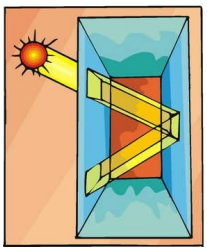


LIGHT AND OPTICS

WORDS

- agree = to have the same opinion
- amplitude = distance between the highest and the lowest point of a wave
- beam = a line of light that shines from the sun
- behave =act
- breathe = to take air into your lungs and send it out again
- certain = special
- claim = to say that something is true
- compare =to be like
- device = machine or tool that does a certain job
- electricity =the power that is in wires or cables; it is used to make things work
- excited = if an atom has more energy than normal
- firefly = an insect with a tail that shines in the dark
- flashlight = a small electric light that you carry in your hand
- frequency = the number of times that something happens in a certain time
- fuel = a material like coal, oil or gas that you can burn to make energy
- gain = get
- glow =shine
- however = but
- light bulb = a glass object with a lamp inside that glows
- magnetic forces =the power produced by a magnet
- operate = to make something work
- oxygen = a gas that is in the air and that we need to live.
- particle = a very small piece of something
- powerful = strong
- process = many things that happen , one after the other
- provide = give
- release = let go
- scientist =a person who is trained in science
- space = the area far away from the earth where the stars and the planets are
- speed =how fast something is
- store = to put things somewhere for a longer time
- straight =not curved or bent
- stream = flow
- substance =material
- tiny = very, very small
- wavelength = the distance between the two high points of a wave
- wire = a very thin piece of metal

Light is the kind of energy that makes it possible for us to see. Without light there would be no life on earth. Green plants use the sun's light to grow and produce food. In this process they produce oxygen, which we need to breathe. Without plants there would be no animals or food.

Light also provides us with fuel. The energy that the sun has sent to earth for millions of years has been stored in plants and then changed into coal, oil and gas – energy that we use today to operate machines and produce electricity and power.

We also get heat from the sun. Without it our planet would be so cold that nothing could live on it.

SOURCES OF LIGHT

All light comes from atoms, tiny particles that make up everything in our universe. When atoms gain energy they give it off as light. An atom that has such energy is called excited.

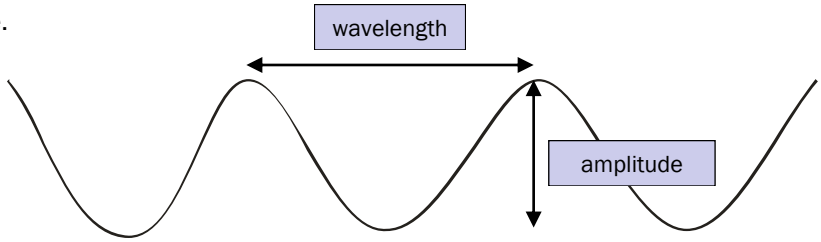
Some light is natural , like sunlight or light from stars . Other light is produced from things people make, like lamps or flashlights. A light bulb glows because electricity heats a wire inside. Candles produce light from fire when you light them. Lasers are devices that produce powerful beams of light in which all particles have the same energy and travel in the same direction.

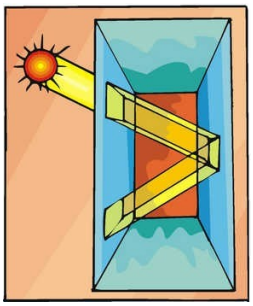
There are certain substances that glow in the dark. Their atoms are excited for a certain time and after that they release light. Some insects, like fireflies glow naturally.

NATURE OF LIGHT

For a long time scientists were not sure about how light travels through space. Some thought that light behaves like a wave, others claimed that light particles travel in a straight line. Today, scientists agree that light is an electromagnetic wave made up of electrical and magnetic forces that travel through space at a very high speed. However, light is also a stream of particles called photons, which travel like a beam.

Light waves can be compared to waves in water. They have a wavelength, frequency and amplitude. The wavelength is the distance between the two highest parts of a wave, the frequency is the number of times that a wave passes a certain point every second, and the amplitude is the distance between the highest and lowest points of a wave.





LIGHT AND OPTICS

WORDS

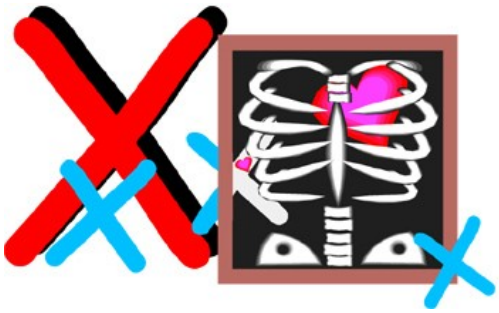
- absorb = to take in
- amount =how much of something
- basically =mostly, mainly
- break up = to divide itself
- broadcast = to send out
- cause =lead to
- depend =to be affected by something
- direction =way, route
- invisible = you cannot see it
- length = how long something is
- opaque = if you cannot see through something
- penetrate = to enter or pass through something, even if it is difficult
- prism = a block of glass that breaks up light into different colours
- ray = a straight beam of light
- reflect = to send back
- refer =to be about
- skin cancer = a disease of the skin from which you might die
- spectrum =the band of light which white light breaks up into
- shape = form
- strike = hit
- sunburn = the red skin that you get when you spend too much time in the sun
- translucent = not transparent, but clear enough so that you can see through a little bit
- transparent = if you can see through something
- wavelength = the distance between the two high points of a wave
- visible = you can see it or them
- X-ray = beams of light that can go through objects and make a picture of the inside of them

ELECTROMAGNETIC WAVES

Not all electromagnetic waves are visible. Light refers to those waves that we can see.

Light that comes from the sun is basically white. It is made up of all colours. When it passes through a specially shaped glass called a prism it breaks up into different colours. When the sun comes out while it is still raining, we often observe a rainbow because light must pass through raindrops. It breaks up into all the colours of the visible spectrum. Violet light is at one end of the spectrum because it has the shortest wavelength, red light, which has the longest wavelength, is at the other end.

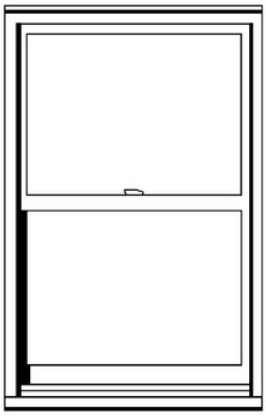
Ultraviolet rays are invisible waves with shorter wavelengths. They cause sunburn and may lead to skin cancer. In small amounts these rays have a good effect on our skin because they produce vitamin D. X rays are even shorter rays that can penetrate a human body. Doctors use them to take pictures of bones and other inside organs.



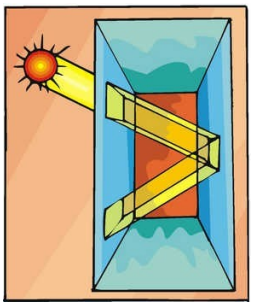
Waves with lengths longer than red light are called infrared rays. When you stand in front of a fire you feel warm, largely because infrared light is shining on you. Microwaves and radio waves are even longer. Microwaves are used to make food warm. Radio and TV stations broadcast programs by sending out radio waves, which may have a wavelength of up to a few meters.

HOW LIGHT BEHAVES

When light waves strike an object three things may happen. The light can be reflected, absorbed or it may change its direction.



What happens to light depends on the kind of object or material that it hits. Transparent objects, like glass, let light waves pass through without mixing them up. You can see through this material. Translucent material also allows rays to pass through, but it mixes them up so that you cannot see through such objects clearly. Opaque materials don't let any light pass through.



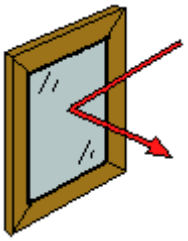
LIGHT AND OPTICS

WORDS

- appear = it seems to be
- bend =to break up or become curved
- bounce off = to hit an object and then quickly move away from it
- densely packed =very crowded; many of them together
- direction =way, route
- farther = a longer distance than before
- horizon = the line far away where the land or sea seems to meet the sky
- mirror = a piece of glass that you can see yourself in
- particle = a very small piece of something
- ray = a straight beam of light
- reach = get to
- reflect = to send back
- refract = light changes direction when it passes through glass , water or another object
- resume = to go on , continue
- scatter = to move quickly into different directions
- scattering =a small number of things spread out over a larger area
- shine = to produce bright light
- smooth =flat, even
- solid = hard , with a fixed shape— fest
- speed =how fast something is
- sparkle =to shine in bright flashes
- tiny = very, very small

REFLECTION

Most objects do not produce their own light. You can see these objects because light from the sun or from a lamp bounces off them and then travels to your eyes.

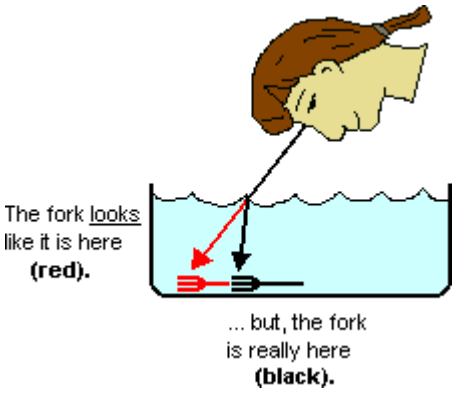


Some objects reflect little light, others, like mirrors or water reflect almost all the light because they are smooth and flat. The rays bounce off in only one direction. Reflected light also makes things sparkle and shine. When light shines on a normal object, like a tree, the rays bounce off in many directions.

REFRACTION

When light passes through an object it slows down because the molecules of a solid object are more densely packed than air molecules. It also changes its direction of travel – it refracts.

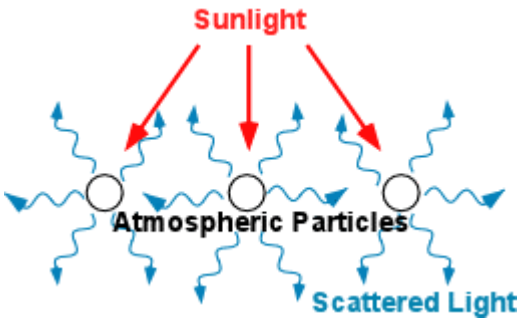
Example: Swimming pools do not look as deep as they really are because of the way light is bent. Water slows light down by about 25 per cent and glass slows it down even more. Light waves bend towards the glass, slow down and behind the glass resume their normal speed.

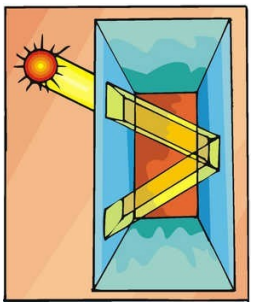


Another example is picking up a stone in water. The stone is not where you think it is. It appears to be farther away than it really is.

SCATTERING

Scattering shows us what happens when light rays hit atoms, molecules or tiny particles. These particles send off light in new and different directions. Most of the sky is blue because air molecules scatter more blue rays towards us than they do the other colours in sunlight. When the sun reaches the horizon in the evening it looks orange or red because the light that gets to us has lost so many of the other colours through scattering.



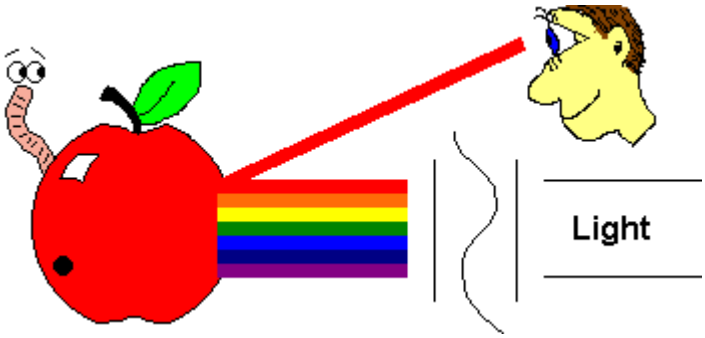


LIGHT AND OPTICS

WORDS

- absorb = to take in
- amount =how much of something
- average =standard, normal, usual
- billion =one thousand million
- block = to stand in or get in the way
- brightness =how strong something shines
- certain =special
- crest = the highest point of a hill or a wave
- date back = go back
- depend =to be affected by something
- emit = to send out
- empty =with nothing in it
- equal = to be the same as something else
- flat =level, smooth
- frequency = the number of times that something happens in a certain time
- intensity = how strong something is
- measure =to find out the amount of something
- path =route, course
- range =from ... to.....
- reach = get to
- receive = get
- reflect = to send back
- scientist =a person who is trained in science
- shine = to produce bright light
- source = where something comes from
- space = the area far away from the earth where the stars and the planets are
- speed =how fast something is
- spectrum =the band of light which white light breaks up into
- surface =the top layer of an object
- visible = you can see it or them
- wavelength = the distance between the two high points of a wave
- wax = the material that candles are made of

COLOUR



The colour of an object depends on the way it reflects and absorbs light. An object can absorb certain colours and reflect others. The colour that we see is a combination of all the colours it reflects, we can't see the colours that it absorbs. An apple, for example, looks red because its surface reflects colours from the red end of the spectrum and absorbs the rest.

White objects reflect all colours of light, black objects absorb all colours.

HOW LIGHT IS MEASURED

SPEED OF LIGHT

Light travels fastest in empty space, where nothing can block its path. Its speed here is always the same: about 300,000 km per second. The light from the sun, which is about 150 million km away from the earth, reaches our planet in about 9 minutes.

BRIGHTNESS

The brightness of light is measured in the unit candles, a name that dates back to the old days when wax candles were the only ways of lighting up a room. The amount of light that an object receives depends on how far away the light source is. If a simple candle shines directly on a flat surface that is one foot (about 30 cm) away light has an intensity of one foot-candle. An average 60 watt light bulb emits about 60 foot candles of light. In the metric system we measure the intensity of light in the unit lux. 1 lux is the light that shines on a flat surface one metre away.

WAVELENGTH AND FREQUENCIES

Scientists measure wavelengths in nanometres, which equals one billionth of a metre. Visible light ranges from 400 nanometres for violet light to about 700 nanometres for red light.

Frequencies are measured in a unit called hertz. A wave has a frequency of one hertz if one crest of the wave passes a checkpoint every second. Because visible light has a short wavelength and a high speed it has a high frequency, Violet light for example has a frequency of 750 trillion hertz. Radio waves, on the other hand have very low frequencies.