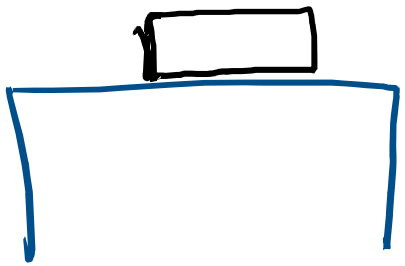
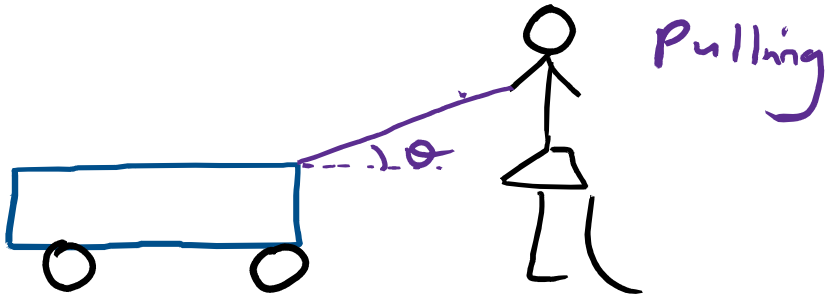
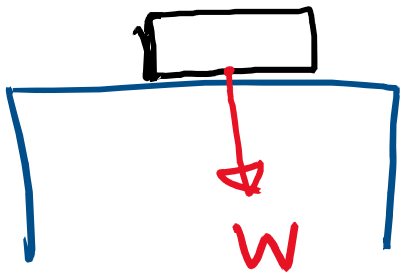
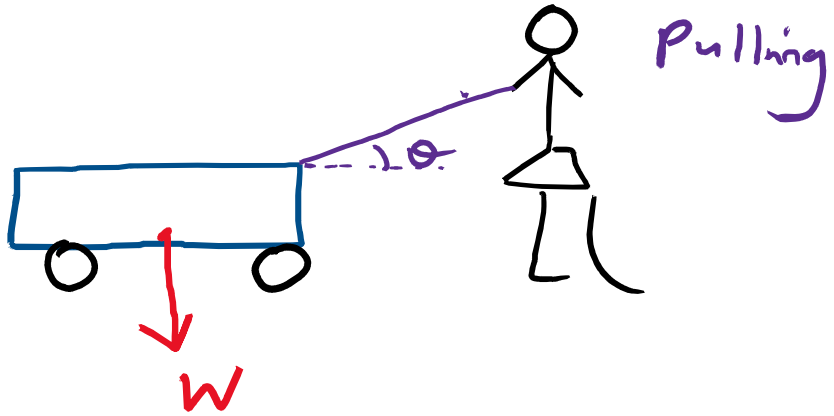
FREE BODY DIAGRAM (FBD)

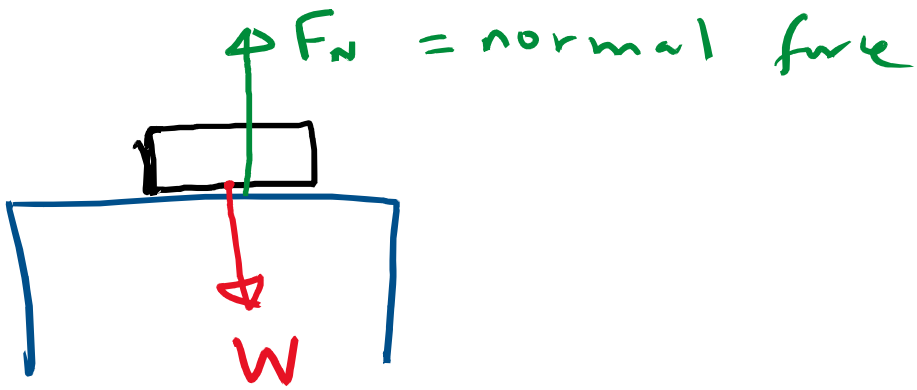
- The picture that isolates and identifies only the forces that are acting on the object of interest.
- Simplifies problem solving

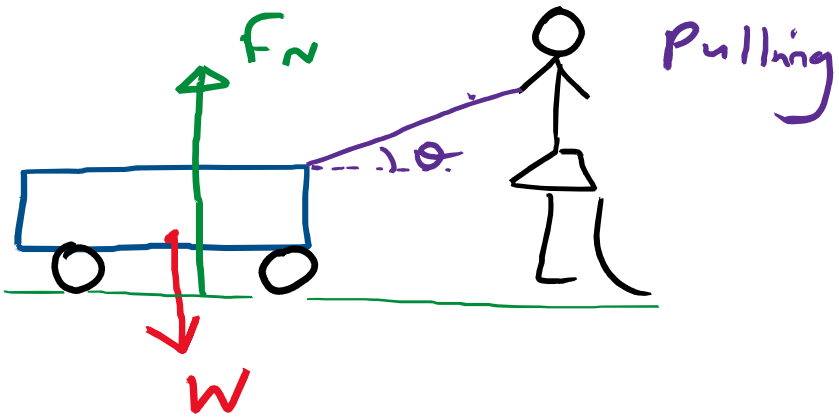


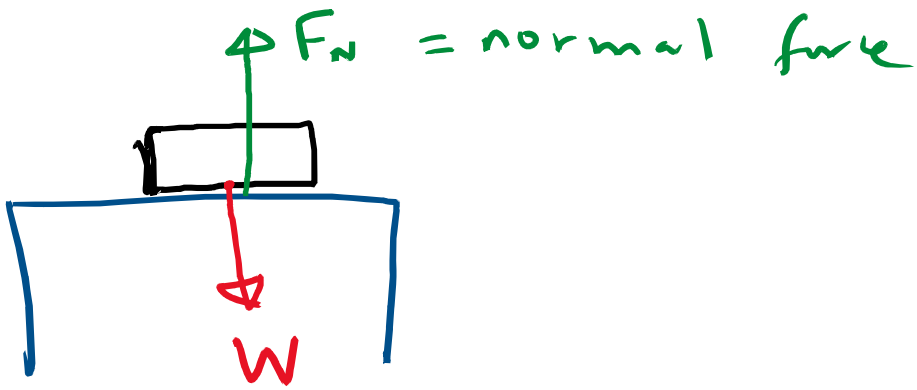

Pulling
θ


W


Pulling
θ
W


F_N = normal force
W


F_N
Pulling
θ
W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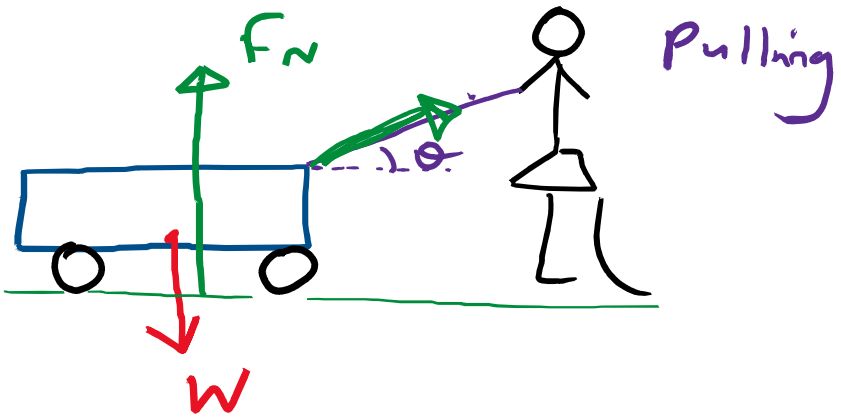
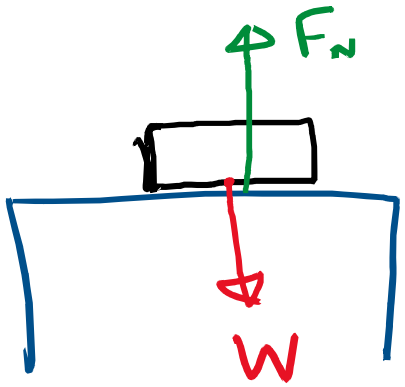
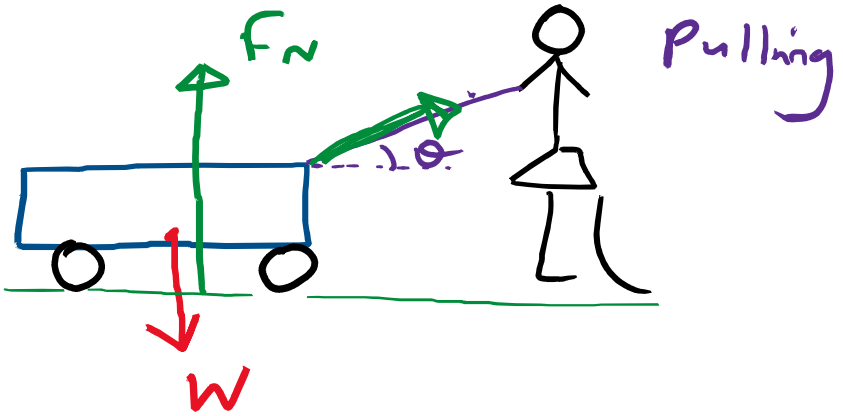
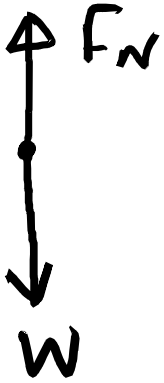
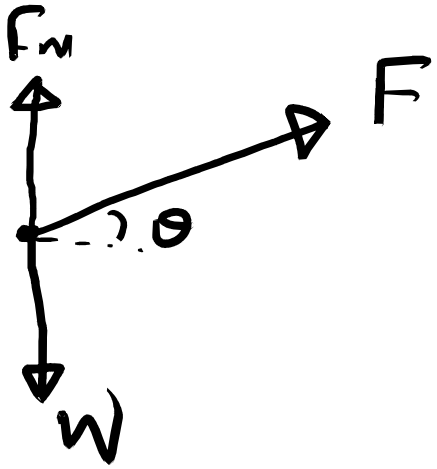

F_N
Pulling
θ
W



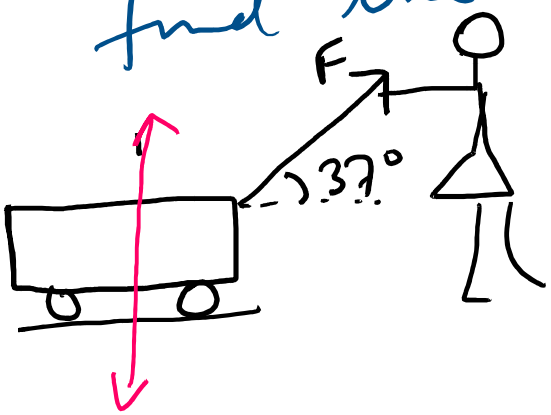


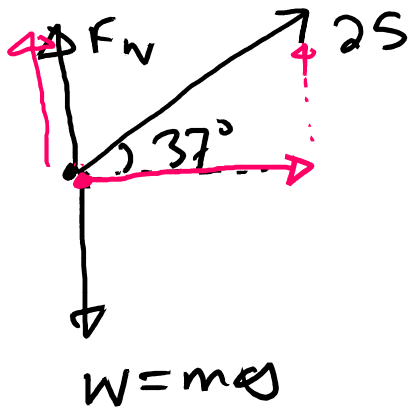


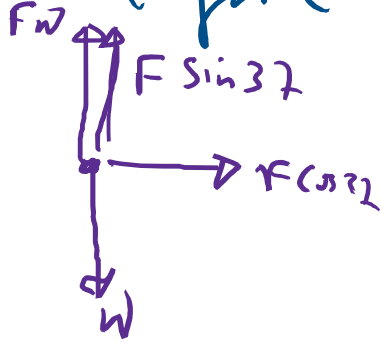
FBD



Suppose $F = 25\,N$ and the wagon is 10 kg find the acceleration & the normal force







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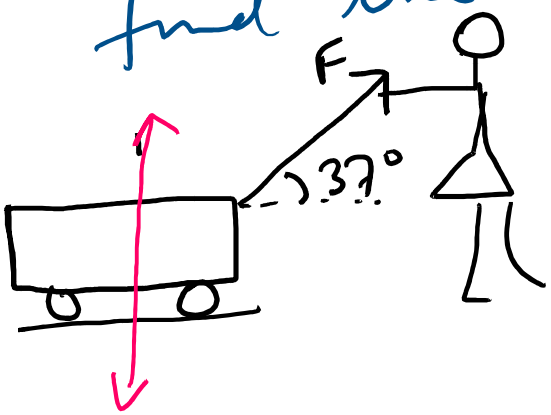
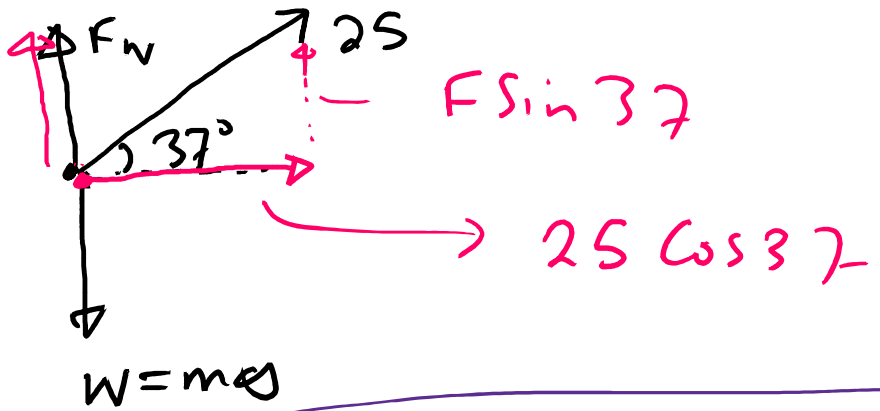
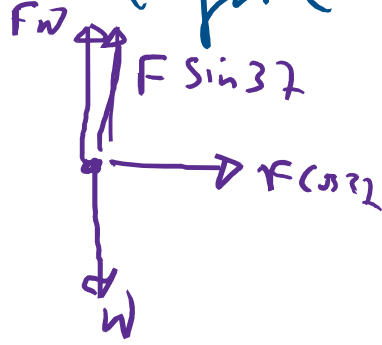






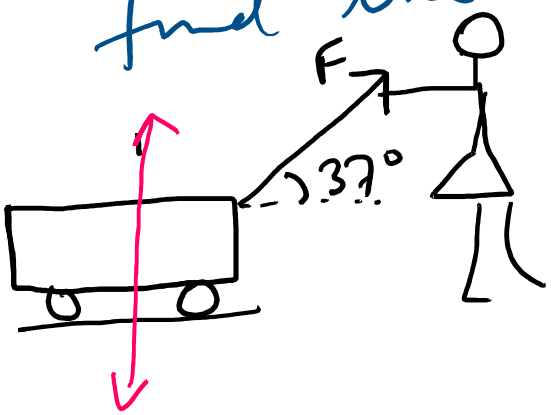
$$\Sigma F = ma$$

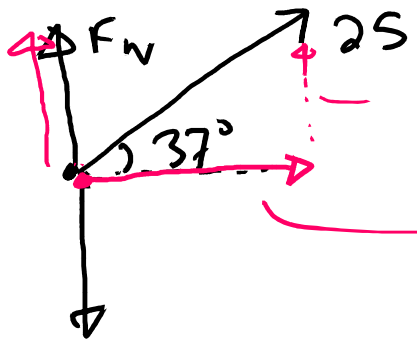
$$(F_{net})_x = ma_x$$

$$25\cos 37 = 10(a_x)$$

$$a_x = \frac{25\cos 37}{10} = 2\,m/s^2$$

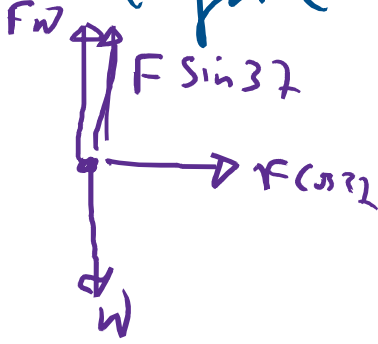
Suppose $F = 25\,N$ and the wagon is 10 kg find the acceleration & the normal force





$F \sin 37$

$25 \cos 37$



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$(F_{net})_x = ma_x$

$25 \cos 37 = 10(a_x)$

$a_x = \frac{25 \cos 37}{10} = 2\,m/s^2$

$\Sigma F_y = ma$

No movement in y-direction $\therefore a = 0$.

$F_N + F \sin 37 + (-w) = 0$

$F_N + F \sin 37 = w$

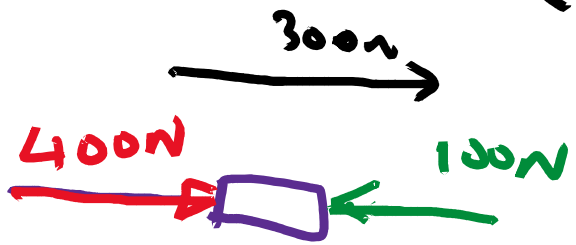
$F_N = w - F \sin 37$

$= 10(9.8) - 25 \sin 37$

$= \_\_\_\_\_ N.$

A boy is pushing a box with a force of 400N. If the friction between the box and the table is 100N, Calculate the acceleration of the box whose mass is 15kg.

(Unbalanced force causes motion)



$F_{net} = ma$ or $\Sigma F = ma$

$400 + (-100) = ma$

$300 = 15a$

$a = 20 m/s^2$

The first law is contained in the Second Law:

$$\sum F = ma \Rightarrow \text{General}$$

An object obey 1st law

$v = 0$, $a = 0$: Constant velocity

$$\sum F = m(0)$$

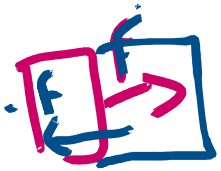
$$\sum F = 0 \longrightarrow 1^{st} \text{ law}$$

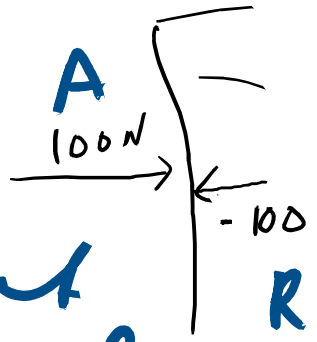
Newton's Third Law of Motion

- If an object A exerts a force F on an object B, then B exerts a force −F on object A. Equal in magnitude but opposite in direction.
- One of these forces is the <u>action force</u> & the other one is the <u>reaction force</u>.

Action = − Reaction

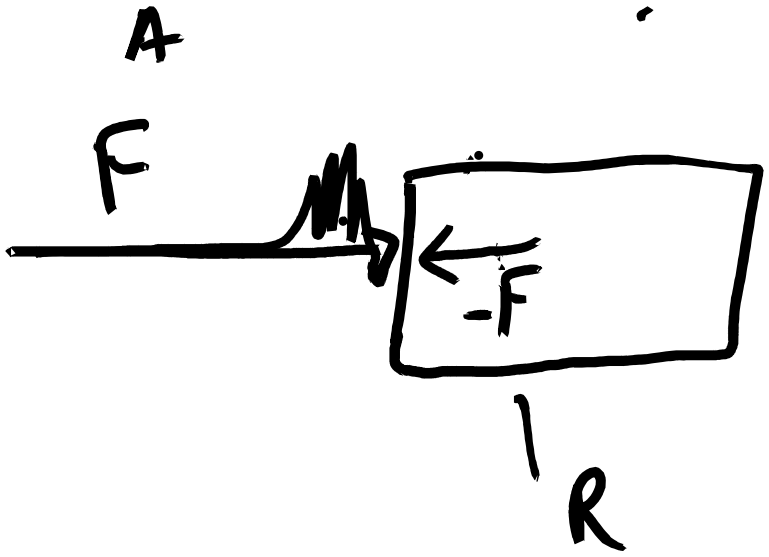
Reaction force

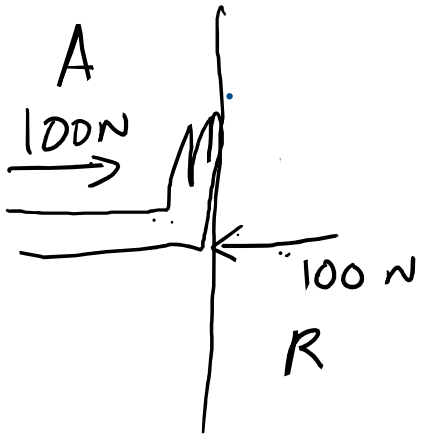


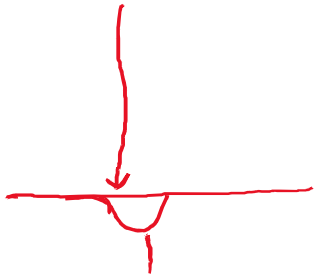


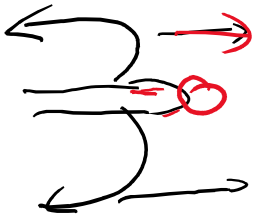
Re-statement
For every action force there is an equal but opposite reaction force

– Action & Reaction pairs always act on different objects.









Why is it difficult to walk on sand?

Why is it difficult to walk on Sand?

when we press on Sandy ground in the backward direction, the Sand gets pushed away and we get a very small rxn force from the Sandy ground. It makes it very difficult to walk on Sand.

Whiplash

- Neck bones are rather delicate and can be fractured by even a moderate force.
- Fortunately the neck muscles are relatively strong and are capable of absorbing a considerable amount of energy.
- If, however, the impact is sudden, as in a rear-end collision, the body is accelerated in the forward direction by the back of the seat, and the unsupported neck is then suddenly yanked back at full speed.
- Here the muscles do not respond fast enough and all the energy is absorbed by the neck bones, causing the well-known whiplash injury).

Consequences of 1st Law.

The neck & head tries to continue at its original speed but the body accelerates →

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Consequences of 1st Law.

The neck a head tries to continue at its original speed but the body accelerates →

Mass and its relation to weight

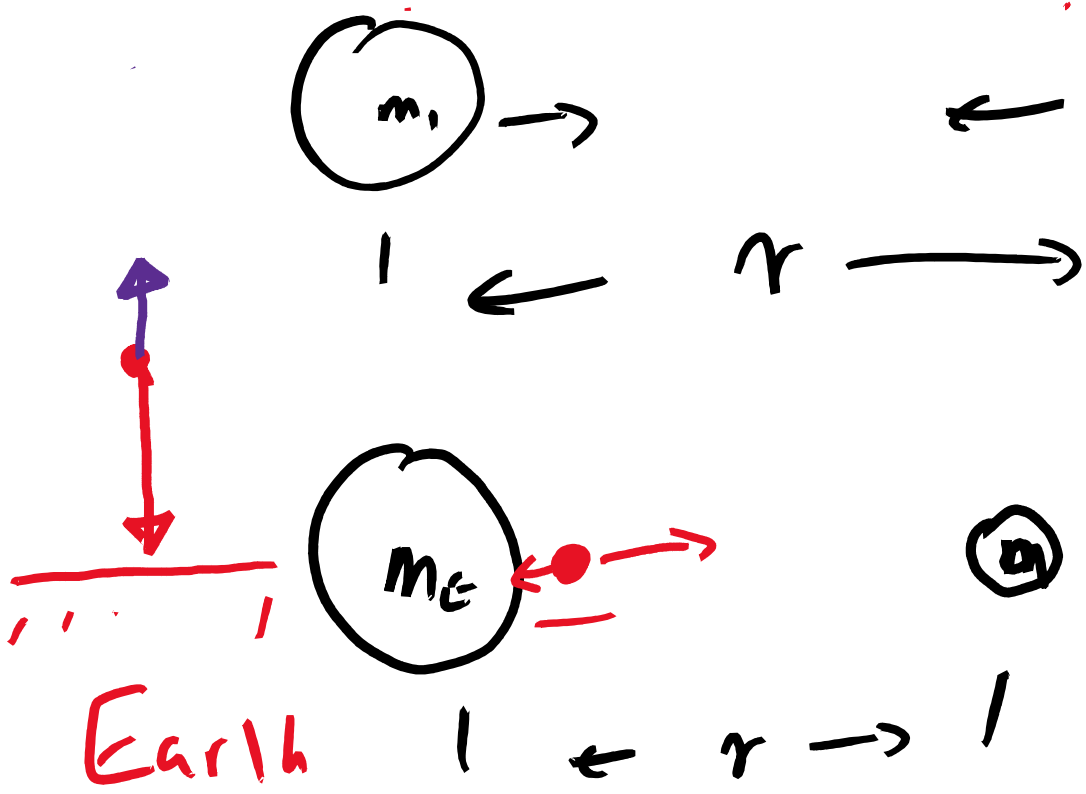
- The weight of an object is the force that gravity exerts on objects.
- not to be confused with mass
- $W = mg$

$W = F = ma$

$\boxed{W = mg}$

- Varies depending on the Strength of gravitation field at the location of the object.

Law of gravitation



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

In case

$$F_g = W = \frac{G m_E m}{r^2}$$

$$= m g$$

When the moon is directly above you you weigh less

True or False

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True or False

m = 50 : W = mg
= 490N

E

FBD

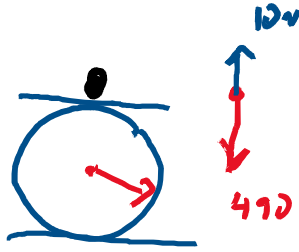
W = 490N

When the moon is directly above you, you weigh less

True or False

m = 50 : W = mg
= 490N

E



$70 \times 9.8 \approx 700N$

When the moon is directly above you you weigh less

True ✓ or False