MEGA LECTURE

Formulae

Key points

# Physics IGCSE Mocks Revision



Simple

Easy

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# Volume and Density

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\rho(\text{rho}) = \frac{m}{V}$$

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# Volume and Density

How to find the volume of an irregular solid?

- You need to fill up a measuring cylinder with water and measure till where it is filled.
- Then lower the irregular solid into the measuring cylinder and measure how much the water has risen.
- Subtracting the two values that you have will give you the volume of the substance.

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# Speed

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

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# Velocity

$$\text{Average Acceleration} = \frac{\text{Change in velocity}}{\text{Time Taken}}$$



$$a = \frac{v-u}{t}$$

Negative acceleration is called deceleration or retardation

v= final velocity
u=initial velocity

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# Forces

- A force is a push or a pull.
- Force is measure in Newton's (N).

If no external forces are applied to an object:

- It will remain stationary
- It will keep moving at a constant speed.

What is Terminal Velocity?

It is when something is at its maximum speed.

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# Forces



Force = Mass x Acceleration

F = m x a

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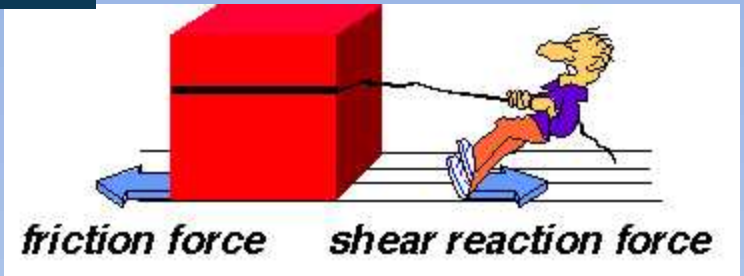
# Friction




- Friction is a force that stops two materials from sliding across each other.
- Static Friction resists the lateral (sideways) movement of two objects.
- Dynamic Friction is the friction between two objects that are moving. It heats up the material. When something is moved against the force of friction the kinetic energy is changed into thermal energy.

STATIC FRICTION IS GREATER THAN DYNAMIC FRICTION

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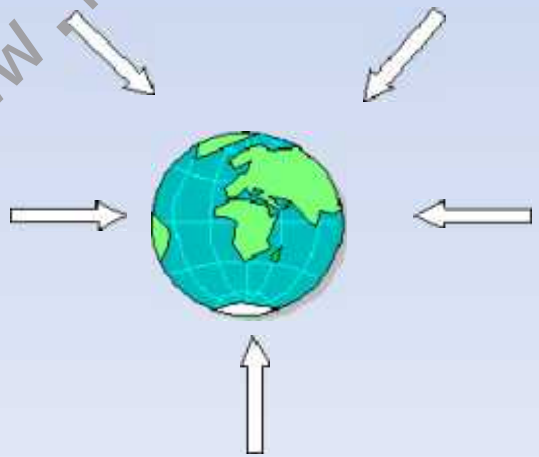
# Gravitational Force

- All the masses attract each other.
- The greater the mass, the greater the force.
- The closer the mass, the greater the force.

- To every action there is an equal but opposite reaction.



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# Gravitational Force

Weight = Mass x Gravity

W = m x g

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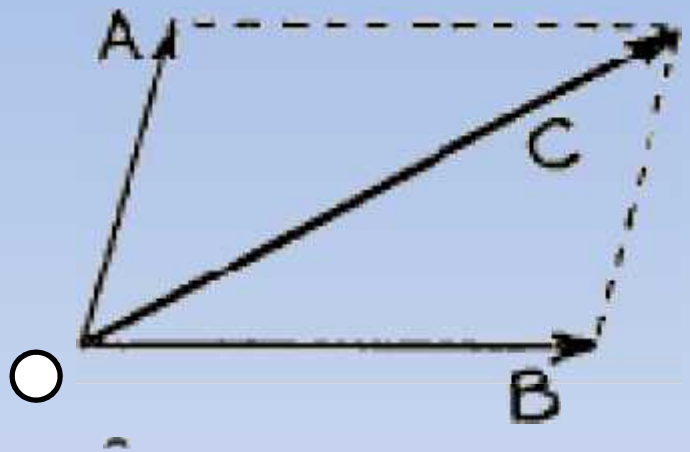
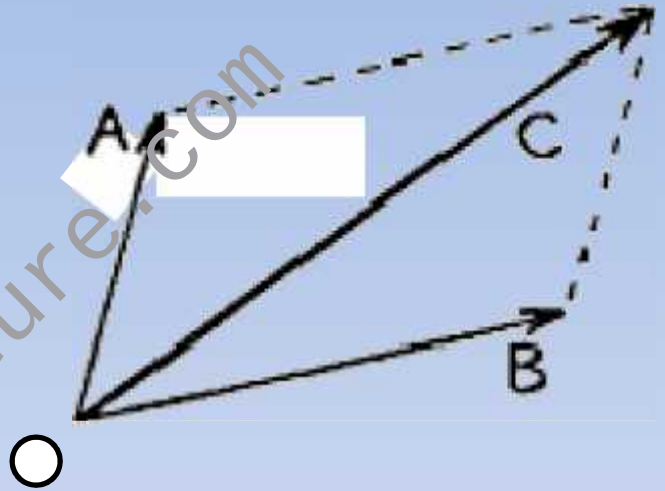
# The Parallelogram Rule






1. First you need to draw the two lines given to you. The directions should be accurate and the length of each line should be in proportion to the magnitude of each vector.
2. Then draw in two more lines to complete the parallelogram.
3. Diagonal from 'O' and then measure its length.

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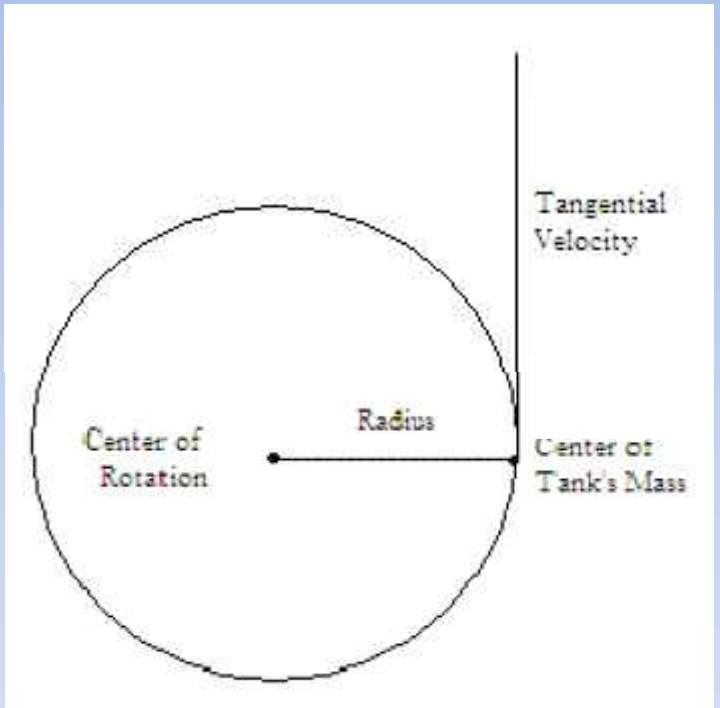
# Centripetal Force

- It is an inward force needed to make an object move in a circle.

More centripetal force is needed if:

- Mass of the object is increased
- Speed of the object is increased
- Radius of the circle is decreased.



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# Moments

Moment of a force about a point = Force x Perpendicular distance from the pivot



The Principle of Moments

Clockwise moments = Anticlockwise moments

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# Hooke's Law

A material obeys Hooke's law if, beneath the elastic limit, the extension is proportional to the load.

$$\text{Load} = \text{Spring Constant} \times \text{Extension}$$

$$F = k x$$

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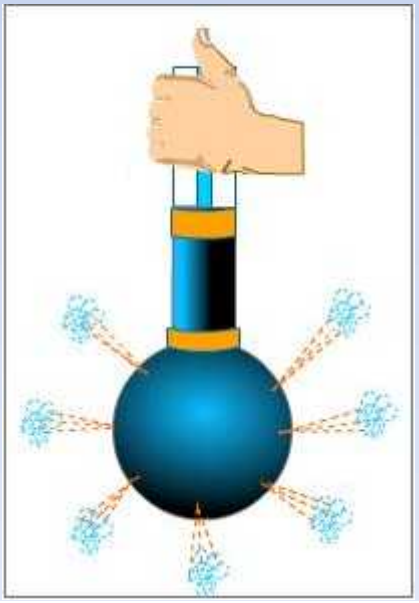
# Pressure

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





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# Pressure in Liquids

- Its in all directions
- It increases with depth
- It depends on the density of the liquid
- It doesn't depend on the shape of the container.

Pressure = Density x Gravity x Height

$$\text{pressure} = \rho(\text{rho}) \times g \times h$$

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# Hydraulic Jack*

$$\frac{\text{Output Force}}{\text{Input Force}} = \frac{\text{Output Piston area}}{\text{Input Piston area}}$$



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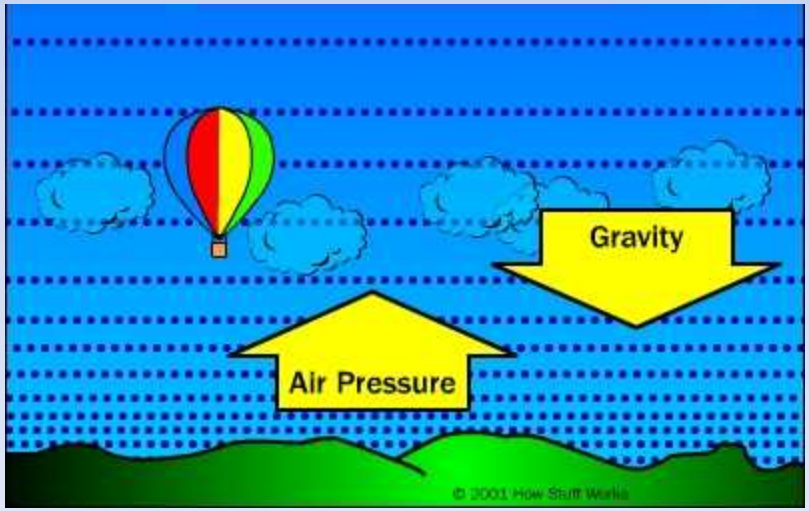
# Pressure in Air

- Pressure decreases as you rise through it.
- It acts in all directions.

Barometer: Measures atmospheric pressure

Manometer: Measures the pressure difference



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# Gas Law

- When studying a gas, the following things should be considered:

a) Pressure
b) Volume
c) Temperature

- Gas Law:

  For a fixed mass of gas the pressure times the volume divided by the temperature is constant

$$\frac{PxV}{T} = \text{Constant}$$

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# Energy

Work Done = Force x Distance moved in the direction of the force

$$W = F \times d$$

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# Different Forms of Energy

- Kinetic energy
- Potential energy
- Gravitational energy
- Elastic energy
- Chemical energy
- Electrical energy
- Nuclear energy
- Thermal energy
- Radiated energy

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# Energy

- The law of conservation of energy

  Energy cannot be made or destroyed, but it can change from one form to another.

Gravitational potential energy $= m \times g \times h$

Kinetic Energy $= \frac{1}{2} m v^2$

Gain in kinetic energy is a loss in potential energy

V = Speed

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# Scalar and Vector Quantities

Scalar: has magnitude but no direction

-Speed (magnitude of velocity)

- Time
- Mass

Vector: has magnitude and direction.

-Energy

-Displacement

-Velocity

-Acceleration

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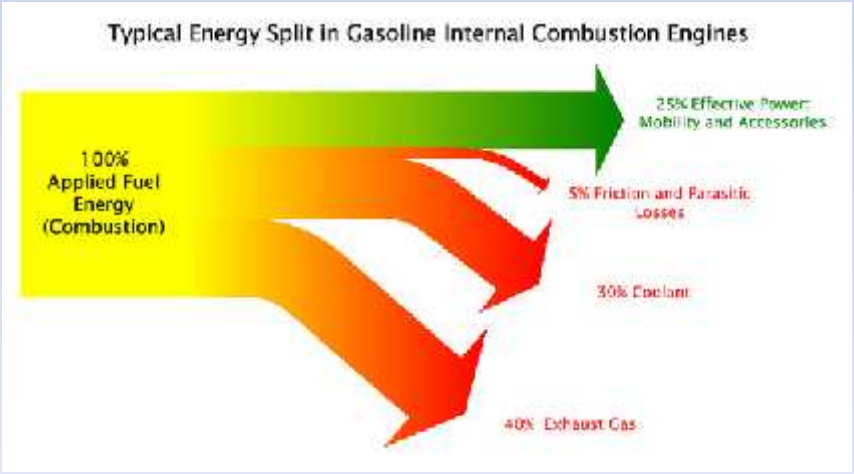
# Efficiency and Power

$$\text{Efficiency} = \frac{\text{Useful Work done}}{\text{Total energy input}}$$



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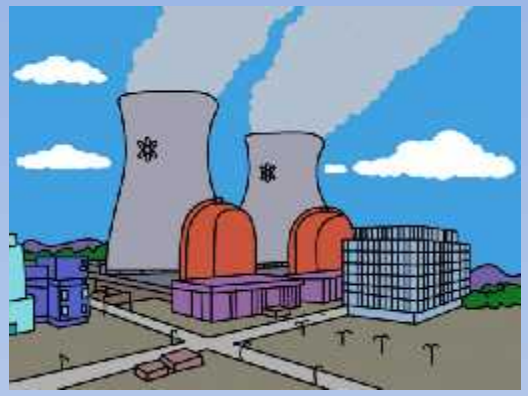

$$\text{Power} = \frac{\text{Work done}}{\text{Time Taken}}$$

$$\text{Useful Power Output} = \text{Force} \times \text{Speed}$$

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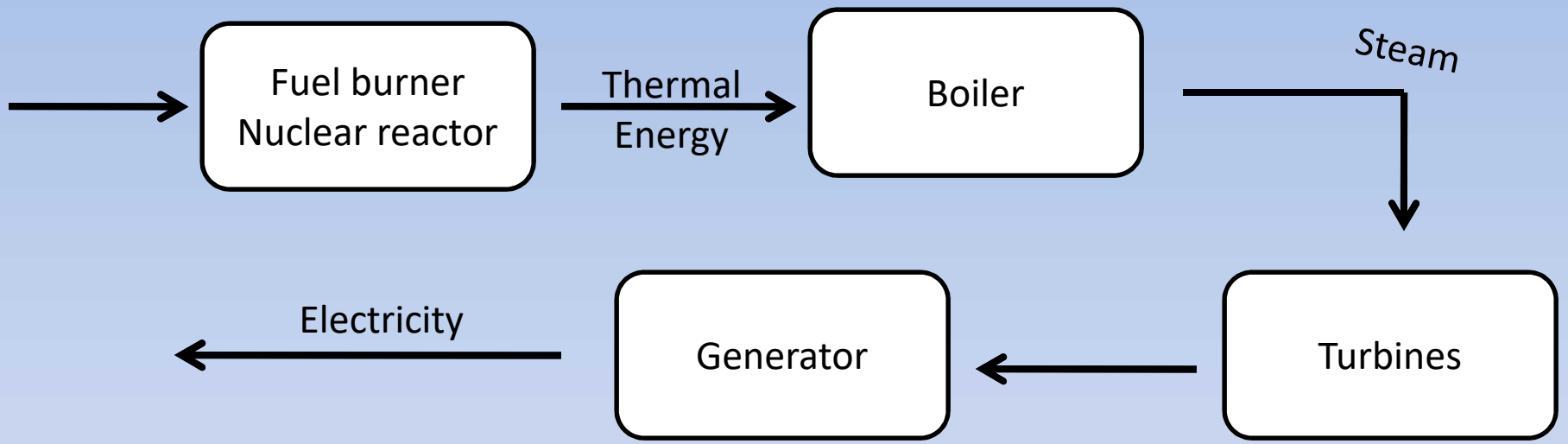
# Thermal Power Stations




Fuel + Oxygen → Carbon Dioxide + Water + Thermal Energy

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# Thermal Power Stations Problems

- Increased rate of global warming
- Sulphur dioxide causes acid rain
- Transporting fuels could lead to pollution due to leaks
- Radioactive wastes are very dangerous
- Nuclear accidents

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# Power Schemes

1- Pumped storage scheme – wind farms

2- Tidal power scheme

3- Hydroelectric power scheme


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# Energy Sources

## Non-renewable

Coal, oil, natural gas

- Supplies are limited
- Carbon dioxide concentration is increasing

Nuclear fuels

- Expensive to build and decommission

## Renewable

Hydroelectric and tidal energy

- Expensive to build
- Few areas are suitable
- May cause environmental damage

Wind energy

- Large, remote, windy sites required
- Noisy, ruin landscape

Wave energy

- Difficult to build

Geothermal energy

- Deep drilling difficult and expensive

Solar energy

- Sunshine varies
- Solar cells difficult to transport

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# Thermal Effects

- Solids-fixed volume and shape 
- Liquids-fixed volume but no fixed shape 
- Gases-no fixed shape and no fixed volume. 

- Internal energy: total kinetic and potential energy of all atoms in a material.

  Objects as the same temperature have the same average kinetic energy per particle

Hotter material → faster the particles move→ the more internal energy it has

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# Absolute Zero

-273°C= 0 Kelvin (0 K)

Kelvin Temperature/K = Celsius Temperature/°C+273

This is the lowest temperature there is.

It is a thermodynamic scale. It is based on the average kinetic energy of particles.

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# Thermal Effects

- Thermal expansion: this is when a substance is heated and its volume slightly increases.

The pressure law:

- When the Kelvin pressure doubles so does the pressure
- Pressure ÷ Kelvin temperature → always has the same value

Thermal Conduction:

Conduction is the process by which thermal energy is transferred from the hot end to the cold end as the faster particles pass on their extra motion to particles along the bar.

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# Thermal Effects

- More thermal energy is transferred if :
- Temperature difference across the ends is increased.
- Cross-sectional area of the bar is increased
- Length of the bar is reduced.



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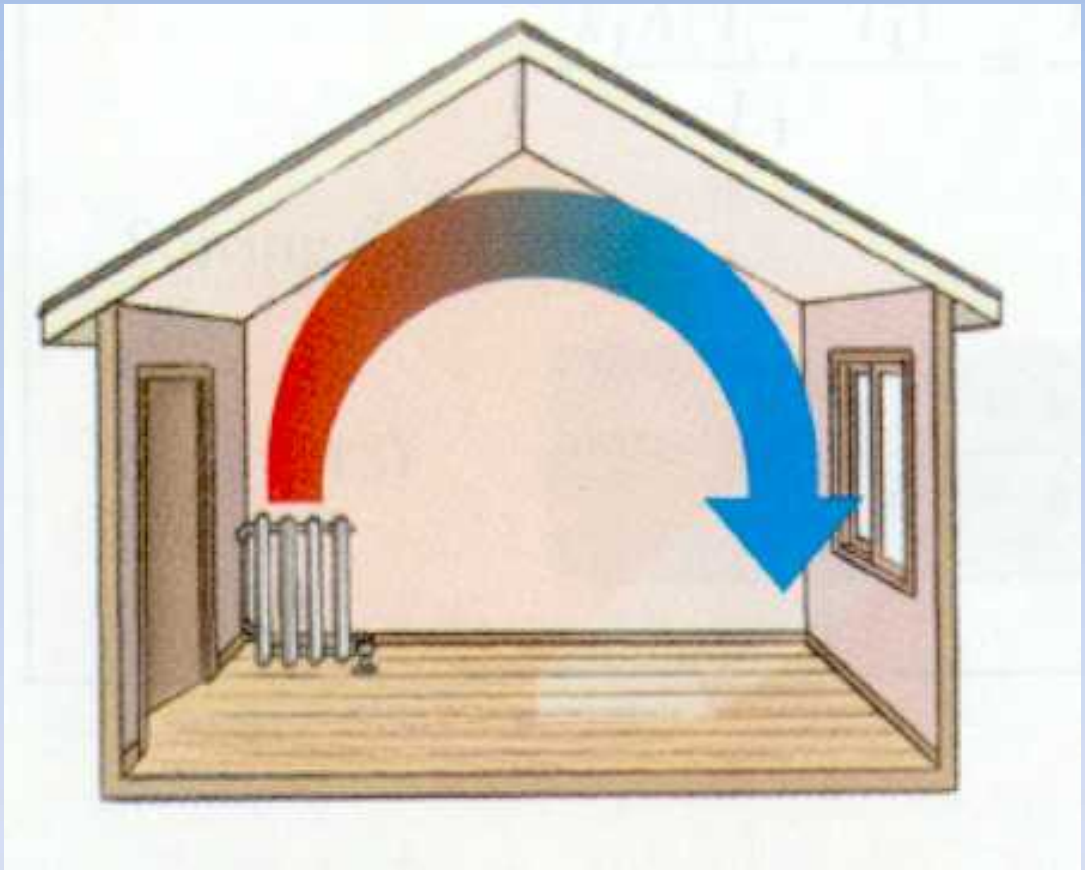
# Convection



Hot air rises and cold air sinks ☺

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# Thermal Radiation

- This is when things that absorb this radiation are warmed up.

To increase the rate of evaporation

- Increase the temperature
- Increase the surface area
- Reduce humidity
- Blow air across the surface

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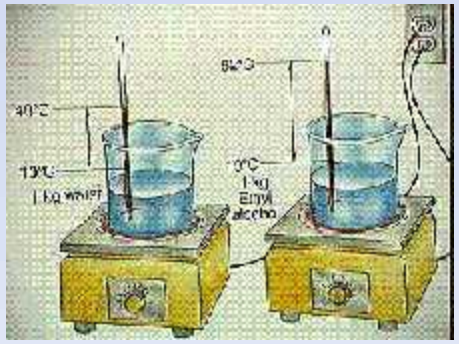
# Specific Heat Capacity

Energy Transferred = mass x Specific heat capacity x Temp change

Energy Transferred = $m \times c \times \Delta t$



Specific heat capacity is 4200J/K kg for water

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# Latent Heat of Fusion

Energy Transferred = Mass x Specific Latent Heat

Energy Transferred = mL

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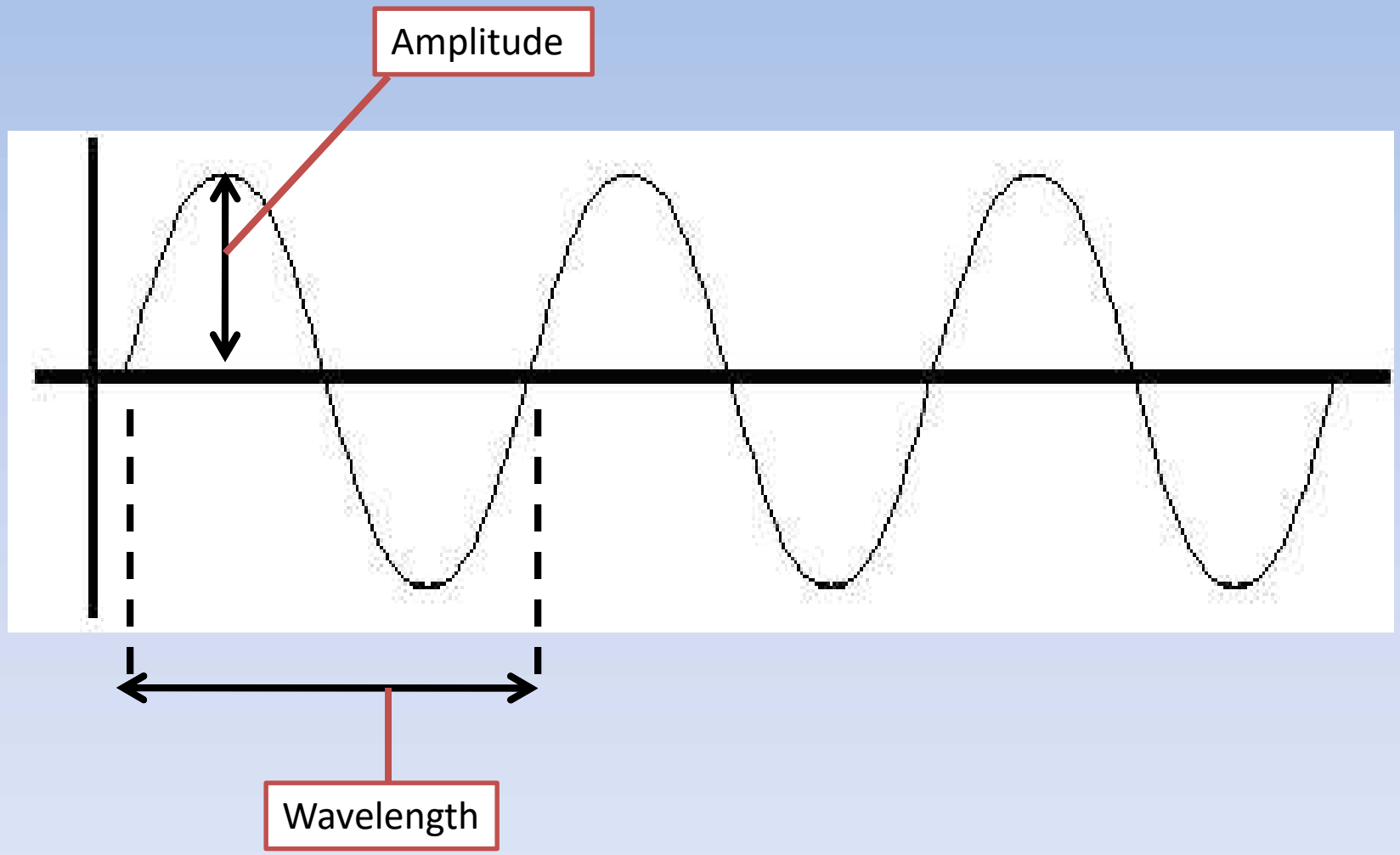
# Describing Waves



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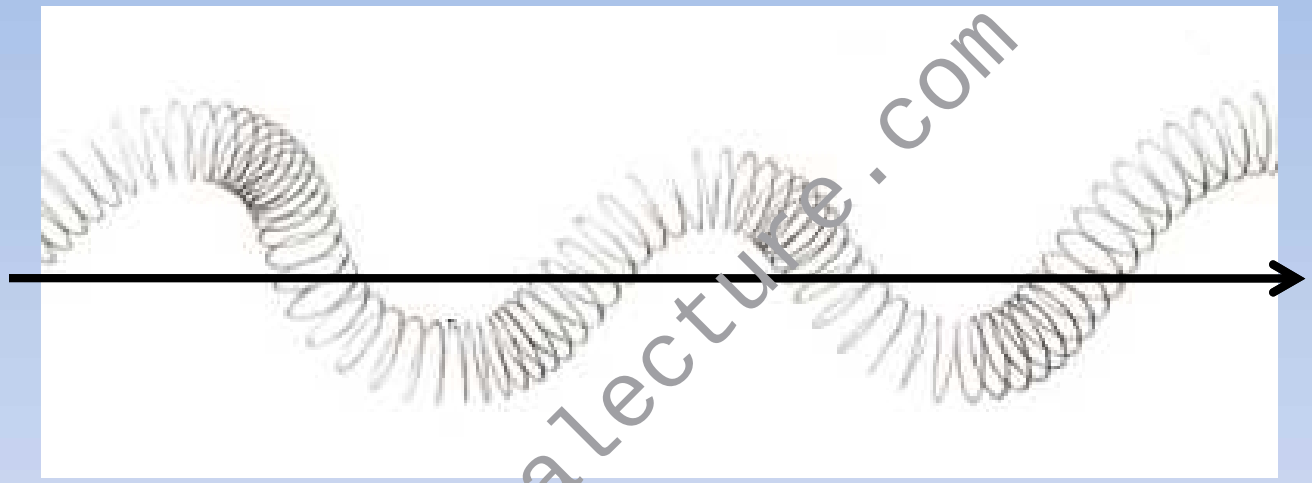
# Transverse Waves





- The oscillations are at right angles to the direction of the wave.
- For example light waves.

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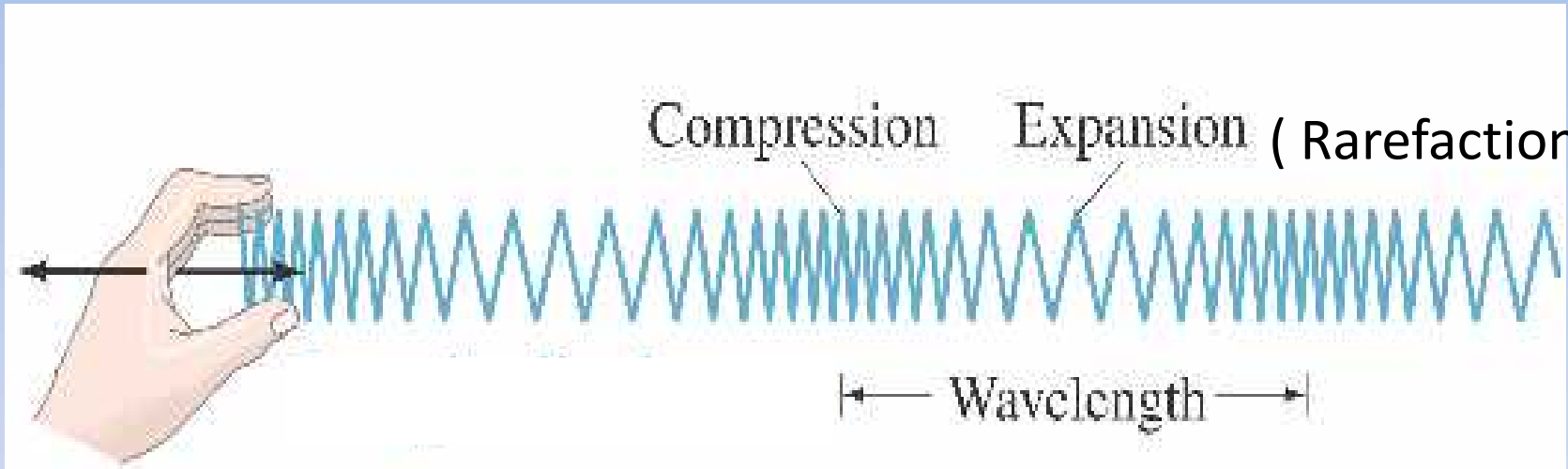
# Longitudinal Wave




- It consists of compressions and rarefactions.
- Oscillations are in direction of travel.
- For example: Sound waves.

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# The Wave Equation

Speed = Frequency x wavelength

$V = f \times \lambda$



$\lambda$ = Lambda

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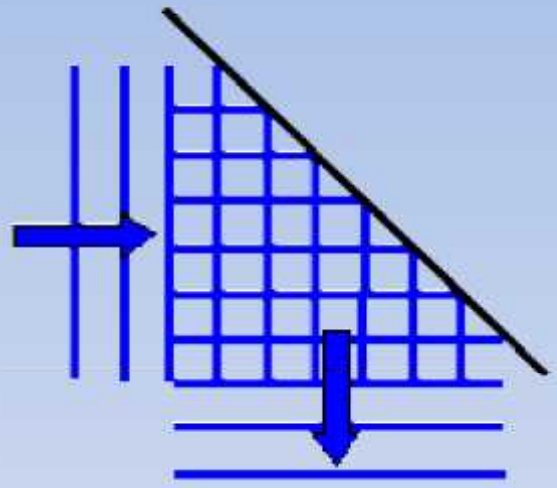
# Wave Effects: Reflection



The waves are reflected from the surface at the same angle they hit it.

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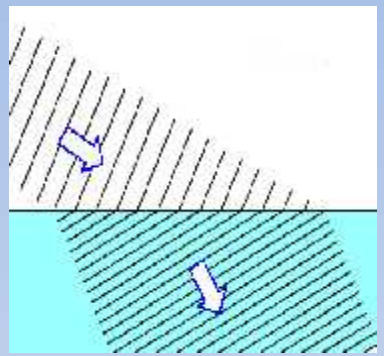
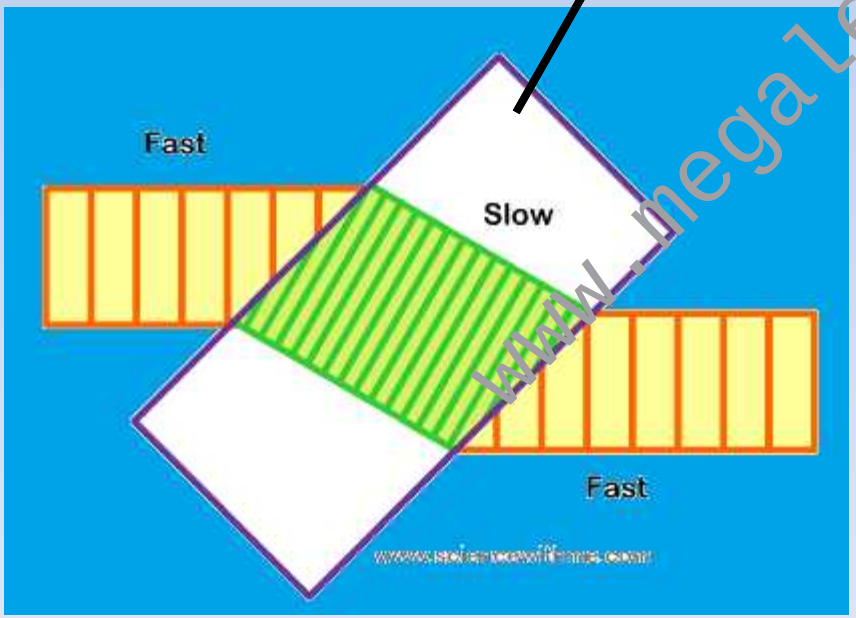
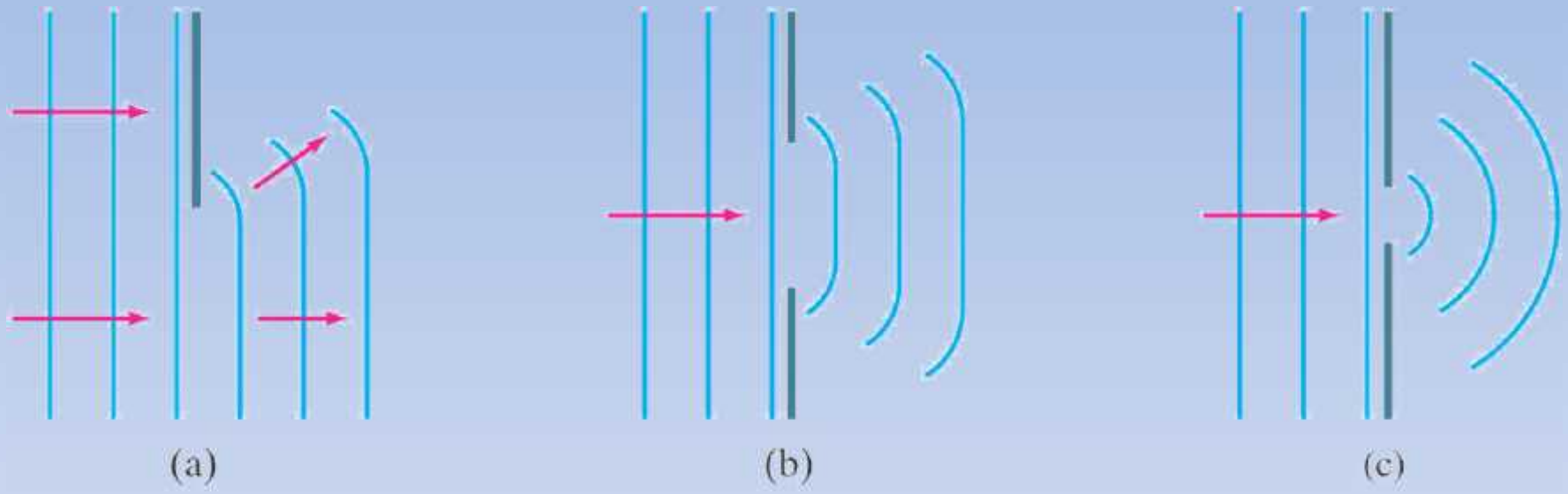
# Wave Effects: Refraction






Due to the plastic the water becomes shallower causing the waves to slow down. This effect is called refraction.

# Wave Effects: Diffraction




- Diffraction is when the light bends around obstacles.
- Wider gaps produce less defraction.

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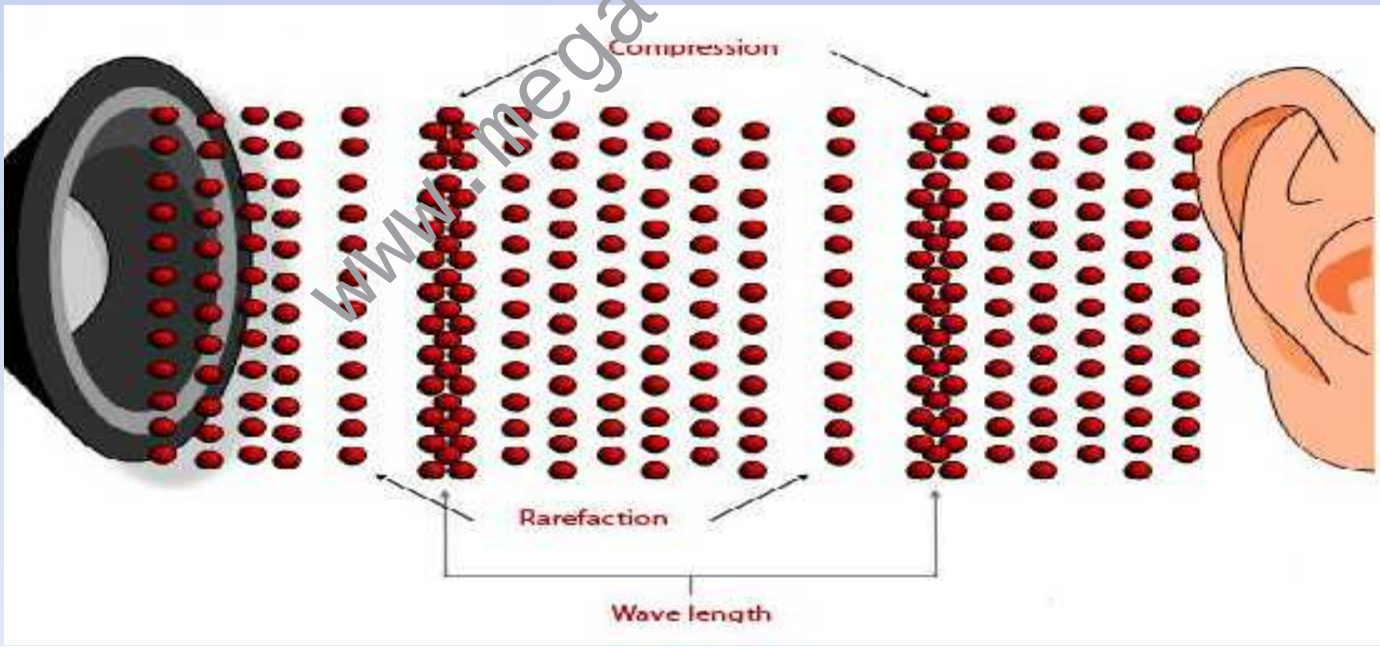
# Sound waves

- Sound waves are caused by vibration
- Sound waves consist of Longitudinal waves.

  - Compression passes→ Air pressure increases

  -Rarefaction passes→ Air pressure decreases



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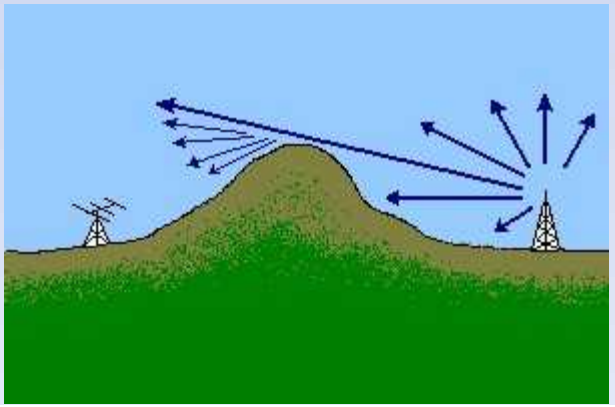
# Sound Waves

- Sound waves need a medium to travel in. For instance the air.
- Sound waves can also be diffracted due to their long wavelength.
- They can be displayed on an oscilloscope. The sound enters via the microphone, a metal plate vibrates, these vibrations cause electrical oscillations producing a wave front.

**IT IS NOT A PICTURE OF THE SOUND WAVE BECAUSE SOUND WAVES ARE NOT TRANSVERSE**



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# Speed of Sound

- Temperature of air: Sound travels faster through hot air.
- Does NOT depend on pressure: the pressure may change but the speed of the wave will remain the same
- The speed of sound is different through different materials.

Ultrasound: sounds above the range of human hearing which is between 20Hz & 20kHz

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# How to Measure the speed of an echo?

To measure echo

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Take note here the distance is the distance from to the wall and then BACK !

You could use:

- Echo-sounder
- Electronic tape measure (Works like an echo-sounder)
- Radar

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# Features of Light

1. Form of radiation
2. Travels in straight lines
3. Transfers energy
4. Transverse waves
5. Can travel through vacuum
6. 300,000 000 m/s

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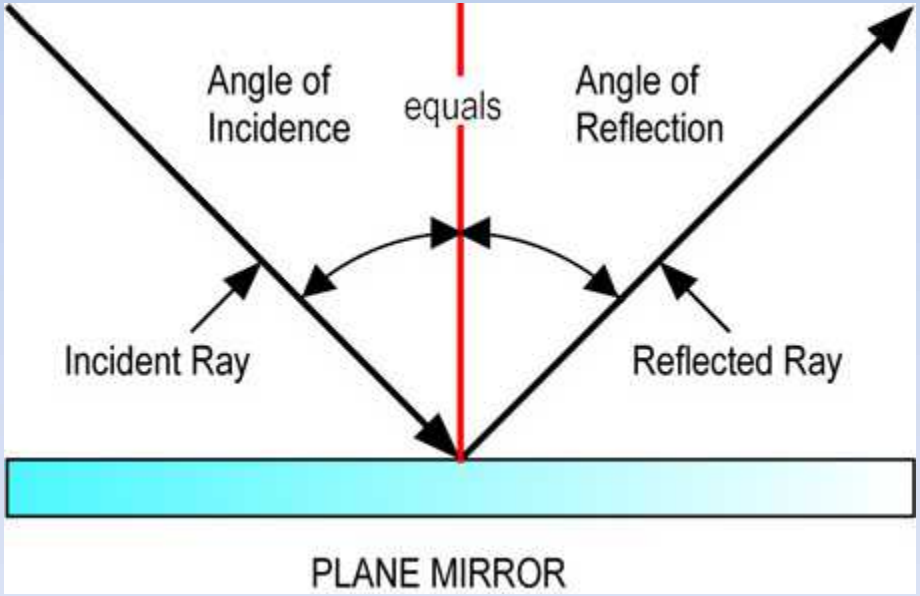
# Law of reflection

- $i^\circ = r^\circ$
- i, r and normal lie on the same plane.



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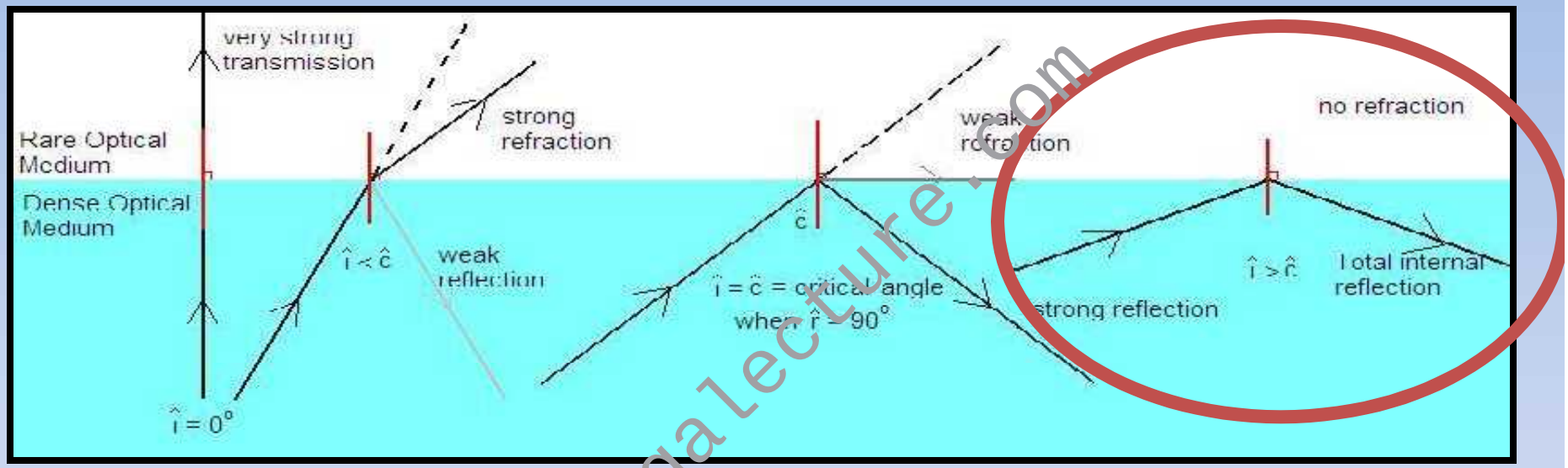
# Total Internal Reflection






- Anything greater than the critical angle does not have a refracted ray. Which means that all the light is reflected thus leading to TOTAL internal reflection.

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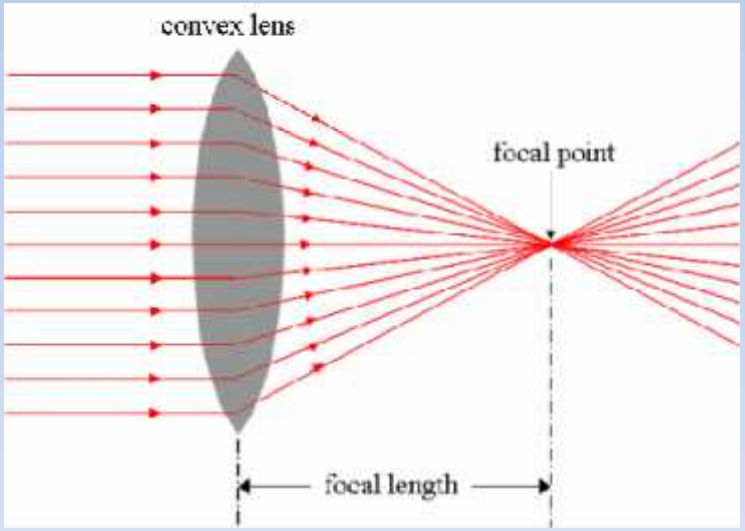
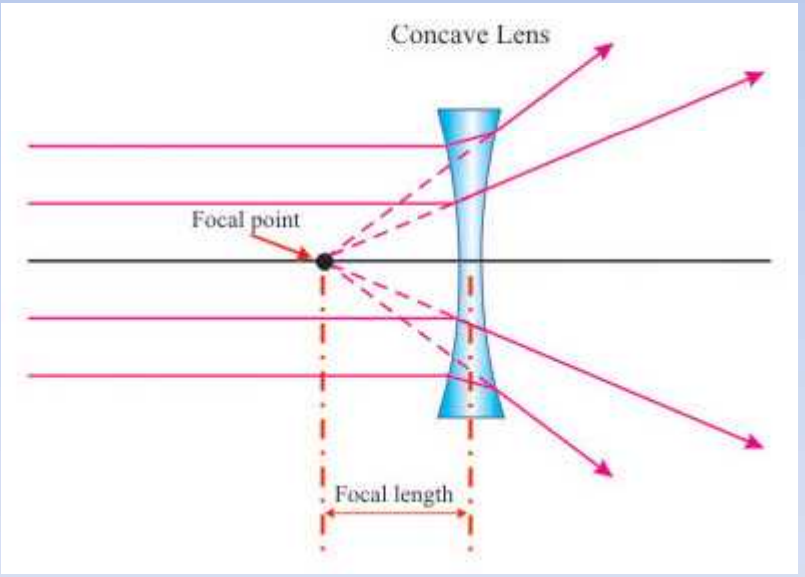
# Lenses

## Convex Lens




## Concave Lens




Convex lenses are used in projectors as they form large, inverted, real images on the screen

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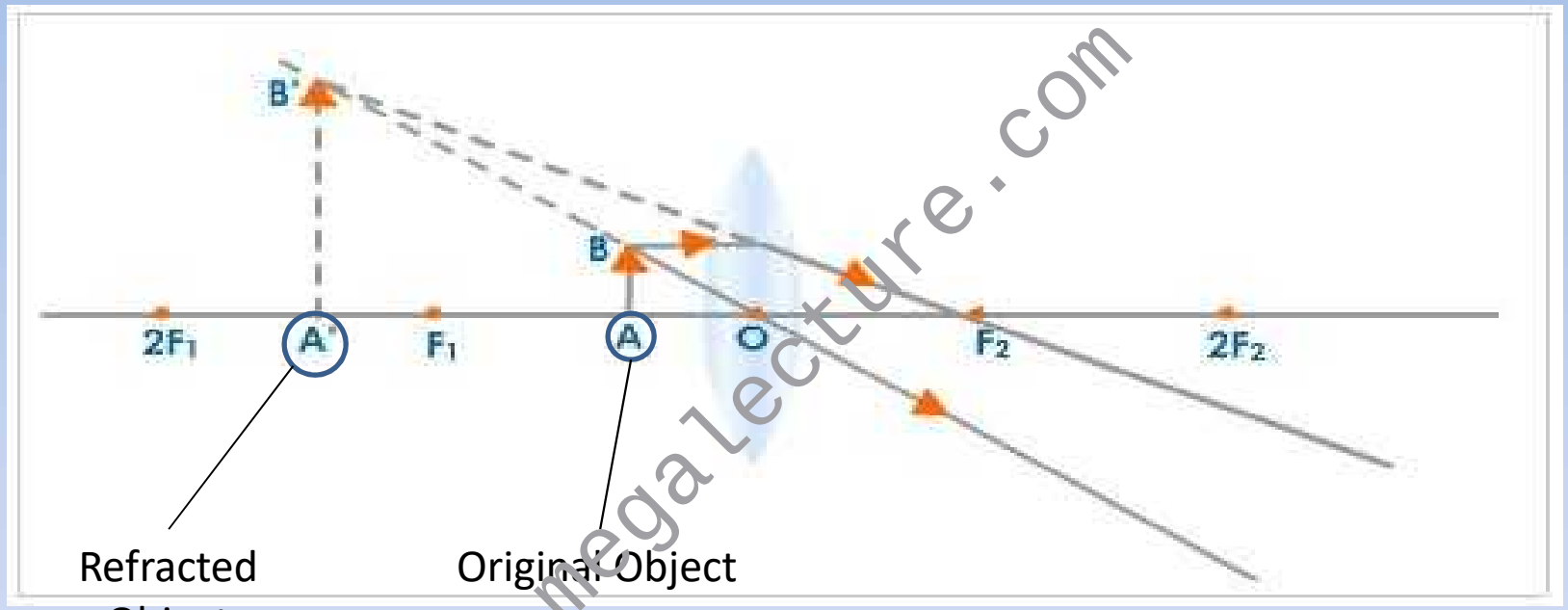
# When the object is less than $F_1$






Refracted image is
-Upright
-Larger
-Virtual

-It is also on the same side as F1

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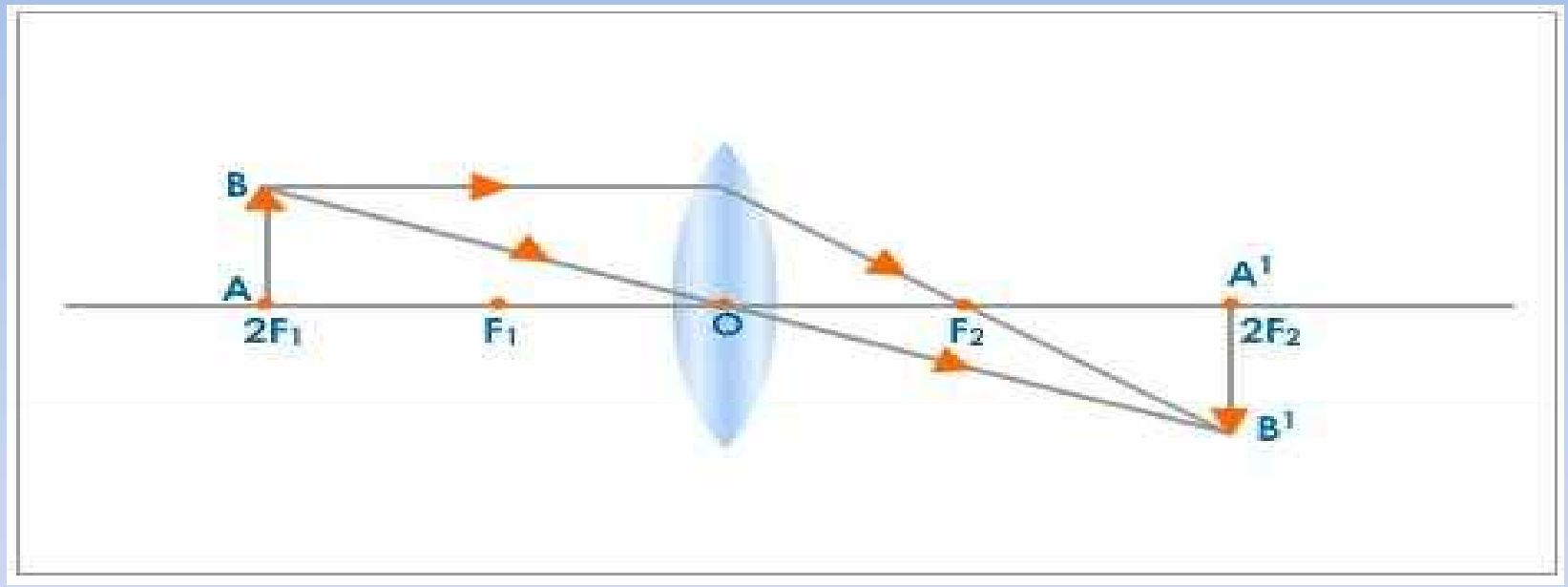
# When the object is at $2F_1$




Refracted image is
-At 2F2
-Inverted
-The same size
-Real

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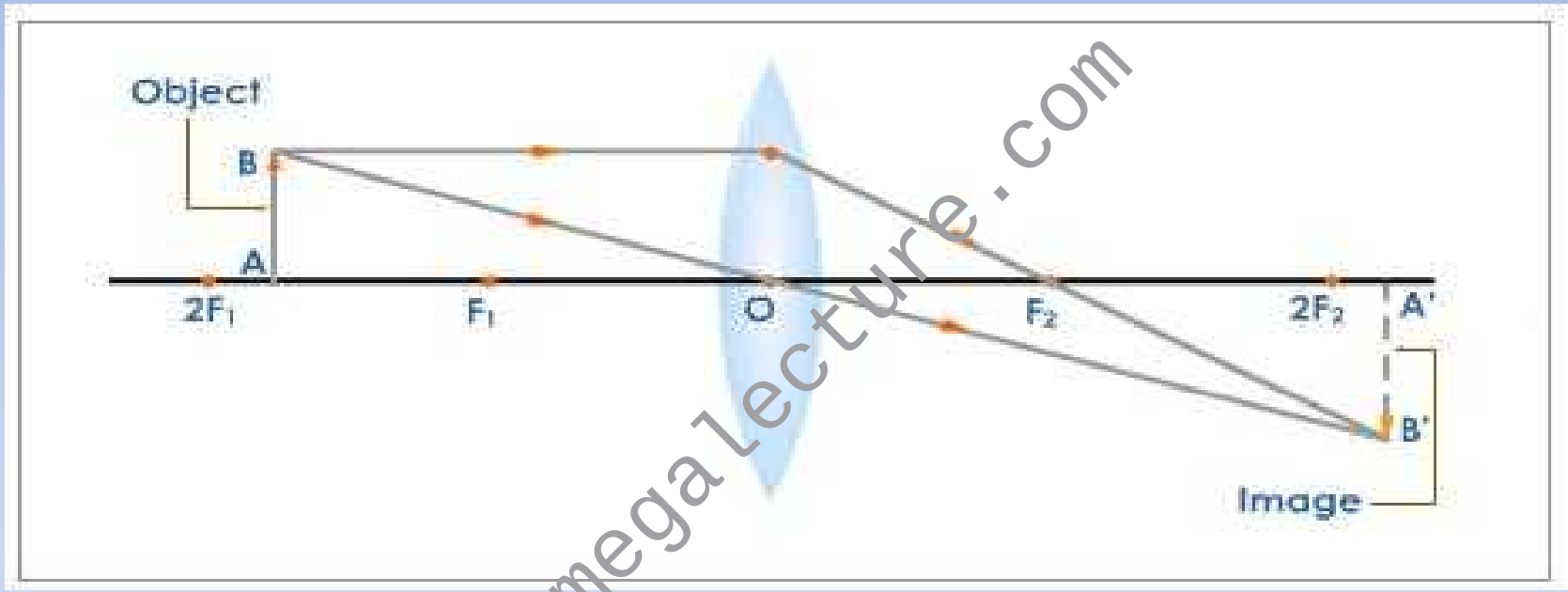
# When the Object is between $F_1$ and $2F_1$






Refracted image is
-Beyond 2F
-Inverted
-Larger
-Real

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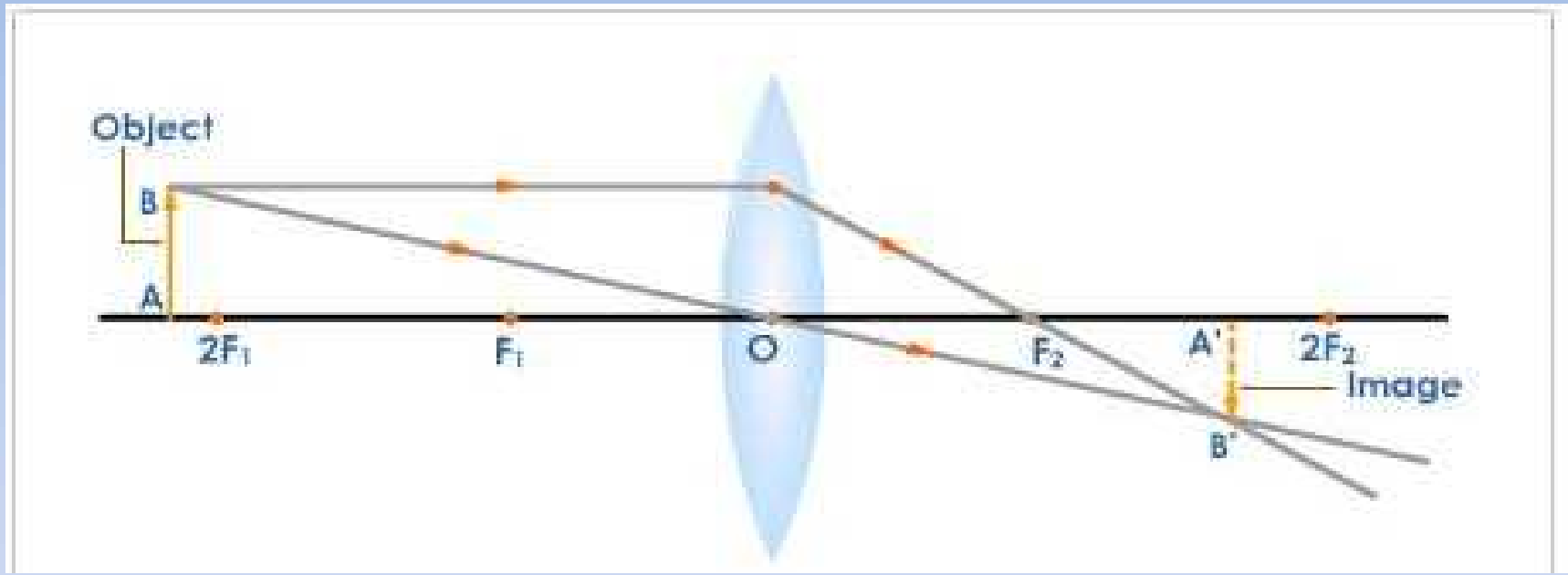
# When the object is beyond $2F_1$




Refracted image is
-Between $F_2$ and $2F_2$
-Inverted
-Smaller
-Real

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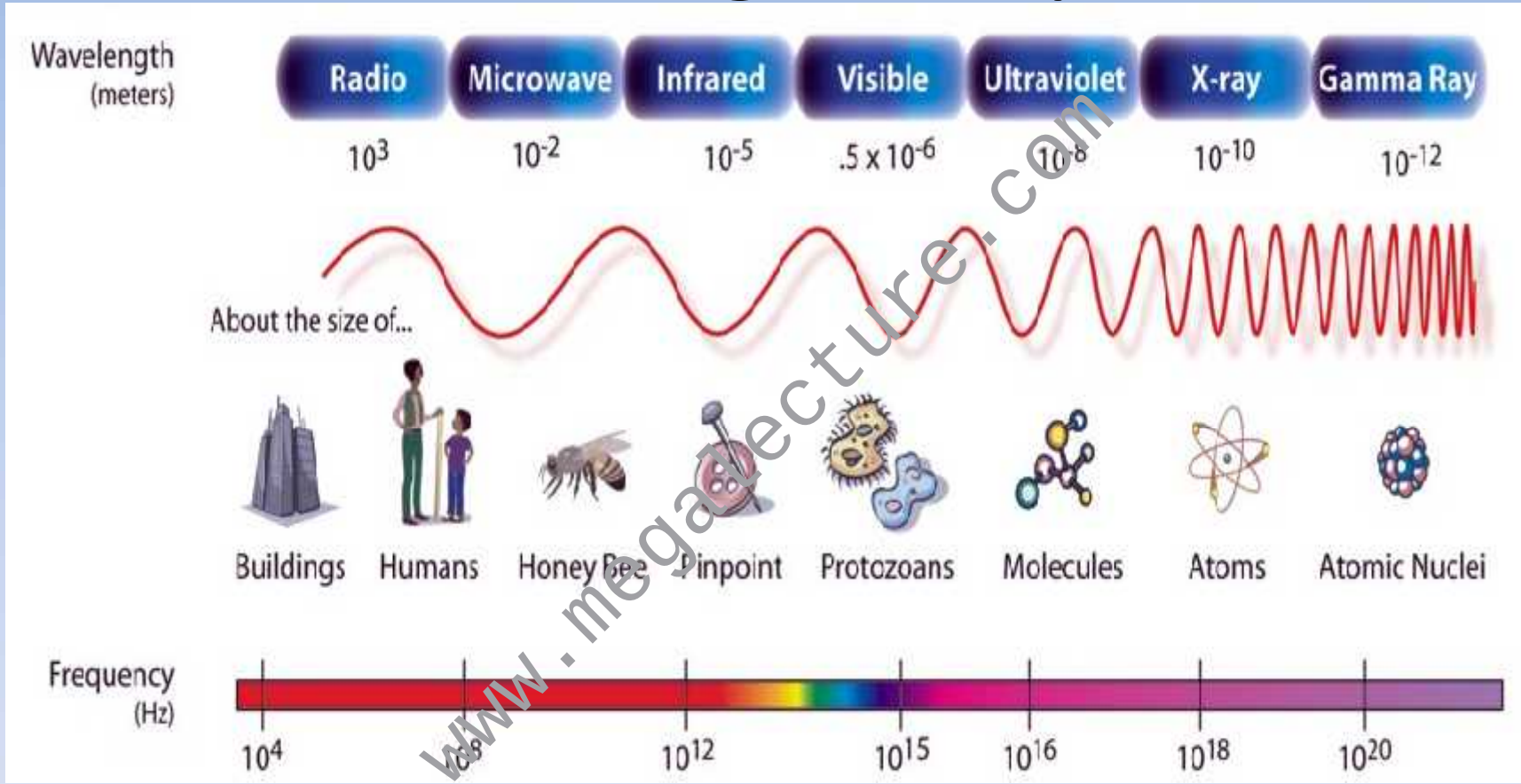
# The Electromagnetic Spectrum






Electromagnetic waves are emitted when a charged particle oscillate or loose energy in some way.

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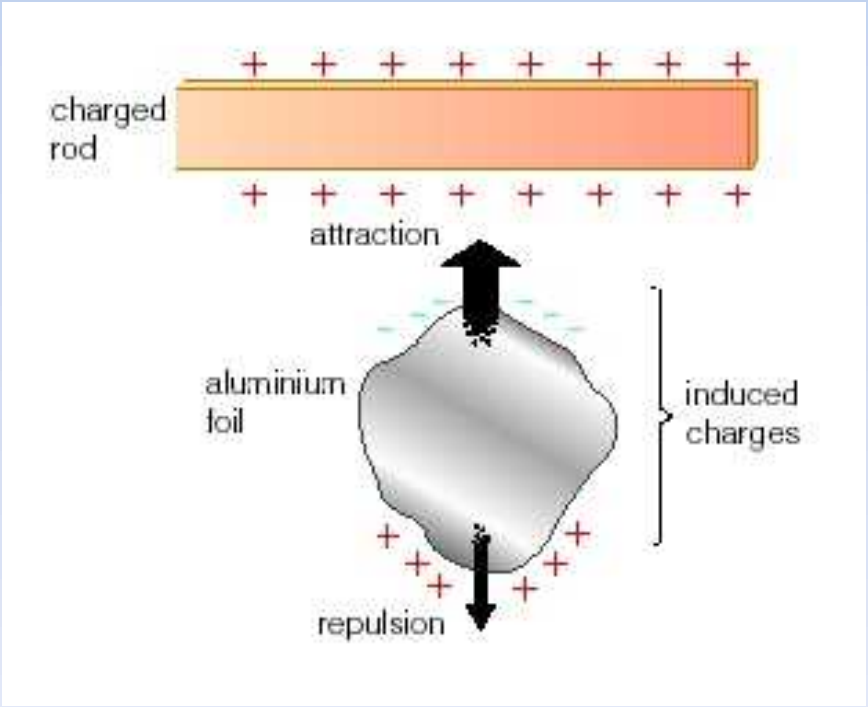
# Electricity

- Rubbing materials does not MAKE charge, it only separates charges that are already there.
- Induced charge: this is the charge that 'appear' on an uncharged object because of the charged object nearby.

Charge is measured in Coulombs.

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# Electricity*

- Electrostatic precipitators: are fitted into chimneys in order to reduce pollution

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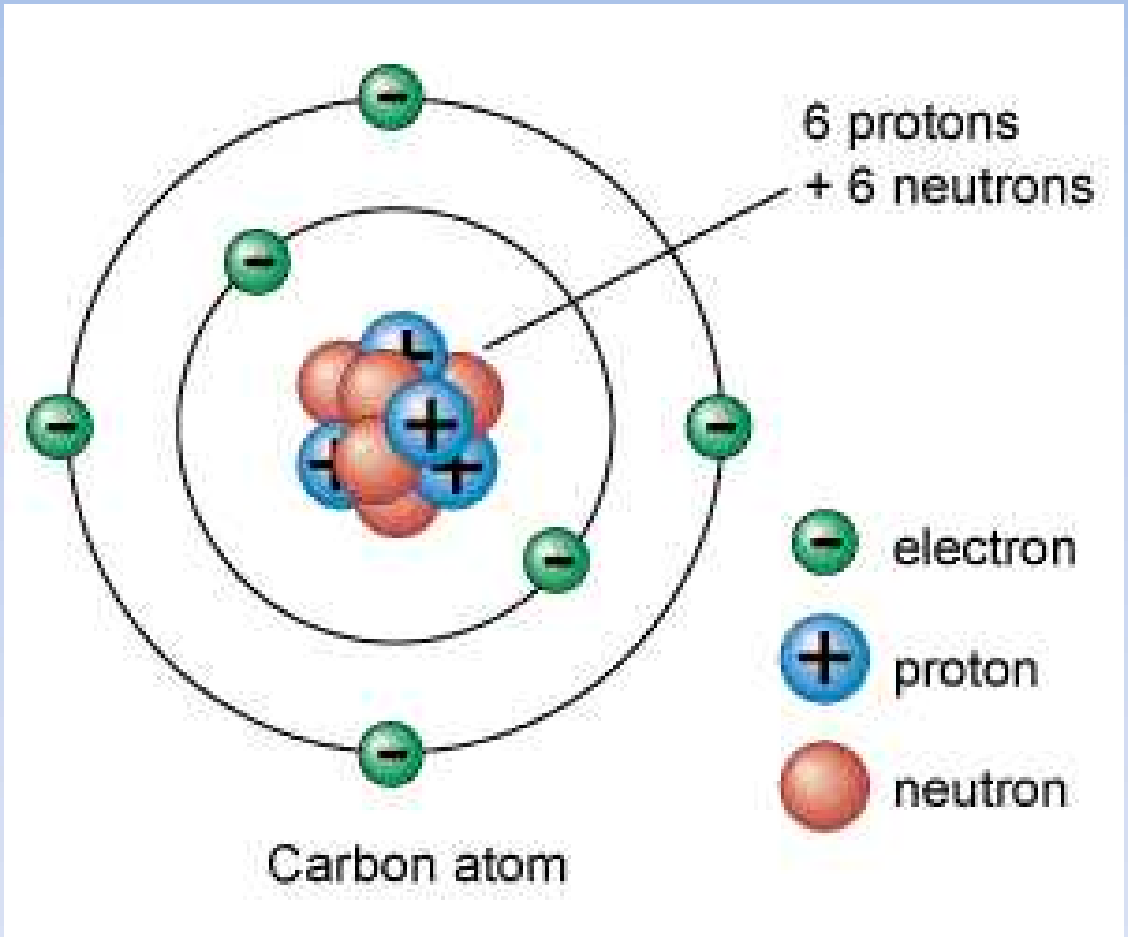
# Atoms



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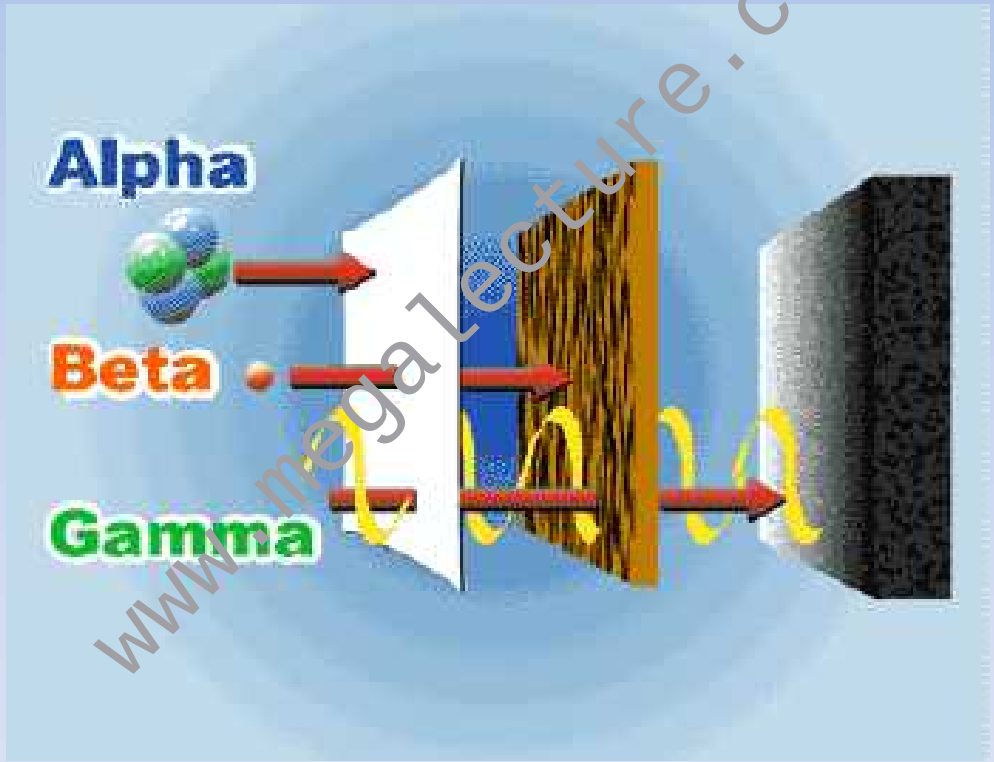
# Nuclear Radiation



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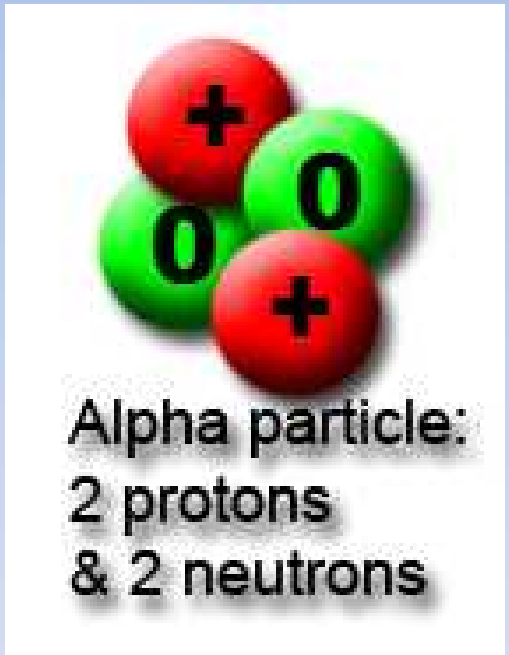
# Alpha




- Alpha particles are made of 2 protons and 2 neutrons.
- This means that they have a charge of +2, and a mass of 4.
- Alpha particles are relatively slow and heavy.
- They have a low penetrating power - you can stop them with just a sheet of paper.
- Because they have a large charge, alpha particles ionize other atoms strongly

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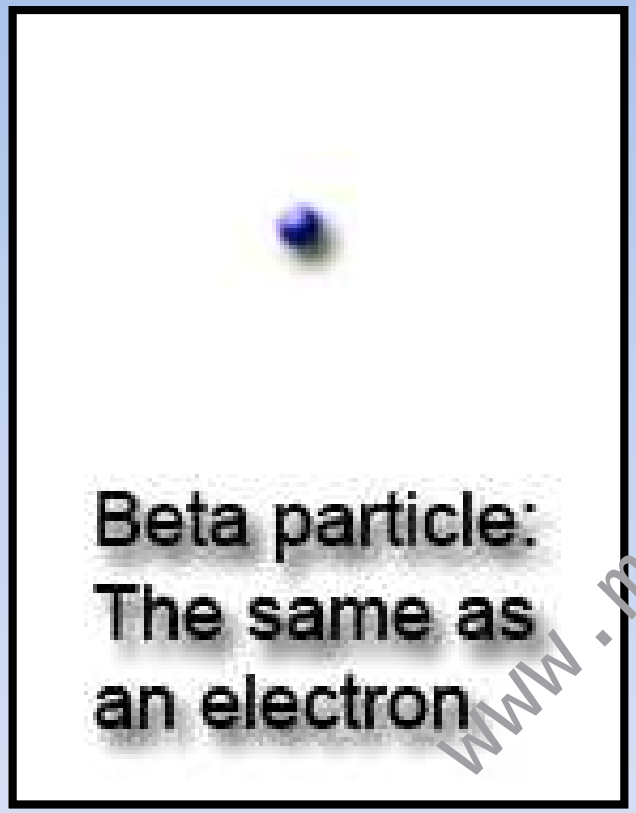
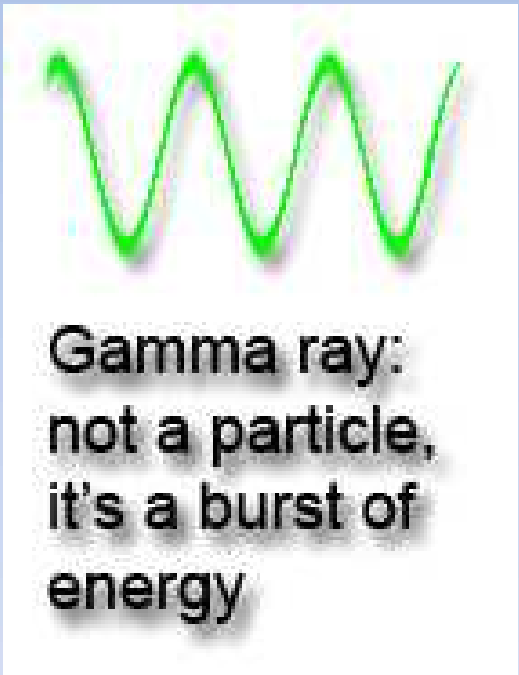
# Beta




- Beta particles have a charge of minus 1, and a mass of about 1/2000th of a proton. .
- They are fast, and light.
- Beta particles have a medium penetrating power - they are stopped by a sheet of aluminum
- Beta particles ionize atoms that they pass, but not as strongly as alpha particles do.

MEGA LECTURE

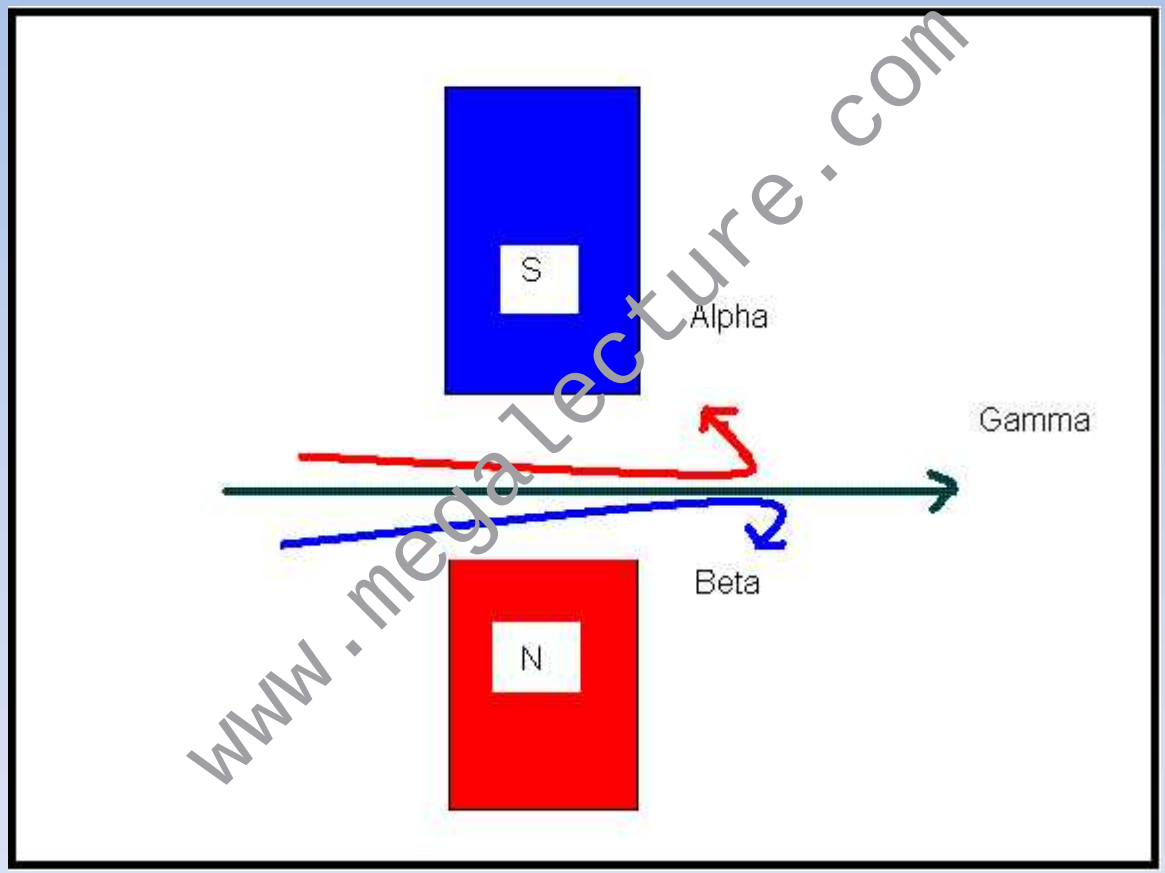
# Gamma




- Gamma rays are waves, not particles. This means that they have no mass and no charge.
- Gamma rays have a high penetrating power - it takes a thick sheet of metal such as lead, or concrete to reduce them significantly.
- Gamma rays do not directly ionize other atoms
- We don't find pure gamma sources - gamma rays are emitted alongside alpha or beta particles. Strictly speaking, gamma emission isn't 'radioactive decay' because it doesn't change the state of the nucleus, it just carries away some energy.

MEGA LECTURE

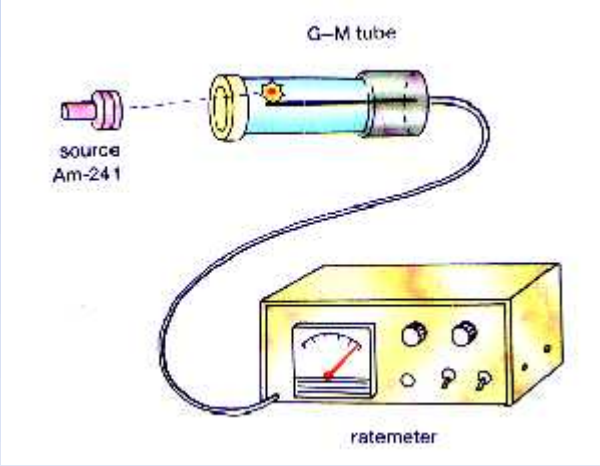
# In a Magnetic Field



MEGA LECTURE

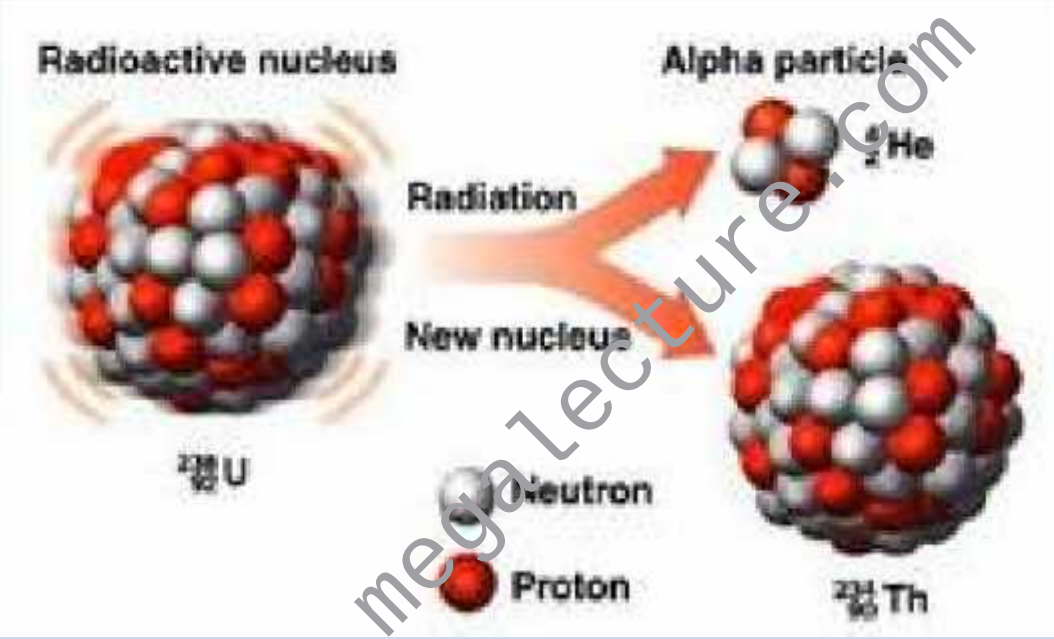
# What is Background Radiation?

- Background radiation comes from naturally decaying substances such as soil, rocks, air, food and drink.
- It is detected by a Geiger Muller Tube



MEGA LECTURE

# Radioactive decay- Alpha Decay

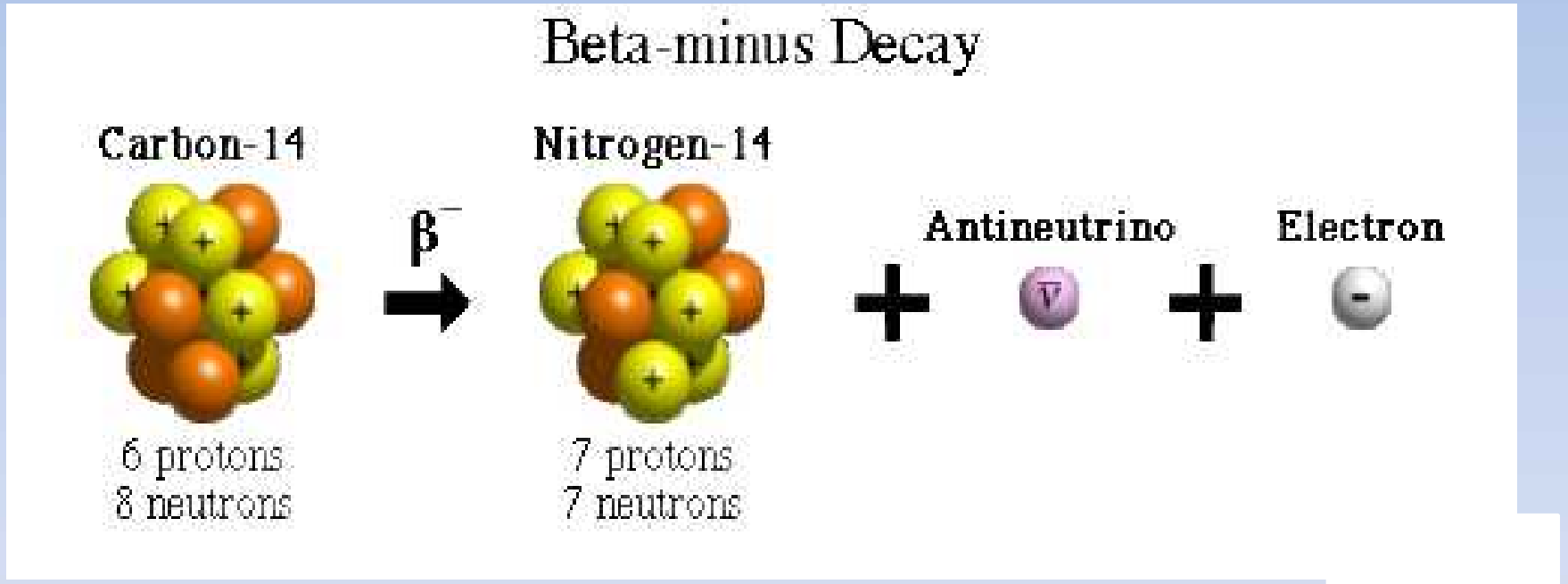





Large, unstable nucleus → Smaller, more stable nucleus + Alpha particle

MEGA LECTURE

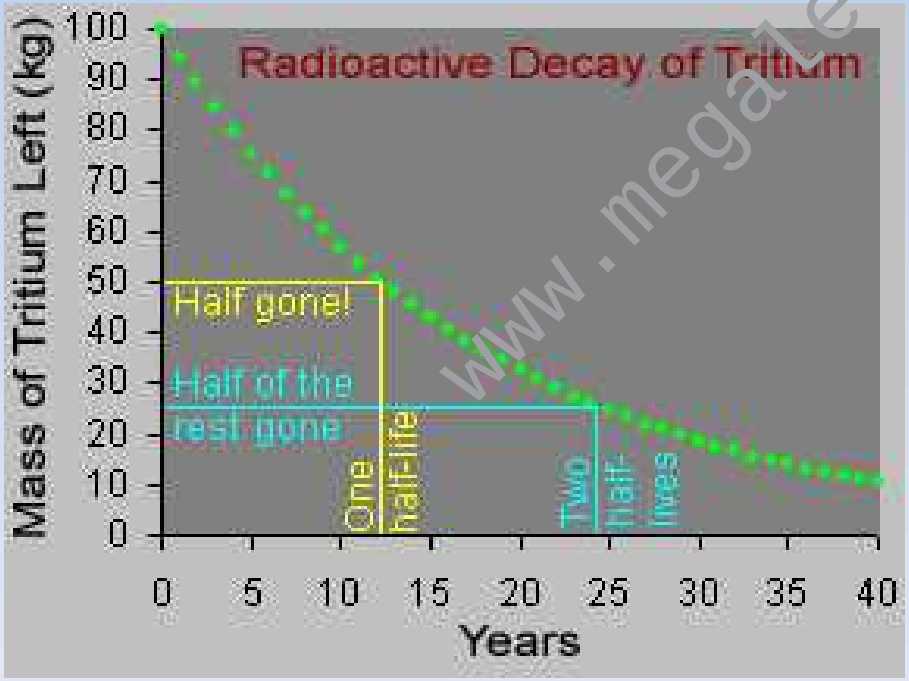
# Radioactive decay- Beta Decay



MEGA LECTURE

# Half-Life

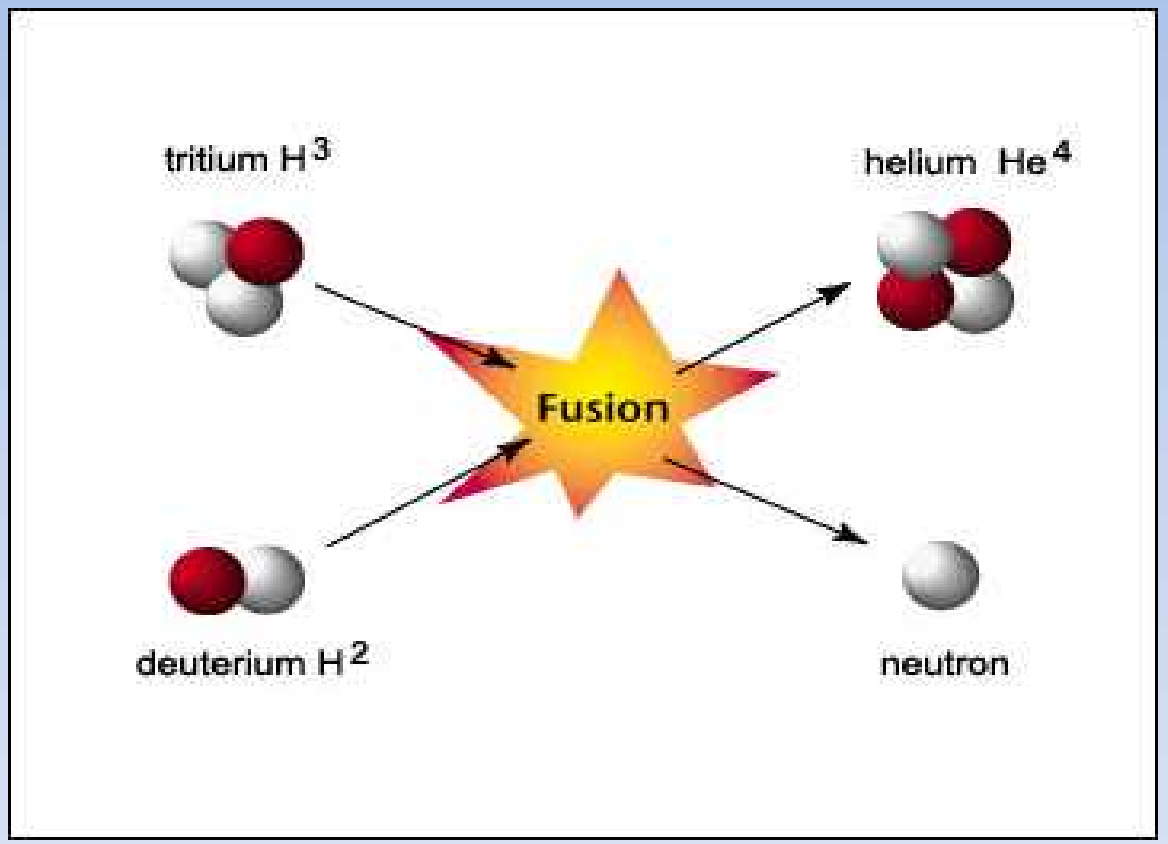
- This is the amount of time taken for the nuclei of a radioactive substance to decay.




| Isotope | Half - life |
|---|---|
| Carbon $^{14}C$ | 5700 years |
| Iodine $^{131}I$ | 8 days |
| Polonium $^{214}Po$ | $1,6 \cdot 10^{-4}$ seconds |
| Radium $^{226}Ra$ | 1620 years |
| Uranium $^{238}U$ | $4,5 \cdot 10^{9}$ years |

MEGA LECTURE

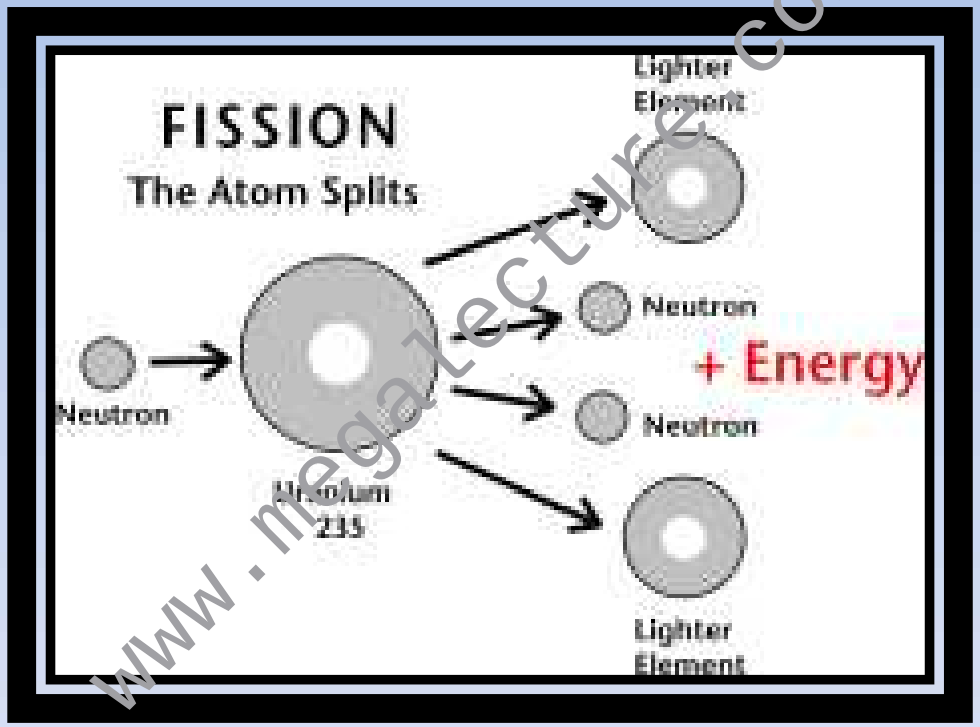
# Nuclear Fusion




This does not take place on Earth so far. It is the process that powers the stars.

MEGA LECTURE

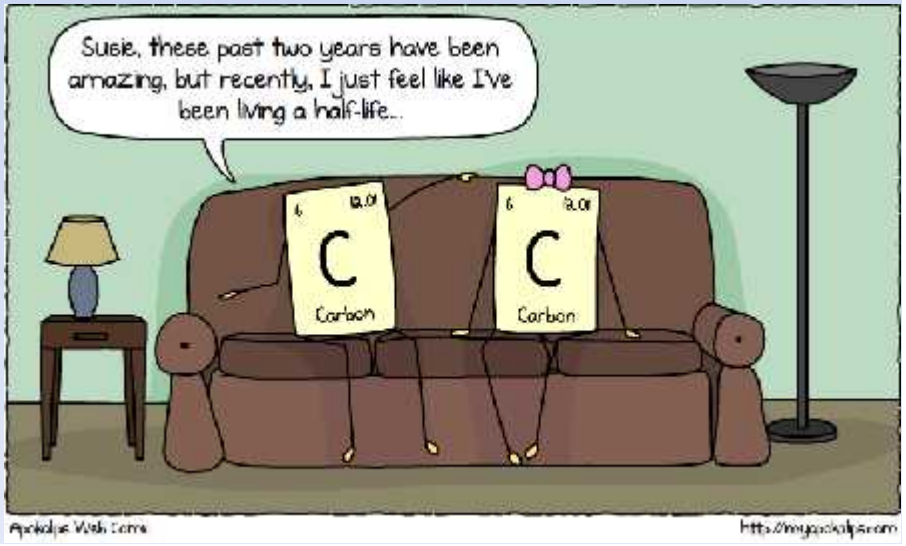
# Nuclear Fission



MEGA LECTURE

# What can Radioactivity be used for?

1. Tracers
2. Radiotherapy
3. Testing for cracks
4. Thickness monitoring
5. Carbon Dating- after an organism dies the amount of C-14 inside it begins to decay. It can be used to find out how old a substance is.
6. Dating Rocks



MEGA LECTURE

# This is the physics syllabus Complete

# Best of luck for your IGCSE mock exams