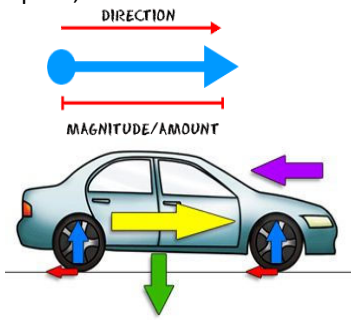
Forces A - Forces and their interactions

Keyword	Definition
Force	Something that makes a change happen
Magnitude	The value of a force in Newtons
Scalar	Things that have magnitude but not direction
Vector	Things that have a magnitude and a direction. Forces are always vectors
Contact force	Can only act when two things touch
Non-contact force	Can act on things not touching
Balanced (forces)	When forces are equal and opposite each other also called **equilibrium**
Unbalanced (forces)	When opposing forces are not equal to each other
Resultant (force)	The overall force once all the forces are considered
Force arrows	Show direction and size of a force
Newton	**Unit force is measured in**
Newtonmeter	A spring calibrated so it has a scale to measure force
Centre of mass	A point in the middle of an object where all its mass acts
Elastic	A material that returns to its original shape after being deformed
Plastic	A material that does NOT return to its original shape after being deformed

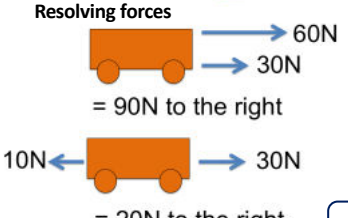
A — Fo 01

Key Point

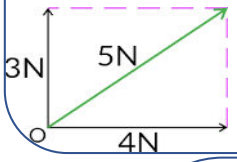
Force is a **vector** quantity. It matters not only how hard you push, but in what direction.



Resolving forces



HT only



How to calculate the resultant force when two forces act on an object at right angles to each other.

Required Practical:

Force and extension of spring

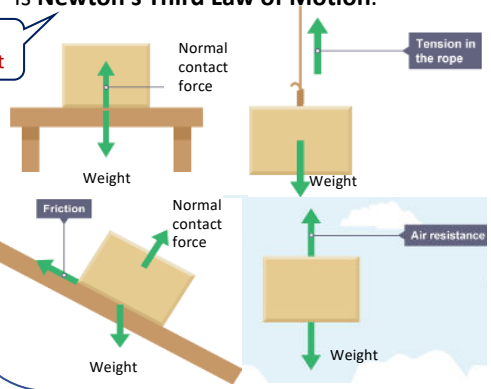
Mathematical Skills:

Be prepared to use ratios, fractions and percentages; Students should recognise and be able to use the symbol for proportionality, ∝; change the subject of an equation; substitute numerical values into algebraic equations using appropriate units for physical quantities; translate information between graphical and numeric form.

A — Fo 02

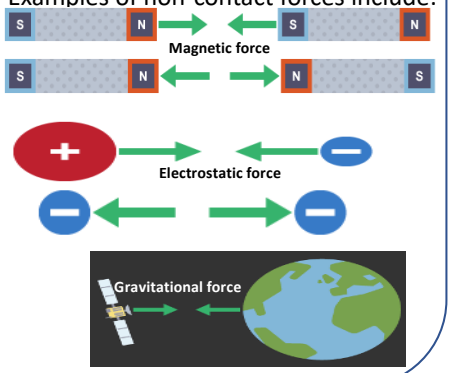
When a **contact force** acts between two objects, both objects experience the same size force, but in opposite directions. This is **Newton's Third Law of Motion**.

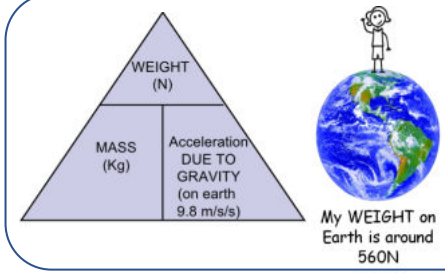
Key Point



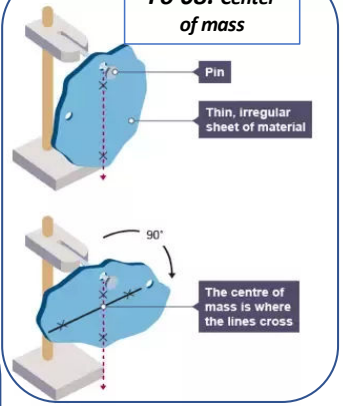
Non-contact forces are forces that act between two objects that are not physically touching each other.

Examples of non-contact forces include:

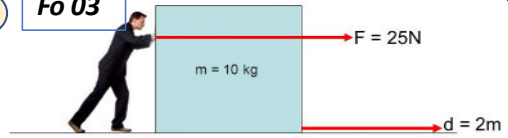




Fo 08. Center of mass

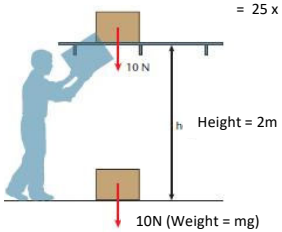


B — Fo 03



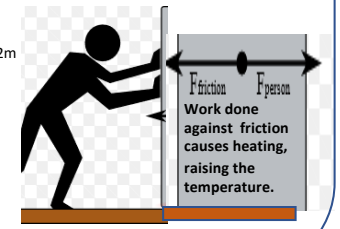
Work done = Force x distance

= 25 x 2 = 50Nm (Joules)

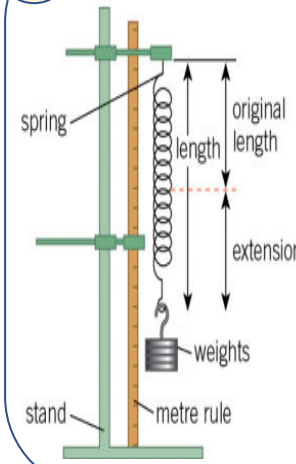


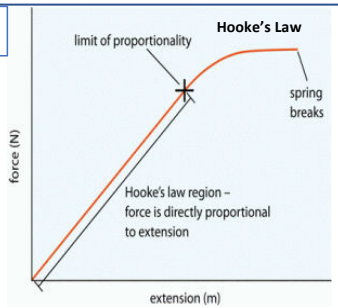
Doing work = increasing energy in gravitational store

= 10N x 2m = 20Nm (Joules)



B — Fo 04&05



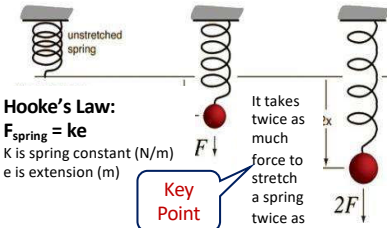


Hooke's Law:

$F_{spring} = ke$

K is spring constant (N/m)

e is extension (m)

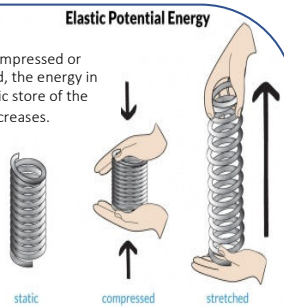


Key Point

It takes twice as much force to stretch a spring twice as far

Elastic Potential Energy

When compressed or stretched, the energy in the elastic store of the spring increases.



$E_e = ½ k e^2$

E_e is elastic potential energy (J)

K is spring constant (N/m)

e is extension (m)

You should be able to apply this equation which is given on the Physics equation sheet. This equation is also given in Changes in energy.

Relevant Modules:

- Energy stores
- Energy changes

Useful YouTube links:

Contact and non-contact forces

Forces and elasticity

Physics Only

Fo 06

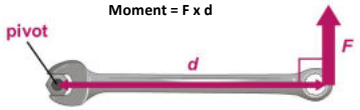
C

A **lever** is a rigid rod pivoted at a fixed hinge or fulcrum.
Its job is to amplify an input force, to provide a greater output force.

Key Point

A **moment is the turning effect of a force**.
Units are newton metres (Nm)

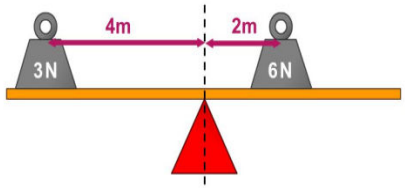
Moment = F x d



F – the force applied in newtons (N).

d – the perpendicular distance (in m) between the pivot and the line of action of the force.

If the total clockwise moment on an object is balanced by the total anticlockwise moment then the object will not rotate.
It will be in **equilibrium**, like the beam below

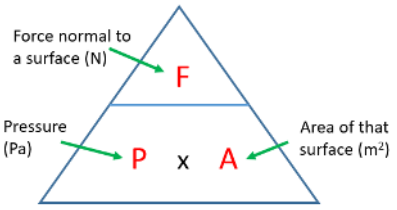


Clockwise moment	=	Anticlockwise moment
6 x 2	=	3 x 4
12Nm	=	12Nm

Fo 09

D

A **fluid** can be either a liquid or a gas.
The pressure in fluids causes a force normal (at right angles) to any surface.
The pressure at the surface of a fluid can be calculated using the equation:

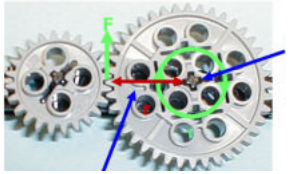


$$\text{Pressure (Pa)} = \frac{\text{Force normal to a surface (N)}}{\text{Area of surface (m}^2\text{)}}$$

Fo 07

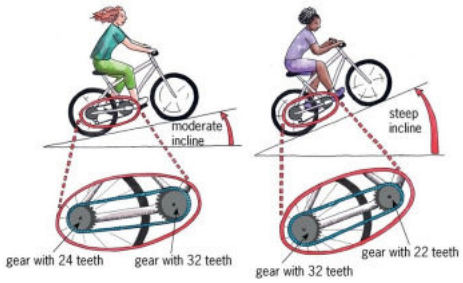
Gears and Moments

The force from the small gear's tooth pushes against the large gear's tooth. This creates an equal (and opposite) force in the large gear. This is Newton's 3rd Law.



It produces a larger turning force **(moment)** on this gear

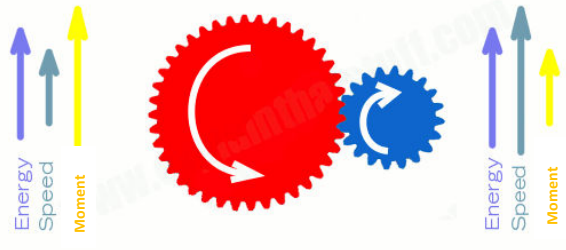
The force acts through this larger distance so, F x d is larger



- Gears are used for transmitting power from one part of a machine to another. EG. in a bike, the gears (and chain) take the power from the pedals to the back wheel.
- Each time power is passed from one gear to another, three things can happen:

1) **Change in speed:** if the first gear has more teeth (or is bigger), the second gear will move faster, with less turning force.
2) **Change in force:** if the second gear has more teeth than the first (or is bigger), it will turn slower than the first, but with more turning force.
3) **Change in direction:** When two gears are meshed, the second one always turns in the opposite direction.

- Gears are used in cars, bikes, whisks, clocks, drills, food processors, etc.



Useful YouTube links:

Levers and gears

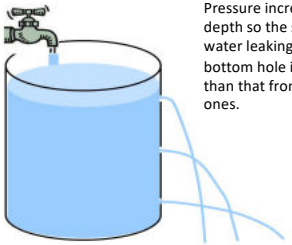
Pressure in fluids - atmosphere

Pressure in fluids – floating or sinking

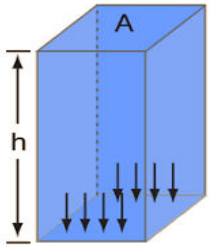
Fo 09

HT Only

Pressure in fluids



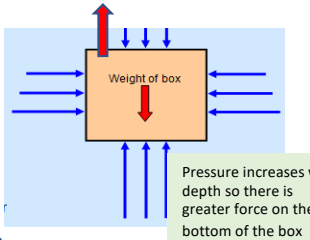
Pressure increases with depth so the speed of water leaking from the bottom hole is larger than that from the higher ones.



You should be able to apply this equation which is given on the Physics equation sheet.

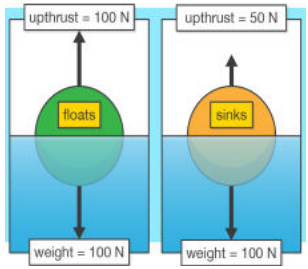
Pressure (Pa) in a column of liquid at **depth h (m):**
P = ρ x g x h
ρ is density (Kg/m³)
g is gravitational field strength (N/Kg)

The resulting force on the bottom of the box pushes it upwards and this is called the UPTHRUST on the box.

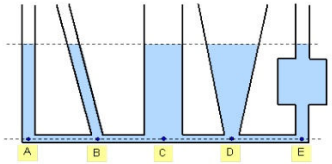


Pressure increases with depth so there is greater force on the bottom of the box

Objects of density less than that of a liquid will float



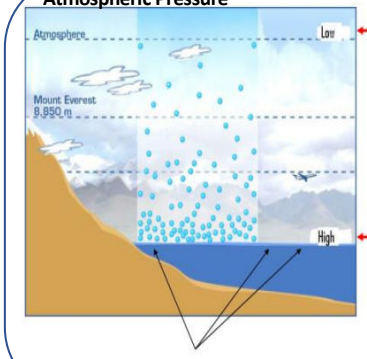
Objects of density greater than that of a liquid will sink



- In tubes A, B, C, D and E, the height of level of water is identical because pressure is equal in all tubes (P_{atm})
- This shows that pressure is not influenced by the shape or orientation of the tube

Fo 10

Atmospheric Pressure



Higher altitudes have a lower pressure.

There is less air above you.

Lower altitudes have a higher pressure.

There is more air above you.

Sea level = 1 ATM of pressu (101KPa)