Forces Basics

15th Sep

A force is a PUSH or a PULL. Some forces only have an effect when objects touch each other. These are CONTACT forces.

Example contact forces; drag (air/water resistance), normal contact force, tension, push or 'applied force', thrust

Forces that can have an effect at a DISTANCE are called NON-CONTACT forces.

Example non-contact forces; weight (caused by gravity), electrostatic attraction or repulsion (caused by electric fields), magnetic attraction or repulsion (caused by magnetic fields).

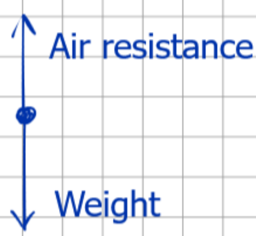
Forces are VECTOR quantities - this means they have a MAGNITUDE and a DIRECTION. We represent forces in diagrams with ARROWS.

When we wish to show all of the forces acting on a SINGLE OBJECT we can draw a FREE BODY DIAGRAM.

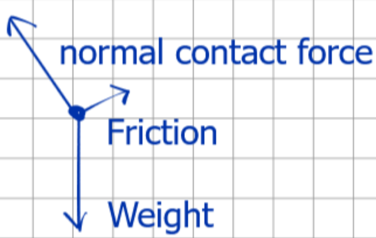
- objects are represented by a dot
- forces acting on the object are drawn as arrows that start at the dot and point away from it
- the lengths of the arrows represent the size of the forces relative to each other (judged by eye)

Examples:

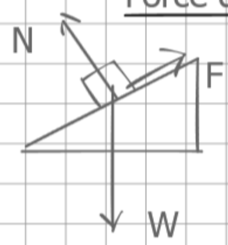
Object falling at a constant speed:



Object resting on a sloped surface:



Force diagram



Notes on different forces

- NORMAL CONTACT FORCE acts on any object sat on a surface, and acts at 90° to the surface
- A forward pushing force from an engine is often called THRUST.
- LIFT is an upwards force that helps keep flying objects in the air
- UPTHRUST is a force that acts on submerged/partially submerged object

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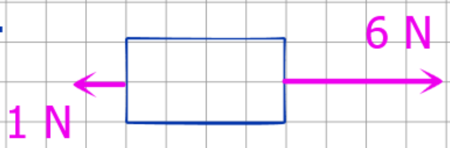
Resultant Forces

17th Sep

To see the effect of multiple forces on an object we must combine the forces together to find the RESULTANT FORCE. This is a single force that has the same effect as all of the forces combined.

To find a resultant force we begin by comparing forces that are colinear (acting along the same line). If forces are in the same direction we ADD THEM TOGETHER, and if they are in the opposite direction we SUBTRACT the smaller force from the larger one.

e.g.



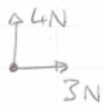
The resultant force: 6N − 1N

= 5N to the right

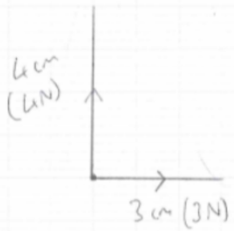
If the forces are PERPENDICULAR to each other then we need a SCALE DIAGRAM to find the RESULTANT FORCE.

SCALE DIAGRAM EXAMPLE

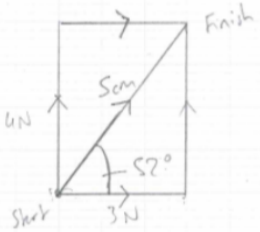
Find the size and direction of the resultant force;



1. Choose a scale ie. 1 cm = 1 N
2. Draw forces to scale starting from the same point:



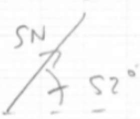
3. Complete the parallelogram / rectangle / square



4. Draw an arrow from where you started to where your forces meet.

5. Measure length of this new arrow to find the size of the resultant force (using your scale).
   Measure the direction as an angle to the horizontal.

Answer: 5 N at an angle of 52° to the horizontal



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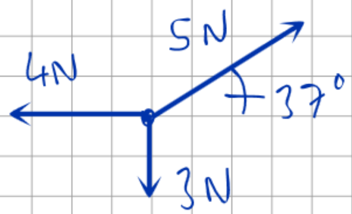
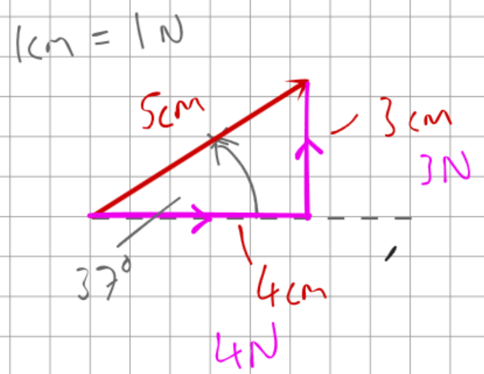
Components of Forces

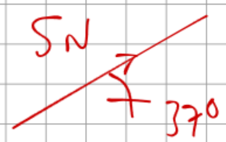
18th Sep

Sometimes we are faced with a situation where a vector (usually a force) is neither colinear with others, or perpendicular to them e.g.



To find the resultant force here we can break down the 5 N force into a HORIZONTAL COMPONENT (how far across it goes) and a VERTICAL COMPONENT (how far up it goes) and then redraw the diagram.





becomes

So this 5 N force at an angle of 37 degrees has a HORIZONTAL COMPONENT of 4 N to the right, and a VERTICAL COMPONENT of 3 N upwards.

Mass and Weight

24th Sep

"Weight is directly proportional to mass!"

Annoying Y7 2025

Physics skills recap:

- If a graph of two variables is a STRAIGHT LINE through THE ORIGIN then they are DIRECTLY PROPORTIONAL.
- If one doubles when the other does then the variables are directly proportional
- If dividing one variable by the other always gives you the same number (a constant) then they are directly proportional

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Mass is the amount of matter in an object.

Weight is the force that gravity exerts on a mass.

The Earth's gravitational field exerts a force of roughly 9.8 newtons on each kilogram of mass.

Earth's gravitational field strength, g = 9.8 N/kg.

Weight = mass x gravitational field strength

$$W = mg$$

W – in N

m – in kilograms

g – in newtons per kilogram

When we draw diagrams of forces we always draw the weight acting from the CENTRE OF MASS.

If an object is 'uniform' its mass is spread evenly, and the centre of mass will be at the centre of the object.

The centre of mass is where we consider all of an objects mass to be concentrated.

Work Done

29th Sep

The amount of WORK DONE is the same as the amount of ENERGY transferred from one store to another.

Work can be done by forces acting on objects.

Pushing an object 1 m, with force of 1 N will do 1 J of work.

Work done = Force x distance

$$W = Fs$$

W – in joules, J

F – in newtons, N

s – in metres, m

When calculating work done we ensure that the DIRECTION of the DISTANCE used is PARALLEL to the FORCE we use.

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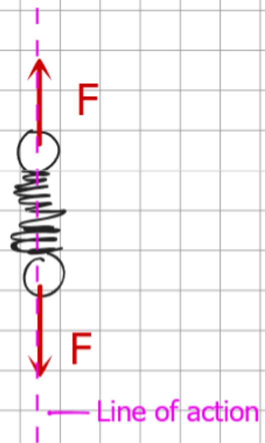
weight (N)	name	distance (m)	Time (s) 1st	2nd	3rd	mean time (s)	work done (J)	Power (W)
845	Sir	3.5	9.47	9.93	8.59	9.33	2957.5	316.99
750	Thee	3.5	12.06	12.19	11.75	12.00	2625	218.75
675	Alfred	3.5	5.44	5.50	5.94	5.63	2362.5	419.63
575	Matthew	3.5	13.84	13.97	13.50	13.77	2012.5	~~144.06~~ 146.15
600	Louis	3.5	15.22	15.13	14.90	15.08	2100	139.26
593	Adam	3.5	13.81	13.46	13.47	13.58	2075.5	152.84

Force and Extension of Springs

1st Oct

To change the length of a spring (to stretch or compress it) we require TWO FORCES acting in OPPOSITE DIRECTIONS along the SAME LINE OF ACTION.



To find the change in length (EXTENSION if stretched or COMPRESSION if squashed) we must find the DIFFERENCE between the length of the spring before and after we apply a force.

To investigate the relationship between the force applied to a spring and its change length we can:

- Hang masses from a spring, to exert a force
- Measure the force exerted with a newtonmeter
- Use a ruler to measure the length of the spring before and after the force is applied
- Use a set square to reduce RANDOM ERRORS i.e. ruler not vertical or taking readings at an angle instead of eye level

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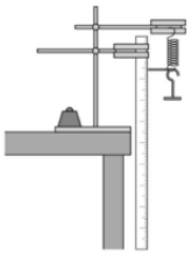
GCSE Physics Required Practical 6: Force and Extension

Method

You are provided with the following:

- a spring
- a metre ruler
- a splint and tape to act as a pointer
- a 10 N weight stack
- a clamp stand, with two clamps and bosses
- a heavy weight to prevent the apparatus tipping over
- a mystery object to weigh.



Read these instructions carefully before you start work.

1. Attach the two clamps to the clamp stand using the bosses. The top clamp should be further out than the lower one.
2. Place the clamp stand near the edge of a bench. The ends of the clamps need to stick out beyond the bench.
3. Place a heavy weight on the base of the clamp stand to stop the clamp stand tipping over.
4. Hang the spring from the top clamp.
5. Attach the ruler to the bottom clamp with the zero on the scale at the top of the ruler.

   If there are two scales going in opposite directions, you will have to remember to read the one that increases going down.
6. Adjust the ruler so that it is vertical. The zero on the scale needs to be at the same height as the top of the spring.
7. Attach the splint securely to the bottom of the spring. Make sure that the splint is horizontal and that it rests against the scale of the ruler.
8. Take a reading on the ruler – this is the length of the unstretched spring.
9. Carefully hook the base of the weight stack onto the bottom of the spring. This weighs 1.0 newton (1.0 N).
10. Take a reading on the ruler – this is the length of the spring when a force of 1.0 N is applied to it.
11. Add further weights. Each 100g disc weighs 1.0 N. Measure the length of the spring each time.
12. Record your results in a table such as the one below.

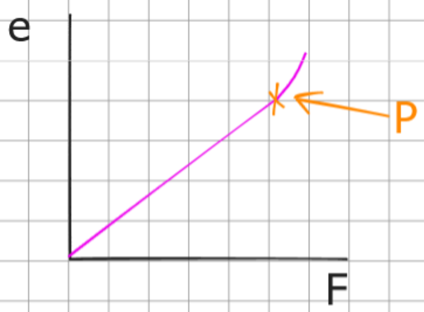
    You will need a third column for the extension. This is the amount the spring has stretched. To calculate this you subtract the length of the unstretched spring from each of your length readings.

Weight (N)	Length of spring (cm)	Extension of spring (cm)

13. Do not put the apparatus away yet.
14. Plot a graph with:
    - 'Extension of spring in cm' on the y-axis
    - 'Weight in N' on the x-axis.
15. Find the gradient of your graph (using change in y ÷ change in x).
16. Calculate 1 ÷ gradient. This is the spring constant, *k*, of your spring in N/cm.
17. Hang the unknown object on the spring. Measure the extension and use your graph to determine the object's weight. Check it with a newtonmeter.

Hooke's Law

2nd Oct



Up to point P, the EXTENSION is DIRECTLY PROPORTIONAL to the FORCE applied.

Point P is called the LIMIT OF PROPORTIONALITY.

Up to point P the object obey's HOOKE'S LAW.

Up to the ELASTIC LIMIT (close to point P) the object deforms ELASTICALLY (it returns to its original shape if the force is removed).

Beyond the elastic limit the object's shape is permanently changed. It has deformed INELASTICALLY.

The force and extension are linked by a constant;

Force = spring constant x extension

$$F = ke$$

F – in newtons, N

k – in newtons per metre, N/m

e – in metres

extension – could also be 'compression'

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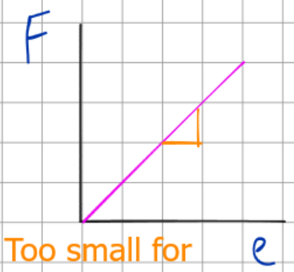
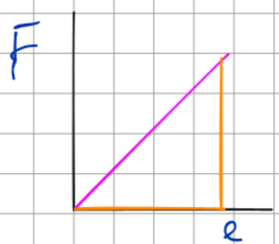
If we are given a graph with EXTENSION on the Y-AXIS and FORCE on the X-AXIS we find the spring constant by:

- Use the graph to find the largest pair of 'e' and 'F' from the LINEAR part of the graph
- Substitute into F = ke

If we are given a graph with FORCE on the Y-AXIS and EXTENSION on the X-AXIS we find the spring constant by:

- Finding the GRADIENT of the LINEAR part of the graph
- Use the largest triangle possible





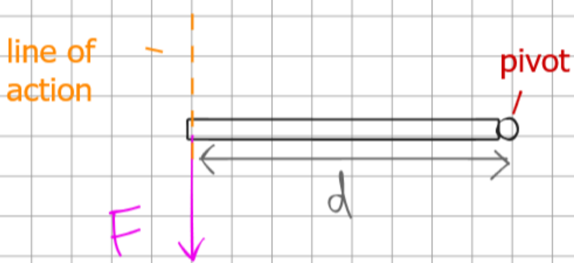
MOCK CONTENT ENDS HERE

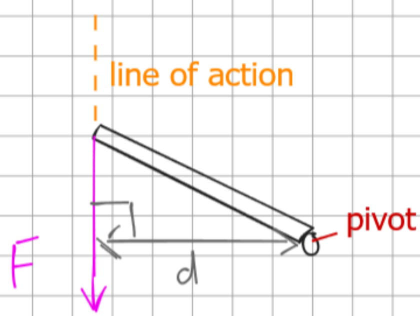
Moments

8th Oct

Description: a moment is the TURNING EFFECT of a force

Definition: a moment is the product of the FORCE APPLIED and the PERPENDICULAR DISTANCE between the LINE OF ACTION of the force and the pivot/hinge/fulcrum.





Moment = force x perpendicular distance

perpendicular distance: distance 'normal to the direction of the force'

$$M = Fd$$

- M: newton metres, N m
- F: newtons, N
- d: metres, m

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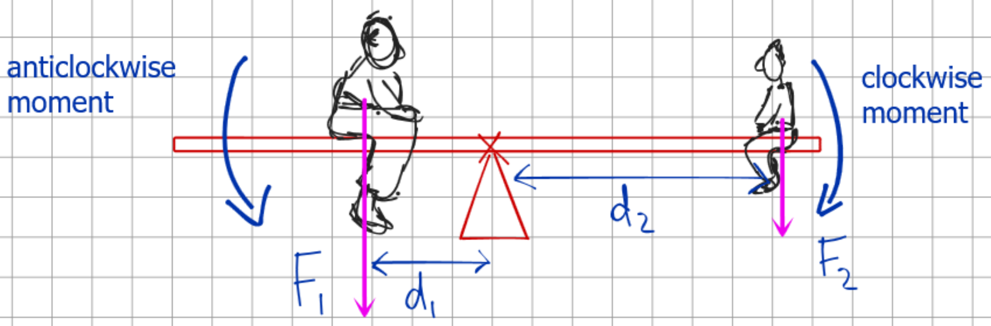
A system where we have some moments that act to turn a lever clockwise, and some that act to turn it anticlockwise will be in ROTATIONAL EQUILIBRIUM (won't rotate) if the clockwise moments balance the anticlockwise ones.



If this see-saw is in equilibrium then the anticlockwise moment caused the adult MUST BE equal in size to the clockwise moment caused by the child.

$$\text{ACW moment} = \text{CW moment}$$

$$F_1 d_1 = F_2 d_2$$

Pressure

13th Oct

The pressure exerted by a force can be calculated by:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F}{A}$$

- P in newtons per square metre, N / m^2
- F in newtons, N
- A in square metres, m^2

Note: 1 N / m^2 can also be written as 1 Pa (pascal)

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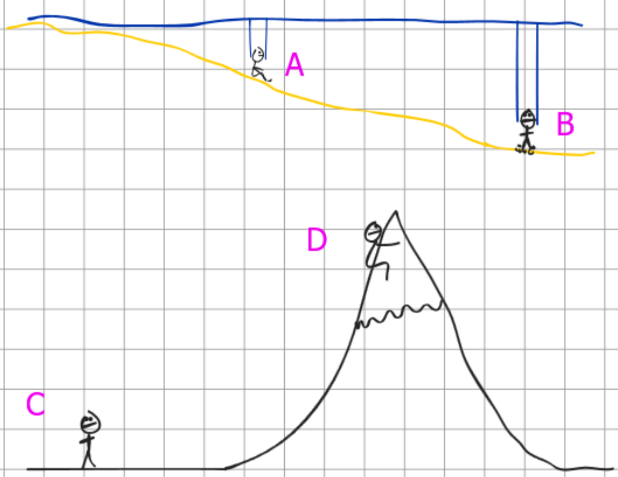
Pressure with depth, and upthrust

15th Oct

The pressure exerted on an object by a fluid (liquid or gas) INCREASES as the DEPTH of the object in the fluid INCREASES.



Person B experiences a greater pressure from the fluid than Person A as there is more fluid above them.

The WEIGHT of this fluid exerts a FORCE on the person.

Person D experiences a lower atmospheric pressure than Person C for similar reasons to those stated above.

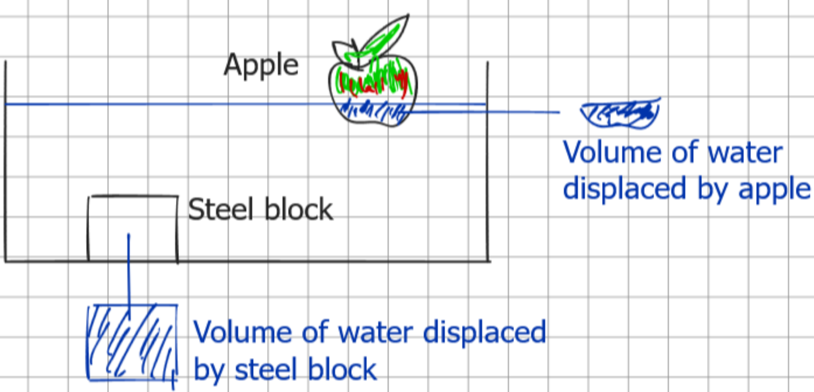
But also the DENSITY of the atmosphere DECREASES at HIGHER ALTITUDES

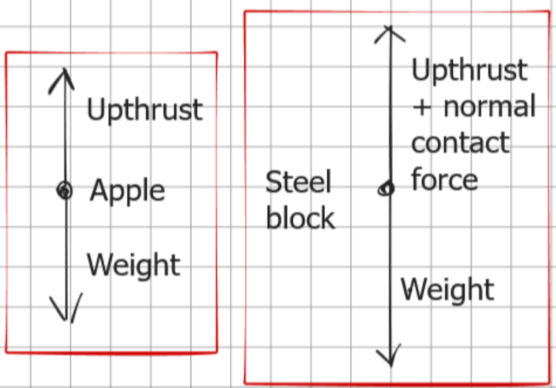
This means there are FEWER PARTICLES to COLLIDE with a surface, so a LOWER FORCE exerted on them.

pressure = density x gravitational field strength x depth (or height)

$$p = \rho g h$$

- p — newtons per square metre, N/m^2
- ρ — in kilograms per cubic metre, kg/m^3
- g — in newtons per kilogram, N/kg
- h — in metres, m





The magnitude of the upthrust is EQUAL TO the WEIGHT of the FLUID that has been DISPLACED.

The apple is LESS DENSE than water, so only has to displace a small volume of water before upthrust balances its weight. So it floats.

The steel block is MORE DENSE than water, so it cannot displace a big enough volume of water to create an upthrust big enough to balance its weight. It sinks.

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