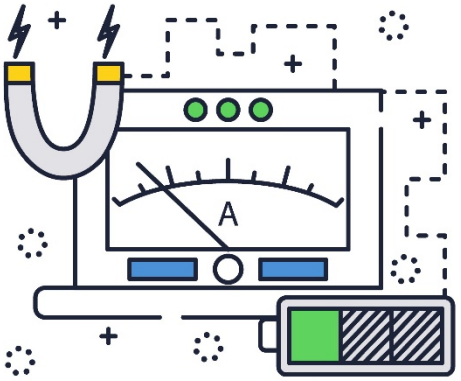
Adept Tuition



PHYSICS

ULTIMATE QUESTIONS GUIDE

Principal and sole tutor: Mr Shamik Amin

Qualified Teacher Status (QTS), PGCE (Distinction), BSc (Hons),

NVQ Speech and Language & Enhanced DBS checked.

07552 377 989

To purchase a plan please visit
https://www.adepttuition.com/plans-pricing

Contents

By the end of this topic I will be able to:

- *Describe how particles are laid out in a solid*
- *Describe how particles are laid out in a liquid*
- *Describe how particles are laid out in a gas*
- *Describe the differences in how much energy particles in solids, liquids and gases have*
- *Explain how the differences in how the particles are arranged leads to differences in properties*

Complete the following summary table:

	Solid	*Liquid*	*Gas*
Particles are arranged in...			
Particles have … energy			
Particles move ...			
Diagram showing particle arrangement			

Fundamental rules of kinetic theory

1. All matter is composed of tiny particles.
2. These particles are in constant motion.
3. The amount of motion is proportional to temperature.
   So, a higher temperature means **more** motion.
4. Solids, liquids and gases differ in the freedom of motion of their particles and the extent to which the particles interact with each other.

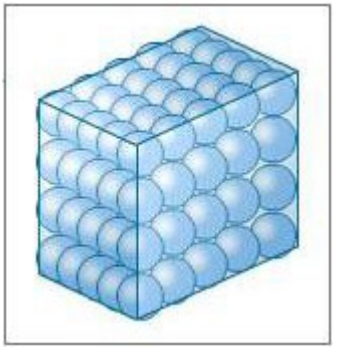
Solids

Particles are packed together as closely as they can be.

Particles are arranged in a regular, repeating pattern.

There is some empty space between the particles but not a lot.

The particles **vibrate around a fixed point**.



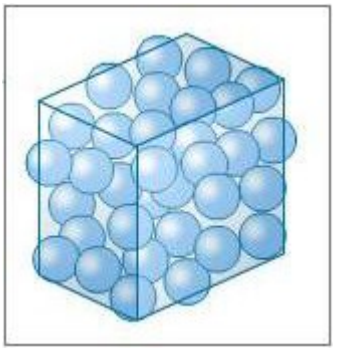
Liquids

The particles are moving quickly.

Particles are **NOT** arranged in a regular pattern.

There are bigger spaces between the particles.

Particles **slide over each other**.



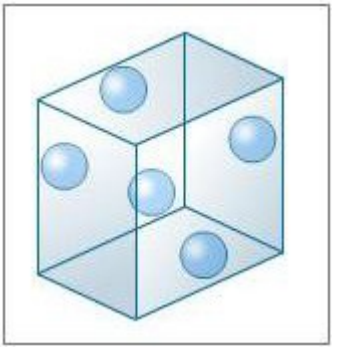
Gases

Particles are moving **VERY** quickly.

Particles are **NOT** arranged in a regular pattern.

Spaces between the particles are **HUGE** compared.

Gases have **no fixed shape or volume**.



Particles have increasing energy – solid à liquid à gas

1) Particles in a solid are arranged in a r_____ pattern.

2) Particles in a liquid have / have no regular pattern.

3) Particles in a gas have the most / least amount of energy.

4) Why can you compress a gas, but not a solid or a liquid?

_____

_____

5) Why can liquids and gases take on the shape of their containers, but a solid cannot?

_____

_____

6) Draw a quick sketch for how the particles are arranged in…

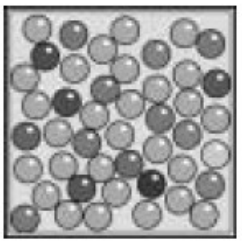
a) A solid

b) A liquid

c) A gas

7) All matter is composed of (made of) ? _____

Marbles inside a box can be used as a model for the particles in a solid, a liquid or a gas.



Use words from the box to complete the following sentences. Each word can be used once, more than once or not at all.

gas	**liquid**	**solid**

(a) The particles in a .....vibrate about fixed positions.

(1 mark)

(b) The particles in a .....move at high speed in any direction.

(1 mark)

(c) The particles in a ..... are arranged in a pattern.

(1 mark)

Phillip noticed that the tyre became harder as he pumped more air into it.

(a) (i) Explain how the air in the tyre produces a pressure.

.....

.....

(2)

(ii) Suggest why the pressure increases when more air is put in.

.....

.....

(1)

By the end of this topic I will be able to:

- *Describe how heat is transferred by radiation.*
- *Describe how heat is transferred by conduction.*
- *Explain why metals are better conductors.*
- *Describe how heat is transferred by convection.*
- *Explain the effect of colour, finish, surface area and temperature on the amount of radiation absorbed or emitted by a surface.*
- *Describe how to insulate a house, reduce heat loss.*

Complete the following summary table:

Radiation	Conduction	Convection

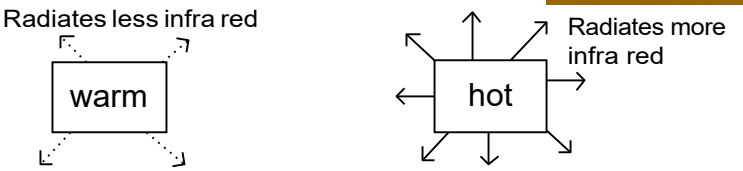
All bodies emit (give off) and absorb (take in) thermal energy.

Types of Thermal Energy Transfer:

Radiation

Thermal energy is **transferred** from one body to another through the air by **electromagnetic waves** of **infra red radiation.**

The hotter the body the more energy (infra red radiation) it gives off!!!

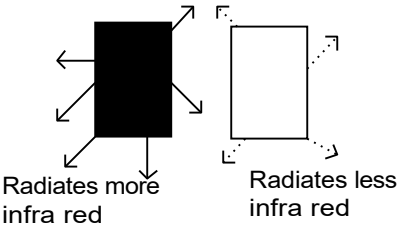


Note : The larger the surface area the more energy (infra red radiation) an object gives off!!!

Dark, matt surfaces emit **more radiation** than **light, shiny surfaces** at the same temperature.

Dark, matt surfaces are good absorbers (poor reflectors) of radiation.

Light, shiny surfaces are good reflectors (poor absorbers) of radiation.



Conduction

Conduction is when heat is transferred through or between **solids.** The heat is passed on by **vibrations** in the molecules. These vibrations get BIGGER when the solid has more ENERGY (i.e. when it is being heated).

Different types of materials transfer heat at different rates:

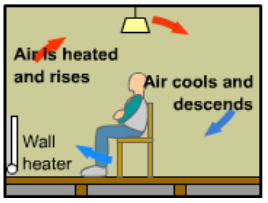
Metals are good conductors of heat, this is because the heat is carried by free electrons that can carry the energy around the metal and give it to other electrons and ions.

However non-metals and gases are usually poor conductors of heat. Poor conductors of heat are **good insulators.**

Heat energy is conducted from the hot end of an object to the cold end.

Convection

Convection is when a gas or liquid ("fluid") moves and carries heat with it. When the fluid is heated it expands. This means that it will become less dense (lighter) than the colder fluid around it. The warm fluid raises. This is called a convection current. This is how heat reaches us from the wall heater in a room.



In CONDUCTION the heat was passed on by VIBRATIONS in a SOLID

In CONVECTION the heat is passed on by the FLUID expanding, rising and TAKING THE HEAT with it

Note: Evaporation is when a liquid is heated and becomes a vapour, carrying the heat away with it as it escapes, i.e. when you sweat.

Heat energy is transferred from a hotter body to cooler surroundings or from hotter surroundings to a cooler body. The speed this energy is transferred depends on the difference in temperature between a body and its surroundings, <u>the greater the difference, the faster the rate of transfer.</u>

The shape, and size (surface area) of a body effects the rate heat is transfer to a body or from it

1) What type of thermal heat transfer happens as waves of infra red radiation

_____ .

2) Does a hotter body emit more or less radiation than a cool body? _____

3) Does a dark matt surface emit more or less radiation than a light shiny body?_____

4) Does a surface with a larger surface area emit more or less radiation than a surface with a smaller surface area?_____

5) Does a dark matt surface absorb more or less radiation than a light shiny body?_____

6) What type of heat transfer happens through a solid? _____

7) How is heat conducted through a solid?

_____

_____

8) Why are metals better conductors than non metals?

_____

_____

9) Heat energy is conducted from the hot end to the_____ end.

10) What type of heat transfer happens through a fluid? _____

11) When a gas or liquid is heated what happens to its density? _____

12) Describe how a convection current is produced.

_____

_____

13) Describe how you would insulate a house to reduce heat loss.

_____

_____

14) Double glazing stops heat loss by conduction and convection but not radiation, why?

_____

1) Match words from the list with the numbers 1 to 4 in the sentences.

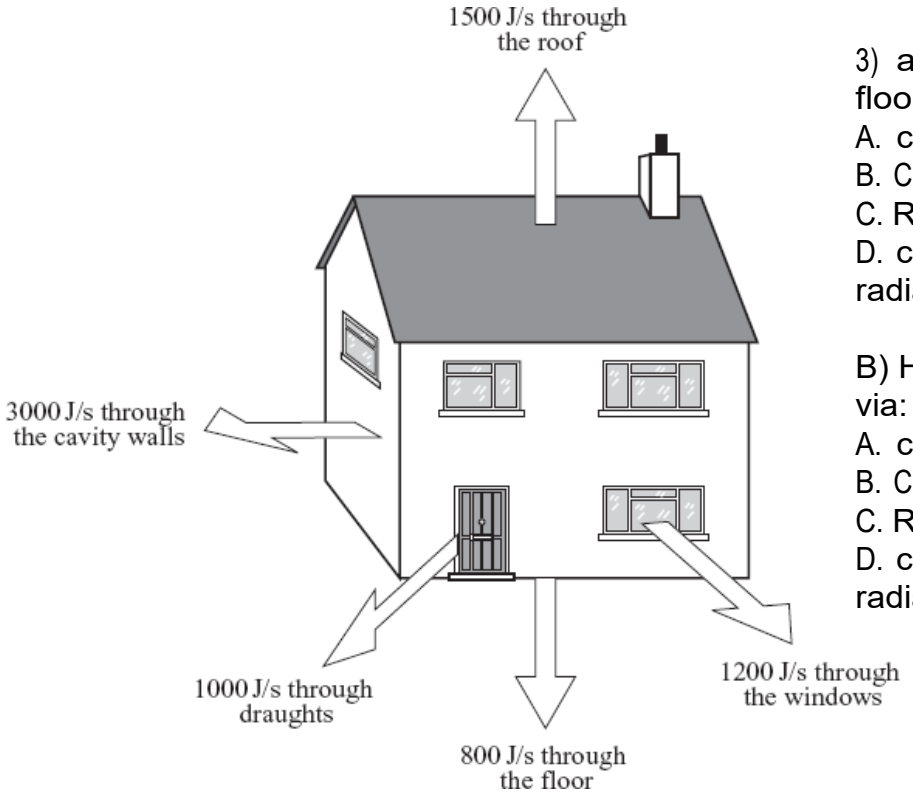
A. conduction
B. convection currents
C. loss of warm air
D. Radiation

Heat spreads from the inside of a brick wall to the outside by …….1……..
Heat spreads from downstairs to upstairs by …….2……..
When the doors or windows are open, heat is removed by ……...3……
The outside surfaces of a house lose heat by ……...4……..

2) Match words from the list with numbers 1 to 4 in the sentences.

A. black
B. Increase
C. Reduce
D. White

In hot counties, houses are often painted .....1.....
This is done to ……2 ..... absorption of Sun"s radiation.
Pipes at the back of the freezer are painted ……3……..
This is done to ……..4 .....radiation of heat energy.



3) a) Heat escapes through the floor via:

A. conduction only
B. Convection only.
C. Radiation only.
D. conduction, convection and radiation.

B) Heat escapes through draughts via:

A. conduction only
B. Convection only.
C. Radiation only.
D. conduction, convection and radiation.

4) The table gives the effect of different conditions on the transfer of energy to an object or from an object.
Match words from the list with the numbers **1 TO 4** in the table.

A. decrease the temperature of the object
B. object made of plastic
C. make the surface of the object shiny
D. paint the surface of the object black

Condition	Effect on object
1	absorbs more heat radiation
2	emits less heat radiation
3	gains less heat by conduction
4	reflects more heat radiation

By the end of this topic I will be able to:

- *Identify the type of energy transferred in examples.*
- *Identify useful and waste energy in examples.*
- *Calculate the efficiency and % efficiency of an energy transfer.*
- *Compare the energy efficiencies between devices (The greater the percentage of the energy that is usefully transformed in a device, the more efficient the device is).*
- *Understand the law = energy cannot be created or destroyed. It can only be transformed from one form to another form*
- *Understand that each time energy gets transferred it gets spread out and harder to use.*

Energy cannot be created or destroyed – but we can transform one type of energy into another.

Electrical energy can be transferred into lots of different types of energy by devices i.e.:

Heat (thermal energy)

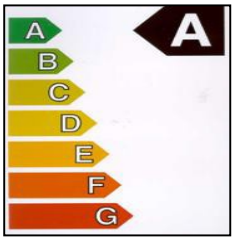
Light

Movement (kinetic energy)

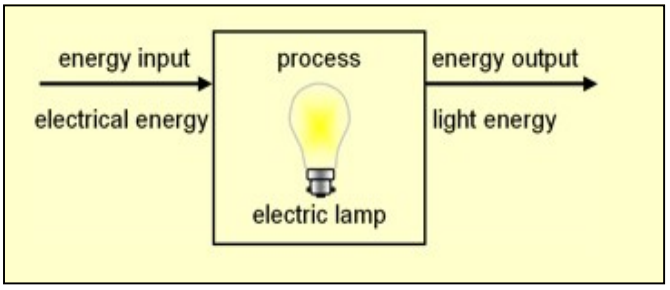
Sound

Whenever energy is transferred, only part of it is usefully transferred the rest is lost as another form of non useful energy i.e. heat or kinetic energy.

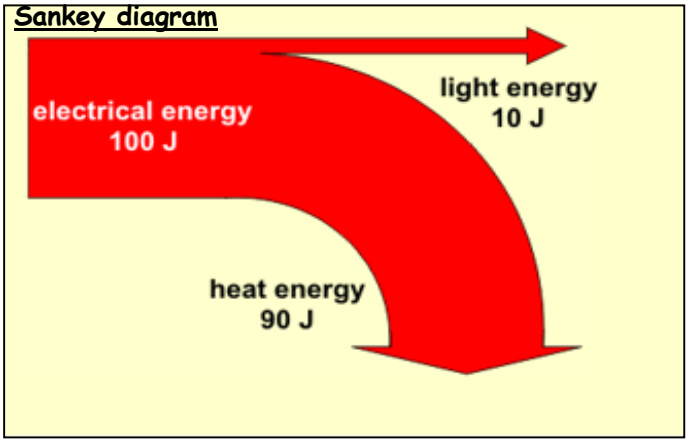
An efficient device transfers most of its input energy (electrical) into output energy (useful energy) and is given an A rating.



The % efficiency of this transfer can be calculated by: $\frac{\text{USEFUL Energy OUT}}{\text{Energy in}} \times 100$



In this example % efficiency = $\frac{10}{100} \times 100 = 10\%$



Sankey diagrams show all the energy transfers taking place in a process. The thicker the line or arrow, the greater the amount of energy involved. This Sankey diagram for an electric lamp shows that most of the electrical energy is transferred as heat rather than light.

Energy which is not usefully transferred by a device is wasted.

This waste energy is not destroyed just transferred into the surroundings, were it spreads out so much it becomes very difficult to use.

All energy is eventually transferred into the surrounding (wasted) and it causes the surrounding to warm up.

The more times energy is transferred, the more spread out it becomes and so the more times you transfer the energy the harder further energy transfers become.

1) Fill in the gaps for the following energy transfers:

a) A torch transfers_____ to light energy.

b) A model steam engine transfers chemical energy to_____ energy, via thermal energy.

c) A pendulum transfers_____ energy into kinetic (movement) energy.

d) A ball on a slope transfers_____ energy into kinetic (movement) energy.

e) A hairdryer transfers _____ energy into heat energy.

f) A wind-up radio transfers _____ energy into sound energy.

g) A Motor transfers _____ energy into _____ energy.

H) A drill transfers _____ energy into _____ energy.

The % efficiency of an energy transfer can be calculated by: $\frac{\text{USEFUL Energy OUT}}{\text{Energy in}} \times 100$

The efficiency of An energy transfer can be calculated by: $\frac{\text{USEFUL Energy OUT}}{\text{Energy in}}$

2) Calculate the efficiency of a light bulb that gives of 40J of light from 200J of electrical energy.

— — — —

3) Calculate the percentage efficiency of a motor that does of 60J of work from 240J of electrical energy.

— — — —

4) Calculate the efficiency of a radio that gives of 30J of sound from 300J of electrical energy.

— — — —

5) Calculate the efficiency of a runner who produces of 500J of kinetic energy from 2500J of chemical energy.

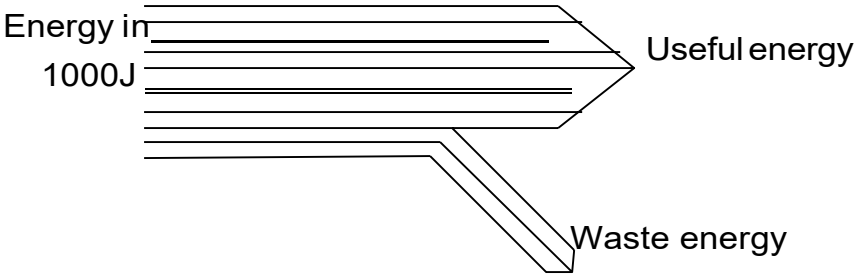
— — — —

6) Calculate the percentage efficiency of a kettle that gives 50J of heat from 1000J electricity.

— — — —

7) 

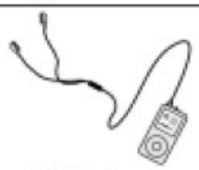
This Sankey diagram shows how much energy is usefully transferred by the kettle. Use the information provide to calculate % efficiency of the kettle.



The diagrams in **List A** show three electrical appliances. Each appliance is designed to transfer electrical energy.

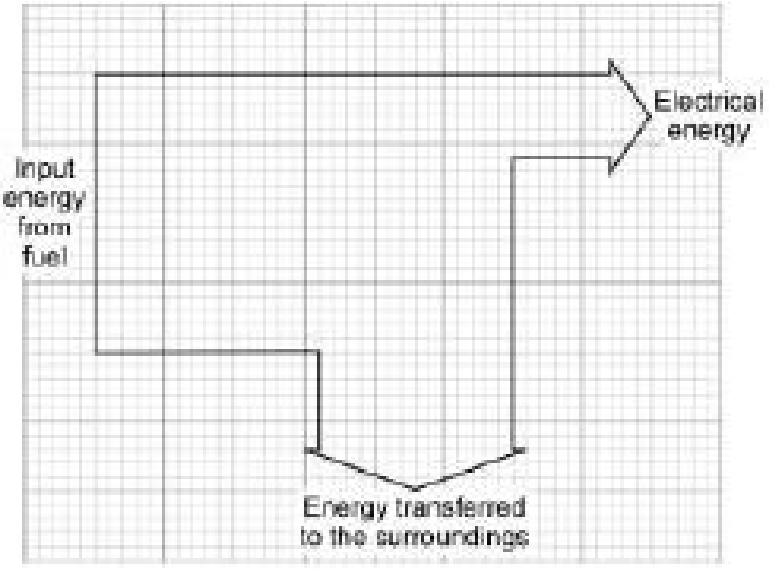
Draw **one** straight line from each appliance in **List A** to the useful energy output produced by that appliance in **List B**.

Draw only **three** lines.

List A **Appliance**	**List B** **Useful energy output**
 MP3 player	Light
 Food processor	Sound
 Desk lamp	Electrical
	Kinetic

(3 marks)

The diagram shows the energy transformations in a coal burning power station.



Calculate the efficiency of the power station.
Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

Efficiency = ...

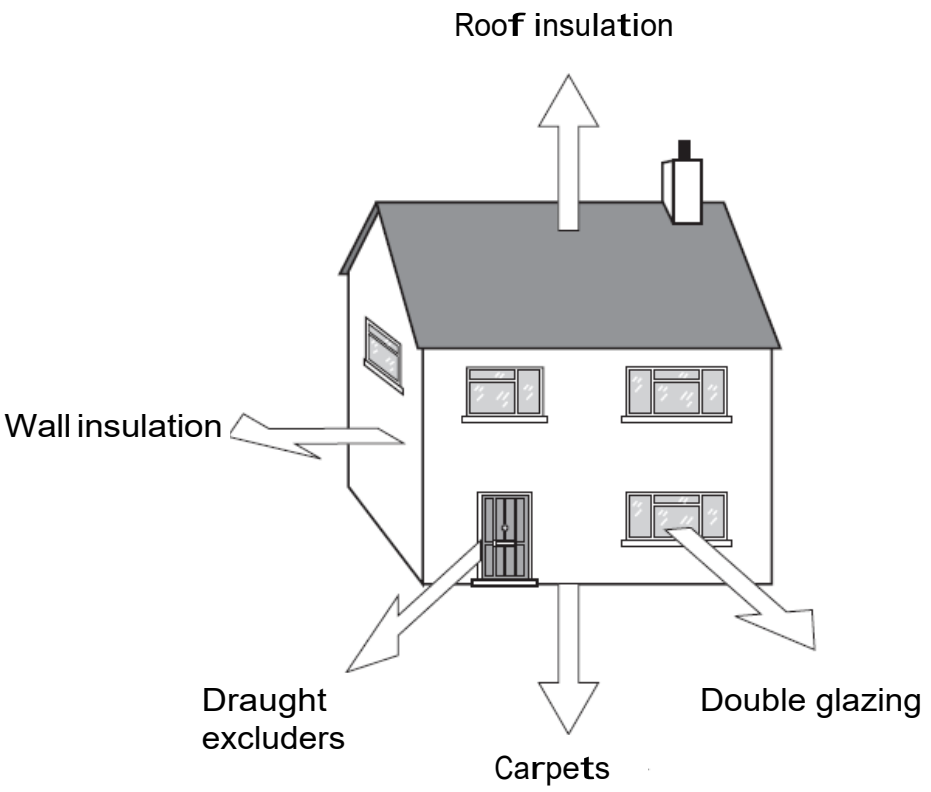
(2 marks)

By the end of this topic I will be able to:

- *Describe what U values measure*
- *Explain that the lower the U value, the less efficient a material is as an insulator*
- *Describe how solar panels can be used to heat a house's hot water*
- *Calculate payback times*
- *Evaluate the cost effectiveness of different methods of insulating a house*

Summary:

There are many ways of insulating a house



Some of these ways of insulating a house cost more than others in the first place.

But some save you more money than others.

The time it takes for you to save the money that you paid in the first place is called the „payback" time.

So, if the double glazing cost £3000 to install and it saves you £150 a year on your heating costs. It will take you 20 years to save what you first paid. It has a payback time of 20 years.

Payback time = Cost of insulation / Saving per year

U values

U values are used to measure how good an insulator a material is.

The **LOWER** the U value, the **BETTER** a material is at being an insulator.

The **HIGHER** the U value, the **WORSE** a material is at being an insulator.

Using solar panels to heat water

Some solar panels have copper tubes inside them so that the water is heated as it runs through the tubes.

Using solar panels like this relies on the using the **specific heat capacity of water** (the amount of energy needed to change the temperature of **1 kg** of a substance by **1°C**.)

1) List three ways you can insulate a house.

2) Which is a better insulator – a material with a high or a low u-value? _____

3) Describe briefly how solar panels can be used to heat water for a house or workplace.

_____

_____

_____

4) Calculate the payback time on fitting carpets which cost £250 when they save you £75 per year. Show your working out.

_____

_____

_____

5) Calculate the amount of energy needed to heat 50kg of water from 20°C to 30°C. The specific heat capacity of water is 4200 J/kg°C. Show your working out.

_____

_____

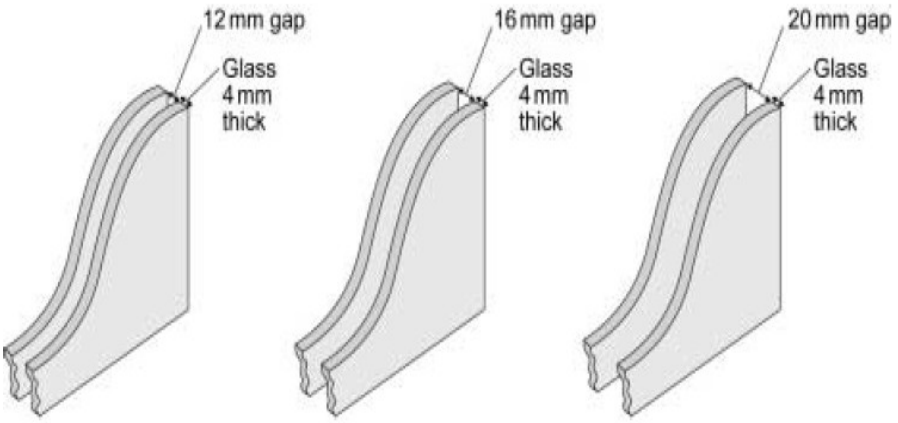
_____

_____

_____

_____

The diagrams show the cross-section of three double glazed windows.



The gap between the two sheets of glass can be filled with either air or a mixture of air and argon.

The U-values for different types of double glazed windows, using different types of glass **X** and **Y**, are given in the table.

	Type of window	12 mm gap	16 mm gap	20 mm gap
1	Glass type **X** with air	2.9	2.7	2.8
2	Glass type **X** with air and argon	2.7	2.6	2.6
3	Glass type **Y** with air	1.9	1.8	1.8
4	Glass type **Y** with air and argon	1.6	1.5	1.5

(a) Which type of window, **1**, **2**, **3** or **4**, is the least energy efficient?

.....

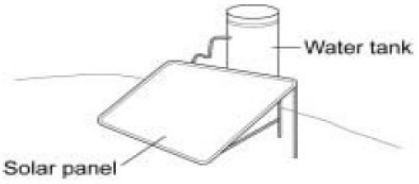
(1 mark)

(b) Which windows should be compared to decide if adding argon to the gap improves the energy efficiency of the window?

.....

(1 mark)

The picture shows one type of solar water heater. Water from the tank is slowly pumped through copper pipes inside the solar panel where the water is heated by energy from the Sun.



Explain why the copper pipes inside the solar panel are painted black.

.....

.....

.....

.....

(2 marks)

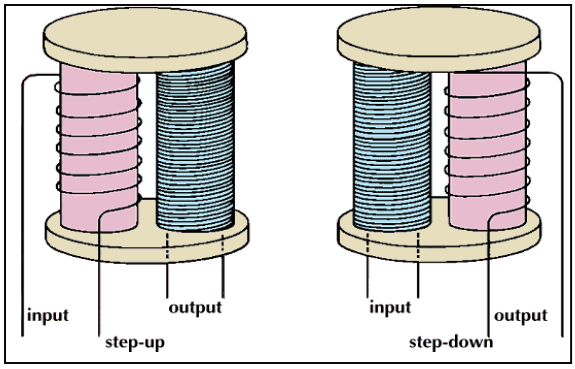
By the end of this topic I will be able to:

- *Calculate the amount of energy transferred from the mains.*
- *Calculate the cost of energy transferred from the mains.*
- *Understand that the amount of electrical energy a device transforms depends on how long the appliance is switched on and the rate at which the device transforms energy.*
- *Know that the power of an appliance is measured in watts (W) or kilowatts (kW).*
- *Know that energy is normally measured in joules (J).*
- *Know that the electricity is transferred To your house from The power station along the National Grid.*
- *Understand why the National Grid uses of step-up transformers to increase voltage (potential difference) and reduces current (to reduces energy losses in the cables) from power station to national grid.*
- *Understand why the National Grid uses of step-down transformers to decrease voltage (potential difference) and increase current (for safety) from national grid to your home.*

Summary:

The electricity we use in our homes is generated in **a power station.** This energy is then transferred from the power station to our home through the wires and cables of the **National Grid**.

When a current flows through a wire some energy is lost as heat. The higher the current, the more heat is lost. To reduce these losses, **the National Grid transmits electricity at a low current**. This needs **a high voltage.**



So step-up transformers are used at power stations to produce the very high voltages needed to transmit electricity through the National Grid power lines.

These high voltages are too dangerous to use in the home, so step-down transformers are used locally to reduce the voltage to safe levels. The voltage of household electricity is about 230V.

How much electrical energy an appliance transfers depend on:

- How long the appliance is switched on;
- How fast the appliance transfers energy (its power).

The power of an appliance is measured in watts (W) or kilowatts (1kW = 1000W).

The total amount of energy transferred by an electrical device can also be calculated as follows:

energy transferred (joule, J) = power (watt, W) x time (second, s)

This is the input energy to a device when calculating energy efficiency.

Time fan has been on for = 120 secs

Power of fan = 15 W

= 15 x 120

Energy transferred = 1800J

But when we want to calculate the amount of energy transferred from the mains it is measured in kilowatt per hours. These are the units of energy displayed on your electrical meter.

For an electrical device the kWh used can be calculated using:

Energy transferred Power (kilowatt, kW) x Time (hour, h)

Time toaster has been on 0.025 hours

Power of toaster = 0.02kW

= 0.02 x 0.025

= 0.005kWh

This allows us to calculate the cost of energy transferred:

Total cost = number of kWh used x cost per kWh

For example, if 5 kWh of electricity are used at a cost of 8p per unit, the total cost will be 5 × 8 = 40p.

1) Calculate the power of a light bulb that uses 36J of electrical energy in 6 seconds.

_____.

2) Calculate the power of a motor that uses 800J of electrical energy in 20 seconds.

_____

3) Calculate the power of a boy who performs 1200J of work in 4 seconds.

_____.

4) Calculate the power of a girl who performs 3000J of work in 6 seconds.

_____.

5) Calculate the power of a car that uses 80000J of chemical energy in 2 seconds.

_____.

6) Calculate the energy used by a light bulb of power 60W in 8 seconds.

_____.

7) Calculate the energy used by an iron of power 700W in 20 seconds.

_____.

8) Calculate the energy used by a radio of power 20W in 200 seconds.

_____.

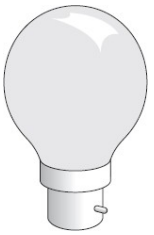
9) Calculate the energy used by a motor of power 2kW in 1 hr.

_____.

10) Calculate the work done by a car of power 4kW in 0.5hrs.

_____.

1) The diagram shows a 100W filament lamp.



a) How many joules of energy does the lamp transfer in one second?

A 0.4
B 2.5
C 100
D 250

b) How many kilowatt-hours of energy would the lamp transfer in one hour?

A 0.1
B 1
C 10
D 100

c) One kilowatt-hour is also called . . . . .

A one watt.
B one kilojoule.
C one kilojoule-hour.
D one Unit.

Electricity costs 8 p per Unit.

d) How much would it cost to use a 3 kW appliance for 4 hours?

A 1.5 p
B 6p
C 96 p
D £9.60

2) This question is about electrical appliances which transfer energy. Which TWO of the following statements P,Q,R,S and T are correct?

P. energy becomes less spread out after energy transfer.

Q. energy is always wasted during energy transfer.

R. the more energy that is wasted during transfer, the more efficient the appliance is.

S. useful energy and wasted energy both end up making the surroundings warmer eventually.

T. wasted energy can always be used for further energy transfers.

By the end of this topic I will be able to:

- *Compare and contrast the particular advantages and disadvantages of using different energy sources to generate electricity.*
- *Understand that in most power stations an energy source is used to heat water. The steam produced drives a turbine which is coupled to an electrical generator. Energy is transferred from fuel to kinetic energy to electrical energy by generator.*
- *Know that coal, oil and gas, are burned to produce heat and that uranium/plutonium, are used in nuclear fission to produce heat.*
- *Know that energy from renewable energy sources can be used to drive turbines directly.*
- *List renewable energy sources*
- *Describe how geothermal energy is used.*
- *Identify the effects of different energy resources on the environment.*
- *Describe how the start-up time of power stations, and the reliability of the energy source differ.*

Summary:

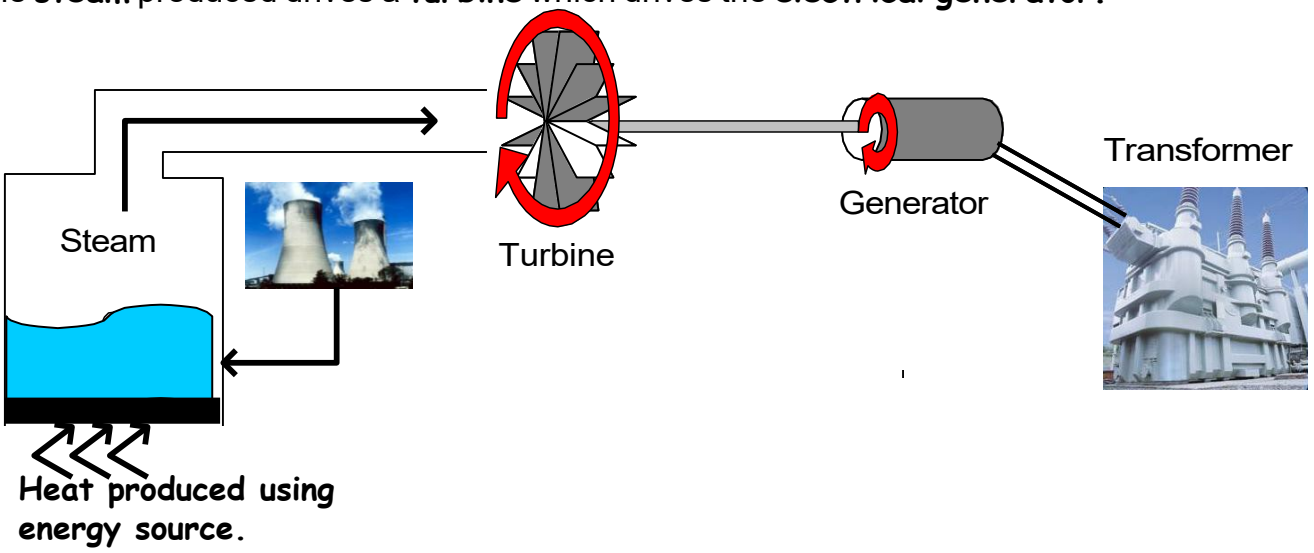
The original source of most types of energy are the sun's radiation.

A **renewable energy source** is clearly one that can be **renewed** ("renew = **make again**"), e.g. wood, solar power etc.

A **non renewable energy source** is one that **when** it has been **used it is gone forever**. The main examples are coal, oil and gas (which are called fossil fuels, as they are made from fossils), and nuclear fuel, which is non-renewable but NOT a fossil fuel.

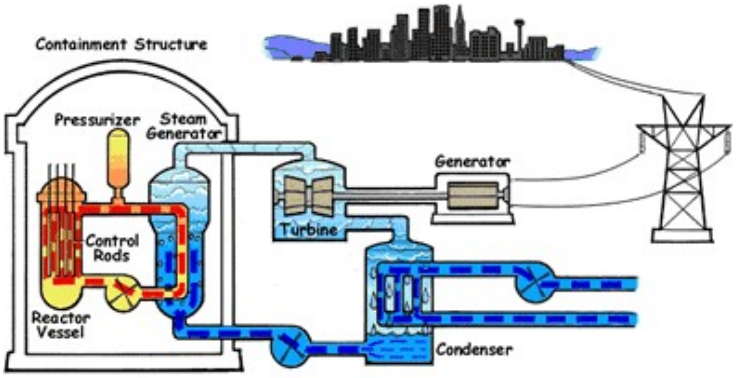
In most power stations an **energy source** is used to **heat water**.

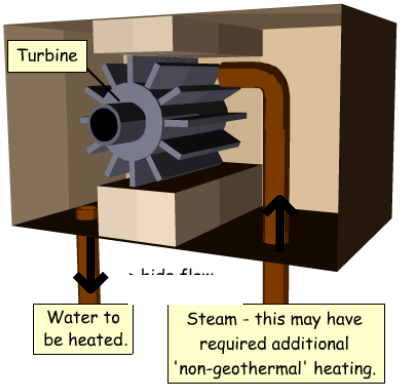
The **steam** produced drives a **turbine** which drives the **electrical generator**.



A **"fuel"** is something that can be burned to **release heat energy** which is used to **drive the turbines. Coal, oil** and **gas** are called **"fossil fuels"**. In other words, they were made from fossils. Not all our energy resources are fuels which need to be burnt to produce heat in this way.**and Nuclear and geothermal use fission to heat the water.**

Nuclear fuels (uranium/plutonium) are used to boil water in a "heat exchanger"
- nonrenewable





In some volcanic areas hot water and steam rise to the surface. The steam can be tapped and used to drive turbines. **This is known as geothermal energy.**

Geothermal Energy
- renewable

Energy from most **renewable energy** sources **drive turbines directly.**

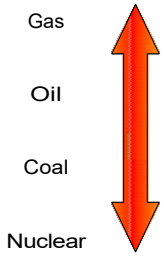
Fossil fuels (non renewable)

Coal was once **plant material**, these plants got their energy from the SUN via photosynthesis. When the plant material dies it is buried and slowly becomes coal.

Millions of years ago, the **dead bodies of sea creatures** settled to the bottom of the ocean. As they were buried, **the remains turned slowly into OIL or GAS.**

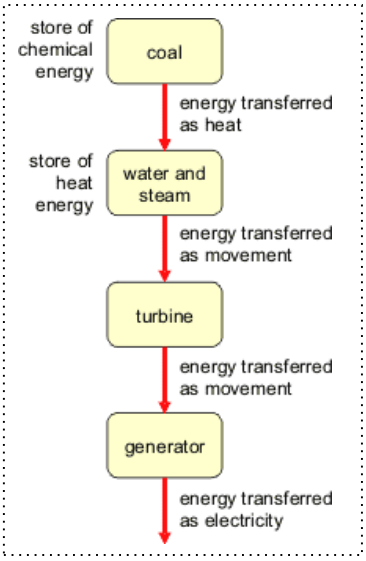
Start up times

Different power stations have different start up times:



Different power plants have different start up times and the examiner likes to ask you about them.

Summary of non renewable energy sources:



Advantages

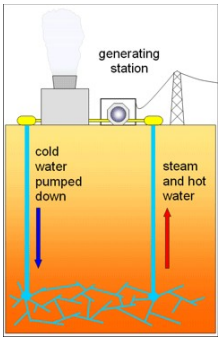
- Cheap fuel costs
- Good for "basic demand"
- Reliable
- Short start-up time for gas and oil
- Nuclear produces little pollution

Coal, oil, gas and nuclear

Disadvantages

- Costs a lot of money to decommission a nuclear plant
- Fuel will run out
- Pollution – CO_2 leads to global warming and SO_2 leads to acid rain

Summary of renewable energy sources:



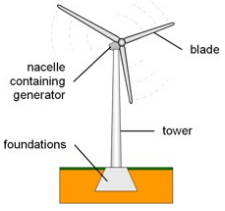
Advantages

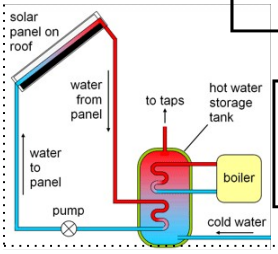
- Zero fuel costs
- Don't produce pollution
- Hydroelectric is good for a "sudden" demand
- Solar is good for remote locations (e.g. satellites)

Wind, tidal, hydroelectric and solar

Disadvantages

- Unreliable (except for hydroelectric)
- Expensive to build
- Tidal barrages destroy the habitats of wading birds and hydroelectric schemes involve flooding farmland





1) Describe what the term renewable means_____

_____

2) Describe what the term non renewable means_____

_____

3) Describe how a power station transfers energy from a fossil fuel to electrical energy

_____

_____

_____

4) List the renewable energy resources_____

5) List the non renewable energy resources_____

6)List the fossil fuels

_____

7) Which type of power station has the longest start up time, gas, oil, coal or nuclear? _____

8) Which of the following is the more expensive power plant to build wind, or gas? _____

9) Which is the most reliable energy source nuclear or solar? _____

10) Which energy source produces the most pollution nuclear or gas? _____

11)What type of energy resources have the lowest running cost renewable or non renewable?

_____

12) Which type of energy resource is good for remote locations?_____

13) The use of which type of energy resource causes damage to the habitats of wading birds._____

14) Which energy resources produce green house gases? _____

15) Which energy resources produce gases which cause acid rain?

_____

1) This question is about different renewable energy resources.
The table shows the places where these resources can be used to produce electricity.
Match words from the list with the numbers 1 to **4** in the table.

A. geothermal
B. hydroelectric
C. waves
D. wind

Renewable resource	Place
1	at sea but not on land
2	at sea or on land
3	in rainy, hilly places
4	in volcanic areas

2) Power stations can cause problems for the environment.
Match words from the list with the numbers **1 to 4** in the table.

A. coal-fired
B. nuclear
C. tidal barrage
D. wind farm

Type of power station	Problem
1	destroys the habitat of mud-living organisms
2	produces noise pollution
3	produces radioactive waste
4	releases sulphur dioxide

3) The radioactive substances that are found within the Earth can release energy.
Which **two** of the following make use of this energy?

A. fossil fuel power stations
B. geothermal power stations
C. nuclear power stations
D. solar cells
E. tidal barrages

4) One advantage of wind farms is that they . . . . .

A can produce a reliable output in any wind speed.
B do not release carbon dioxide into the air.
C have no effect on the environment.
D produce electricity at no cost.

5) Some power stations are classed as .reliable energy resources..
This is because they . . . . .

A can produce electricity at any time.
B can start up very quickly.
C have a very good safety record.
D use fuels which will not run out.

6) Power stations vary in their start-up times.
Which row in the table is correct?

	Shortest start-up time →			Longest start-up time
A	coal	oil	gas	nuclear
B	gas	oil	coal	nuclear
C	nuclear	coal	oil	gas
D	oil	nuclear	gas	coal

7) One argument in favour of building more nuclear power stations is that . . . . .
A building costs are lower than for other types of power station.
B it is easy to store nuclear waste safely.
C they do not add to the greenhouse effect when they generate electricity.
D uranium, the main nuclear fuel, is renewable.

8) This question is about four sources of energy which could be used in power stations.
Match words in the list with the number 1 to 4 in the sentences.
A. coal
B. gas
C. uranium
D. wood
Power stations using .....1.....produce radioactive waste.
Power stations using .....2..... produce the most carbon dioxide for each unit of electricity produced.
Power stations using .....3....can be started up most quickly.
Power stations using .....4....have the advantage of using a renewable energy resource.

9) This question is about one way of producing electricity.
Match words in the list with the number 1 to 4 in the sentences.
A generator
B. steam
C. turbine
D. water
In some volcanic areas hot .....1..... and steam rise to the surface.
The .....2..... can be used to drive a .....3.....
Electricity is then produced by a .....4.....

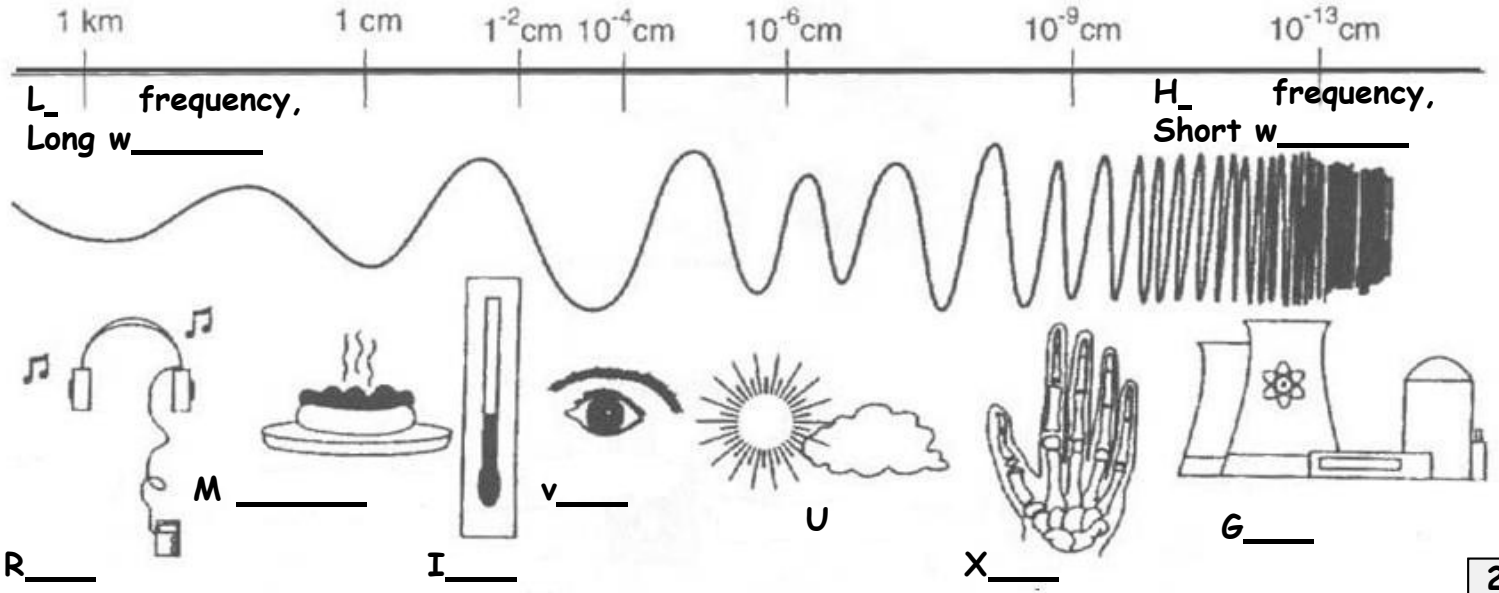
10) In Britain, most power stations use fuels as their source of energy. Which TWO of the following fuels are not burnt to release their energy?
A. coal
B. gas
C. plutonium
D. uranium
E. wood

P7 – Electromagnetic radiation

- Know that electromagnetic radiation travels as waves, moves energy from one place to another.
- Know that all types of electromagnetic waves travel at the same speed through a vacuum (space).
- Give the different types of EM in order of increasing wavelength and decreasing frequency: gamma rays, X-rays, ultraviolet rays, visible light, infra red rays, microwaves and radio waves.
- Give a use for each type of radiation in the electromagnetic spectrum:
  - Radio waves, microwaves, infra red and visible light can be used for communication.
  - Microwaves can pass through the Earth's atmosphere and are used to send information to and from satellites and within mobile phone networks.
  - Infra red and visible light can be used to send signals along optical fibres and so travel in curved paths
- Know that different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface.
- Know that when radiation is absorbed the energy it carries makes the substance which absorbs it hotter and may create an alternating current with the same frequency as the radiation itself.
- Know that different wavelengths of electromagnetic radiation have different effects on living cells. Some radiations mostly pass through soft tissue without being absorbed (radio), some produce heat (Infra red), some may cause cancerous changes and some may kill cells.
- Give possible hazards with the use of different types of electromagnetic radiation. Know that these effects depend on the type of radiation and the size of the dose. Give ways to protect yourself from the hazards of electromagnetic radiation.
- Know communication signals may be analogue (continuously varying) or digital (discrete values only, generally on and off) and that digital signals are less prone to interference than analogue and can be easily processed by computers.

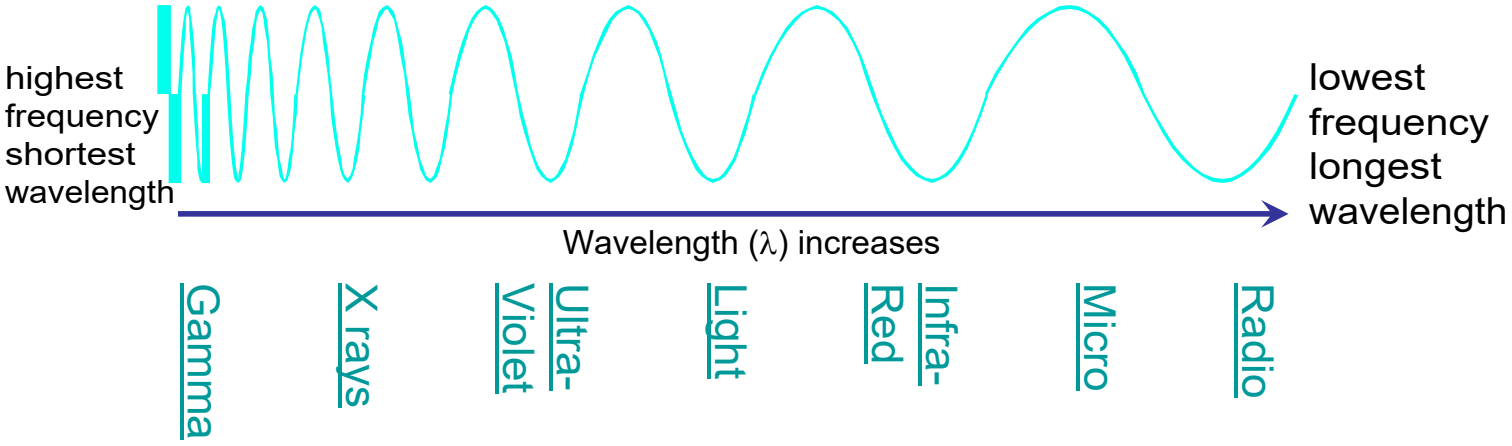
Using the notes sheets on EM spectrum complete the following activities:

There are seven types of electromagnetic waves complete the diagram below:



Electromagnetic radiation travels in waves. These waves transfer energy from one place to another without transferring matter. All types of electromagnetic waves travel at the same speed through a vacuum (space).

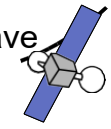
The electromagnetic spectrum is a continuous spectrum, but electromagnetic waves are placed grouped into 7 basic types:



Different wavelengths of electromagnetic radiation are **reflected, absorbed or transmitted** differently by different substances and types of surface. This gives them different properties.

When radiation is absorbed, the energy it carries:

- **makes the substance which absorbs it hotter;**
- **may create an alternating current with the same frequency as the radiation itself.**

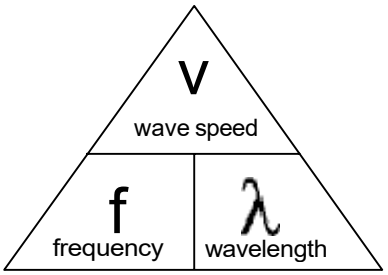
Radiation	Uses	Dangers
Gamma 	Kills bacteria in food, sterilising surgical equipment, killing cancer cells.	High doses can kill cells. Lower doses can cause gene mutations and cells become cancerous.
X ray 	Produce images of luggage and inside the human body.	High doses can kill cells. Lower doses can cause gene mutations and cells become cancerous.
UV 	Sun beds, fluorescent tubes/ lamps and hidden security marks.	Causes skin cancer and can damage the eye. Darker skin gives greater protection from UV.
Light 	Optical fibres, endoscope and photography.	Can damage the retina in your eye causing blindness if you look directly into sun.
IR 	Remote controls, heat transfer (gills, toasters, heat lamps), and night vision.	Very few
Microwave 	Satellite communication, mobile phone networks, cooking, RADAR.	Very few
Radio 	Communications – Radio and TV	Very few

Hospital workers limit exposure to Gamma and X rays by standing behind lead shields or by leaving the room when the radiations are being used.

lowest frequency longest Wavelength are not dangerous!!!

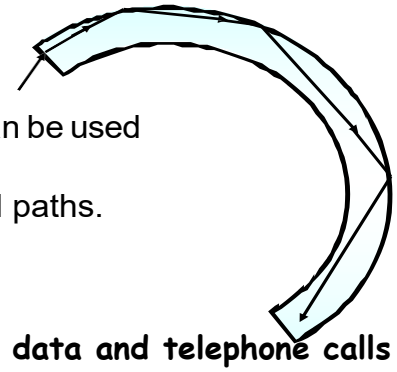
Electromagnetic waves obey the wave formula:

wave speed | frequency (hertz, Hz) × wavelength (metre, m)



A closer look at some of the uses of EM:

Optical fibres



Infra red and **visible light** can be used to send signals along **optical fibres** and so travel in curved paths.

They work by bouncing waves off the sides of a thin inner core of glass, the wave is reflected repeatedly until it comes out the other end.

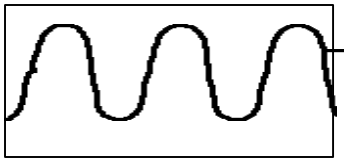
Information such as **computer data and telephone calls can be converted into** either visible light signals or infrared signals, and transmitted by optical fibres.

Optical fibres can carry more information than an ordinary cable of the same thickness. The signals in optical fibres do not weaken as much over long distances as the signals in ordinary cables.

Using EM to carry information (signals)

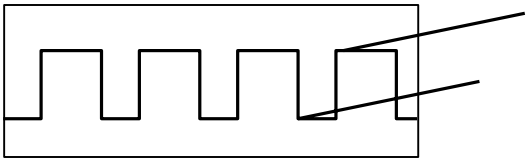
Information like sound and pictures can be converted into electrical signals and then sent down telephone wires or carried by EM waves. Communication signals may be **analogue** (continuously varying) or **digital** (discrete values only, generally on and off).

Analogue signal



Vary all the time

Digital signal



Digital technology is gradually taking over from analogue as digital signals. Why are they better?

- Both types of signal pick up noise (interference) but this affects digital signals LESS:
- Digital signals can be easily processed by computers.

- Many digital signals can be carried at once – so you can send more information at once.

The examiner can ask you to write the seven types of EM from low frequency to high frequency OR from high frequency to low frequency have ago in the boxes below:

low frequency								High frequency
High frequency								Low frequency

R, M, I,V,U,X,G is hard to remember come up with your own rhyme to help you remember these letters in order:

Fill in the gaps:

We can use the rhyme: **R_____ Of Y__ Gave Battle In Vain;** to help us remember the order of colours in the visible light region of the EM spectrum. Each initial letter stands for one of the colours. R is for red, O for o_____, Y for yellow, G for green, B for blue, I for indigo and V for v .

The only difference between these colours is their w_____ or f_____ .

Red light has the l_____ wavelength (or lowest f_____) and violet light has the s_____ wavelength (or highest f_____).

Give the type/s of EM to answer the following:

1) What type of EM which is absorbed by water molecules in food, cooking it from the inside? _____

2) What types of EM are used mainly for communications ? _____

3) What type of EM is produced by a toaster? _____

4) What type of EM causes skin cancer? _____

5) What type of EM is used to sterilise medical equipment and food? _____

6) What type of EM is used to treat cancer (kill cancer cells)?_____ -

Fill in the gaps using the notes pages and own knowledge:

All types of electromagnetic waves travel at the same s_____ through a vacuum. The seven different groups of electromagnetic radiation have different properties because they have different w_____ .

Different wavelengths of electromagnetic radiation are reflected, a_____ and transmitted differently by different substances and types of surface.

When an object absorbs electromagnetic radiation is has one of two effects: h___ it up or produces an a_____ current.

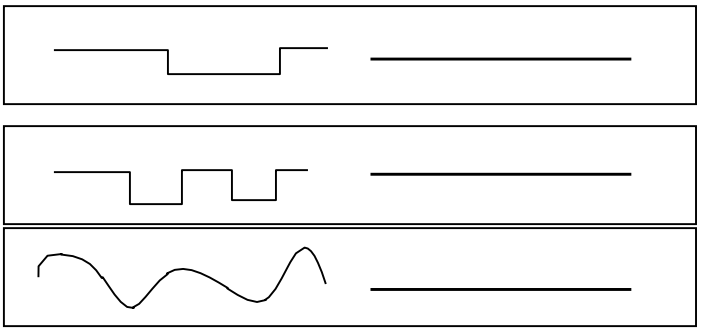
Some types of EM cause damage to cells which leads to cancer, others have few dangers. The shorter the wavelength the more d_____ than EM with longer wavelengths.

List the main hazards of each high frequency EM and come up with some ways people could protect themselves from them:

Fill in the gaps:

Communication signals can be a_____ or d_____ .

The following diagrams are what type of signal – analogue or digital:

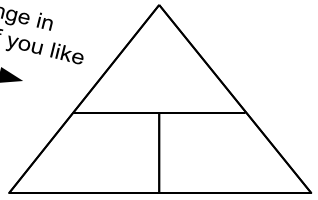


Which type of signal loses more quality as they are transmitted : _____

Complete the following calculations using the wave formula:

Wave speed (metres/sec) = frequency (hertz) x wavelength (metres)

Arrange in triangle if you like



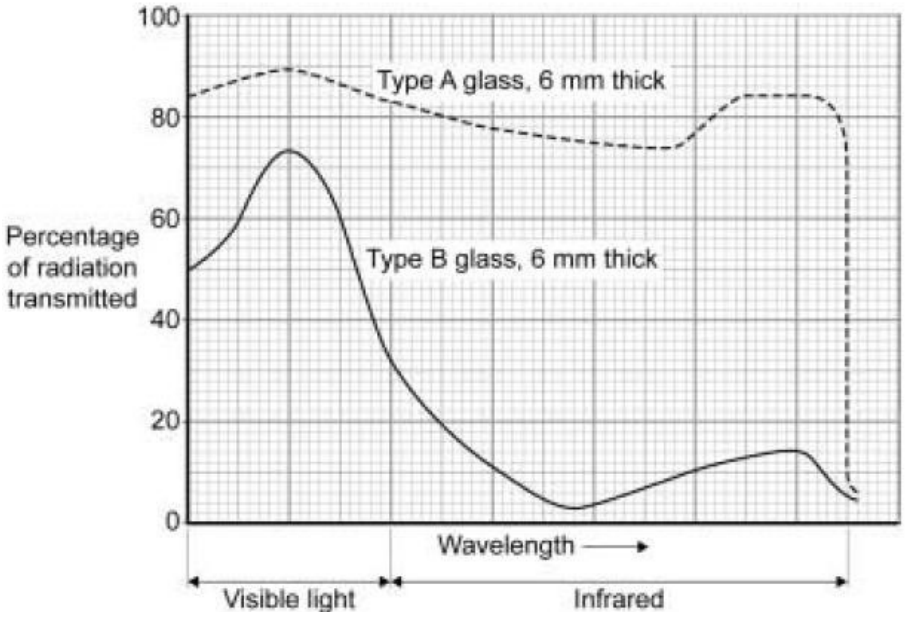
1) If frequency is 200 Hz and the wavelength is 20 m what is the wave speed?

_____

2) If frequency is 4000 Hz and the wavelength is 1000m what is the wave speed?

_____

Glass transmits infrared radiation and visible light. The amount transmitted depends on the type and thickness of the glass. The data from tests on two different types of glass is displayed in the graph below.



A homeowner has a glass conservatory built on the back of the house. The homeowner tells the builder that the inside of the conservatory should stay as cool as possible throughout the summer.

Explain why the builder uses 'Type B' glass for the conservatory.

.....

.....

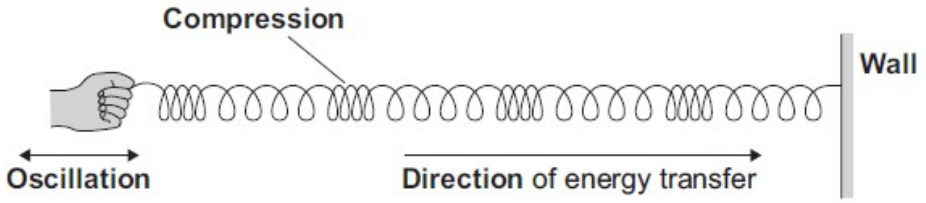
.....

.....

.....

(2 marks)

The diagram shows a longitudinal wave being produced in a stretched spring.



Use the bold words from the diagram to complete the following sentence. Put only **one** word in each space.

A longitudinal wave is one in which the ..... causing

the wave is parallel to the ..... of energy transfer.

(2 marks)

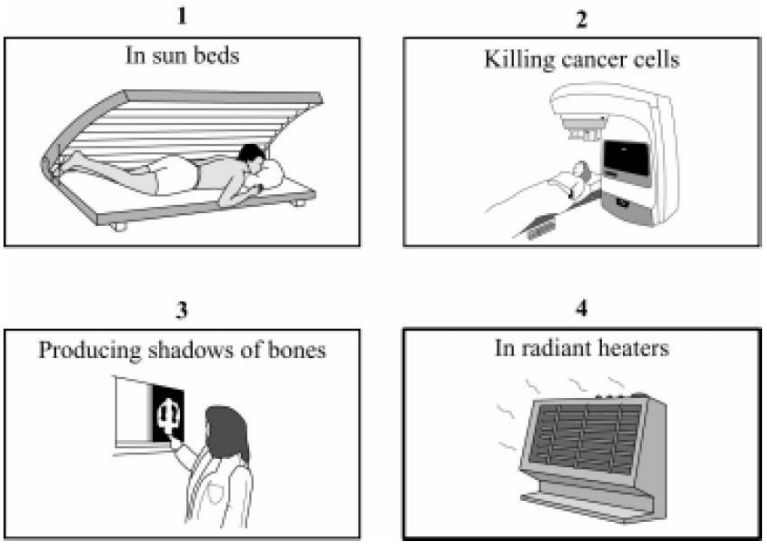
Name the type of energy that is transferred by longitudinal waves.

.....

(1 mark)

1) We use electromagnetic radiation for many different jobs.
Match words, **A**, **B**, **C** and **D**, with the drawings labeled **1 to 4**.

A gamma rays
B infra red waves
C ultraviolet waves
D x-rays

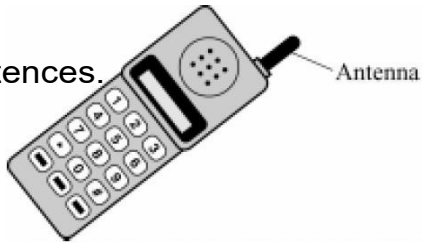


2) Electromagnetic waves can be grouped into types with different wavelengths.
Match words, **A**, **B**, **C** and **D**, with the numbers **1 to 4** in the table.
A infra red waves
B microwaves
C ultraviolet waves
D X-rays

Increasing wavelength ⟶

gamma rays	1	2	visible light	3	4	radio waves

3) The diagram shows a mobile phone.

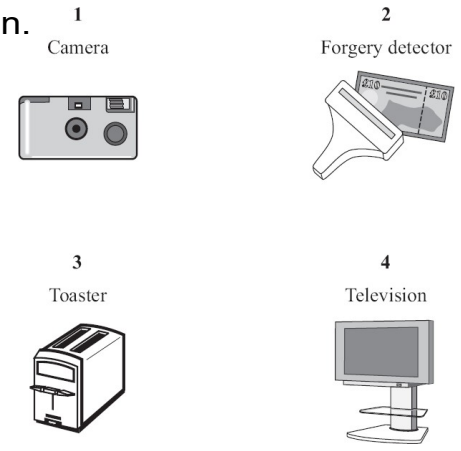


Match words, **A**, **B**, **C** and **D**, with the numbers **1 to 4** in the sentences.
A a digital
B a microphone
C an analogue
D microwave radiation
When we talk into the phone, the sound is detected by . . . **1** . . . .
Sound is . . . **2** ..... signal.
The phone converts this type of signal into . . . **3** .... signal.
The signal is then transmitted from the antenna in the form of . . . **4** . . . .

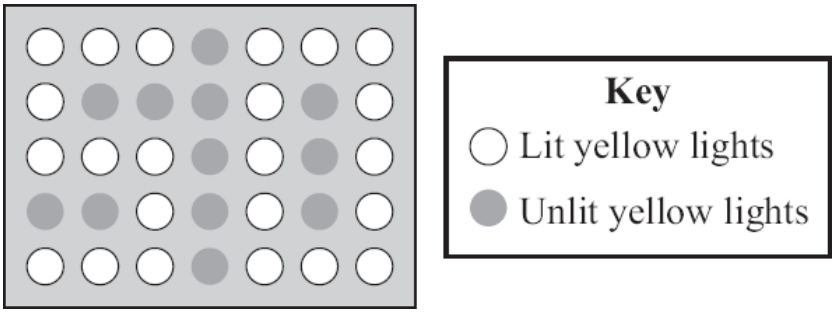
4) Each of these devices uses electromagnetic radiation.

Match the parts of the electromagnetic spectrum, **A**, **B**, **C** and **D**, with the drawings labeled **1–4**.

A infra red
B radio waves
C ultraviolet
D visible light



8) Vehicles on motorways often travel at high speeds. It is important that clear warning signs are used.
Tests were carried out to find the most suitable colour for the lights in the warning sign.
The drawing shows a sign which has yellow lights.



8A) Suggest why yellow light is used for the sign.
1 It has a higher frequency than all other colours.
2 It has a longer wavelength than all other colours.
3 It is easier to see than all other colours.
4 It travels faster than all other colours.

8B) What determines the colour of the light from the display?
1 its brightness
2 its frequency
3 its power
4 its speed in a vacuum

8C) The wavelength of red light is 700 nm and the wavelength of violet light is 300 nm.
What is the likely value of the wavelength of the yellow light from the sign?
1 250nm
2 350nm
3 600nm
4 750nm

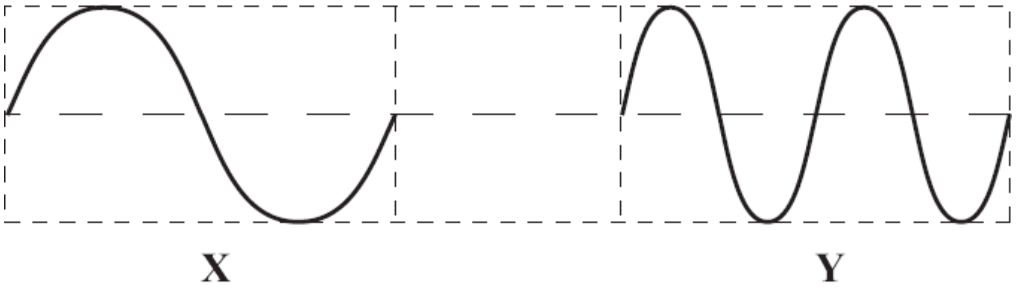
9) The warning sign is switched on by sending a radio signal. The frequency of the signal is 2 000 000 hertz and its wavelength is 150 metres.
A) Calculate the wave speed of the signal in metres/second.

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

1 13 333 m/s
2 1 333 333 m/s
3 300 000 000 m/s
4 3 000 000 000 m/s

10) Which statement about the wavelength of microwaves is correct?
1 longer than both infra red rays and ultraviolet rays
2 longer than infra red rays but shorter than ultraviolet rays
3 shorter than both infra red rays and ultraviolet rays
4 shorter than infra red rays but longer than ultraviolet rays

11) Two electromagnetic waves are shown in the diagrams, which are drawn to the same scale.



Which sentence is correct?
1 The frequency of wave **X** is double that of wave **Y**.
2 The frequency of wave **Y** is double that of wave **X**.
3 The wavelength of wave **Y** is double that of wave **X**.
4 The wavelength of wave **Y** is four times that of wave **X**.

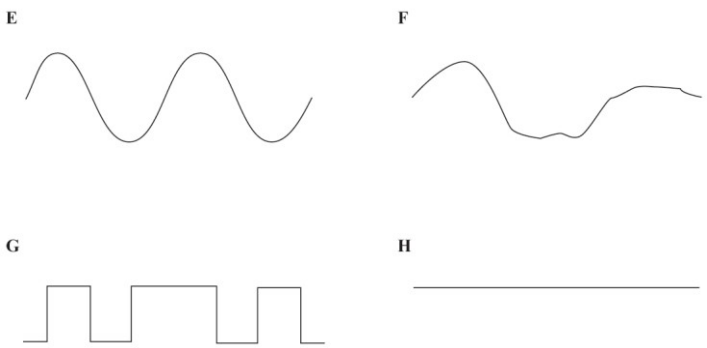
12) A student has been learning about the electromagnetic spectrum.
Which part(s) of the electromagnetic spectrum can be used for communication?
1 radio waves only
2 radio waves and microwaves only
3 radio waves, microwaves and infra red rays only
4 radio waves, microwaves, infra red rays and visible light

13) Waves of the electromagnetic spectrum travel through space.
When they do, which property is the same for all of them?
1 energy
2 penetration
3 power
4 speed

14) The frequency of a radio signal is increased.
Which is correct?
1 Its speed decreases.
2 Its speed increases.
3 Its wavelength decreases.
4 Its wavelength increases.

15) Communication signals are often digital. The diagrams show four signals.

Which two could be digital?
1 **E** and **F**
2 **F** and **G**
3 **G** and **H**
4 **H** and **E**



By the end of this topic I will be able to:

- *Draw diagrams to show how light is reflected from mirrors or other surfaces*
- *Label a ray diagram with the terms incident and reflected ray, angles of incidence and reflection and the normal*
- *Describe how an image is formed by a mirror*
- *Describe how sound is produced*
- *Describe how pitch and frequency affect a sound*
- *Describe how echoes are formed*

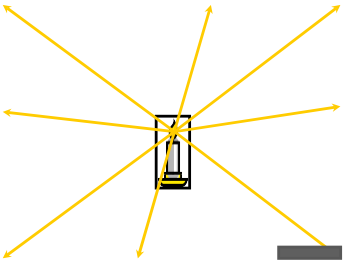
Complete the following summary table:

Light travels in **STRAIGHT** lines.

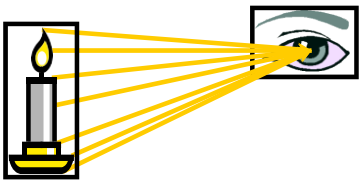
It cannot bend around corners, but it can be **REFLECTED** off almost every surface.

We see because light reflects off objects in front of us and the light enters our eyes.

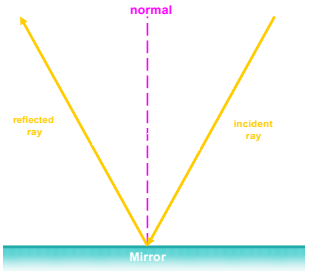
When light hits a plane (flat) mirror, it is reflected off at the **EXACT** angle it hit the mirror with.



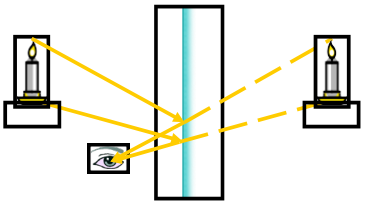
Visible objects EMIT or REFLECT light in all directions.



We see because light converges (comes together) at our eyes.



When light is reflected off a mirror, it hits the mirror at the same angle as it reflects off the mirror.



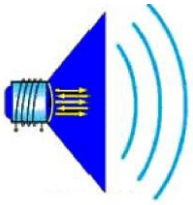
Our eyes believe the light rays came from behind the mirror. Imaginary light rays extend behind the mirror (sight lines).

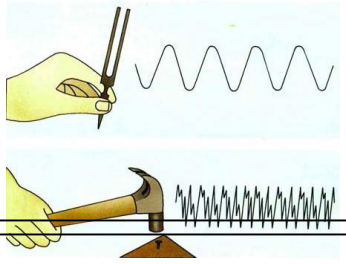
Sound travels as a wave.

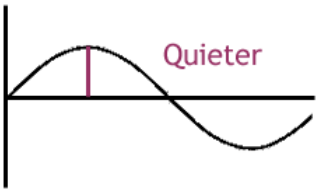
It is caused by objects which **VIBRATE**.

Like light rays, they can be **REFLECTED**.

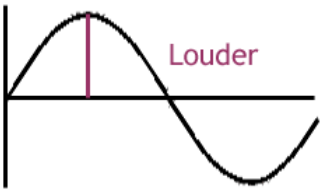
Sound **CANNOT** travel in a vacuum.



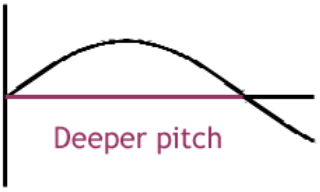




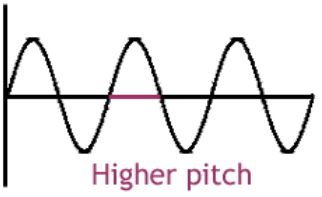
Low amplitude = Quiet sound



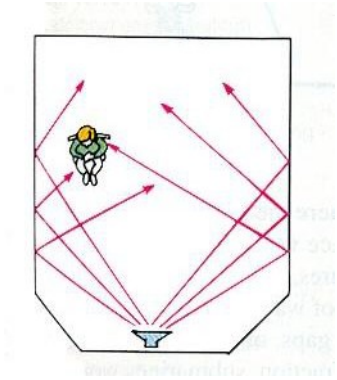
High amplitude = Loud sound



Low frequency = Low pitch



High frequency = High pitch



We hear because sound waves vibrate our ear drums which transmits the waves inside our ears.

Sound can be reflected off surfaces.

Sound travels more slowly than light, so if the reflection takes time to get to our ears, we hear an **ECHO**.

1) Light and sound travel as_____ .

2) Sound is caused by _____.

3) Which cannot travel through a vacuum? _____

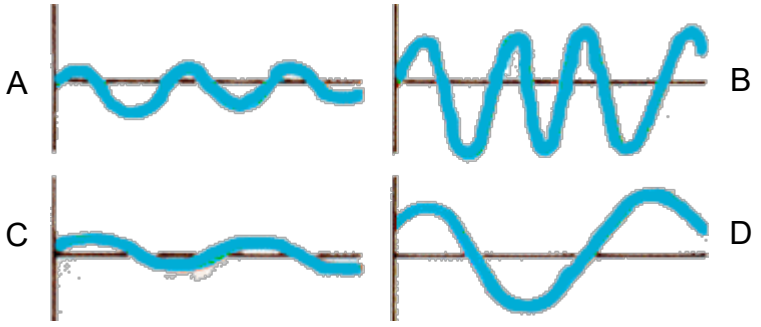
b) Why not? _____

4) When light hits a plane mirror, angle of incidence _____ angle of reflection.

5) In sound, high frequency = _____

b) low amplitude = _____

6) Which of these, a – d, is a high pitched, quiet sound? _____



7) When we see look at an object in a mirror what we're actually seeing is an i_____ .

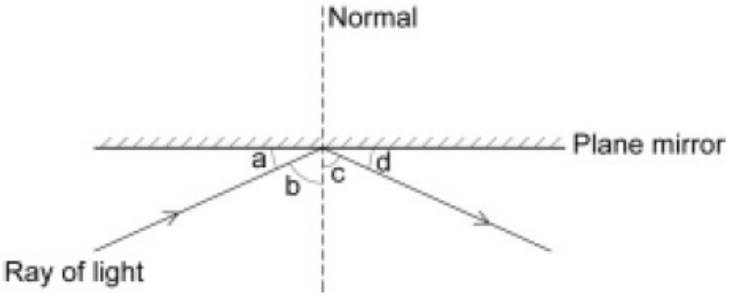
8) All objects which we can see either _____ or _____ light.

9) If you are watching a fireworks display, which will happen first?

- You see the explosion, then hear the explosion
- You hear the explosion, then see the explosion

10) Why does this happen? _____

The diagram shows a ray of light being reflected by a plane mirror.



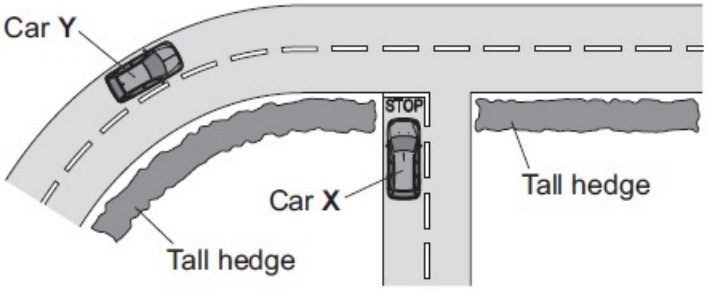
Which of the angles, **a**, **b**, **c** or **d**, is:

the angle of incidence; ☐

the angle of reflection? ☐

(2 marks)

The diagram shows a road junction seen from above.

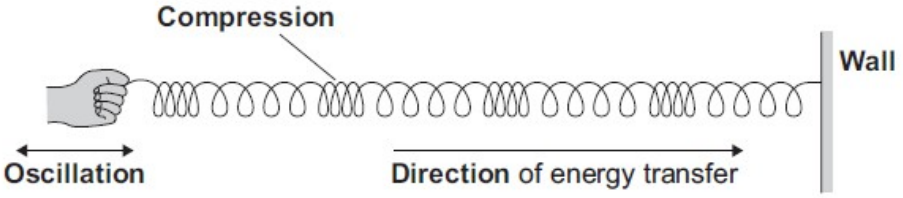


A mirror placed at the side of the road allows the driver of car **X** to see car **Y**.

Using the same mirror symbol given in part (a), draw a plane mirror to show how it should be placed so that the driver of car **X** can see car **Y**.

(2 marks)

The diagram shows a longitudinal wave being produced in a stretched spring.



Use the bold words from the diagram to complete the following sentence. Put only **one** word in each space.

A longitudinal wave is one in which the ..... causing

the wave is parallel to the ..... of energy transfer.

(2 marks)

By the end of this topic I will be able to:

- *Describe the current evidence which supports the Big Bang theory*
- *Explain how red-shift provides evidence for the Big Bang theory*
- *Describe how galaxies that are further away have a bigger red-shift*
- *Describe how galaxies that are moving faster have a bigger red-shift*
- *Describe how cosmic microwave background radiation (CMBR) provides evidence for the Big Bang theory*

Using the notes page fill in the gaps:

We currently believe that the universe is e_____ and the universe began with a b_ b___ . In this big bang we believe that matter and s_____ expanded rapidly from a very small initial point.

We know this because when we look at distant g_____ the light reaching us from them, has a lower f_____ and a larger _____ then we would expect. This is called the r_ shift, because the colour of the light is shifted towards the r_ end of the electromagnetic s_____ . This tells us that these galaxies are moving a_____ from us at great speed and that the universe is e_____ .

There are two pieces of evidence which support the Big Bang theory. They are___ - ____ and_____ (CMBR).

We believe that when the Universe was formed matter and space expanded violently and quickly from a very **small initial point** 13.7 billion years ago – this is called the **Big Bang theory**.

This is the BIG BANG theory

What evidence is there to support the Big Bang theory?

When a wave source is moving and the observer is standing still, there is a change in the observed frequency and wavelength.

This is known as the **Doppler effect**.

The wave sources can be either visible light, microwaves or sound waves.

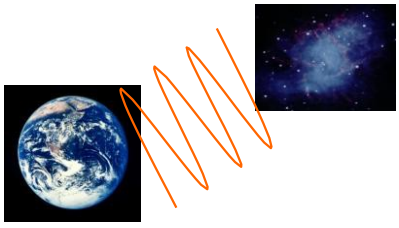
When the source moves **AWAY** from the observer, the wavelength **INCREASES** and frequency **DECREASES**.

When the source moves **TOWARDS** the observer, the wavelength **DECREASES** and frequency **INCREASES**.

Light

When we look at light given off by stars of far away galaxies, we find the **frequency** of the light waves are **slightly lower than we would expect**. This change in frequency tells us that the galaxy is moving away from us at high speed (as the universe continues to expand).

This change in frequency is called the **red shift, because it is shifted toward the red end of the spectrum.**



This is the frequency we would expect.

But because the galaxy is moving away from us, the frequency is lower (wavelength is longer).

This gives the light a colour closer to the red end of the spectrum.

The **FURTHER AWAY** and the **FASTER** a galaxy is moving from us on Earth, the **BIGGER** the red-shift.

Cosmic Microwave Background Radiation (CMBR)

CMBR is from radiation that was present shortly after the beginning of the Universe.

The Big Bang theory is the only theory so far for the start of the Universe which explains the presence of CMBR.

1) What is the name of the theory of how the Universe started which says it started from a very small initial point and exploded outwards? _____

2) What is CMBR? _____

3) What is the name of the effect seen when a wave source moves and the observer stands still?

_____

4) As a wave source moves AWAY, the wavelength _____ and the frequency _____ .

5) As a wave source moves TOWARDS the observer, the wavelength _____ and the frequency_____ .

6) Which piece of evidence supports the Big Bang theory?

- The more distant galaxies are moving the slowest.
- The more distant galaxies are moving the quickest.
- The more distant galaxies are moving towards us.

7) Why is the light from distant galaxies red-shifted?

- They produce more red light than nearby galaxies.
- They are moving away from us.
- The longer wavelengths are filtered out more by dust.

Scientists have observed that the wavelengths of the light given out from galaxies that are moving away from the Earth are longer than expected.

What name is given to this observation?

.....

(1 mark)

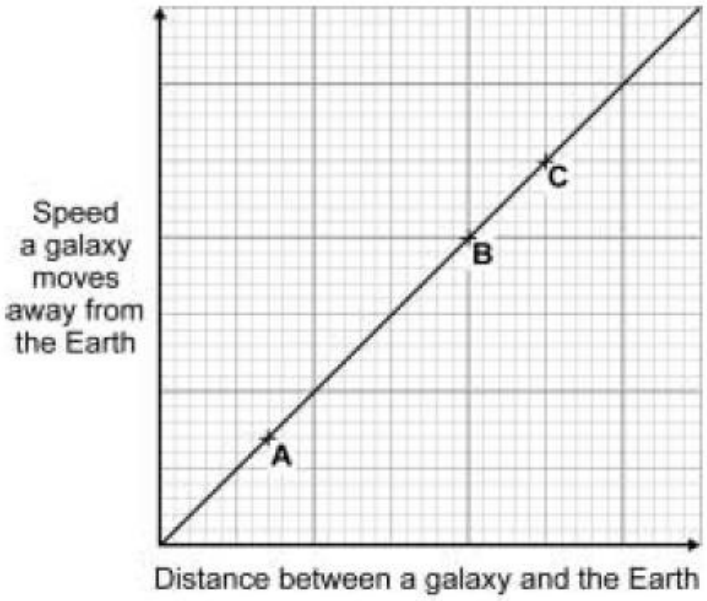
Draw a ring around the correct answer to complete the following sentence.

This observation gives evidence for the idea that the Universe is

shrinking.
not changing.
expanding.

(1 mark)

The graph shows that there is a link between the speed at which a galaxy moves away from the Earth and the distance of the galaxy from the Earth.



The positions of three galaxies, **A**, **B** and **C**, are marked on the graph.

From which galaxy, **A**, **B** or **C**, would the wavelength of the light reaching the Earth seem to have changed the most?

Galaxy .....

Give a reason for your answer.

.....

.....

.....

.....

(2 marks)