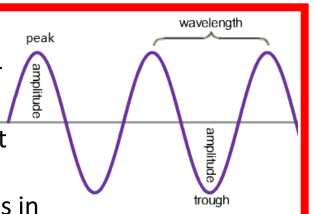
GCSE P6 – Waves

1. Describing waves



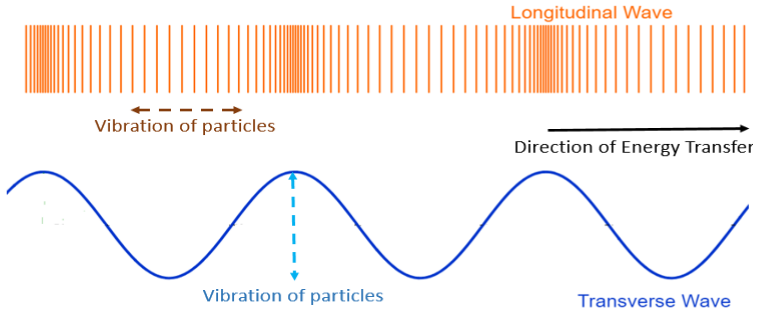
All waves transfer energy but not matter
Mechanical waves cause oscillations of particles in a solid, liquid or gas and must have a medium to travel through.
Electromagnetic waves cause oscillations in electrical and magnetic fields.
Parts of a wave:

- **rest position** - the undisturbed position of particles or fields when they are not vibrating
- **displacement** - the distance that a certain point in the medium has moved from its rest position
- **peak** - the highest point above the rest position
- **trough** - the lowest point below the rest position
- **amplitude** - the maximum displacement of a point of a wave from its rest position
- **wavelength** - distance (m) covered by a full cycle of the wave, usually measured from peak to peak, or trough to trough
- **time period** - the time taken for a full cycle of the wave, usually measured from peak to peak, or trough to trough (s)
- **frequency** - the number of waves passing a point each second (Hz)

2. Longitudinal and Transverse waves

Longitudinal waves: Oscillations are PARALLEL to the direction of energy eg. sound waves & P waves. Compression = area of high pressure. Rarefaction = area of low pressure

Transverse waves: Oscillations are PERPENDICULAR to the direction of energy eg. EM waves, water waves, S waves.



3. Wave speed

Speed of light = 300,000,000 m/s
Speed of sound = 330m/s

$$v = \lambda f$$

wave speed (m/s) = wavelength (m) x frequency(Hz)

$T = \frac{1}{f}$ *Time period (s) = $\frac{1}{\text{frequency (Hz)}}$*

To measure the speed of sound in air:
Stand a distance (m) away from a wall
Make a sound and time how long it takes for the sound to reflect and come back (time to hear the echo). Speed = distance ÷ time

4. Electromagnetic Spectrum

Long wavelength → Short wavelength

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

Low frequency → High frequency

All EM waves:

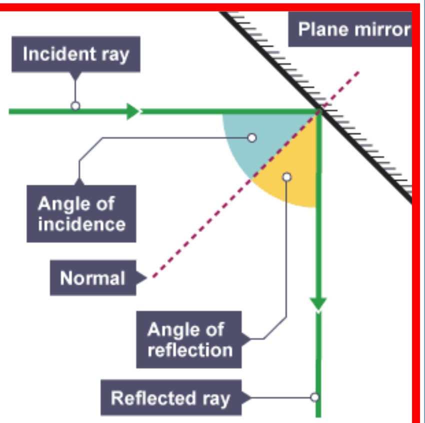
- transfer energy as radiation from the source of the waves to an absorber
- can travel through a vacuum such as in space
- travel at the same speed (3×10^8 m/s)
- can be transmitted, absorbed and reflected

5. Electromagnetic waves

Wave	Use	Danger
Radio	Radio & TV	-
Micro	Satellite communication & cooking	-
Infrared	Heaters, toasters, IR cameras	Burns
Visible light	Fibre optic communication	-
UV	Lamps, sun tanning, forged notes	Skin cancer, aging
X-rays	Medical images	Ionising, cancer
Gamma	Medical scanning and treatment	Ionising, cancer

6. Reflection

Specular reflection – reflection from a smooth flat surface eg. a plane mirror. The image in a mirror is **upright** and **virtual.**

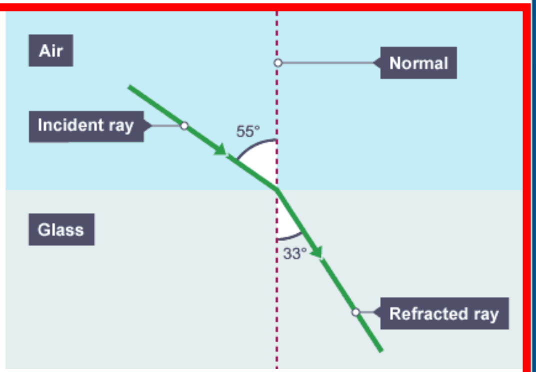


Diffuse reflection – reflected light is scattered in all directions from a rough surface. Image may be **distorted** eg. reflection in rippled water.

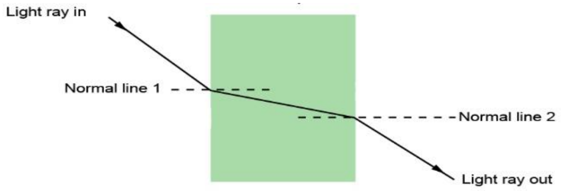
Law of reflection:
angle of incidence = angle of reflection

7. Refraction

Refraction is the **change of direction** of a wave at the boundary between two different mediums eg. air and glass.



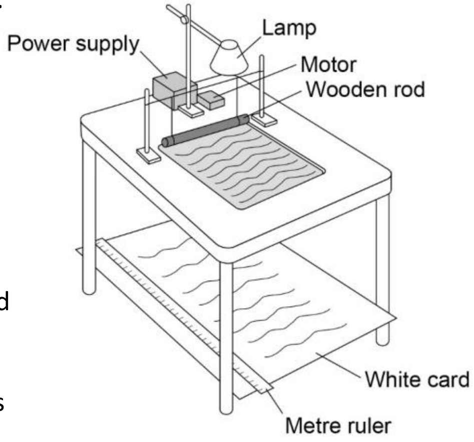
HIGHER TIER
Waves travel more slowly through denser materials.
When a light wave meets a air-glass boundary **at an angle to the normal**, it **bends towards** the normal as it **slows down**. When the light wave meets the glass-air boundary it **speeds up** and so **bends away** from the normal.



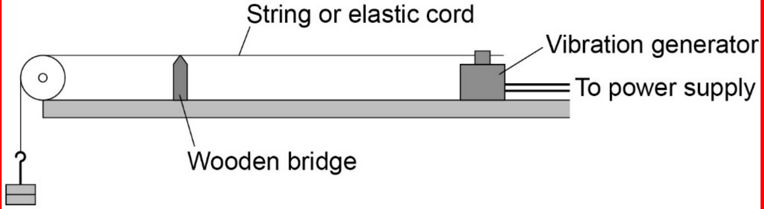
GCSE P6 – Waves

8. Required practical – investigating waves

Measuring water waves:



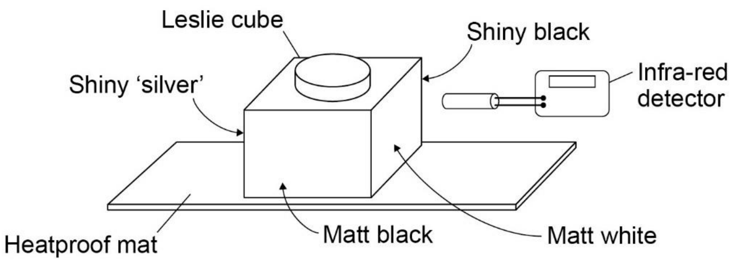
- Set up a ripple tank with about 5cm depth of water.
- Switch on motor so low frequency waves can be observed.
- Measure the length of 10 of waves then divide by 10 to record mean wavelength. A photograph of the wave shadows allows for more reliable measurements.
- Count the number of waves passing a point in ten seconds then divide by ten to record frequency.
- Calculate wave speed = frequency × wavelength.



Measuring waves in a string:

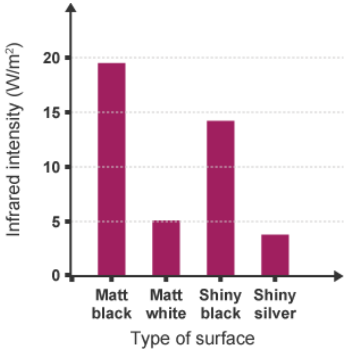
- Attach a string or cord to a vibration generator and use a 200g hanging mass and pulley to pull the string. Place a wooden bridge under the string near the pulley.
- Switch on the vibration generator and adjust the wooden bridge until stationary waves can be observed.
- Measure the length of as many half wavelengths (loops) as possible, divide by the number of half wavelengths (loops). Doubling this number gives the wavelength.
- The frequency is the frequency of the power supply.
- Calculate wave speed = frequency × wavelength.

9. Required practical – investigating how the amount of infrared radiation absorbed or radiated by a surface depends on the type of surface

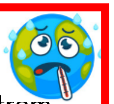


- Place a Leslie cube on a heat-resistant mat. Fill it, almost to the top, with boiling water and replace the lid.
- Leave for one minute. This is to enable the surfaces to heat up to the temperature of the water.
- Use the infrared detector to measure the intensity of infrared radiation emitted from each surface, or the temperature of the surface.
- Make sure that the detector is the same distance from each surface for each reading.
- Plot results as a bar chart

Best – matt black
shiny black
matt white
Worst – shiny silver



10. HIGHER TIER - Earth's temperature

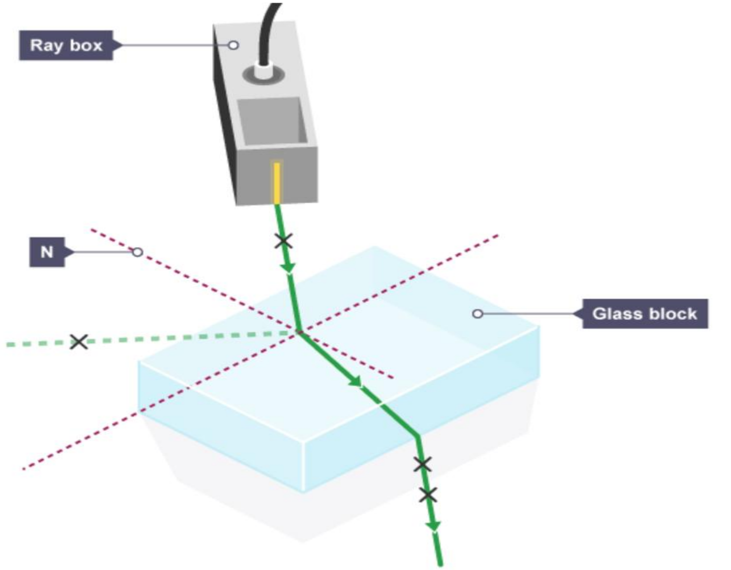


EM radiation absorbed by Earth causes an increase in its internal energy and so its temperature increases. Energy from Earth can be transferred to the atmosphere by conduction and convection. The infrared radiation emitted from the Earth's surface will either travel back into space or it will be absorbed by the greenhouse gases in the Earth's atmosphere and reflected back to the surface.

SINGLE PHYSICS ONLY

11. Required practical – investigating the reflection of light by different types of surface and the refraction of light by different substances

1. Set up the ray box, slit and glass block on a piece of A3 paper
2. Mark the positions of the block, normal and incident ray as it enters and leaves the block.
3. Remove the block and join the lines to show the refracted and reflected light ray
4. Measure the angles of incidence, reflection and refraction
5. Repeat the test with a Perspex block and make a comparison of the angles



Hazard	Consequence	Control measures
Ray box gets hot	Minor burns	Do not touch bulb and allow time to cool
Semi-dark environment	Increased trip hazard	Ensure environment is clear before lowering lights

science physics
chaseterrace academy

science physics

GCSE P6 – Waves

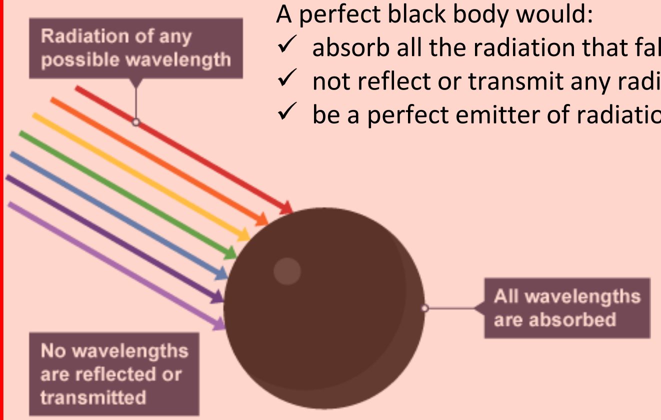
SINGLE PHYSICS ONLY

12. Black body radiation

All bodies emit and absorb infrared radiation. They do this whatever their temperature.

The hotter the body:

- the more infrared radiation it gives out in a given time
- the greater the proportion of emitted radiation is visible light



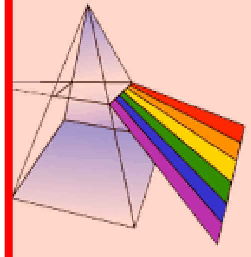
A perfect black body would:

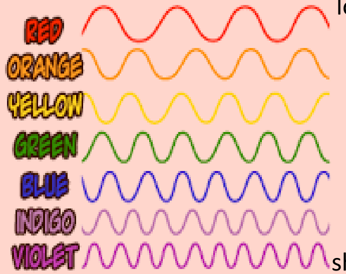
- ✓ absorb all the radiation that falls on it
- ✓ not reflect or transmit any radiation
- ✓ be a perfect emitter of radiation

Stars are considered to be black bodies because they are very good emitters of most wavelengths in the **electromagnetic spectrum**.

White and shiny silvery surfaces are the worst absorbers, as they reflect all visible light wavelengths. Poor absorbers are also poor emitters, and do not emit radiation as quickly as darker colours.

13. Visible light spectrum





low frequency
long wavelength

high frequency
short wavelength

14. Lenses

A lens is a shaped piece of transparent glass or plastic that refracts light. The images formed by a lens can be:

- upright or inverted
- magnified or diminished
- real or virtual

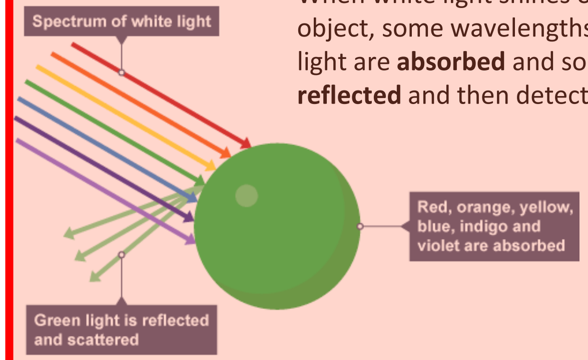
CONVEX lens: parallel light rays that enter the lens **converge**. They come together at a point called the principal focus.

CONCAVE lens: parallel rays **diverge**. They separate but appear to come from a principle focus on the other side of the lens.

Magnification is a measure of the size of an image compared to the size of the object.

$$\textit{Magnification} = \frac{\textit{image height}}{\textit{object height}}$$

15. Absorption, reflection and transmission of visible light



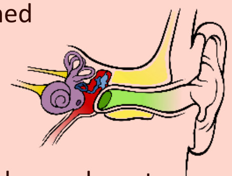
When white light shines on an opaque object, some wavelengths or colours of light are **absorbed** and some are **reflected** and then detected by our eyes.

Transparent and translucent materials transmit light through.

When white light passes through a coloured filter, all colours are **absorbed** except for the colour of the filter.

16. Sound

- high frequency sound waves are high pitched
- low frequency sound waves are low pitched
- high amplitude sound waves are loud
- low amplitude sound waves are quiet



The human ear detects sound.

Sound waves enter the ear canal and cause the eardrum to vibrate. Three small bones transmit these vibrations to the cochlea. This produces electrical signals which pass through the auditory nerve to the brain, where they are interpreted as sound. Normal human hearing is 20 – 20,000Hz

Ultrasound waves have a frequency higher than the upper limit for human hearing - above 20,000Hz

Uses of ultrasound include breaking kidney stones and cleaning jewellery because the high frequency vibrations shake apart the material.

When ultrasound waves meet the boundary between two different materials:

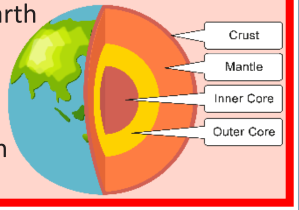
- some of the ultrasound waves are reflected at the boundary
- the time taken for the waves to leave a source and return to a detector is measured
- the depth of the boundary can be determined using the speed of sound in the material and the time taken

This allows ultrasound to be useful in medical and manufacturing internal imaging, sonar and echolocation.

17. Seismic waves

Seismic waves are produced by earthquakes in the Earth's crust:

- P-waves are longitudinal, faster, travel through solid & liquid, can be detected on the other side of the Earth and are refracted as they travel through the Earth
- S-waves are transverse, slower, travel only through solid, can not travel through liquid outer core so can not detected on the other side of the Earth



chaseterrace academy