Forces (and interactions)

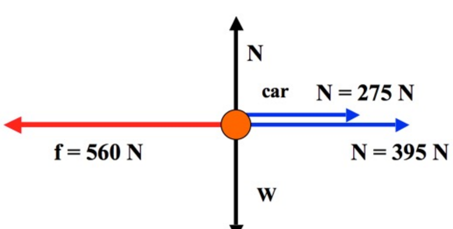
1. Describing forces

Scalar quantities have size only; **vector** quantities have size and direction.

Scalar	Vector
time	force
distance	displacement
speed	velocity

Contact forces are where the 2 objects are physically touching; **non-contact** forces occur where the objects are physically separated. Gravity, magnetic and electrostatic attraction are the only non-contact forces.

As force is vector it is represented by an arrow with size and direction.
A **free body diagram** simplifies an object to single shape (circle or rectangle) so that the force arrows are more obvious.

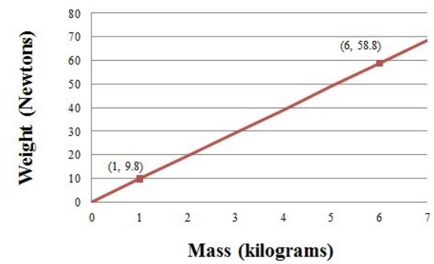


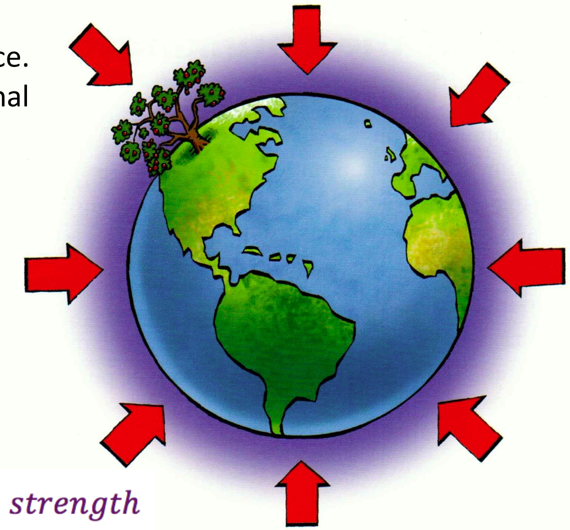
3. Gravity

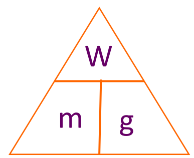
Gravitational force is a weak force.

Weight is the force acting on an object due to gravitational field strength. Weight and mass are directly proportional (α) and will produce a straight-line graph through the origin.

This symbol means directly proportional. $\propto$







Learn

$$weight = mass \times gravitational\ field\ strength$$

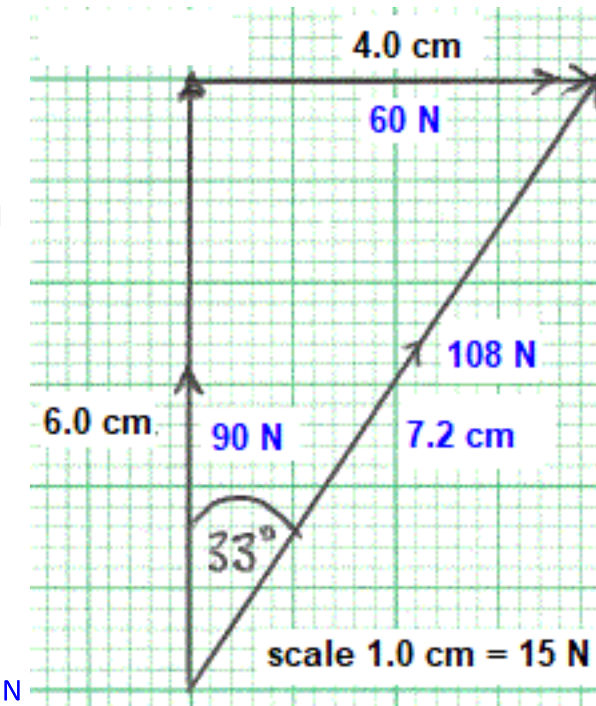
(N) (kg) (9.8 N/kg)

2. Resultant force

A **resultant force** is a single force that has the same effect as a system of forces on an object

Forces can be resolved into two perpendicular components or combined into a single resultant force.
In the graph paper example the vertical and horizontal forces were given. The answer needed to have both a size and a direction, e.g. 108N 33° clockwise from the vertical.

Vector diagrams use scale drawings to illustrate how forces resolve and determine the resultant force. If the resultant force is zero the object will be in equilibrium , having balanced forces.



The resultant force of two forces acting in a straight line will either be the sum (arrows in the same direction) or the difference (arrows in opposite directions) of the two forces.
For example the forward force of the car is 275 + 395 = 670 N

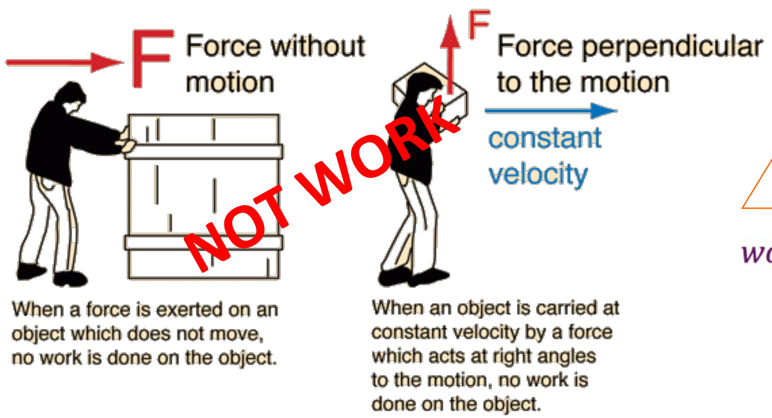
Forces (and energy)

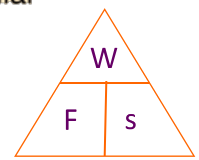
Energy is transferred when work is done.

One joule of work is done when a force of one newton moves and object a distance of one metre, therefore,
1 joule = 1 newton metre (1 J = 1 Nm)

4. Work

Work is done when a force causes an object to move in the direction of the force.



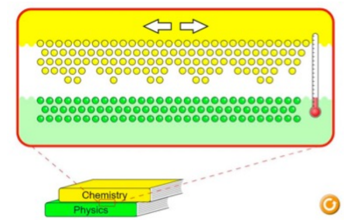


$$work\ done = force \times distance$$

(J) (N) (m)

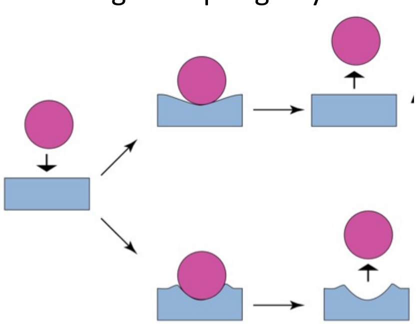
Learn

Work done against **friction** causes an increase in the object's thermal store and the thermal store of the surroundings. This increases the kinetic energy of the particles in the object/surroundings and therefore increases the temperature. **Temperature** is a measure of the average kinetic energy per particle



5. Deformation

Elastic deformation causes a temporary change of shape; the object will return to its original shape when the force is removed. An example is the stretching of a spring beyond its **elastic limit**.



Elastic

Inelastic

Inelastic (or plastic) **deformation** causes an object to permanently change shape.

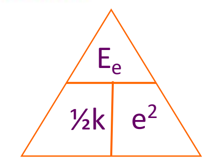
To change the shape of an object **more than one** force needs to be applied.

6. Hooke's Law

On sheet

$$elastic\ potential\ energy = \frac{1}{2} \times spring\ constant \times extension^2$$

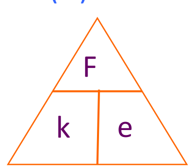
(J) (N/m) (m)



Work is done when a force stretches a spring and all the energy is transferred to the elastic potential store of the spring as long as the elastic limit is not reached.

$$force = spring\ constant \times extension$$

(N) (N/m) (m)



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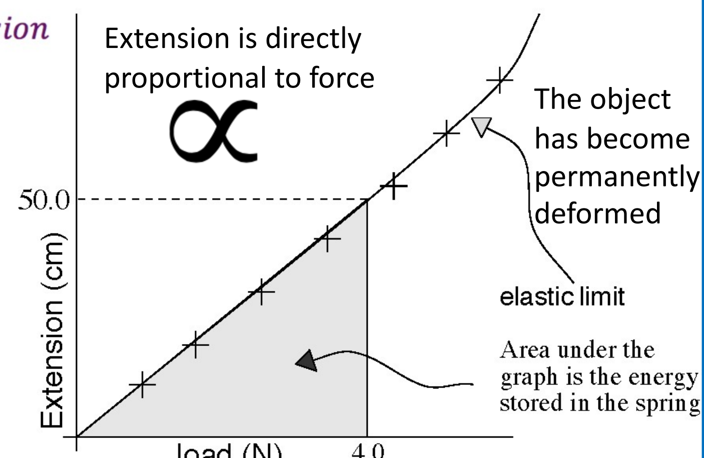
This also applies in compression, where **e** becomes the amount the spring has been compressed by

Hooke's Law is a **required practical**

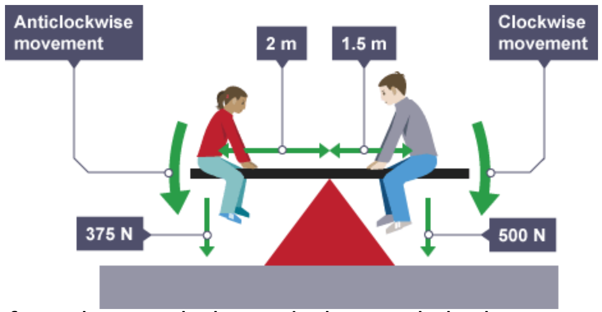


Forces (and pressure)

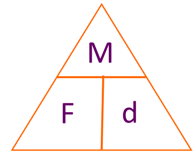
(Separate Physics only)

7. Moments

A **moment** is the turning effect of a force.



If an object is balanced, the total clockwise moments must equal the total anticlockwise moments.

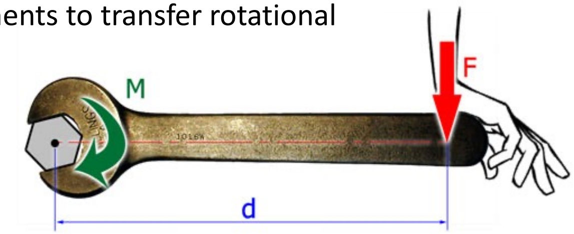


$$moment = force \times distance$$

(Nm) (N) (m)

Learn

Gears and levers are examples of the use of moments to transfer rotational forces.

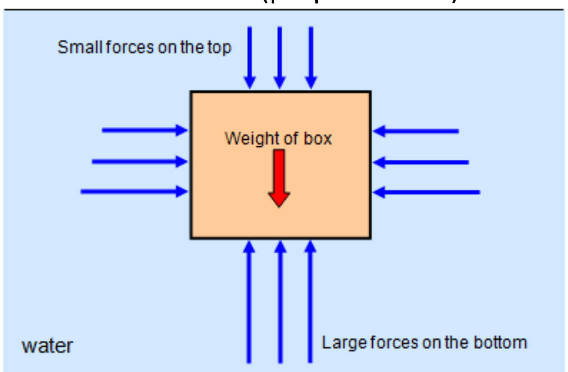


The distance is measured as the perpendicular distance between the force arrow and the pivot.

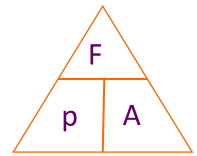
8. Pressure

A **fluid** is a liquid or a gas

Pressure is caused when the particles in the fluid collide with the surface of the container. Pressure in fluids causes a force normal (perpendicular) to a surface.



A submerged object experiences a greater pressure on the bottom surface than the top, creating a resultant force upwards. This is called **upthrust**.

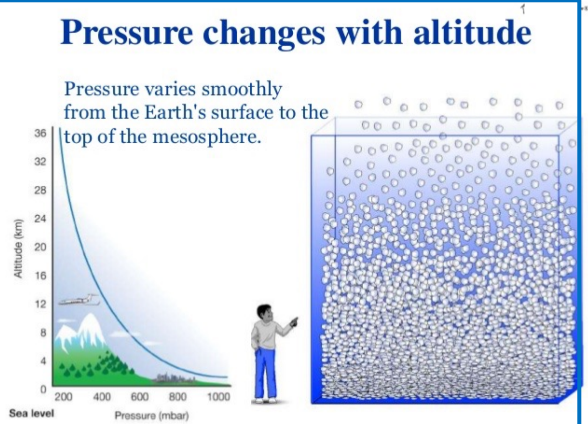


Learn

$$pressure = \frac{force}{area}$$

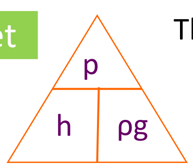
(N/m^2) or (Pa) (N) (m^2)

An object will float because the force of gravity acting on the mass (weight) is equal to the upthrust, i.e. balanced forces.



As you get further from the surface of the Earth the density of the air in the atmosphere gets less. This is due to less air in the column above you having less weight (fewer particles) to compress the particles together.

On sheet



The pressure due to a column of liquid can be calculated using:

$$pressure = height\ of\ column \times density\ of\ liquid \times gravitational\ field\ strength$$

(Pa) or (N/m^2) (m) (kg/m^3) (9.8 N/kg)