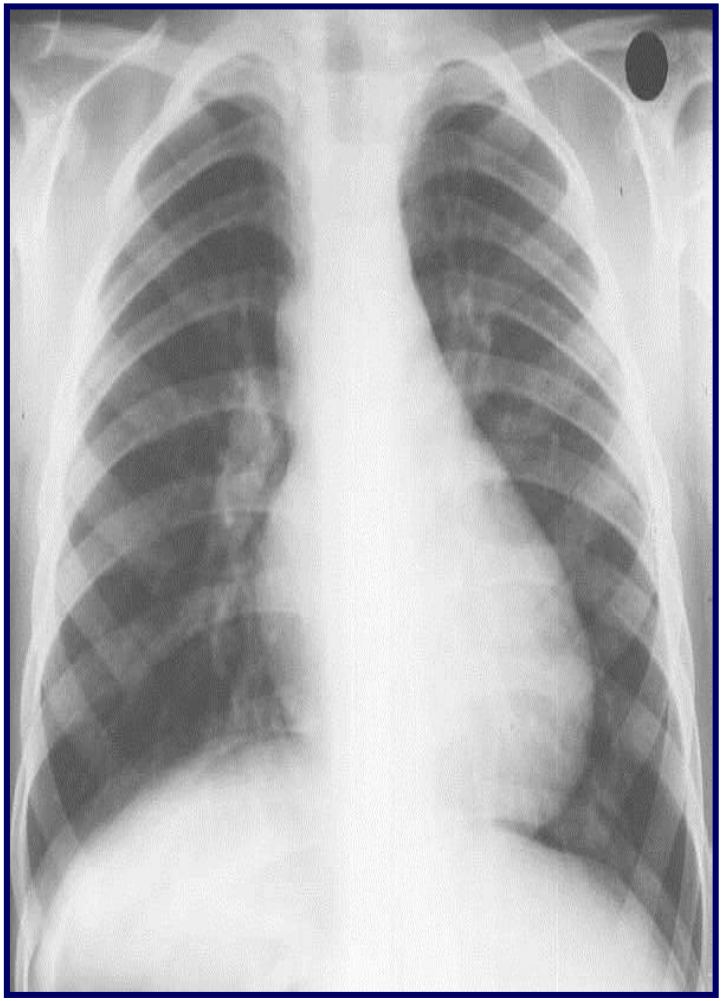
P3 Revision.

How are X-ray slides formed?

- X-rays can penetrate soft tissue but not bone.
- X-rays are absorbed more by some materials than others.
- Photographic film can be used to detect X-rays, but these days hospitals use CCD's.



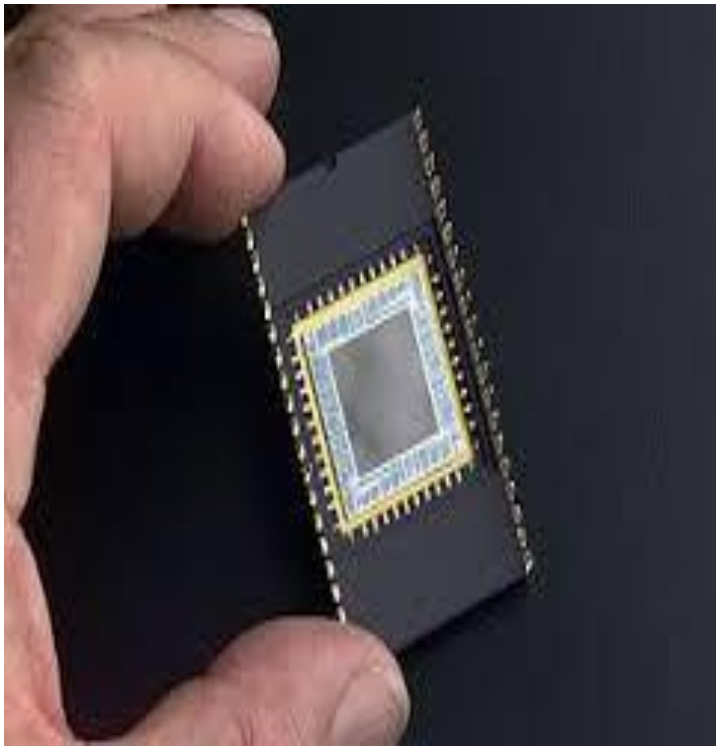
Computerised (axial) tomography.

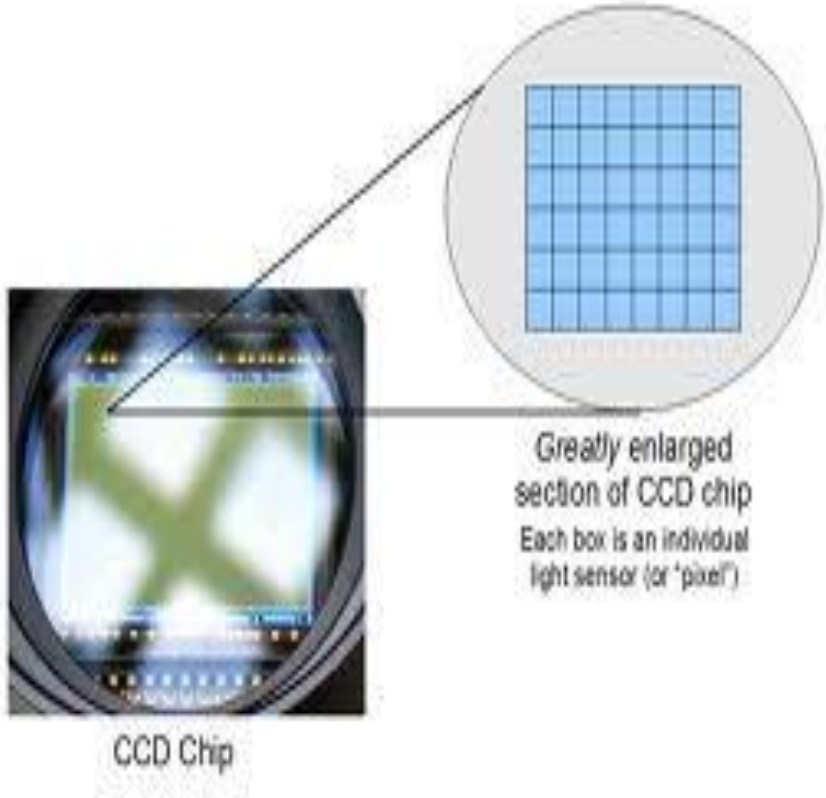
CT images.

X-rays can be used to treat cancer because of their ionising properties.

- The X-rays have to be carefully focuses and the correct dosage used to kill the cancer cells without damaging too many normal cells.
- The Radiographers need to minimise their X-ray dose using lead aprons and screens, or by leaving the room while scans are being done.

Charge-coupled device. Rather than using photographic film to capture the image, CCD's are used instead. The high resolution image is formed electronically with no need to develop a film.

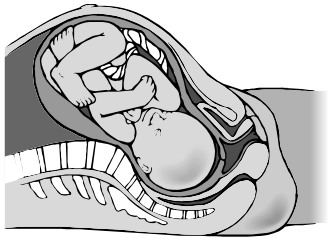




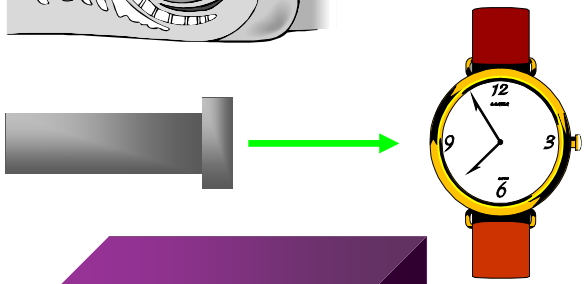
Ultrasound.

Ultrasound is the region of sound above 20,000Hz – it can't be heard by humans. There are a number of uses for ultrasound:

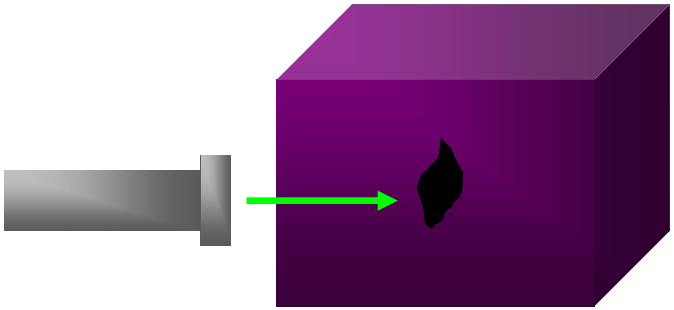
1) *Pre-natal scanning*



2) *Cleaning – it can be used to dislodge dirt*

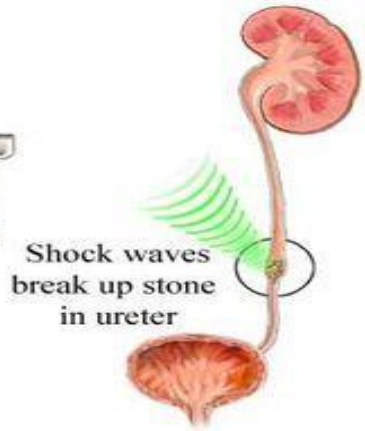


3) *Detecting flaws or cracks*



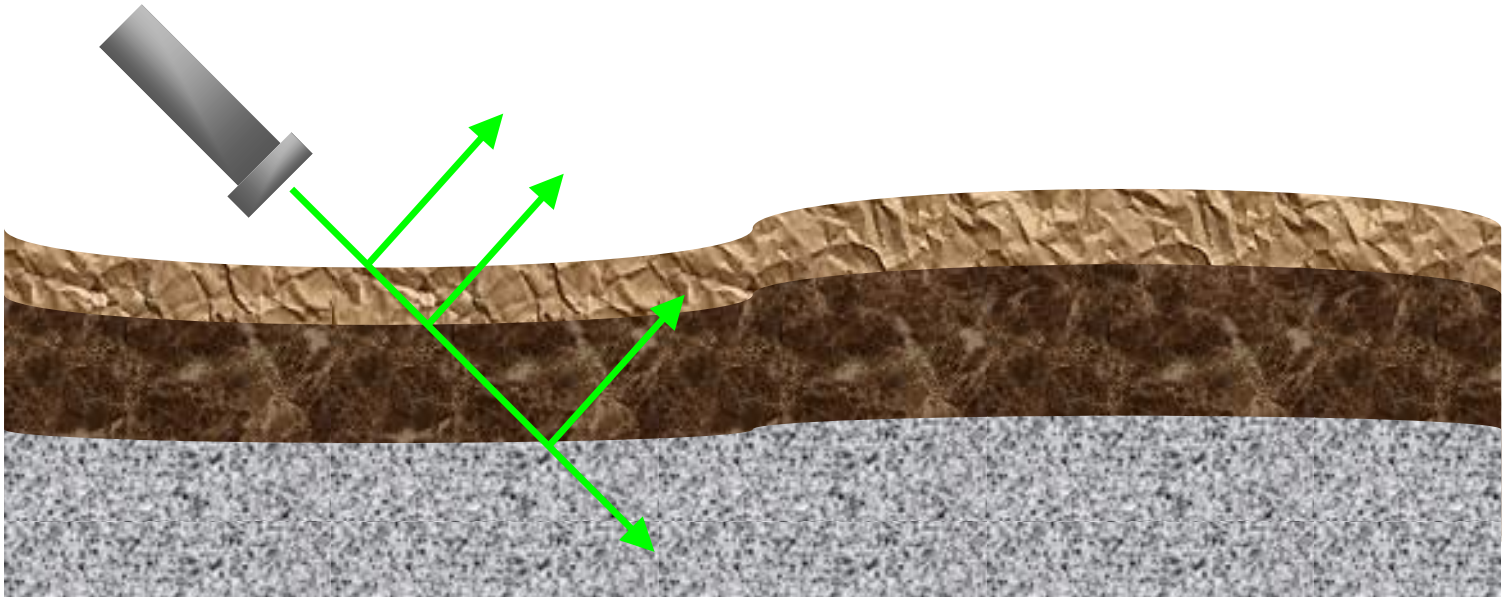
4) *Breaking down kidney stone.*

Extracorporeal shock wave lithotripsy (ESWL) machine



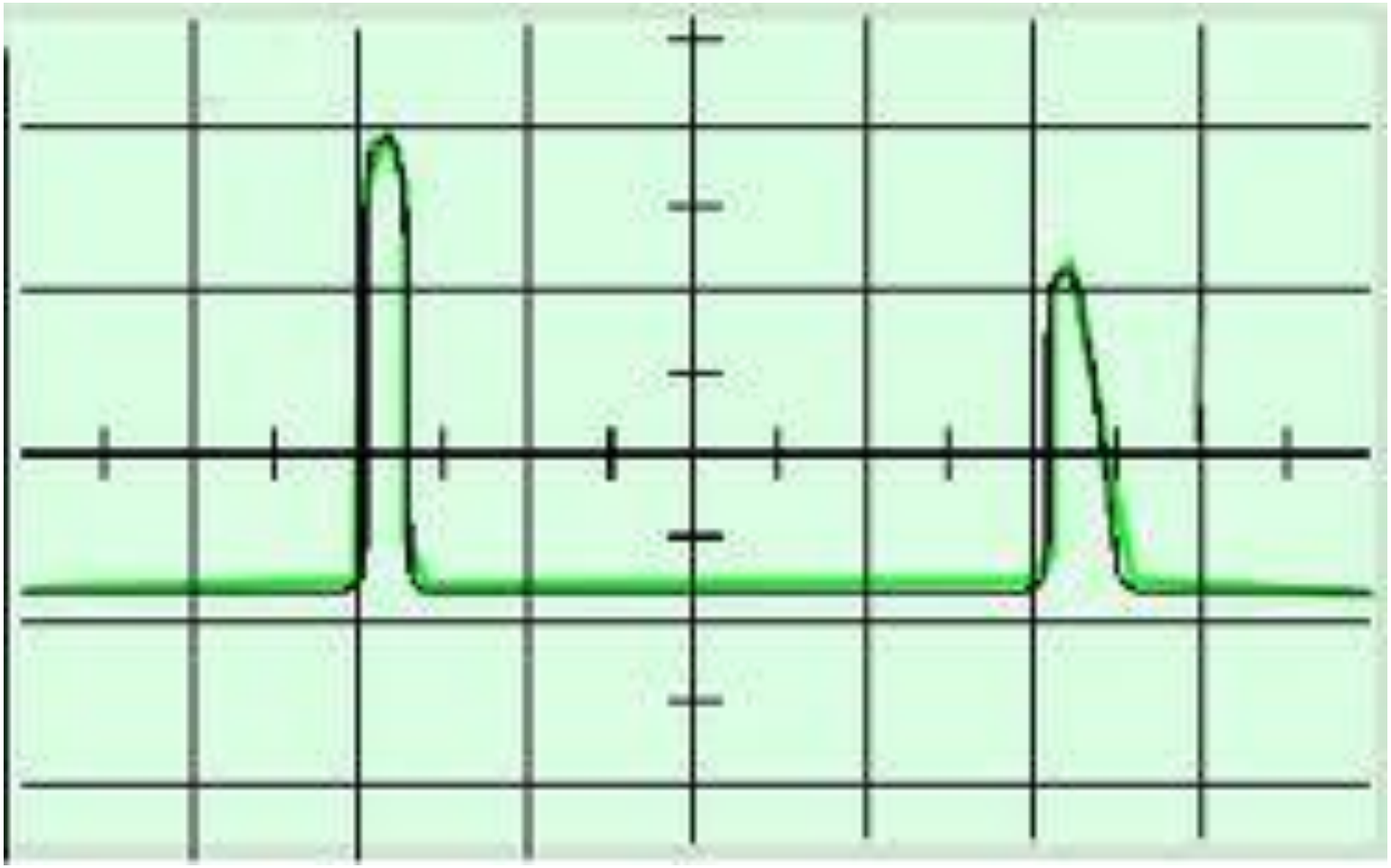
How does ultrasound work?

Ultrasonic waves are partly reflected at the boundary as they pass from one medium to another. The time taken for these reflections can be used to measure the depth of the reflecting surface and this information is used to build up a picture of the object.



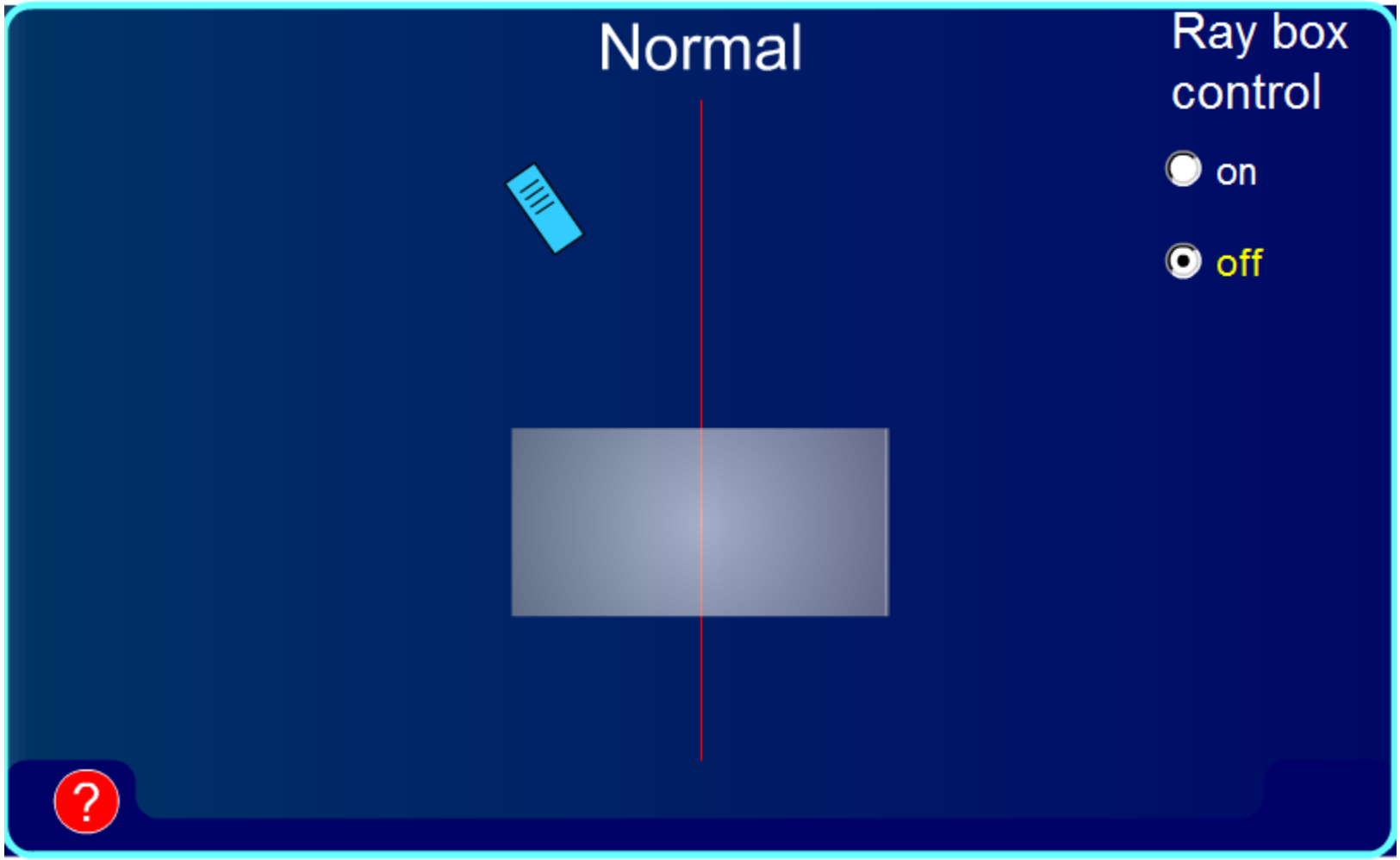
The device measures the time between sending the pulse and detecting its reflection. The speed of the ultrasound in the medium is known.

Oscilloscope trace.

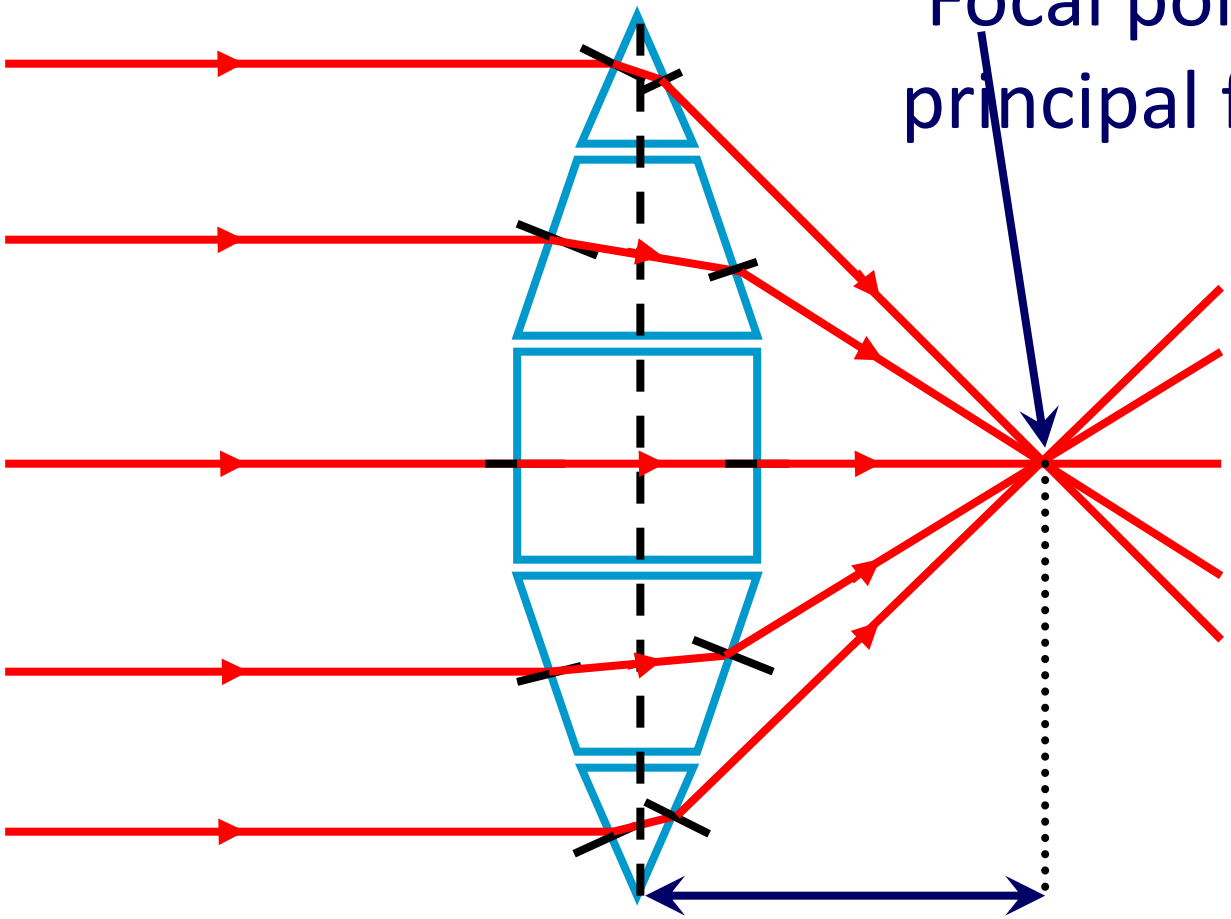


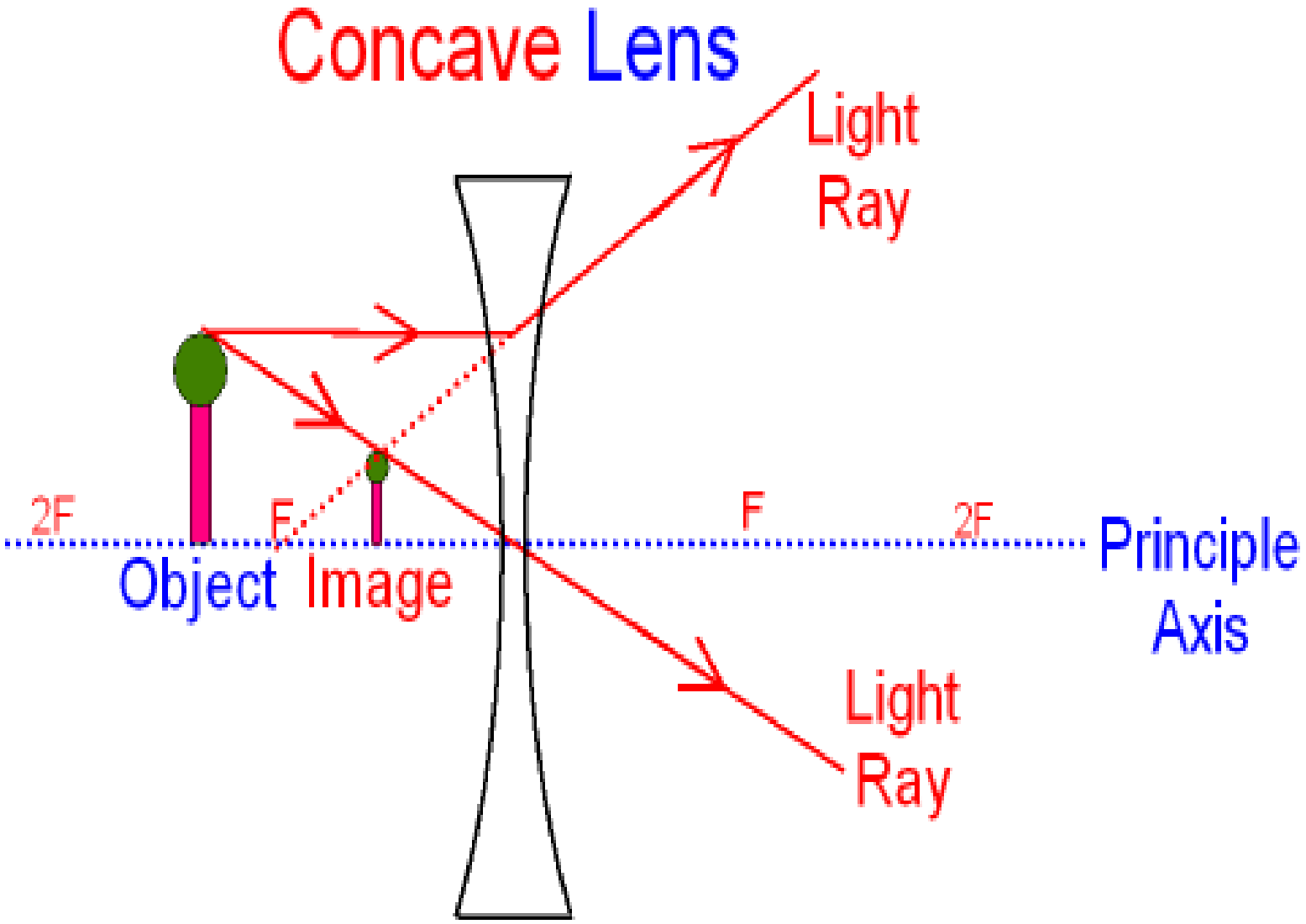
Refraction through a glass block

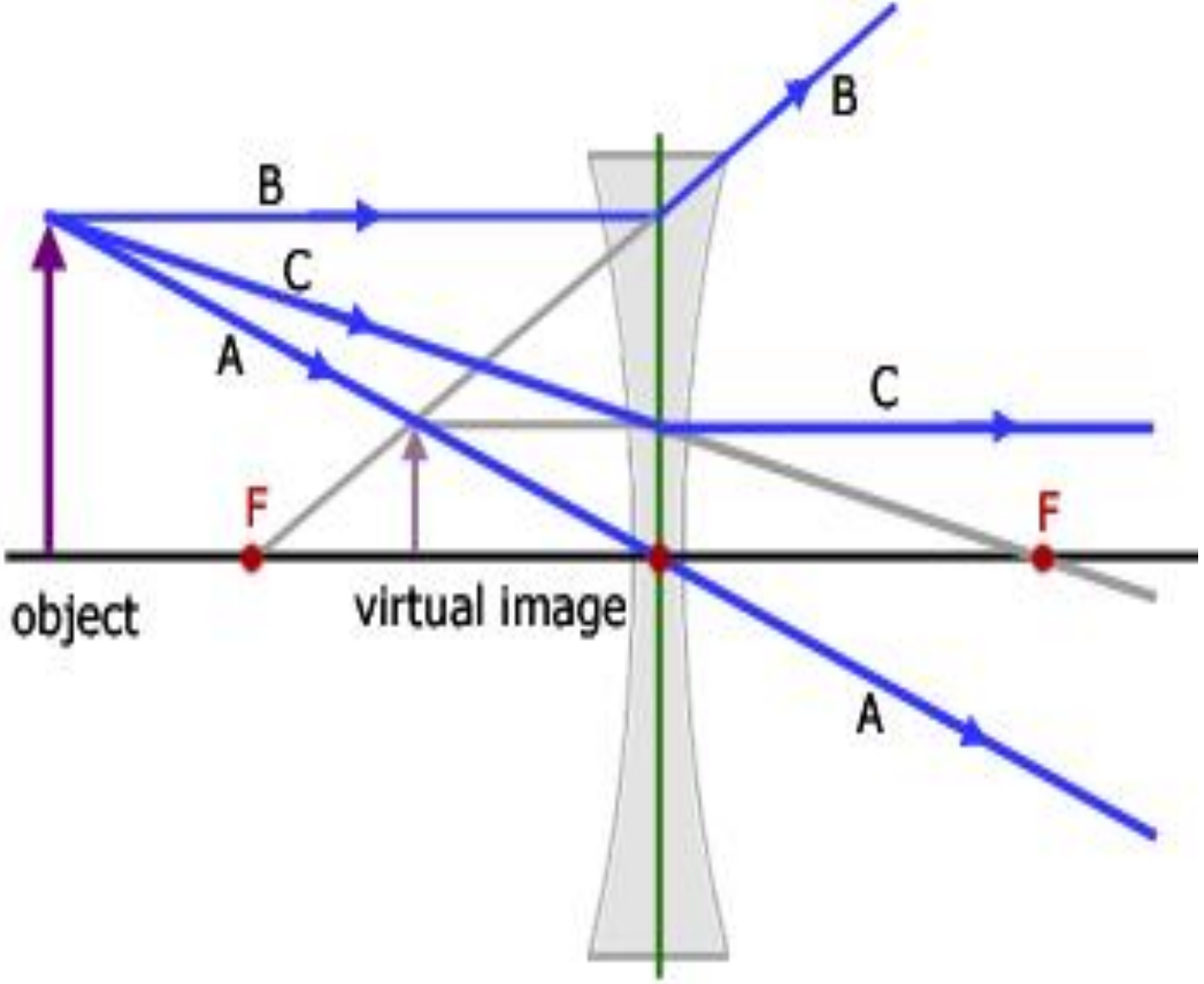
What happens when a light ray passes from glass into air?



Refraction and lenses.




Concave Lens
Light Ray
2F
F
F
2F
Principle Axis
Object
Image
Light Ray


B
B
C
A
C
F
F
object
virtual image
A

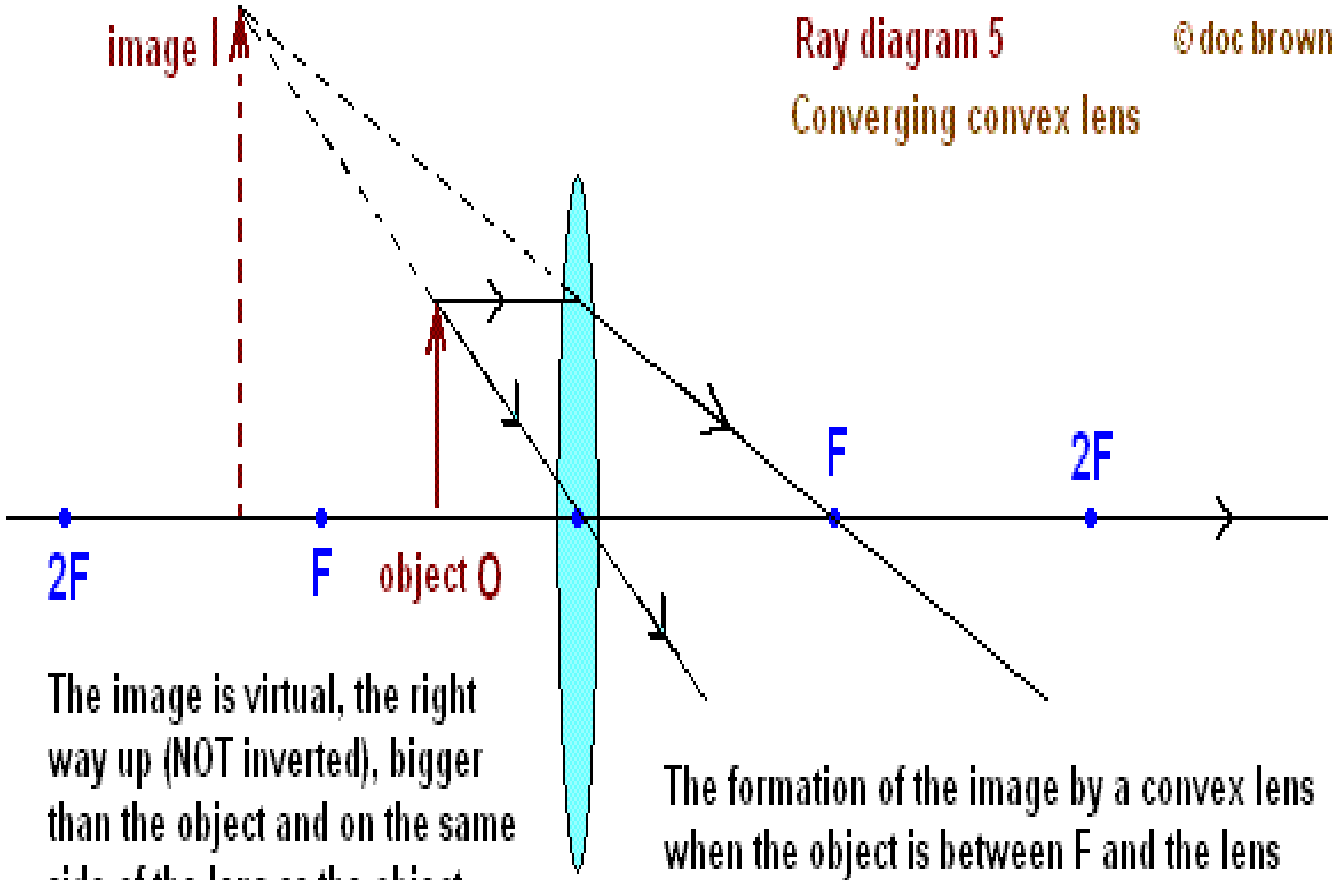
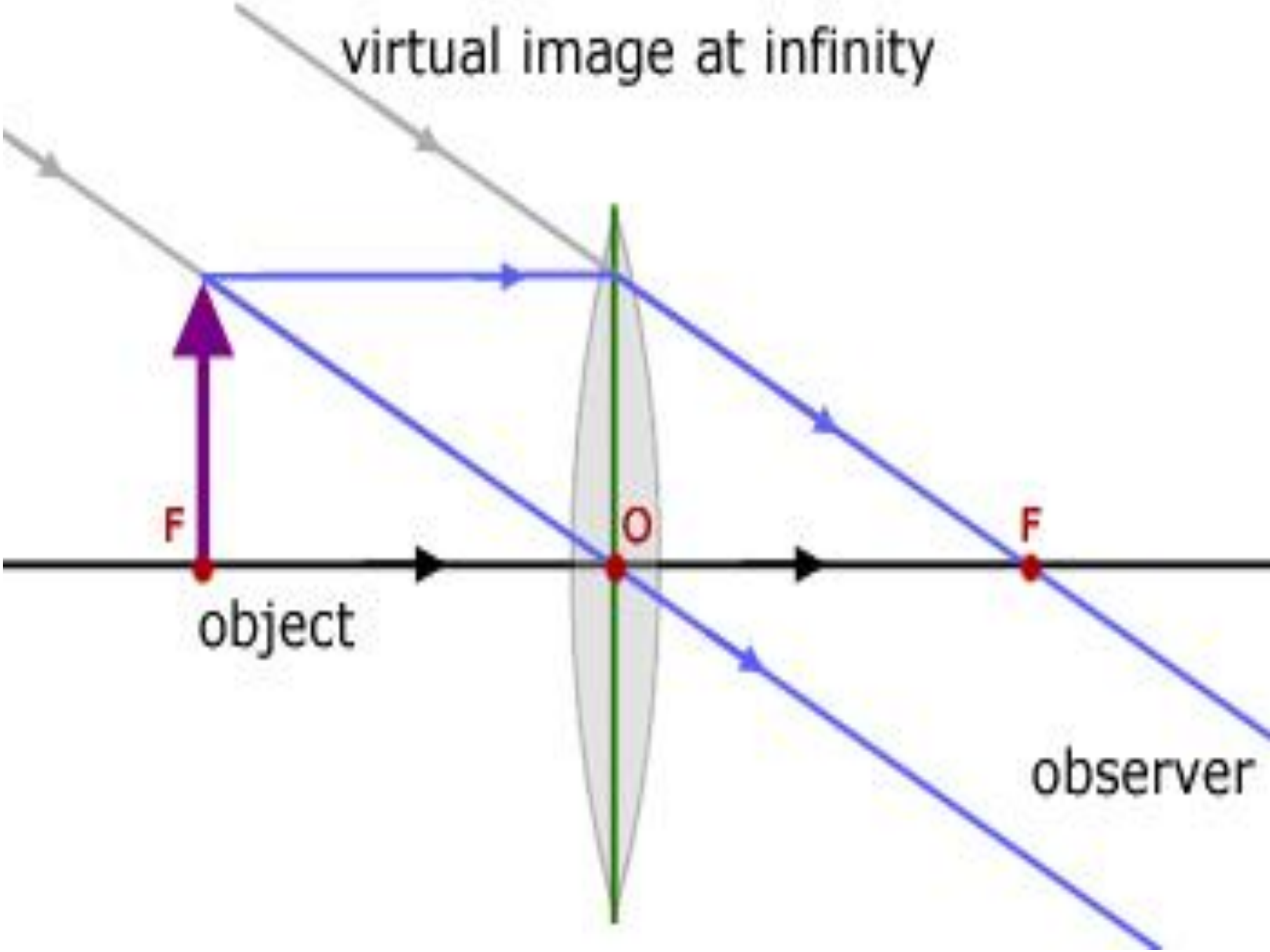
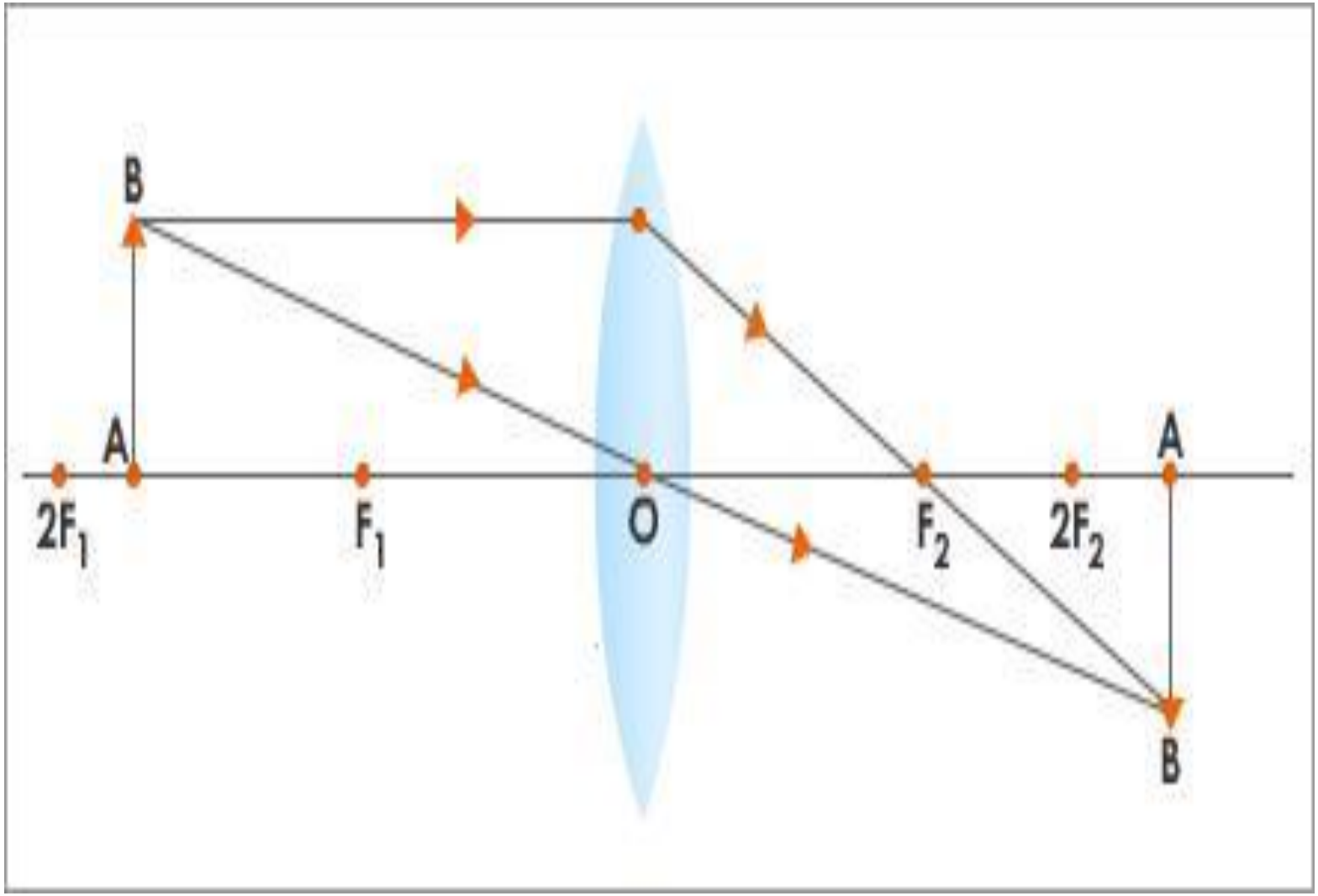
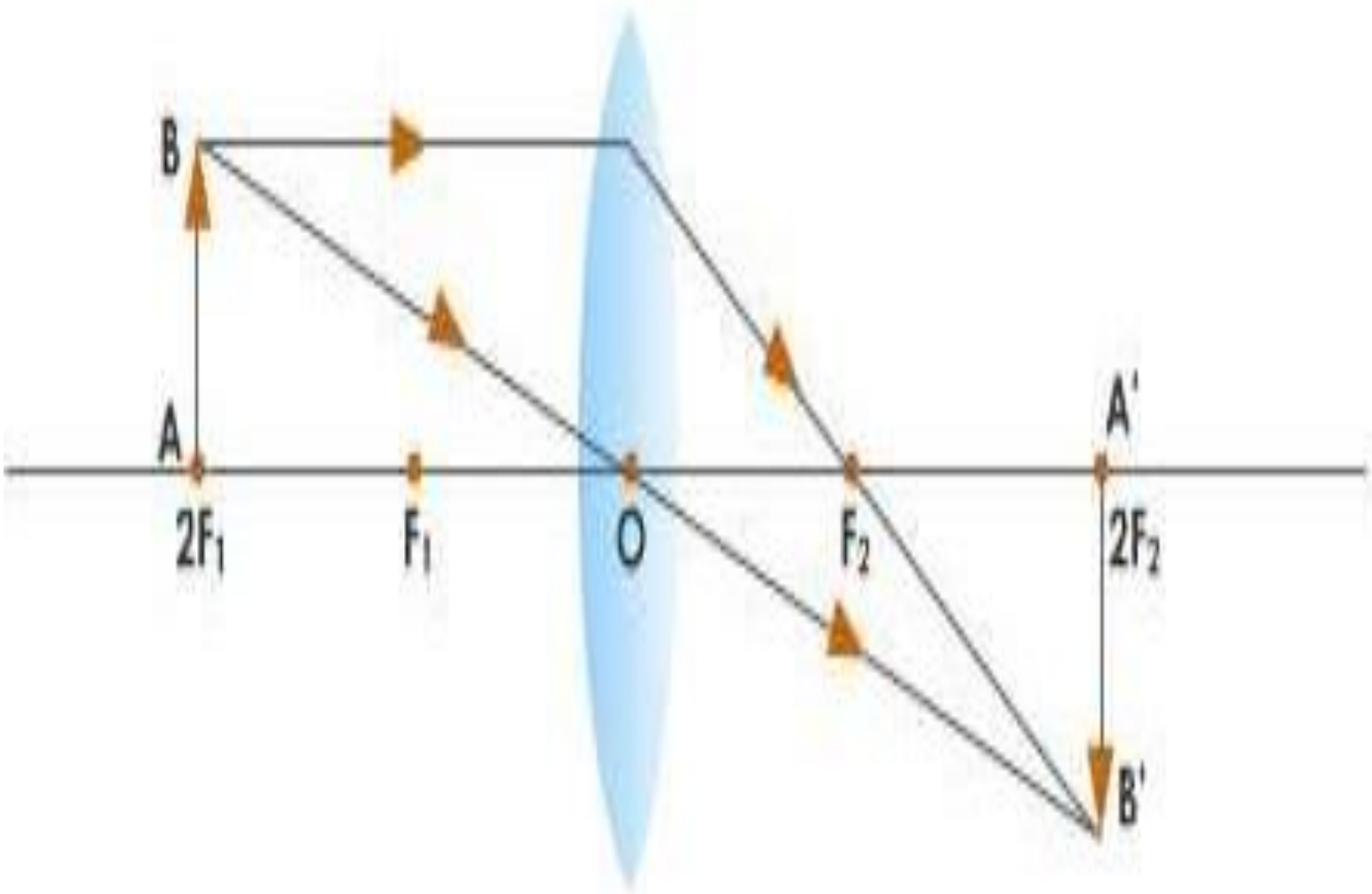
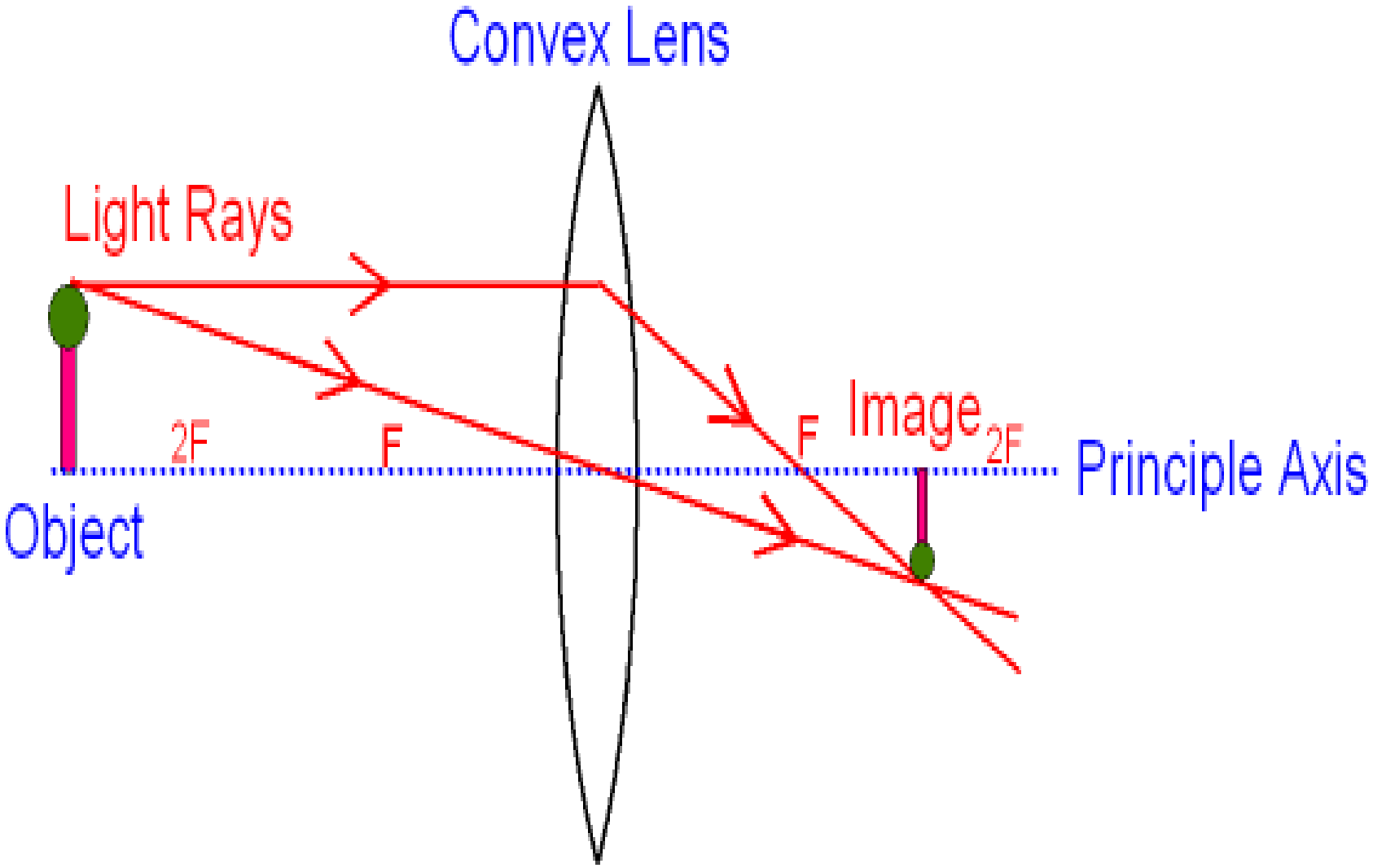


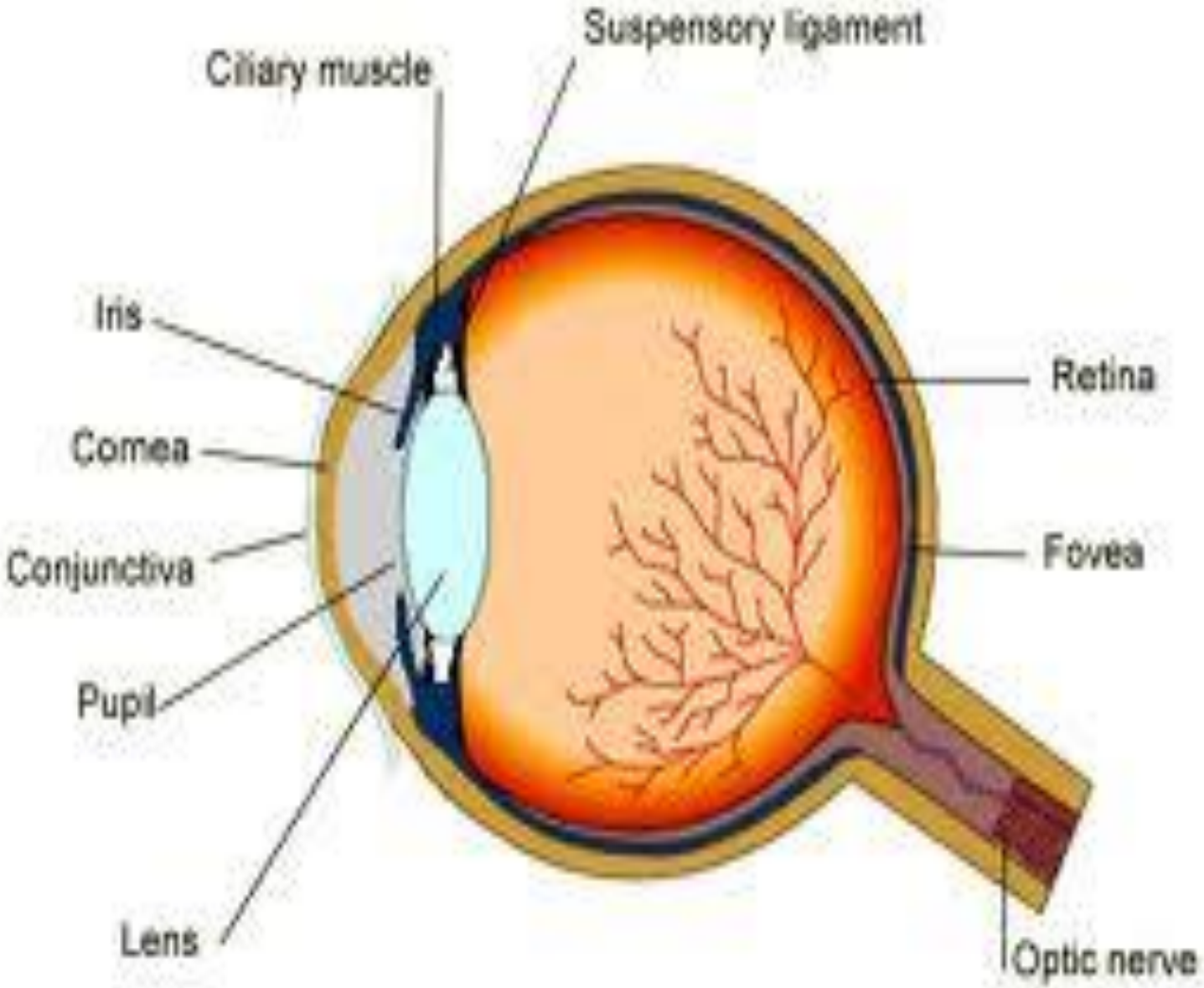
image I
Ray diagram 5
© doc brown
Converging convex lens
F
2F
2F
F
object O
The image is virtual, the right way up (NOT inverted), bigger than the object and on the same side of the lens as the object
The formation of the image by a convex lens when the object is between F and the lens


virtual image at infinity
F
O
F
object
observer

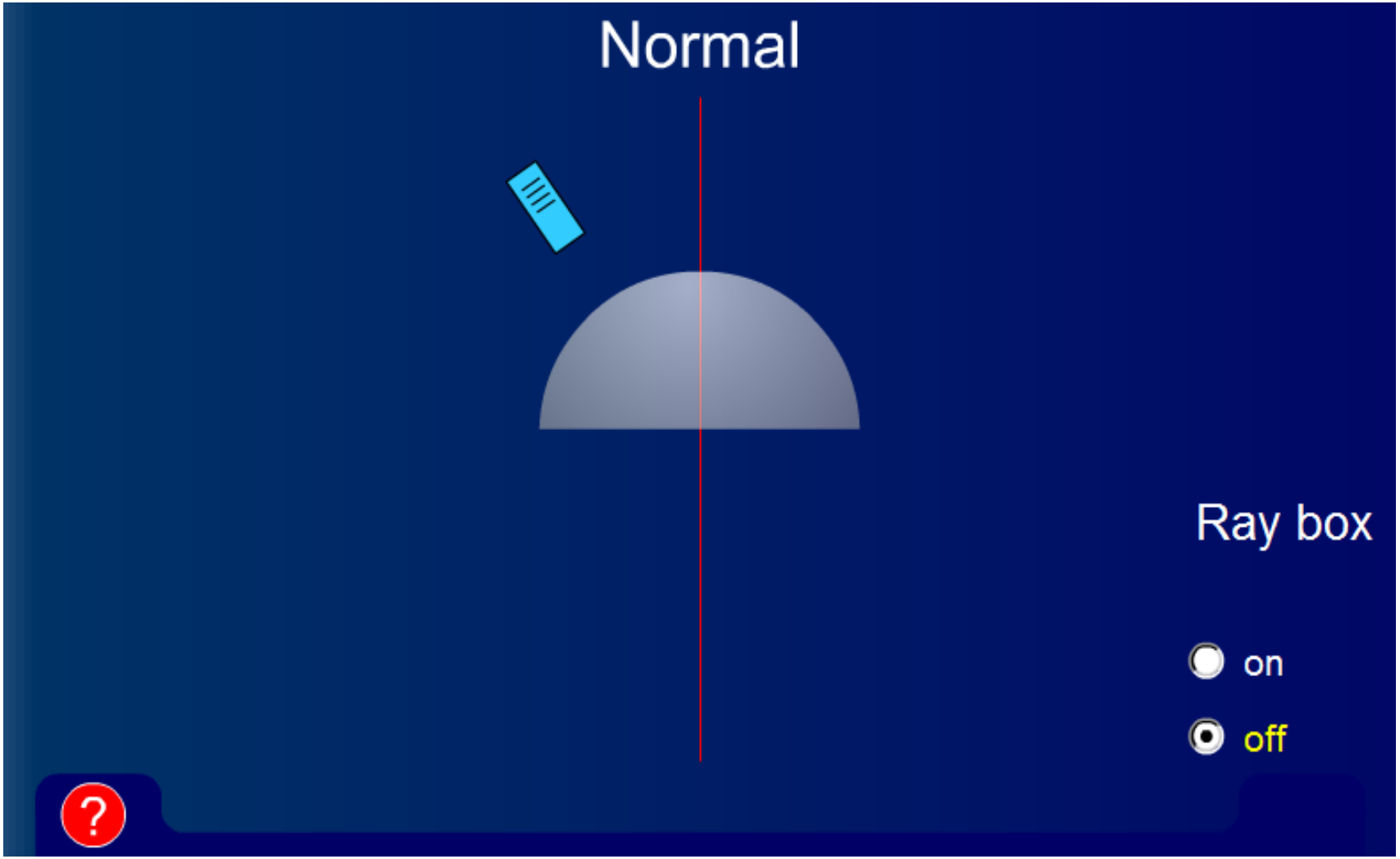

B
A
2F1
F1
O
F2
2F2
A
B


B
A
A'
2F1
F1
O
F2
2F2
B'


Convex Lens
Light Rays
2F
F
F
Image
2F
Principle Axis
Object


Suspenscry ligament
Ciliary muscle
Iris
Retina
Cornea
Fovea
Conjunctiva
Pupil
Lens
Optic nerve

Light ray simulation.

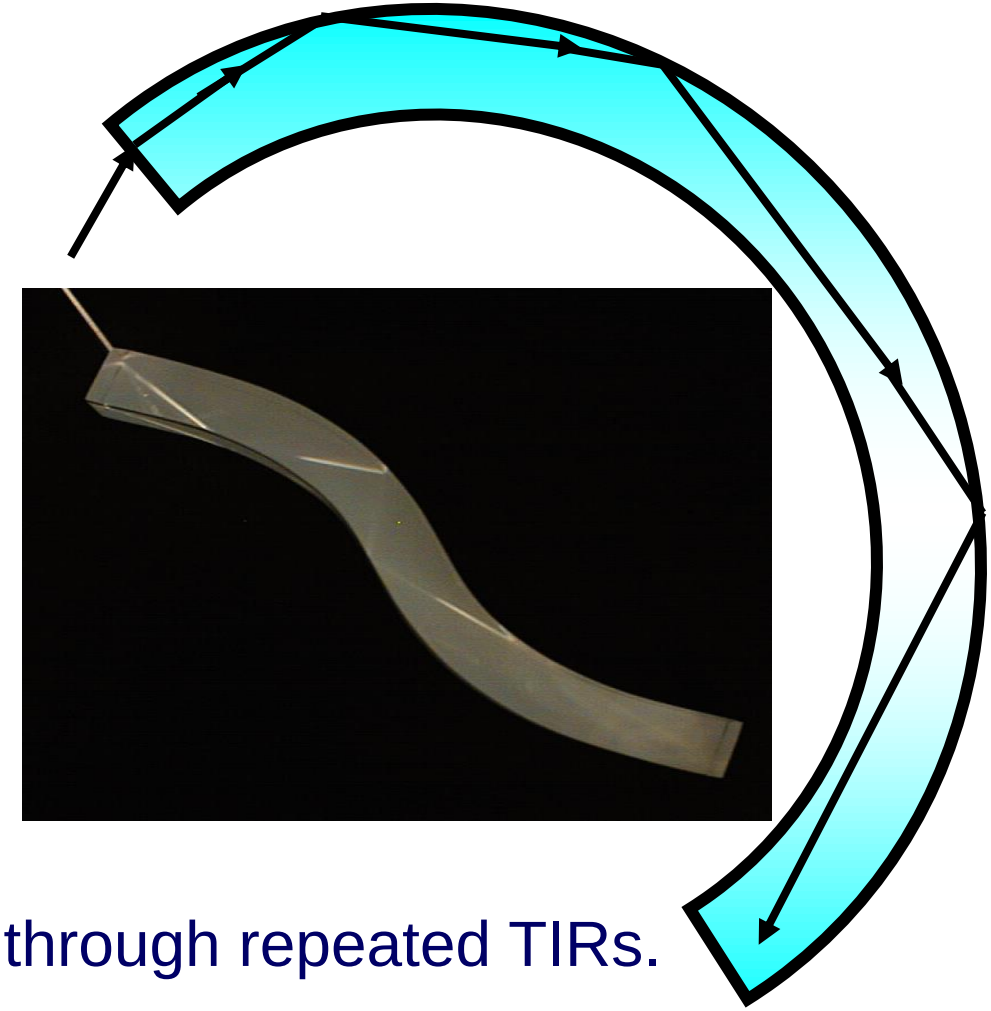


Total internal reflection.

What are the applications of total internal reflection (TIR)?

Optical fibres, used in communication, use TIR.

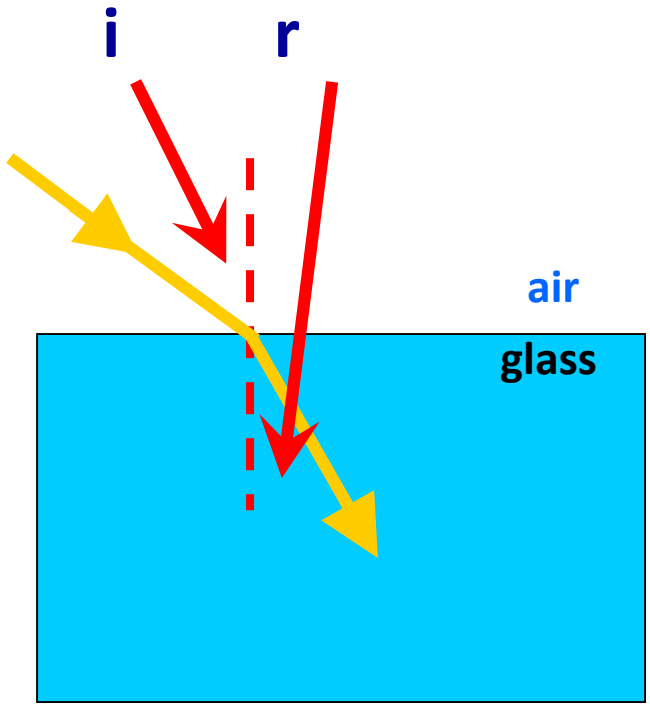
You could be asked to draw on the path of the beam in an exam.



1. A beam of light enters the optical fibre.
2. It is refracted as it enters the fibre.
3. It travels down the fibre through repeated TIRs.

Snell's law:

$$\text{Refractive index} = \frac{\sin i}{\sin r}$$



Example:

When a ray passes into a glass block, i = 45° and r = 28°. What is the refractive index of the glass?

$$\text{Refractive index} = \frac{\sin 45}{\sin 28}$$

Refractive index = 1.5

The critical angle (c).

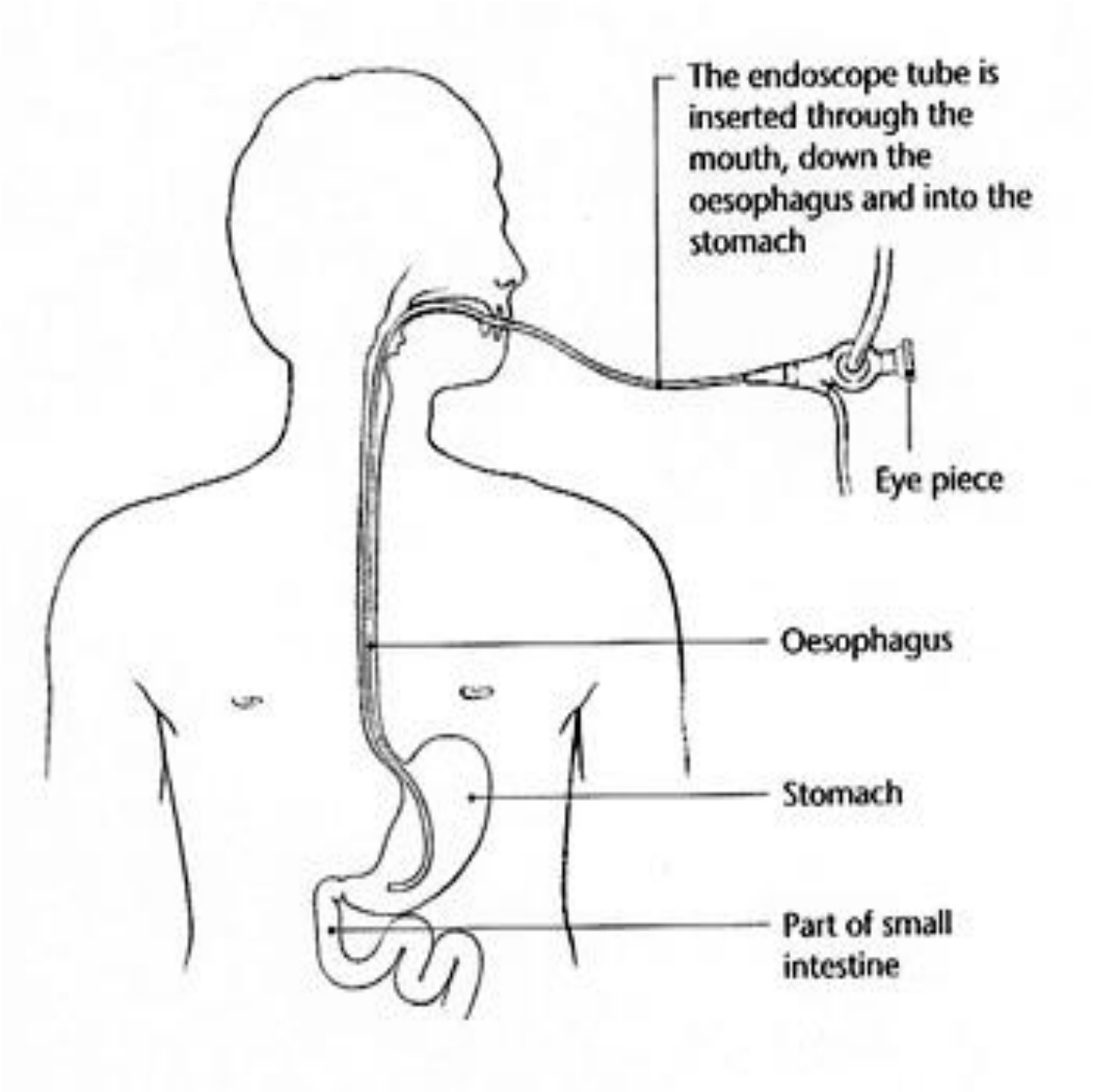
How does the refractive index affect the critical angle?

Refractive index = $\frac{1}{\sin c}$.

Material	Refractive index	Critical angle
Glass	**1.5**	**42°**
Water	**1.33**	**49°**
Diamond	**2.4**	**24°**

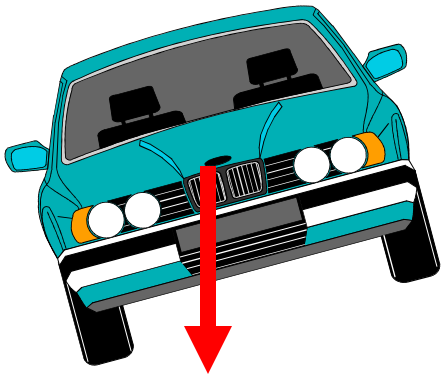
The greater the refractive index, the smaller the critical angle.

Endoscope.

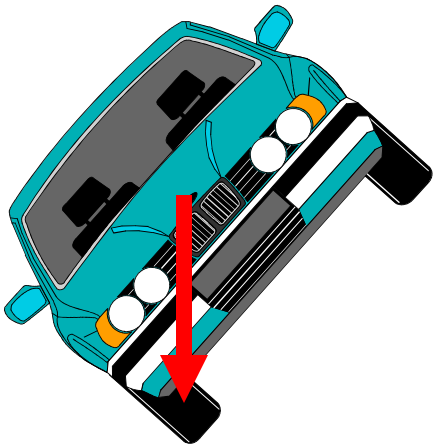

The endoscope tube is inserted through the mouth, down the oesophagus and into the stomach
Eye piece
Oesophagus
Stomach
Part of small intestine

Laser eye surgery.

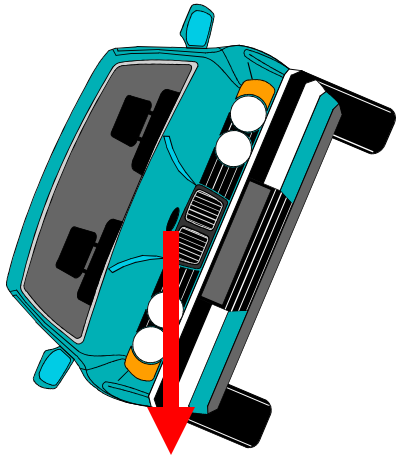
Stability.



1. Centre of mass is within the wheelbase – no problem!



2. Centre of mass is directly above the edge of the wheelbase –car is on the point of toppling



3. Car falls over

Moment calculation.

The size of a **moment** (the turning effect of a force) depends on:

1. The size of the force.

2. The perpendicular distance of the force from the pivot.

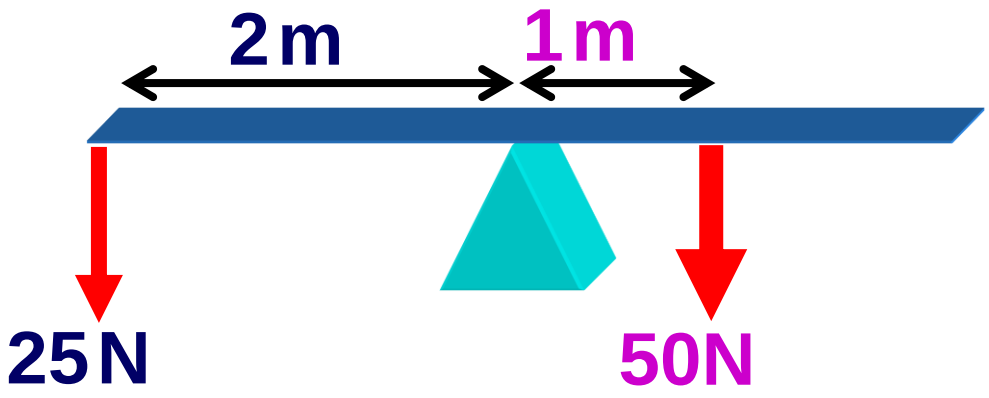
moment = force x perpendicular distance from pivot

What are the units of a moment?

- Force is measured in **newtons** (**N**).
- Distance is measured in **metres** (**m**).
- A moment is measured in **newton metres** (**Nm**).

Using the principle of moments.

At what distance from the pivot should a force of **50 N** be put to balance this see-saw?



anticlockwise moment = clockwise moment

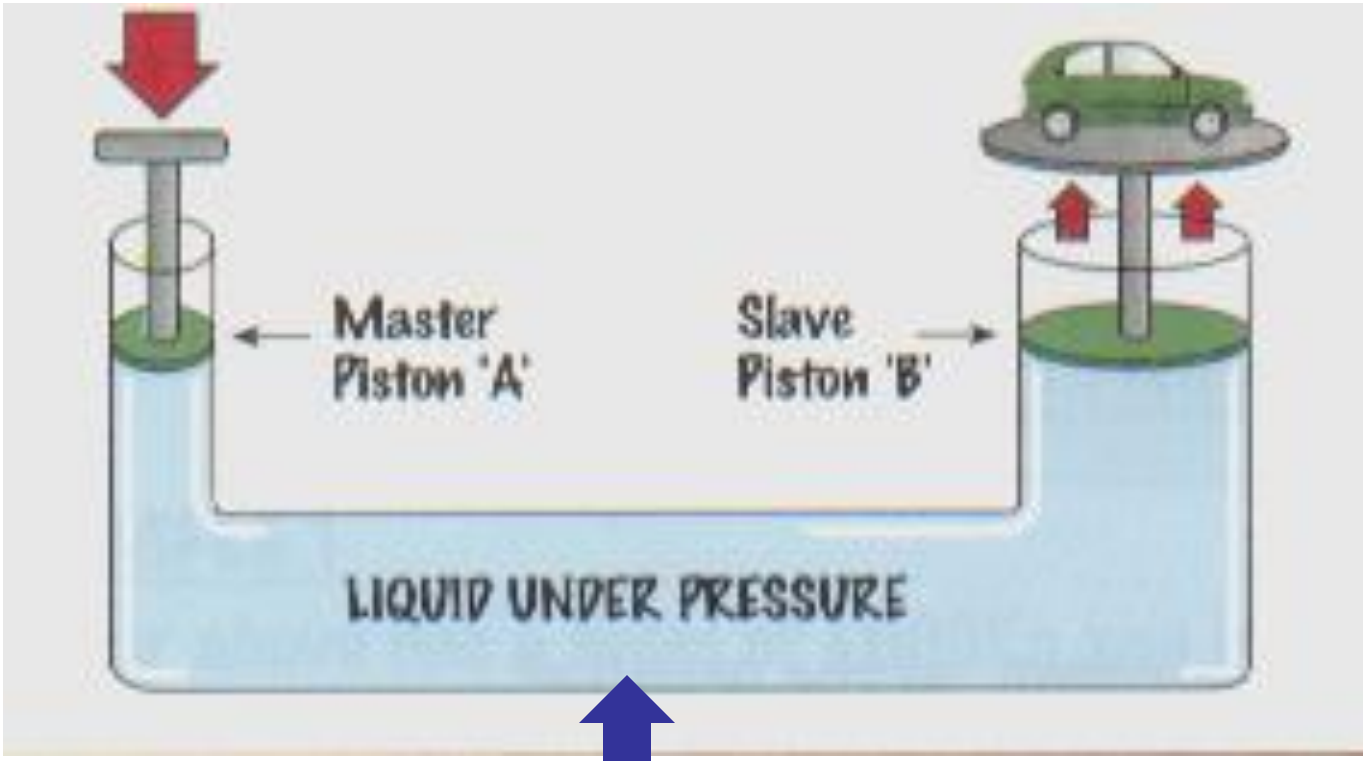
25 N x 2 m = 50 N x ? m

50 Nm = 50 N x ? m

distance for 50 N = $\frac{50\ \text{Nm}}{50\ \text{N}}$

= **1 m**

Hydraulic systems: Can be used as force multipliers because liquids are virtually incompressible.

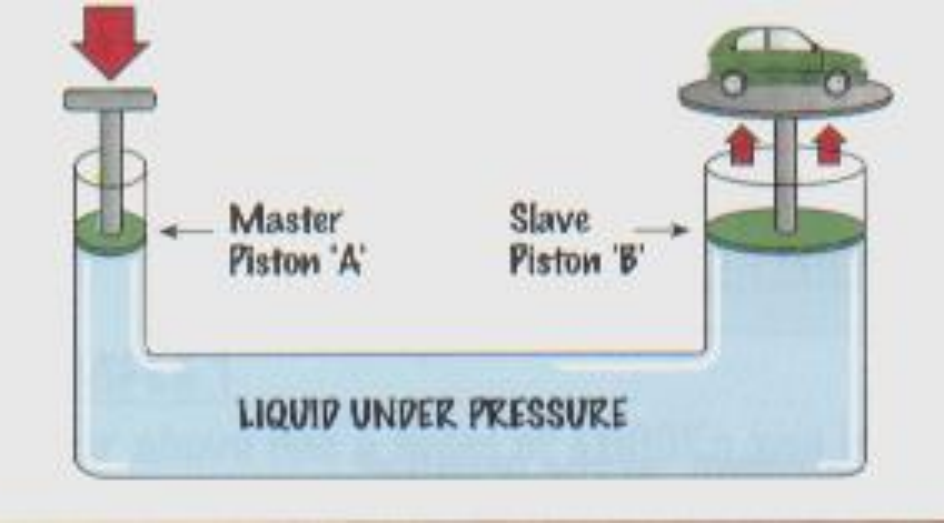


Pressure is constant throughout this liquid

Hydraulic systems.

A smaller force on piston A will produce a larger force on piston B because the pressure of the liquid is constant.

Magic!



(1) If the area of piston A is 5cm^2 and piston B is 20cm^2 how much will the force be multiplied by?

(2) If the area of the slave piston is ten times bigger than the master piston what force will be needed to lift an object weighing 1000N?

(3) A force of 10N is used to lift a weight of 50N. What is the ratio of the master piston area to the slave piston area?

Pressure calculations activity

You will need this equation to answer the following questions about pressure.

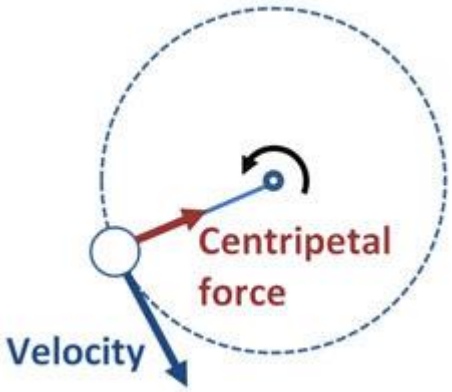
$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Click "start" to begin.

start

Centripetal force.

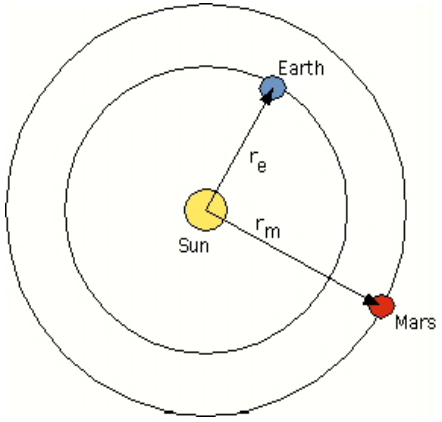
Consider a ball of Plasticine attached to some string:

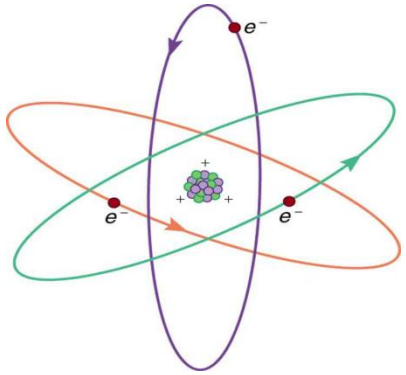


The ball is kept in its path by the tension in the string – an example of a CENTRIPETAL FORCE. This force also produces the change in velocity due to the direction constantly changing.

This force is INCREASED if you increase the mass of the object, its speed or decrease the radius of the circle.

Other examples of centripetal forces:

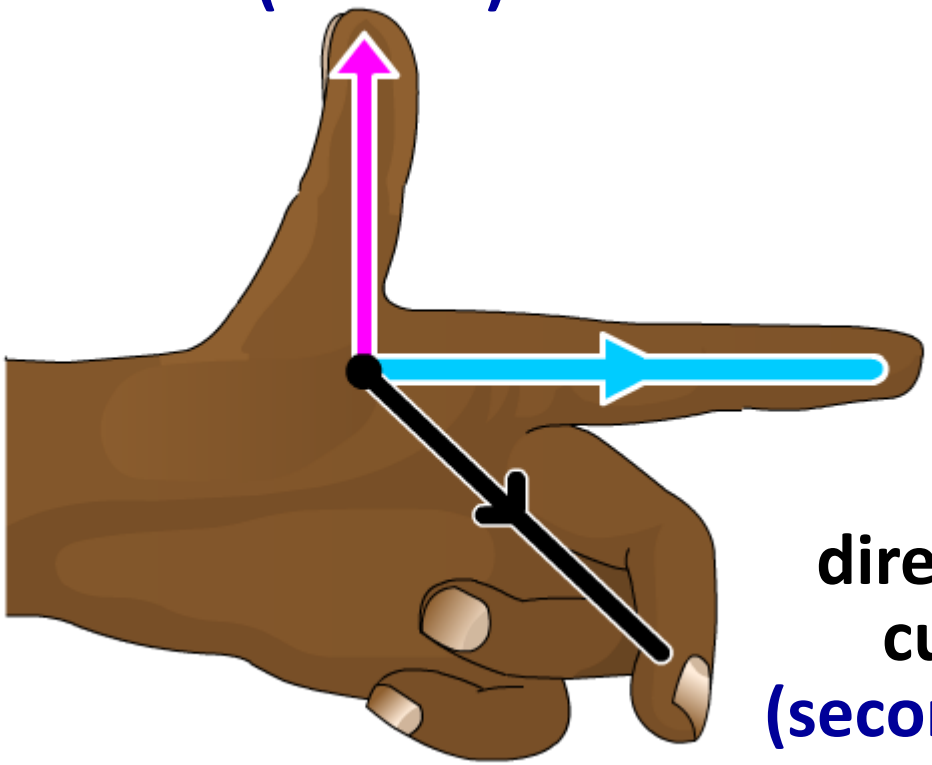




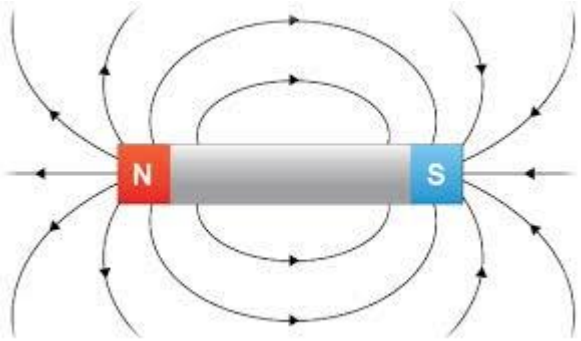
Electrons

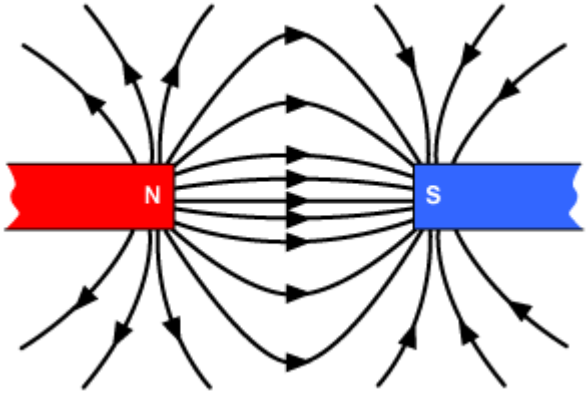
Fleming's left-hand rule.

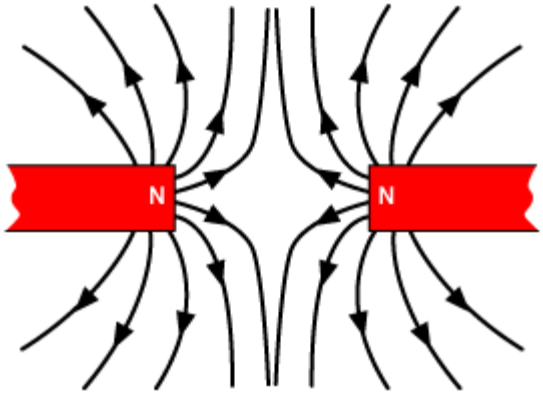
To use Fleming's left-hand rule, hold the thumb and the first two fingers of your left hand at right angles to each other.



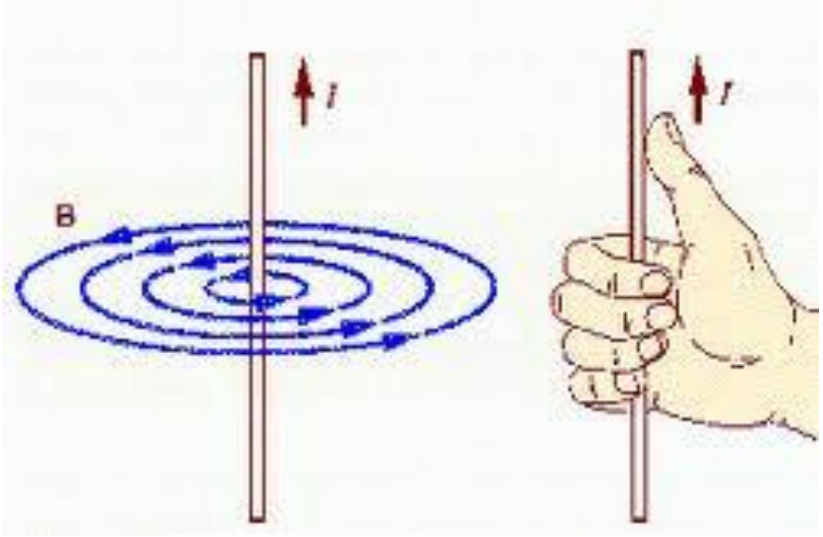
Magnets and their fields.

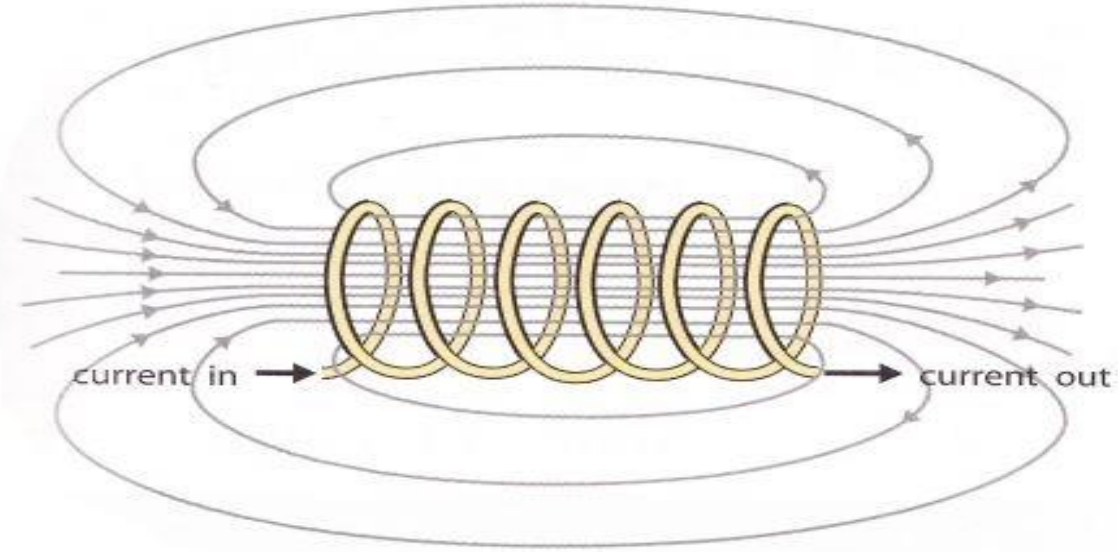


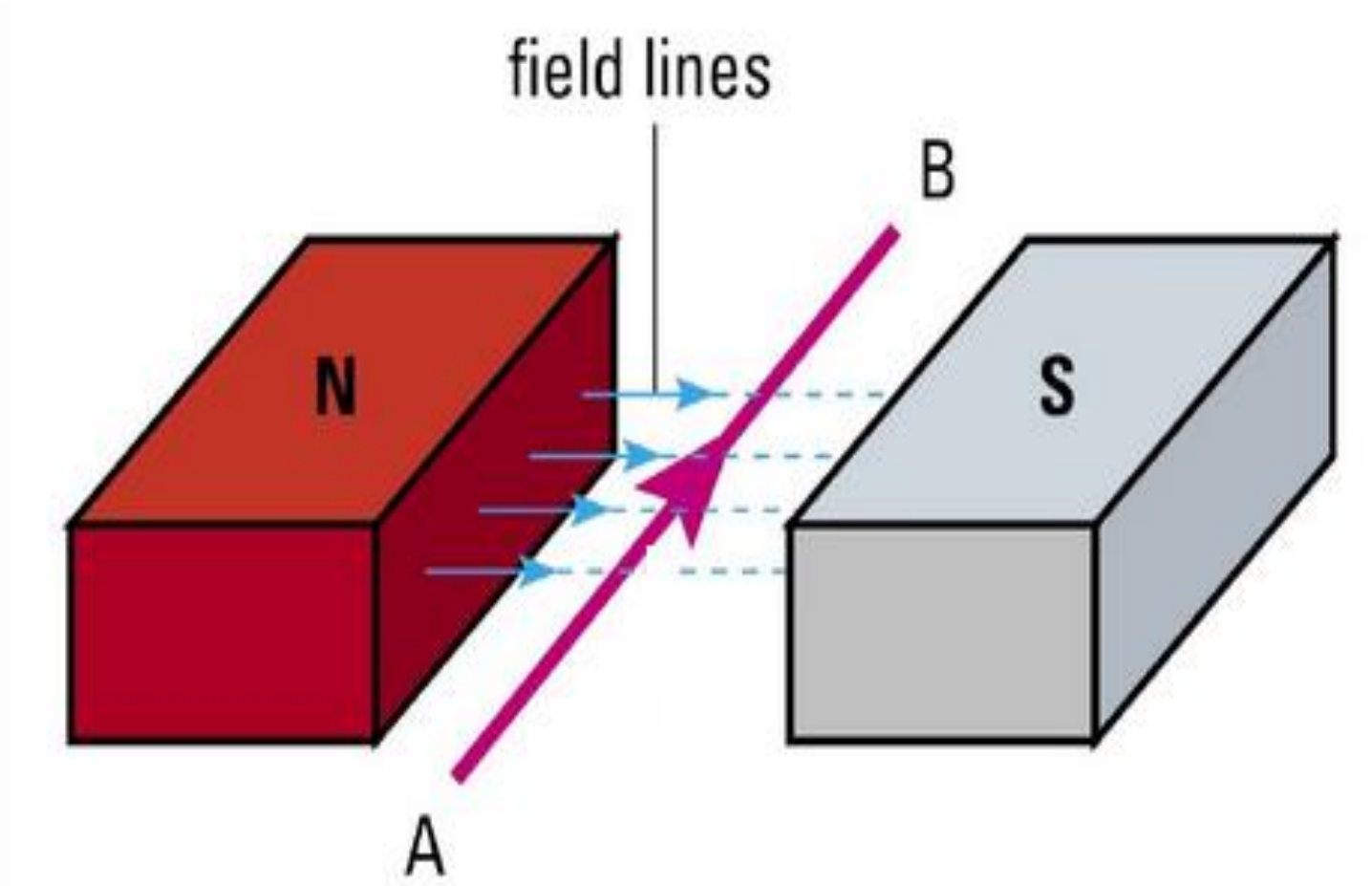




Magnetic fields around a current-carrying conductor.






field lines
B
N
S
A

Increasing the strength of the force.

Which of the following would increase the strength of the force on a wire carrying a current?

more current — **TRUE/~~FALSE~~**

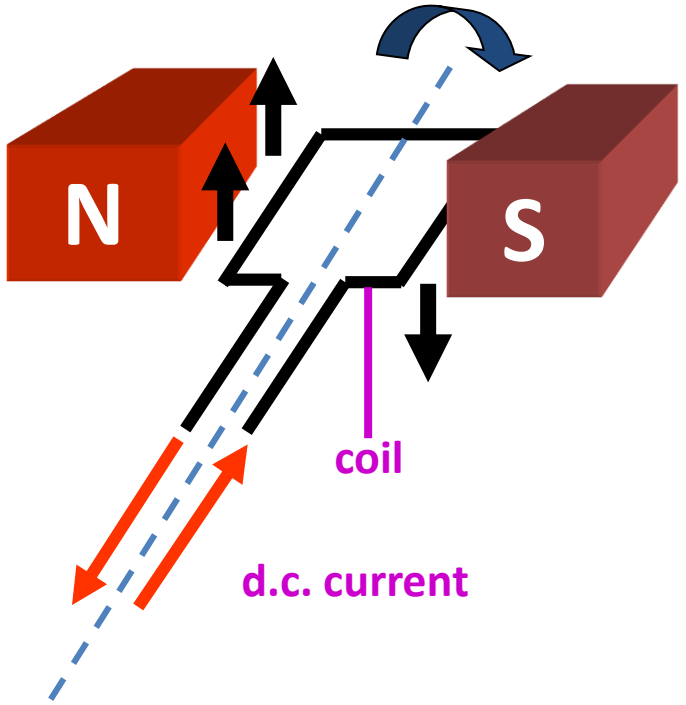
more resistance — **~~TRUE~~/FALSE**

stronger magnetic field — **TRUE/~~FALSE~~**

The DC motor.

A DC motor works using the principle of the motor effect.

When a DC current flows in the coil, the sides of coil are pushed in opposite directions because of the motor effect.



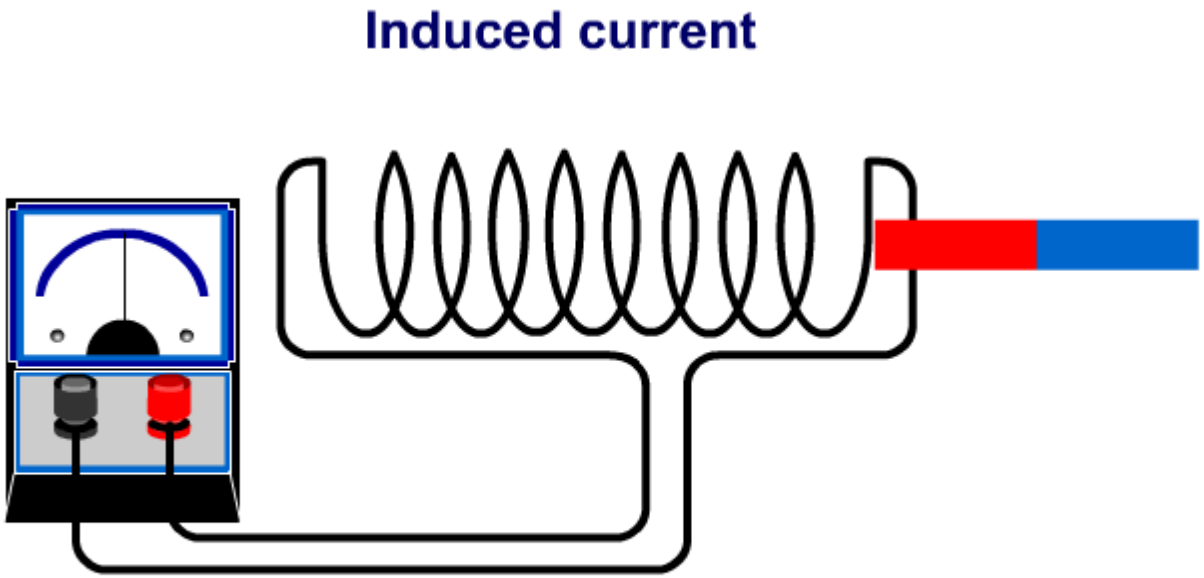
This results in the coil rotating.

What happens to the coil if the direction of the current or the magnetic field is reversed?

The coil will spin in the opposite direction.

Electromagnetic induction.

When a magnet is **moved into** a coil of wire a current is **induced.** When the magnet is **stationary** no current is induced. When the direction of movement is **reversed** the current is **reversed.**



Inducing current.

What will happen if a magnet is moved in and out of a coil of wire repeatedly?

A current will be induced in the coil. When the magnet is moved into the coil, the current will flow in one direction. Then, when the magnet is moved out of the coil, the direction of the current is reversed and flows in the opposite direction.

The induced current is constantly changing direction. What type of current is this?

alternating current

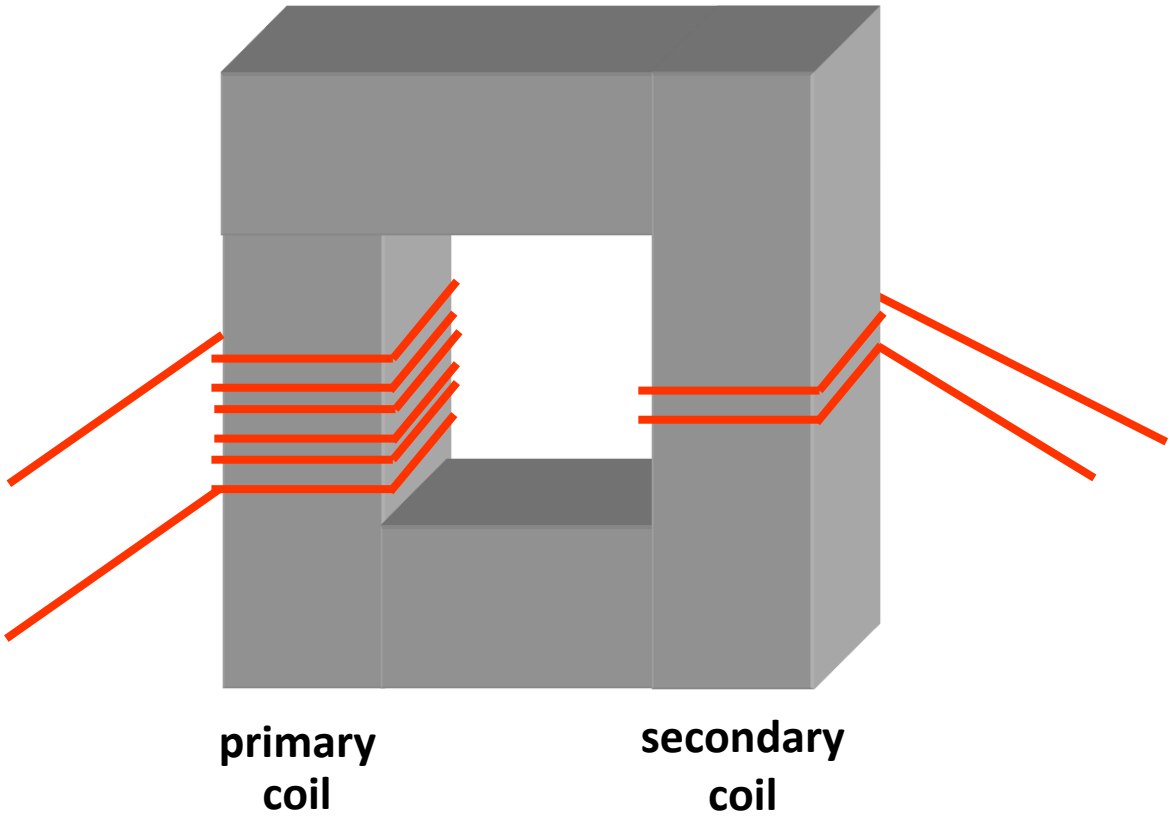
Increasing the size of the induced current.

What are the four ways in which the (induced) current from an AC generator can be increased?

1. faster movement
2. stronger magnetic field
3. more coils
4. larger area of coils

Which type of transformer?

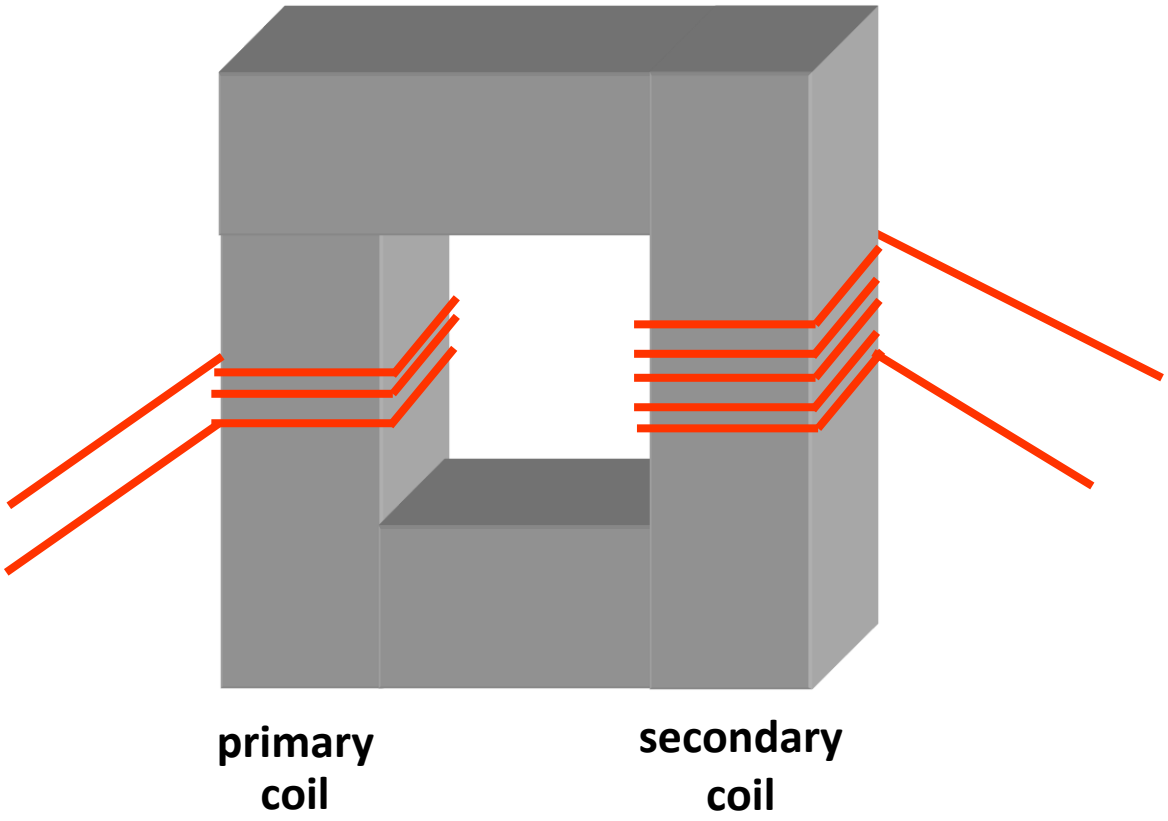
Is this a step-up or a step-down transformer?



This a **step-down transformer** because there are **less turns in the secondary coil** than the primary coil.

Which type of transformer?

Is this a step-up or a step-down transformer?



This a **step-up transformer** because there are **more turns in the secondary coil** than the primary coil.

Transformer calculations.

The size of the output voltage from a transformer depends on the ratio of the turns on the primary and secondary coils.

This can be calculated using the following formula:

$$\frac{V_1}{V_2} = \frac{n_1}{n_2}$$

In this formula, **V** is the voltage in a coil and **n** is the number of turns in that coil.

Transformer question (1).

A transformer has 200 turns on its primary coil and 50 turns on its secondary coil. The input voltage is 920 V.

a) Is this a step-up or step-down transformer? **step-down**

a) What is the output voltage?

$$\frac{V_2}{V_1} = \frac{n_2}{n_1}$$

$$V_2 = \frac{n_2}{n_1} \times V_1$$

$$V_2 = \frac{50}{200} \times 920$$

$$= 230\,V$$

Transformer question (2).

A transformer has 100 turns on its primary coil. It has an input voltage of 35 V and an output voltage of 175 V.

a) Is this a step-up or step-down transformer? **step-up**

a) How many turns are on the secondary coil?

$$\frac{n_2}{n_1} = \frac{V_2}{V_1}$$

$$n_2 = \frac{V_2}{V_1} \times n_1$$

$$n_2 = \frac{175}{35} \times 100$$

$$= 500 \text{ turns}$$

Transformers.

(Only work with ac)

- The alternating current in the primary coil produces an alternating magnetic field in the iron core.
- The alternating magnetic field in the core induces an alternating current in the secondary coil.
- Transformers are nearly 100% efficient so the power in the primary = power out of the secondary.
- Power = current x voltage, so

$(\text{current} \times \text{voltage})_{\text{primary}} = (\text{current} \times \text{voltage})_{\text{secondary}}$

- As the voltage is stepped up the current will be stepped down and vice versa.

Switch mode transformers:

Operate at higher frequencies (50kHz to 200kHz), therefore they are smaller and lighter. They are more efficient and use very little power when on but not charging.