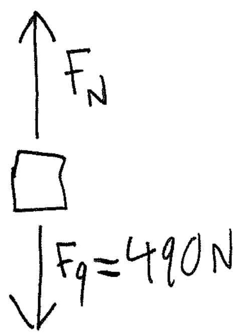
What is the actual weight (force of gravity) of the person?

$$F_g = mg = 50.0\,kg \times 9.8\,\frac{m}{s^2} = 490\,N$$

What is the net force acting on the person?

$$F_{net} = ma = 50.0\,kg \times 2.0\,\frac{m}{s^2} = 100\,N \text{ up}$$

Draw a FBD for the person



What is the apparent weight of the person? F_N is apparent weight

F_N is winner, it wins by 100N, so $F_N = 590\,N$

What will it appear that their mass is?

$$F_g = mg \qquad \frac{F_g}{g} = m$$

$$\frac{590\,N}{9.8\,\frac{m}{s^2}} = 60\,kg$$