Newton's laws

Let's start this section by looking at all the different types of forces we are going to deal with in this section.

Force

Forces can be

- A push or a pull
- tension (in a cable)
- force of gravity on an object

Note that:

Force (F) has magnitude and direction thus it is a vector scalar

It is measured in _____ {write the full word out}

A force is anything that can cause a change to objects. Forces can do things like:

- change the shape of an object,
- accelerate or stop an object, and
- change the direction of a moving object.

A force can be classified as either a *contact force* or a *non-contact force*.

A contact force must touch or *be in contact* with an object to cause a change. Examples of contact forces are:

- the force that is used to push or pull things, like on a door to open or close it
- applied force
- frictional force
- Normal force
- Tension

- Air friction (because the air is literally in contact with the object)

A non-contact force does not have to touch an object to cause a change. Examples of non-contact forces are the forces due to:

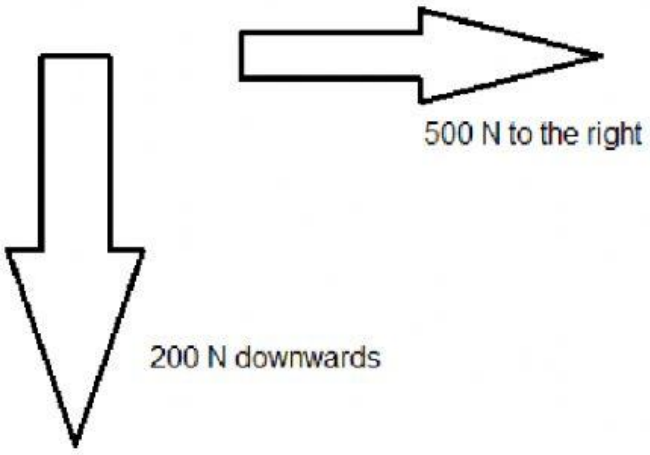
- gravity, like the Earth pulling the Moon towards itself;
- electricity, like a proton and an electron attracting each other; and
- magnetism, like a magnet pulling a paper clip towards itself.

Let's look at the forces in more detail:

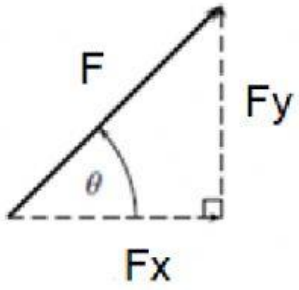
Applied force (F_A)

Applied force will always be a contact non-contact force

This force is applied directly to the object (like a person pushing or pulling a box). This force can be horizontal or vertical and can even act at an angle to the box.



If the force is at an angle we can always calculate the horizontal and vertical component of this force. (Think back to electrostatics)



If we are given the force F, then we can calculate the horizontal and vertical component of that force using Trig.

Fy = F. Sin Θ

Fx = F.Cos Θ

Y sine** when you can **Cos x

Frictional force (F_f)

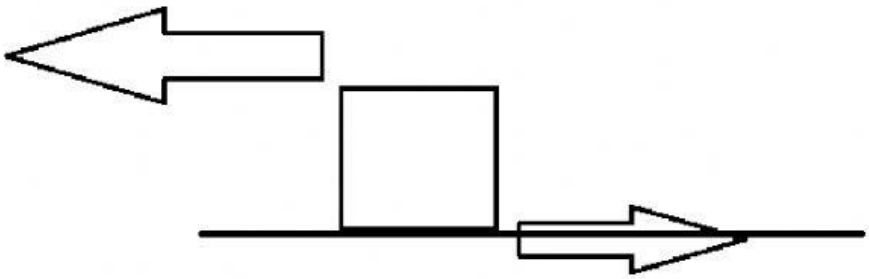
Frictional force will always be a contact non-contact force

Frictional force is the force that opposes the motion of an object in contact with a surface and it acts parallel to the surface the object is in contact with.

This is a force which opposes the motion, like if a box is pushed on a rough surface, the surface will actually apply a force on the box, to try to stop the box.

Frictional force is always in the ***opposite direction as the motion*** of the object.

F_A = 300 N



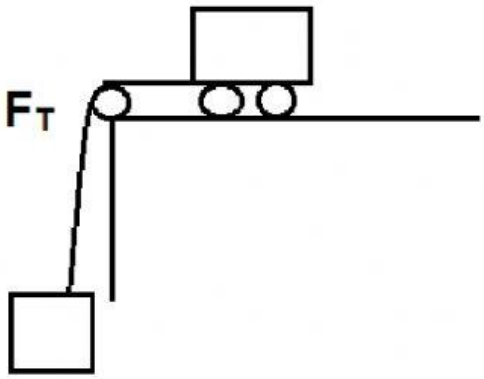
F_f = 100 N

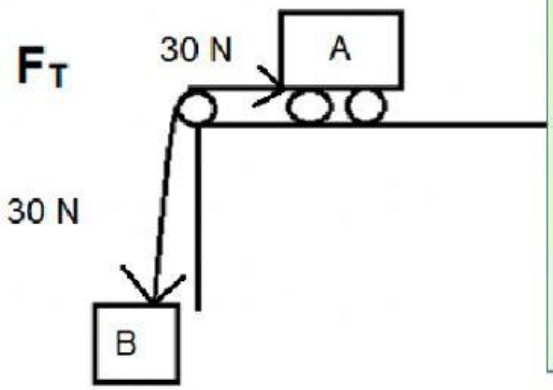
The **frictional force cannot exceed the applied force** on the object.

Tension force (F_T)

Tension force will always be a contact non-contact force

When a rope is stretched because it is pulled there is tension in the rope.





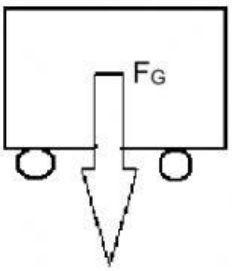
The tension pulling in both directions will be the same within the same rope. For example if the tension in this string is 30N then the tension force trying to pull box A down is 30 N and the tension trying to keep box B from dropping to the floor is also 30N

Gravitational force (F_G)

Gravitational force will always be a contact non-contact force

The force that the earth exerts an all objects vertically downwards is the gravitational force. (As long as the object is inside the earth's gravitational field).

This force "pulls" objects downwards towards the centre of the earth.



Gravitational force is calculated with the following formulae

$F_g = m.g$

F_g – gravitational force (N)

m – mass of the object (Kg)

g – gravitational acceleration (9,8 $m.s^{-2}$)

g is a constant and is always given on the data sheet as 9,8

Exercise 1:

Calculate the gravitational force on the object

Use the first one as an example

- ✓ Leave no spaces between values and units

Remember mass must be in kg in physics

1.1 A 5 kg object

$F_g = m.g$

$= 5(9.8)$

$= 49N$ downwards

1.2 A 9 kg object

= _____ _____

Answer value and unit

Direction

1.3 A 4,5 kg object

= _____ _____

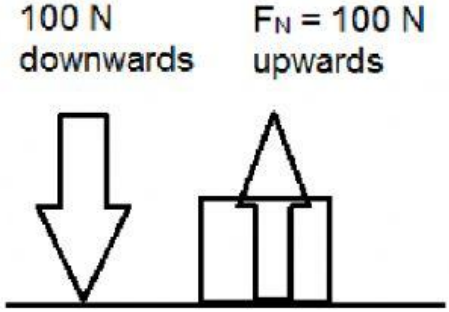
1.4 A 11 kg object

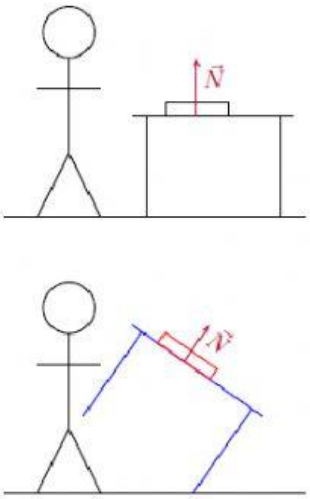
= _____ _____

Normal force (F_N or N)

This is the reaction force of the surface on the object, and it acts **perpendicular** to the surface.

When a box is resting on the table and being pulled down by gravity, the reason the box doesn't just drop straight down is that the table/surface that it is resting on exerts a force upwards on the objects, preventing in from falling. This is known as the normal force.





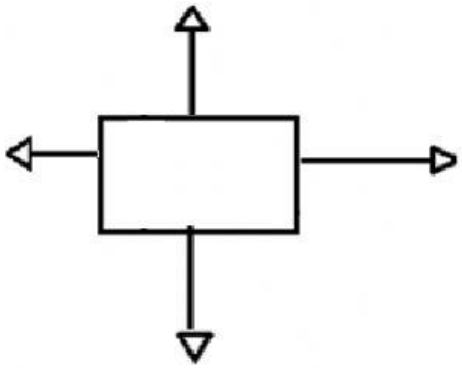
* Normal force acts perpendicular to the surface irrespective of whether the plane is horizontal or inclined.

Force and free body diagrams

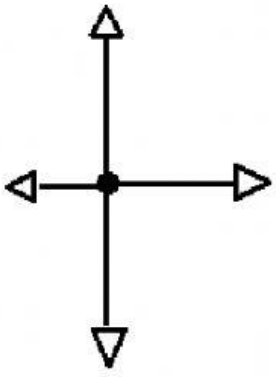
How to draw sketches of forces:

There are two types of sketches to draw to represent forces:

Force diagram



Free body diagram

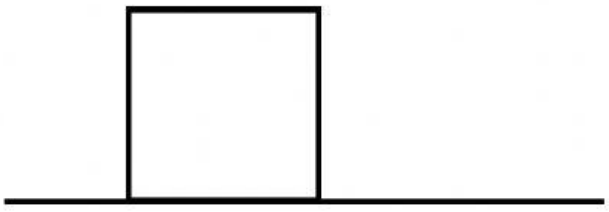


Normal force is probably the trickiest force to understand in this section.

Watch this short video below, before you start answering the next questions:

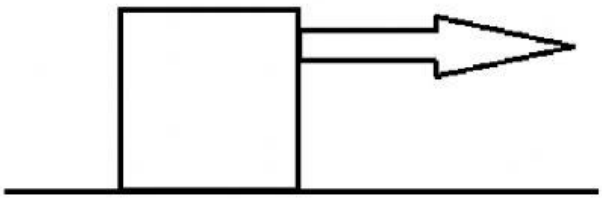
Identify whether the following objects will have a normal force exerted on them

1. A box lying on a flat surface



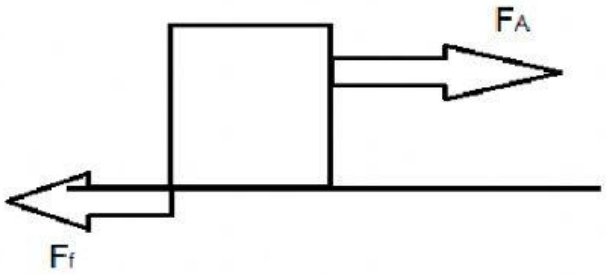
Yes (there will be a normal force on it) No

2. A box is being pushed to the right on a flat surface Yes No



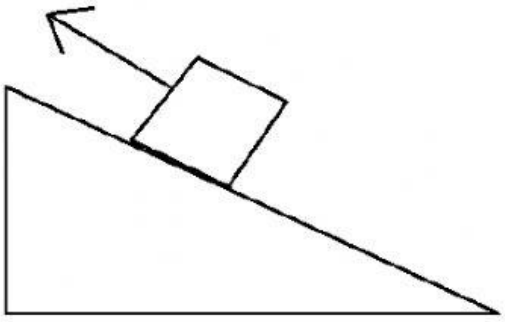
3. A box is pulled to the right on a flat surface, while there is frictional force acting on the block. (Remember that frictional force always acts in the opposite direction as the motion.)

Yes No



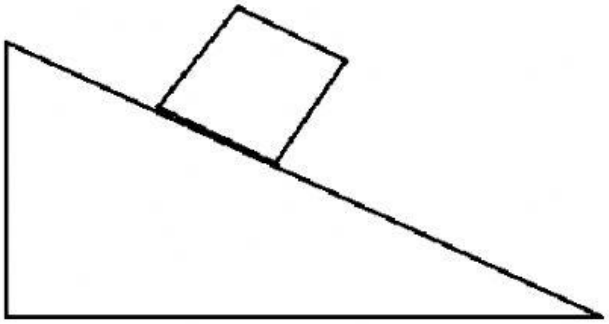
4. A box is pulled up an inclined surface

Yes No



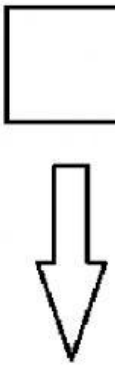
5. A box slides down an inclined surface because of gravity

Yes No



6. A box is dropped from a 1m height

Yes No



7. A box is lifted into the air

Because the box is in the air there is no surface on which the box is lying

Yes No