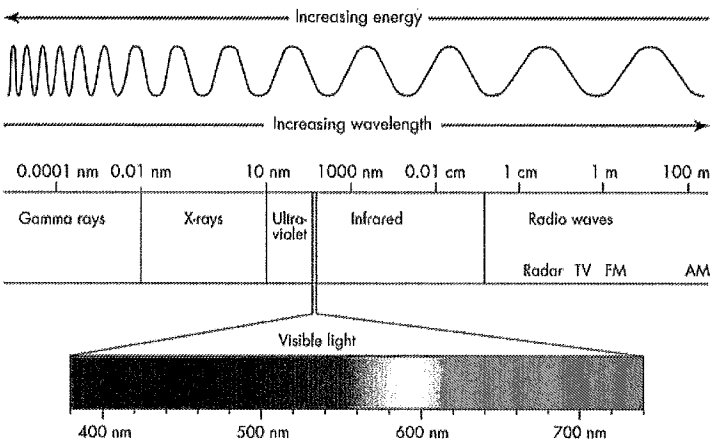
Harris Academy Greenwich

Science

Core Physics

Revision Pack



Student Name: _____

Teacher Name: _____

Unit 1: Physics 1 Tick Sheet

- Tick column A when you have covered the statement in class.
- Tick column B when you feel you understand the statement
- Tick column C when you are confident you can answer any questions on it.
- In your revision for the P1 exam, concentrate most time on those statements **not** ticked.
- Statements in bold can only appear on the Higher tier paper.

P1.1 The transfer of energy by heating processes and the factors that affect the rate at which that energy is transferred	A	B	C
compare ways in which energy is transferred in and out of objects by heating and ways in which the rates of these transfers can be varied			
evaluate the design of everyday appliances that transfer energy by heating, including economic considerations			
evaluate the effectiveness of different types of material used for insulation, including U-values and economic factors including payback time			
evaluate different materials according to their specific heat capacities.			
P1.1.1 Infrared radiation	**A**	**B**	**C**
a) All objects emit and absorb infrared radiation.			
b) The hotter an object is the more infrared radiation it radiates in a given time.			
c) Dark, matt surfaces are good absorbers and good emitters of infrared radiation.			
d) Light, shiny surfaces are poor absorbers and poor emitters of infrared radiation.			
e) Light, shiny surfaces are good reflectors of infrared radiation			
P1.1.2 Kinetic theory	**A**	**B**	**C**
a) The use of kinetic theory to explain the different states of matter.			
b) The particles of solids, liquids and gases have different amounts of energy.			
P1.1.3 Energy transfer by heating	**A**	**B**	**C**
a) The transfer of energy by conduction, convection, evaporation and condensation involves particles, and how this transfer takes place.			
b) The factors that affect the rate of evaporation and condensation.			
c) The rate at which an object transfers energy by heating depends on: ■ surface area and volume ■ the material from which the object is made ■ the nature of the surface with which the object is in contact.			
d) The bigger the temperature difference between an object and its surroundings, the faster the rate at which energy is transferred by heating.			
P1.1.4 Heating and insulating buildings	**A**	**B**	**C**
a) U-values measure how effective a material is as an insulator.			
b) The lower the U-value, the better the material is as an insulator.			
c) Solar panels may contain water that is heated by radiation from the Sun. This water may then be used to heat buildings or provide domestic hot water.			
d) The specific heat capacity of a substance is the amount of energy required to change the temperature of one kilogram of the substance by one degree Celsius. *Energy transferred = mass x specific heat capacity x temperature change* $E = m \times c \times \theta$			
P1.2 Energy and efficiency	**A**	**B**	**C**
compare the efficiency and cost effectiveness of methods used to reduce 'energy consumption'			
describe the energy transfers and the main energy wastages that occur with a range of appliances			

interpret and draw a Sankey diagram.			
P1.2.1 Energy transfers and efficiency	**A**	**B**	**C**
a) Energy can be transferred usefully, stored, or dissipated, but cannot be created or destroyed.			
b) When energy is transferred only part of it may be usefully transferred, the rest is 'wasted'.			
c) Wasted energy is eventually transferred to the surroundings, which become warmer. The wasted energy becomes increasingly spread out and so becomes less useful.			
d) To calculate the efficiency of a device using: efficiency = $\frac{\text{useful energy out}}{\text{total energy in}}$ X 100% efficiency = $\frac{\text{useful power out}}{\text{total power in}}$ X 100%			
P1.3 The usefulness of electrical appliances	**A**	**B**	**C**
compare the advantages and disadvantages of using different electrical appliances for a particular application			
consider the implications of instances when electricity is not available.			
P1.3.1 Transferring electrical energy	**A**	**B**	**C**
a) Examples of energy transfers that everyday electrical appliances are designed to bring about.			
b) The amount of energy an appliance transfers depends on how long the appliance is switched on and its power.			
c) To calculate the amount of energy transferred from the mains using: Energy transferred = power x time E = P x t			
d) To calculate the cost of mains electricity given the cost per kilowatt-hour.			
P1.4 Methods we use to generate electricity	**A**	**B**	**C**
evaluate different methods of generating electricity			
evaluate ways of matching supply with demand, either by increasing supply or decreasing demand			
compare the advantages and disadvantages of overhead power lines and underground cables.			
P1.4.1 Generating electricity	**A**	**B**	**C**
a) In some power stations an energy source is used to heat water. The steam produced drives a turbine that is coupled to an electrical generator. Energy sources include: ■ the fossil fuels (coal, oil and gas) which are burned to heat water or air ■ uranium and plutonium, when energy from nuclear fission is used to heat water ■ biofuels that can be burned to heat water.			
b) Water and wind can be used to drive turbines directly.			
c) Electricity can be produced directly from the Sun's radiation.			
d) 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.			
e) Small-scale production of electricity may be useful in some areas and for some uses, e.g. hydroelectricity in remote areas and solar cells for roadside signs.			
f) Using different energy resources has different effects on the environment. These effects include: ■ the release of substances into the atmosphere ■ the production of waste materials ■ noise and visual pollution ■ the destruction of wildlife habitats.			

P1.4.2 The National Grid	A	B	C
a) Electricity is distributed from power stations to consumers along the National Grid.			
b) For a given power increasing the voltage reduces the current required and this reduces the energy losses in the cables.			
c) The uses of step-up and step-down transformers in the National Grid.			
P1.5 The use of waves for communication and to provide evidence that the universe is expanding	A	B	C
compare the use of different types of waves for communication			
evaluate the possible risks involving the use of mobile phones			
consider the limitations of the model that scientists use to explain how the universe began and why the universe continues to expand.			
P1.5.1 General properties of waves	A	B	C
a) Waves transfer energy.			
b) Waves may be either transverse or longitudinal.			
c) Electromagnetic waves are transverse, sound waves are longitudinal and mechanical waves may be either transverse or longitudinal.			
d) All types of electromagnetic waves travel at the same speed through a vacuum (space).			
e) Electromagnetic waves form a continuous spectrum.			
f) Longitudinal waves show areas of compression and rarefaction.			
g) Waves can be reflected, refracted and diffracted.			
h) Waves undergo a change of direction when they are refracted at an interface.			
i) The terms frequency, wavelength and amplitude.			
j) All waves obey the wave equation: $v = f \times \lambda$			
k) Radio waves, microwaves, infrared and visible light can be used for communication.			
P1.5.2 Reflection	A	B	C
a) The normal is a construction line perpendicular to the reflecting surface at the point of incidence			
b) The angle of incidence is equal to the angle of reflection.			
c) The image produced in a plane mirror is virtual, upright and laterally inverted.			
P1.5.3 Sound	A	B	C
a) Sound waves are longitudinal waves and cause vibrations in a medium, which are detected as sound.			
b) The pitch of a sound is determined by its frequency and loudness by its amplitude.			
c) Echoes are reflections of sounds.			
P1.5.4 Red-shift	A	B	C
a) If a wave source is moving relative to an observer there will be a change in the observed wavelength and frequency. This is known as the Doppler effect.			
b) There is an observed increase in the wavelength of light from most distant galaxies. The further away the galaxies are, the faster they are moving, and the bigger the observed increase in wavelength. This effect is called red-shift.			
c) How the observed red-shift provides evidence that the universe is expanding and supports the 'Big Bang' theory (that the universe began from a very small initial point).			
d) Cosmic microwave background radiation (CMBR) is a form of electromagnetic radiation filling the universe. It comes from radiation that was present shortly after the beginning of the universe.			
e) The 'Big Bang' theory is currently the only theory that can explain the existence of CMBR.			

Physics Unit 1 Revision

Energy

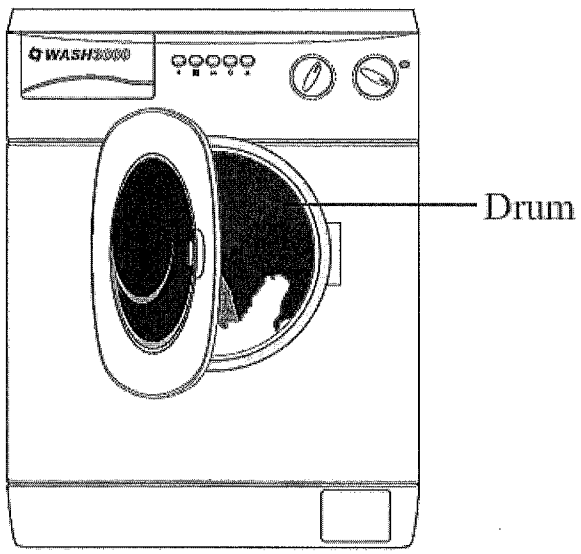
There are 9 different forms of energy:

Light Heat Chemical Kinetic (movement) Electrical
Elastic (Gravitational) potential Nuclear Sound

Energy is never created or destroyed! Energy is transferred from one form to another form. Not all of the energy transferred by a device is useful energy. Potential energy is stored energy. All energy will eventually spread out to the surroundings as heat.

Sample question 1

The picture shows a new washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



(a) Complete the following sentences.

(a) (i) An electric motor is designed to transform electrical energy into

..... energy.

(1 mark)

(a) (ii) Some of the electrical energy supplied to the motor is wasted as

..... energy and ..... energy.

(1 mark)

(b) What happens to the energy wasted by the electric motor?

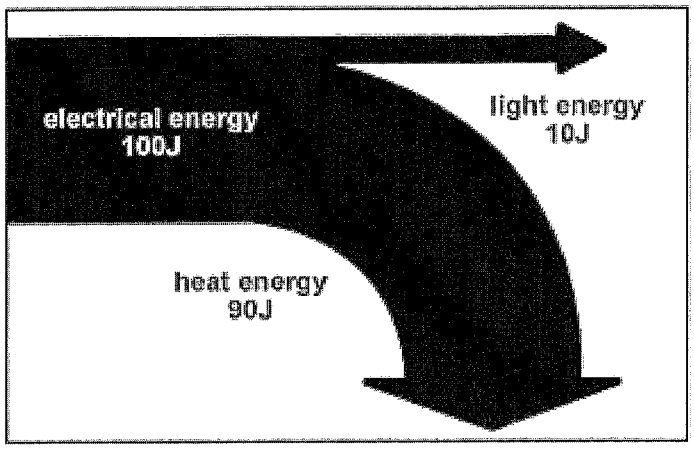
.....

.....

(1 mark)

Sankey diagrams and efficiency

Sankey diagrams are ways of representing the different energy transformations that take place in different electrical devices. The start of the sankey diagram shows the total energy going into the device. The diagram then splits off into different sized arrows to represent the other energy transfers that take place, the bigger the arrow the larger the energy. The energy entering the device must equal the energy leaving the device.



Sample sankey diagram for a light bulb

To know how good a device is at transferring energy you need to be able to calculate the efficiency. To do that you need to use the following equation (which will be given in the exam)

$$Efficiency = \frac{Useful\ energy\ out}{Total\ energy\ in}$$

OR

$$Efficiency = \frac{Useful\ power\ out}{Total\ power\ in}$$

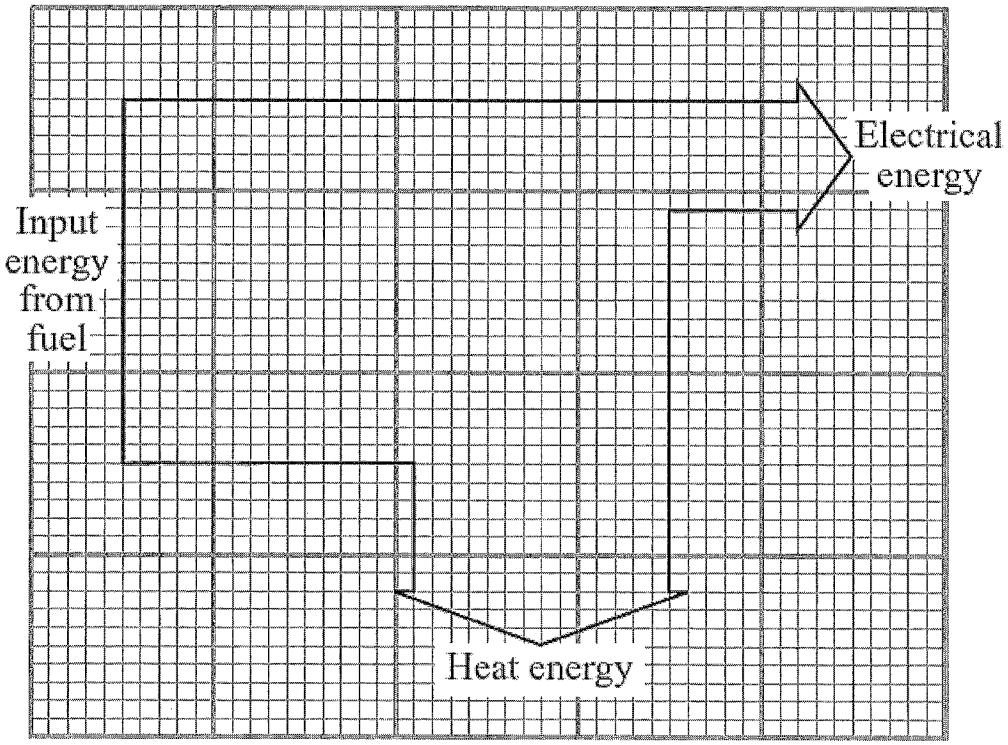
So for the above example the answer would be

$$Efficiency = \frac{10}{100} = 0.1$$

The closer the efficiency is to 1 the more useful energy the device is transferring. So for the light bulb example we got an efficiency of 0.1, so the light bulb isn't very good and transferring useful energy.

Sample question 2

(a) The diagram shows the energy transformations in a fuel burning power station.



(ii) Use the diagram and the equation in the box to calculate the efficiency of the power station.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

.....

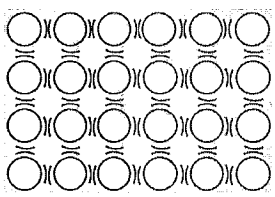
.....

Efficiency = ...

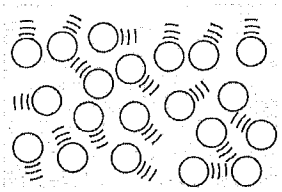
(2 marks)

Kinetic theory

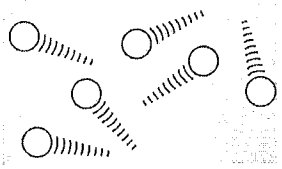
Most matter or substances can be classed as being solids, liquids or gases.



Solids: They have the least amount of energy are arranged in a pattern. They vibrate around fixed positions



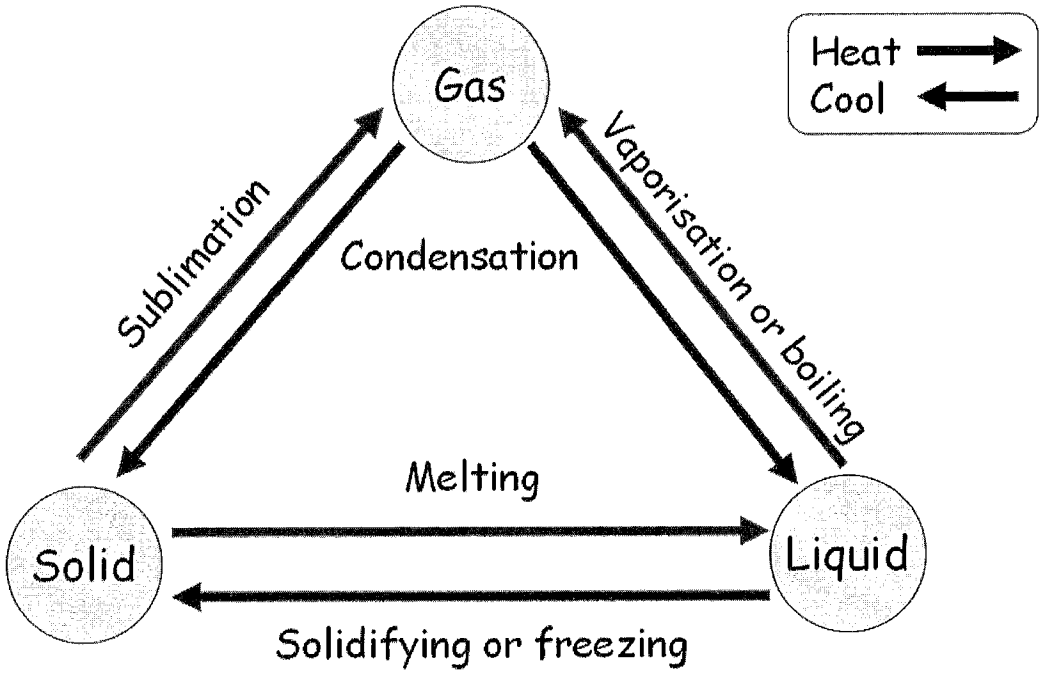
Liquids: The particles are closely packed together but can move about freely over one another.



Gases: They have the most amount of energy and move around at high speeds and can collide with one another.

	Flow	Shape	Volume	Density
Solid	no	fixed	fixed	much higher than a gas
Liquid	yes	fits container shape	fixed	much higher than a gas
Gas	yes	fills container	can be changed	low compared with a solid or liquid

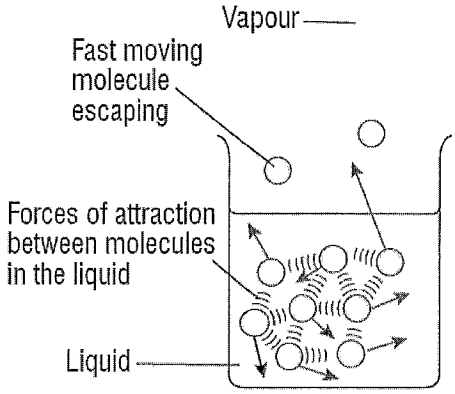
Matter can also change from one state to another e.g. ice to water to water vapour.



Evaporation and condensation

There are 3 things that can cause evaporation to happen quicker

- A larger temperature
- A larger surface area
- A draught of air moving over the surface



Evaporation has a cooling effect

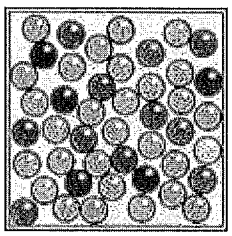
There are attractive forces between the particles in the liquid. Evaporation happens when the liquid particles that have the most kinetic energy break away from the attractive forces. These particles escape from the surface of the liquid and enter the air. This makes the average kinetic energy of the remaining particles less and the temperature goes down.

Condensation is when a liquid turns to a gas, like water forming on a cold window. The rate of condensation can be increased by 2 things

- Bigger surface area
- Reducing the surface temperature

Sample question 3

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)

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

(1)

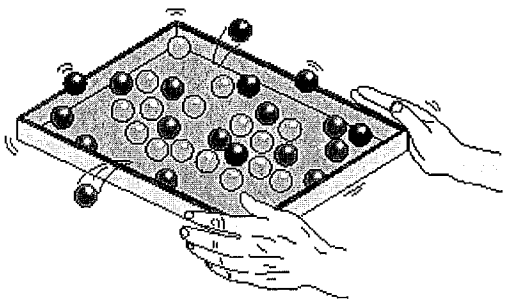
(c) The particles in a ..... are arranged in a pattern.

(1)

(Total 3 marks)

Sample question 4

(a) The diagram shows a tray of marbles being shaken from side to side. As this happens some of the marbles jump out of the tray.



Explain how the tray of marbles is acting as a model for the evaporation of a liquid.

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(2)

(b) Before giving an injection, a nurse dabs some alcohol onto the patient's arm. This makes the patient's skin feel cold.

Explain what happens to make the patient's skin feel cold.

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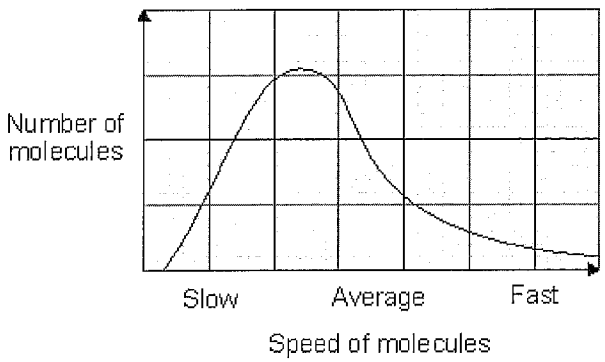
(2)

(c) The graph shows that the molecules in a liquid do not all have the same speed.



Use the information in the graph to explain why a liquid cools down when it evaporates.

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(5)

(Total 9 marks)

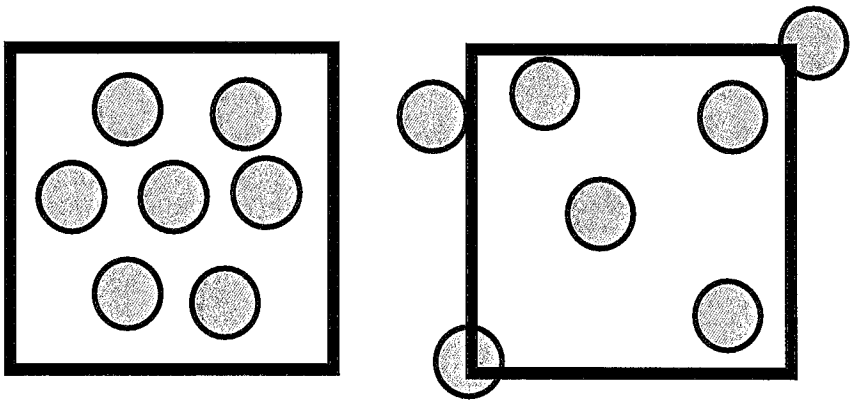
Heat transfer

Heat can be transferred quicker if the temperature difference between the substance and surroundings is greater.

Heat can be transfer by 3 methods

Conduction: Occurs in solids and felt by direct physical contact. The heat travels by the vibration of the atoms. In metals, the heat also moves by the movement of free electrons or ions. Heat flows from the warm area to the cold area.

Convection: Occurs in liquids and gases. This happens because when an area gets hotter the particles move further apart, i.e. that area expands. This makes that area less dense and lighter than the surroundings so it rises. When it then starts to cool that particles move closer together again and it will fall. In short the hotter section expands and rises, the cool part falls. This motion is called convection currents.



Before being heated After being heated

Radiation: All objects do it. It can travel through empty space (vacuum) and travels in waves. This heat radiation is called infrared radiation. Black matt objects are good absorbers and emitters of radiation but light reflective surfaces are bad absorbers and emitters of radiation. Large surface areas radiate heat quicker

Insulation

You can prevent heat loss from objects by using insulation. Air and other gases are bad conductors of heat but make good insulators. For convection you must stop the heat from rising e.g. using a lid.

Trapped air helps to prevent heat loss by conduction and convection. A vacuum (empty space with no particles) also stops conduction and convection as those methods need particles to transfer heat

Radiation can be reduced by using light reflective surfaces.

House insulation: There are different types of insulation for the home e.g. loft insulation, double glazing, cavity wall insulation etc. House insulation is given a rating to determine how good it is at insulating.

This rating is called the **U-Value**; the **lower** the u-value, the **better** it is at insulating.

For example: If 2 types of double glazing windows have U-values of 2.8 and 1.6, the better type to choose is the U-value of 1.6 as it is a better insulator

Pay back time: This is the amount of time it takes you to save back on your energy bills the money spent on the insulation

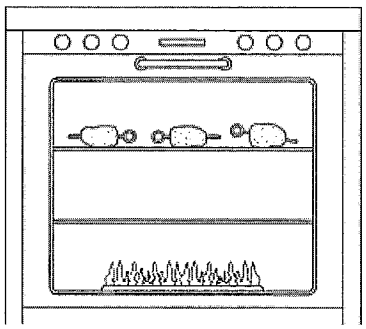
$$Pay\ back\ time = \frac{Cost\ of\ insulation}{Energy\ bill\ saving}$$

For example: if double glazing costs £150 but you save £50 per year on your energy bill then the pay back time is 3 years

$$Pay\ back\ time = \frac{£150}{£50} = 3\ years$$

Sample question 5

The diagram shows potatoes being baked in a gas oven. Each potato has a metal skewer pushed through it.



(a) Explain how heat is transferred by the process of convection from the gas flame at the bottom of the oven to the potatoes at the top of the oven.

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(3 marks)

(b) The metal skewers help the potatoes to cook by transferring heat to the inside of the potatoes.

By what method is heat transferred through a metal skewer?

..... *(1 mark)*

(c) When the potatoes are taken from the oven, they start to cool down.

Suggest **one** factor that will affect how fast a potato cools down.

.....

(1 mark)

(d) If the potatoes need to be kept hot, they may be wrapped in shiny aluminium foil.

Why does this help to keep the potatoes hot?

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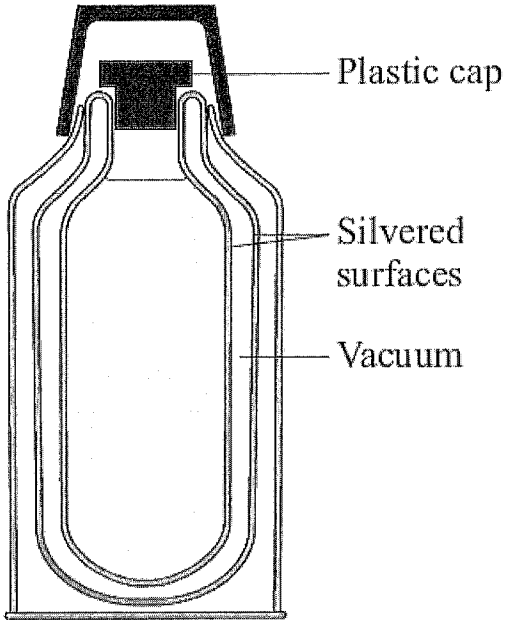
(1 mark)

Sample Question 6

A vacuum flask is designed to reduce the rate of heat transfer.



(a) (i) Complete the table to show which methods of heat transfer are reduced by each of the features labelled in the diagram.

The first row has been done for you.

Feature	Conduction	Convection	Radiation
vacuum	✓	✓	
silvered surfaces			
plastic cap			

(2 marks)

(a) (ii) Explain why the vacuum between the glass walls of the flask reduces heat transfer by conduction and convection.

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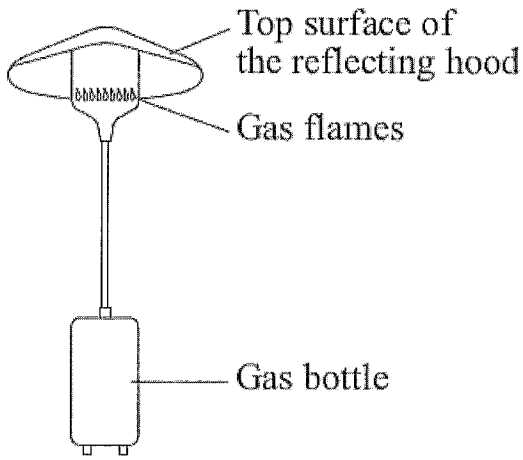
(2 marks)

(b) The diagram shows a gas flame patio heater.



(b) (i) Explain why the top surface of the reflecting hood should be a light, shiny surface rather than a dark, matt surface.

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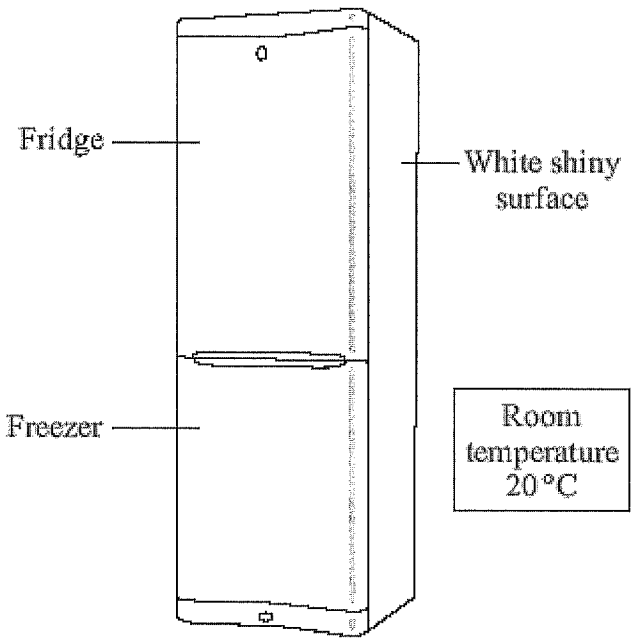
(2 marks)

Sample Question 7

The diagram shows a fridge-freezer.



(a) By which method is heat transferred through the walls of the fridge-freezer?

.....

(1)

(b) The inside of the fridge is at 4 °C. The inside of the freezer is at –18 °C.

Into which part of the fridge-freezer will the rate of heat transfer be greater?

Draw a ring around your answer.

the fridge **the freezer**

Give a reason for your answer.

.....

.....

(1)

(c) The outside surface of the fridge-freezer is white and shiny.

Give **two** reasons why this type of surface is suitable for a fridge-freezer.

1 .....

.....

2 .....

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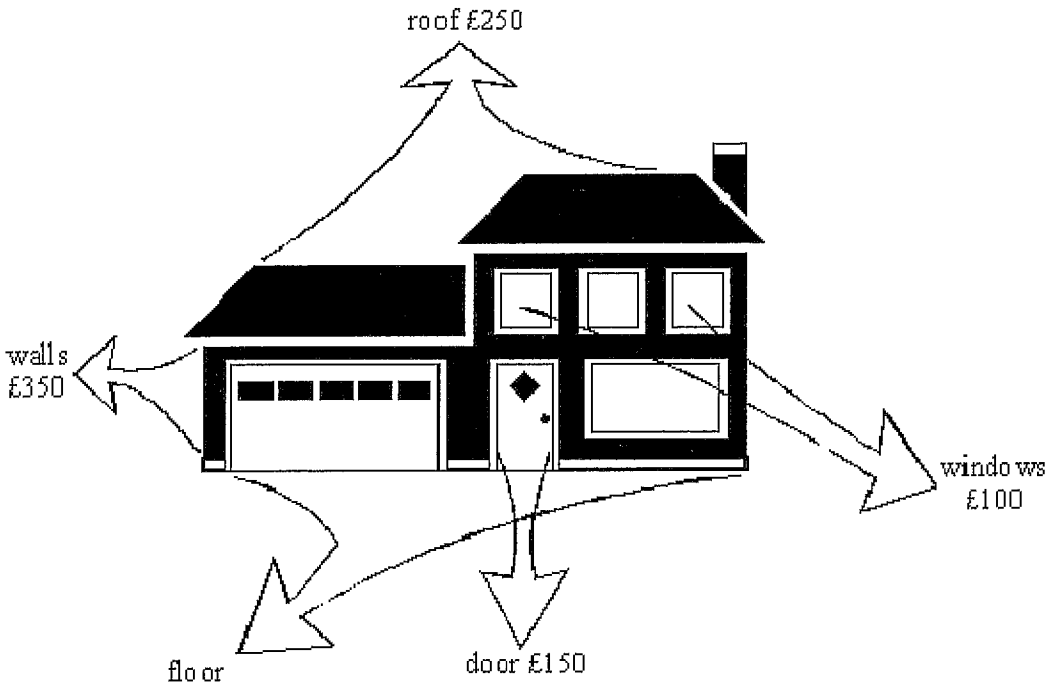
(2)
(Total 4 marks)

Sample Question 8

The diagram below shows a house which has **not** been insulated. The cost of the energy lost from different parts of the house during one year is shown on the diagram.



(a) The total cost of the energy lost during one year is £1000.

(i) What is the cost of the energy lost through the floor?

.....

(2)

(ii) Suggest one way of reducing this loss.

.....

(1)

(b) The table below shows how some parts of the house may be insulated to reduce energy losses. The cost of each method of insulation is also given.

WHERE LOST	COST OF ENERGY LOST PER YEAR (£)	METOD OF INSULATION	COST OF INSULATION (£)
roof	250	fibre-glass in loft	300
walls	350	foam filled cavity	800
windows	100	double glazing	4500
doors	150	draught proofing	5

(i) Which method of insulation would you install first? Explain why.

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(3)

(ii) Which method of insulation would you install last? Explain why.

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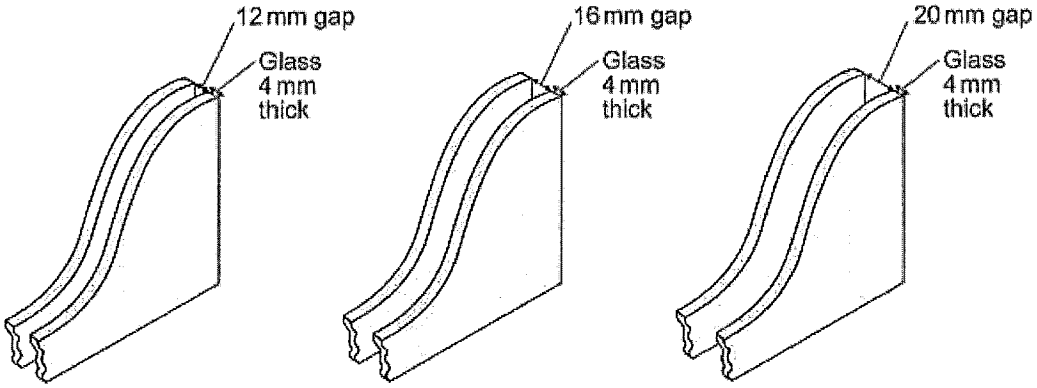
(3)

(Total 9 marks)

Sample Question 9

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)

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

.....

(1)

(c) A householder is going to buy new windows. The sales assistant recommends that the householder buys windows with a 20 mm gap. These windows are much more expensive than those with a 16 mm gap.

It is **not** worth the householder paying the extra cost to buy 20 mm windows rather than 16 mm windows.

Explain this in terms of energy efficiency.

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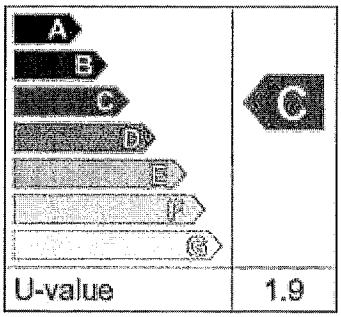
(2)

(d) Windows are given an energy rating, from **A** down to **G**. The diagram shows the energy label from one type of double glazed window.



All new double glazed windows must have an energy rating of **C** or above.
Windows having a **C rating** have a U-value of 1.9.

Which windows given in the table would the householder be **unable** to buy?

.....

(1)
(Total 5 marks)

Specific heat capacity

Specific heat capacity is the amount of energy needed to raise the temperature of a 1 kilogram substance by 1°C. If an object has a low specific heat capacity then it is quick to heat up, if it has a large specific heat capacity then it will take longer to heat up as it needed more energy.

$$Energy\,(J) = mass\,(kg) \times specific\,heat\,capacity\,(J/kg\,°C) \times temperature\,change\,(°C)$$

Example: If 10kg water is heated from 20°C to 30°C, how much energy has it gained if the specific heat capacity is 4200 J/kg °C ?

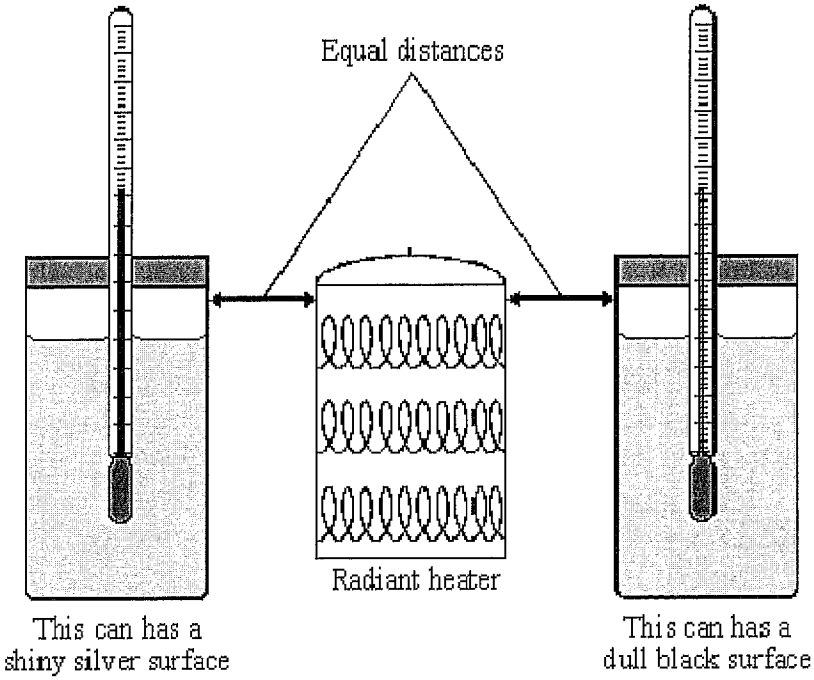
Temperature change = 30 - 20 = 10°C

Mass = 10kg

$$Energy = 10 \times 4200 \times 10$$
$$Energy = 420000J$$

Sample Question 10

A student did two experiments on radiation. The apparatus he used is shown in the diagram.



(a) Which coloured surface heated up quicker and explain your answer?

.....

.....

.....

[2]

(b) The water in the can with the dull black surface began at 20°C and rose to 80°C. The mass of water in the can is 100g. Calculate the energy gained by the water.

Specific heat capacity of water is 4200 J/kg °C

.....

.....

.....

.....

.....

.....

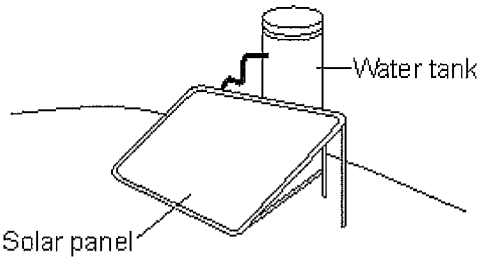
Answer: .....

[4]

(Total 6 marks)

Sample Question 11

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.



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

.....

.....

.....

.....

(2)

(b) Each day the average European family uses 100 kg of hot water.
To kill bacteria, the water going into the tank at 20 °C must be heated to 60 °C.

Calculate the energy needed to increase the temperature of 100 kg of water by 40 °C.

Specific heat capacity of water = 4200 J/kg °C.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

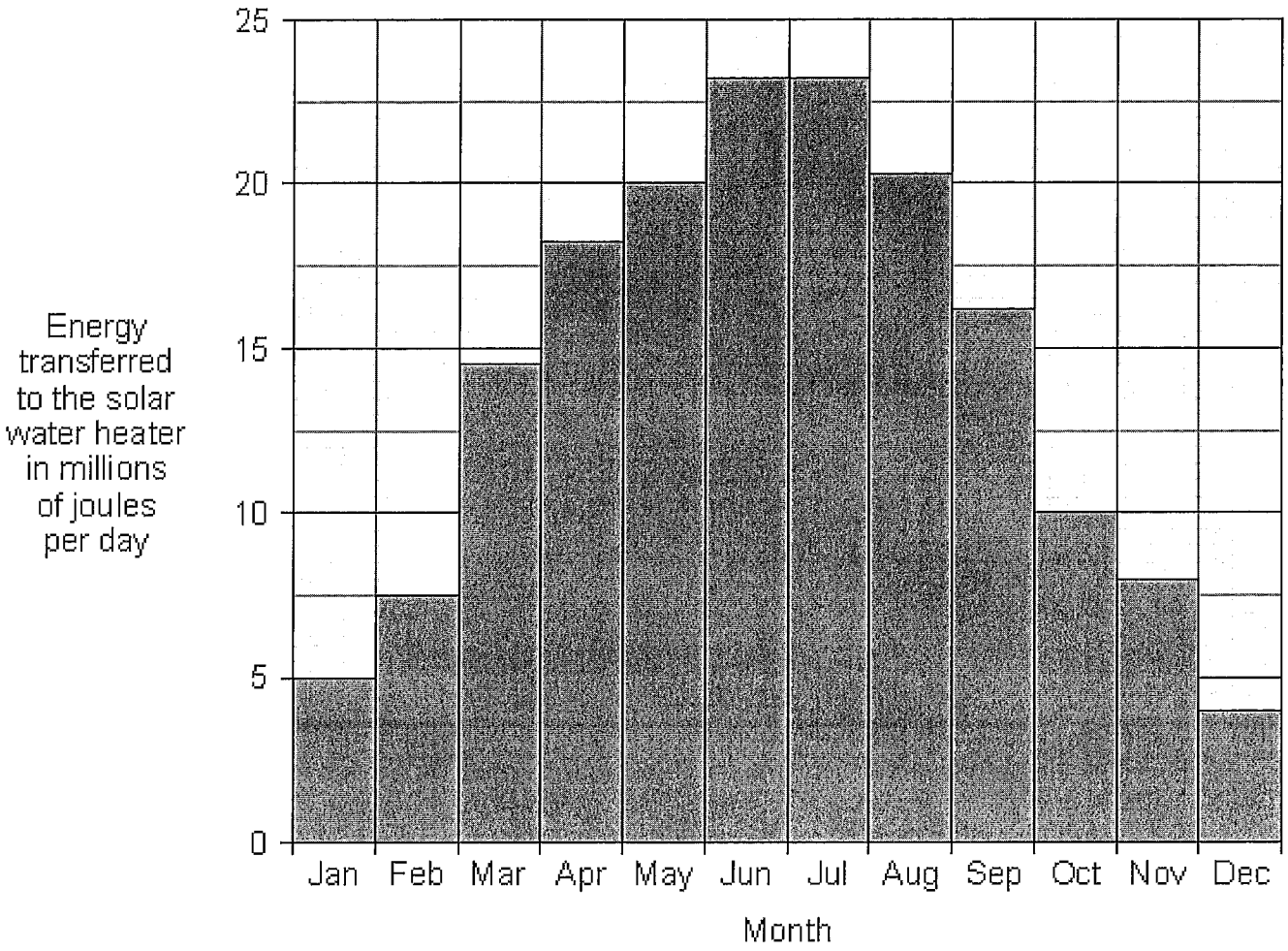
.....

.....

Energy transferred = ... J

(2)

(c) The bar chart shows how the amount of solar energy transferred to the water heater varies throughout the year.



How many months each year will there **not** be enough solar energy to provide the hot water used by an average European family?

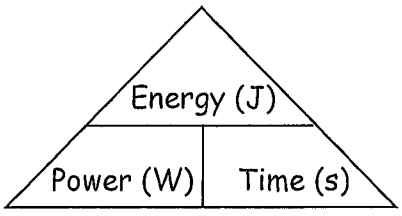
..... months

(1)

Power and electricity bills

Power is measured in watts (W) and it is the amount of energy transferred in one second. So a 60W bulb transfers 60 Joules of energy every second.

$$Power\ (W) = \frac{Energy\ (J)}{Time\ (s)}$$



To know how much electrical energy you have used, you need to multiple the power of the device by the number of hours it has been on for. So if the bulb has been on for 5 hours then it has use 300 Watt-hours of energy. However, the electricity companies use kilowatt-hours (kWh) to work out your bill.

$$Units\ of\ electricity\ used\ (kWh) = Power\ (kW) \times time\ (hours)$$

$$1\ kilowatt.hour = 1000\ Watt.hours \qquad 1\ Watt.hour = \frac{1}{1000}\ kilowatt.hour$$

So the bulb would then have used 0.3 kilowatt-hours of electrical energy. Electricity companies charge you for every kilowatt-hour of electricity you use.

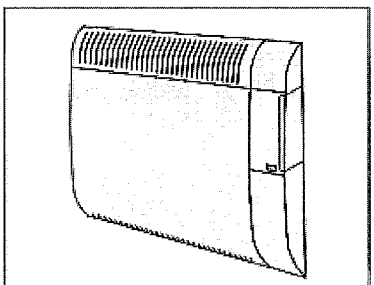
$$Cost = Electrical\ energy\ used\ (kilowatt.hours) \times cost\ per\ kilowatt.hour$$

So, for example, if an electricity company changes you 10p per kilowatt-hour of electricity used then the bulb has cost you:

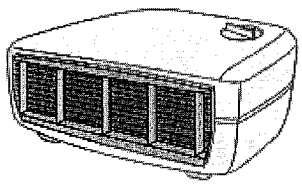
$$Cost\ of\ electricity = 0.3\ kilowatt.hours \times 10p = 3p$$

Sample Question 12

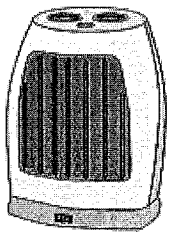
The pictures show three different types of electric heater.



400W oil-filled panel heater (wall mounted)
- 3 heat settings
- Efficient background heat
- Safety overheat cut-out



3kW fan heater
- 2 heat settings
- Power indicator light
- Cool air fan setting



1800W ceramic heater
- 2 heat settings
- 8 hour timer
- Power indicator light
- Safety overheat cut-out

(a) The ceramic heater is run on full power for 5 hours.

Use the following equation to calculate, in kilowatt-hours, the amount of energy transferred from the mains to the heater.

energy transferred = power × time

Show clearly how you work out your answer.

.....

.....

Energy transferred = ... kilowatt-hours

(2)

(b) Which heater will be the most expensive to run on its highest heat setting?

.....

(1)

(c) A heater is needed for a small office.

Comparing each type of heater with the other two, give **one** advantage of using each type of heater in the office.

oil-filled panel heater .....

.....

fan heater .....

.....

ceramic heater .....

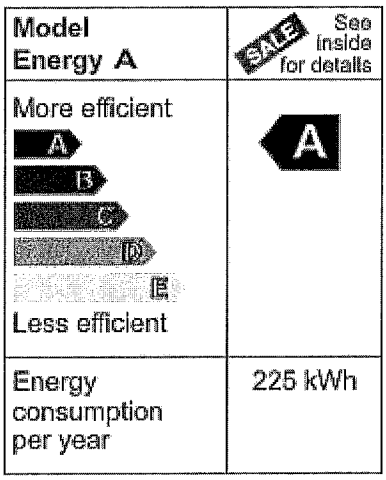
.....

(3)

(Total 6 marks

Sample Question 13

The diagram shows the label from a new freezer.



(a) An old freezer has an energy consumption per year of 350 kWh.

Use the equation in the box to calculate the extra cost of using the old freezer for one year compared with using a new 'A' rated freezer.

total cost = number of kilowatt-hours × cost per kilowatt-hour

Assume 1 kilowatt-hour (kWh) of energy costs 12 p.

Show clearly how you work out your answer.

.....

.....

Extra cost per year = £ .....

(2)

(b) The price of the new freezer was reduced in a sale.

Reducing the price reduces the payback time for replacing the old freezer from 12 years to 9 years.

Calculate, in pounds, how much the new freezer was reduced in the sale.

Show clearly how you work out your answer.

.....

.....

Price reduced by = £ .....

(2)

(c) An advertisement in a shop claims that:

'Replacing an old freezer with a new 'A' rated freezer will benefit the environment.'

Do you agree that replacing the freezer will benefit the environment?

Answer yes or no. .....

Explain the reasons for your answer.

.....

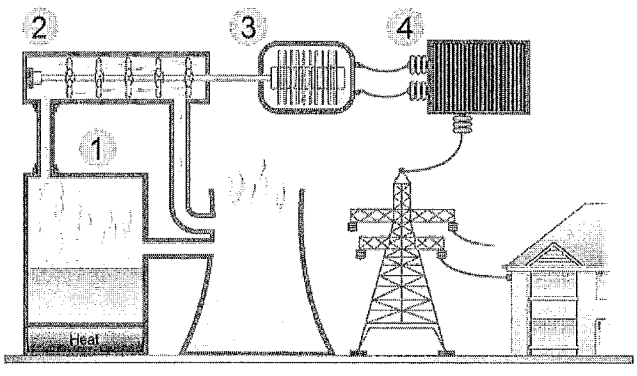
.....

.....

.....

(2)
(Total 6 marks

Generating Electricity

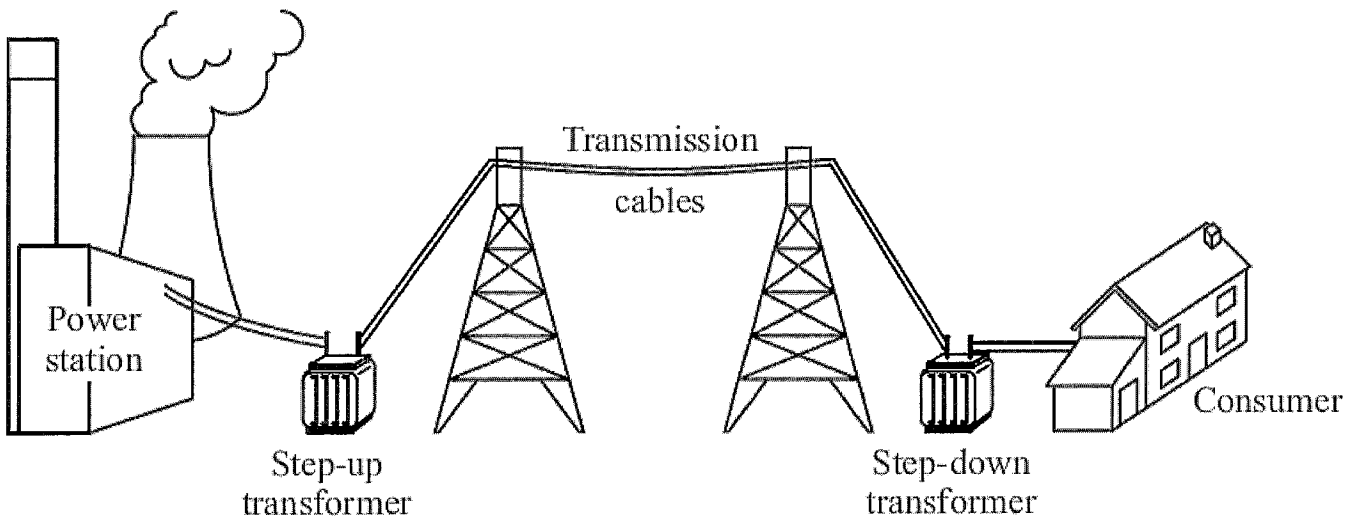


The way electricity is generated is by burning fuels to heat water. This water then turns to steam (1). The steam then spins the turbine (2) which is connected to a generator (3). The generator creates electricity and travels to a transformer where the voltage is "stepped up" or increased (4). The electricity then travels down the electrical lines and then gets stepped down by another transformer and enters the home.

Transformers: When electricity travels down the power lines some of the energy is lost as heat because of friction. If the current was increased then even more energy would be lost as heat (think about when you rub your hands together really fast). So step up transformers are used to increase the voltage (not the current) before it travels down the line, it then gets stepped down at the other end.

Sample Question 14

3 The diagram shows how electricity is distributed from power stations to consumers.



(a) (i) What name is given to the network of cables and transformers that links power stations to consumers?

.....

(1 mark)

(ii) What does a step-up transformer do?

.....

(1 mark)

(iii) Explain why step-up transformers are used in the electricity distribution system.

.....

.....

.....

.....

(2 marks)

Energy resources

Electricity can be generated from several different resources such as wind, water, fossil fuels, light, biomass and nuclear. Some are renewable (can be used again) and other are non renewable.
Fossil fuels are fuels which were made from plants and animals that lived millions of years ago. Examples of these fuels are coal, oil and gas.

Fossil fuels need to be burned in order to be used to generate electricity. This is also true for biomass. The other energy resources don't require combustion to work but they do involve making a turbine spin except for solar. For solar energy the light gets converted directly into electricity.

Energy type	Renewable	Causes acid rain	Causes global warming	Reliable (will always work)	Other info
Wind	YES	NO	NO	NO	Free energy source
Wave	YES	NO	NO	NO	Free energy source
Solar	YES	NO	NO	NO	Free energy source
Geothermal	YES	NO	NO	NO	Free energy source, Creates steam
Fossil fuels	NO	YES	YES	YES	Needs burning
Nuclear-fuel is uranium/plutonium	NO	NO	NO	YES	High decommissioning (dismantle and remove radioactive waste) costs, produces radioactive waste, no other pollution
Hydroelectric	YES	NO	NO	YES	Free energy source, Good for sudden electricity demand
Biomass	YES	NO	YES	YES	Free energy source
Tidal	YES	NO	NO	YES	Free energy source

Sample Question 15

(a) Solar energy is a *renewable* energy source that can be used to generate electricity.

(a) (i) What is meant by an energy source being *renewable*?

.....

(1 mark)

(a) (ii) Name **two** further renewable energy sources used to generate electricity.

1 .....

2 .....

(1 mark)

Sample Question 16

Over the next 15 years, some of the older nuclear power stations will be closed down, and the process of *decommissioning* will start. In the same period, several countries plan to build a number of new nuclear power stations.

(a) (i) What does it mean to *decommission* a nuclear power station?

.....

.....

(1 mark)

(a) (ii) How does *decommissioning* affect the overall cost of electricity generated using nuclear fuels?

.....

.....

(1 mark)

Sample Question 17

(b) By 2020, most of the UK's nuclear reactors and one-third of coal-fired power stations are due to close, yet the demand for electricity is expected to increase.

Four students, **A**, **B**, **C** and **D**, were asked how a demand of 380 billion kilowatt-hours could be met. They made the suggestions given in the table.

Student	Fossil fuels	Nuclear	Renewable	Bought from other countries
A	200	100	40	40
B	80	240	40	20
C	160	80	100	40
D	280	0	100	0

(b) (i) Which student has made the suggestion most likely to result in the lowest carbon dioxide emissions?

.....

Give a reason for your answer.

.....

.....

(2 marks)

(b) (ii) Suggest **one** realistic way in which a householder could help to reduce the annual electricity demand.

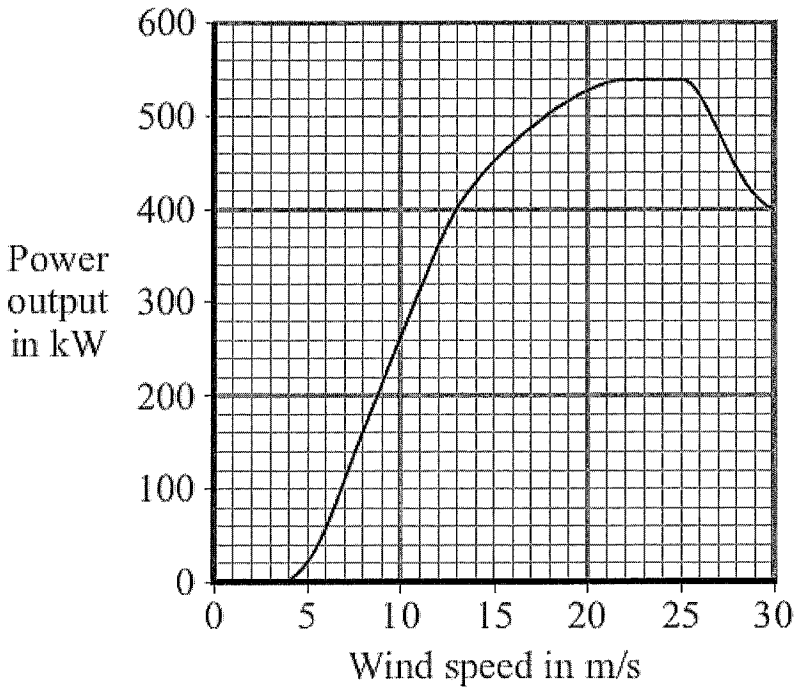
.....

.....

(1 mark)

(c) To increase the amount of electricity generated using renewable energy resources would probably involve erecting many new wind turbines.

The graph shows the power curve of a wind turbine.



(c) (i) Describe, in detail, how the power output of the turbine varies with the wind speed.

.....

.....

.....

.....

.....

.....

(3 marks)

(c) (ii) Give **one** disadvantage of using wind turbines to generate a high proportion of the electricity required in the UK.

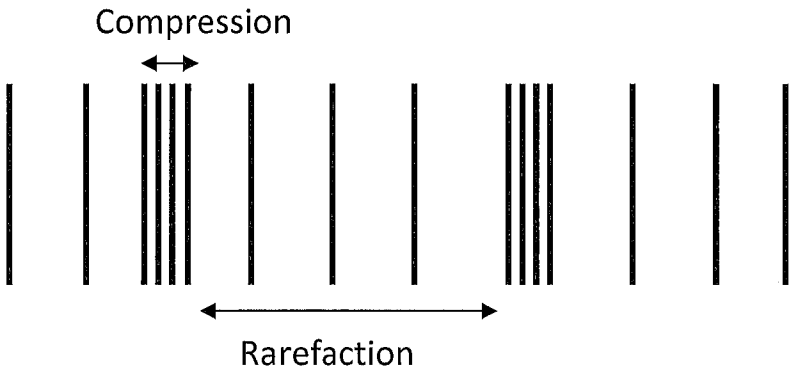
.....

.....

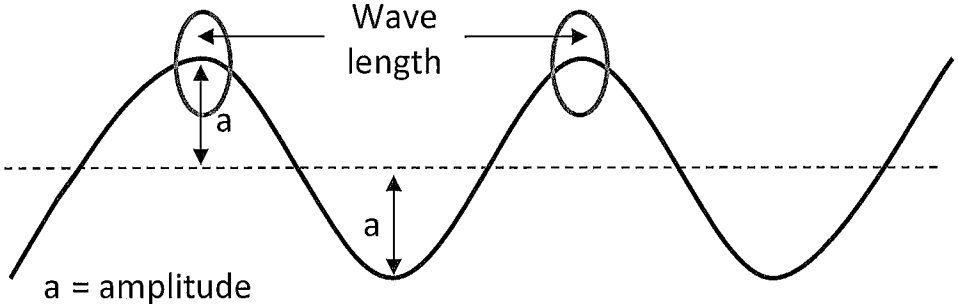
(1 mark)

Waves and their properties

Waves can be classed as either **longitudinal** or **transverse** waves.



Longitudinal waves oscillate parallel to the direction of travel e.g. sound waves



Transverse waves oscillate perpendicular (right angles) to the direction of travel e.g. all EM waves

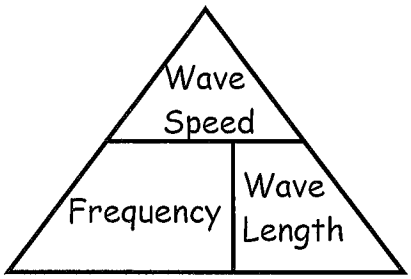
The frequency is the number of waves that occur every second. The frequency is measured in Hertz (Hz). In the case of sound, the frequency determines the pitch.

Amplitude is how 'tall the wave is and in the case of sound a large amplitude means a loud sound, a small amplitude means a quite sound

The wavelength the distance between one point on the wave to the next corresponding point, measured in metres (m). The easiest way to think of it is the distance between one peak and the next peak OR one compression to the next compression, this is one complete wave.

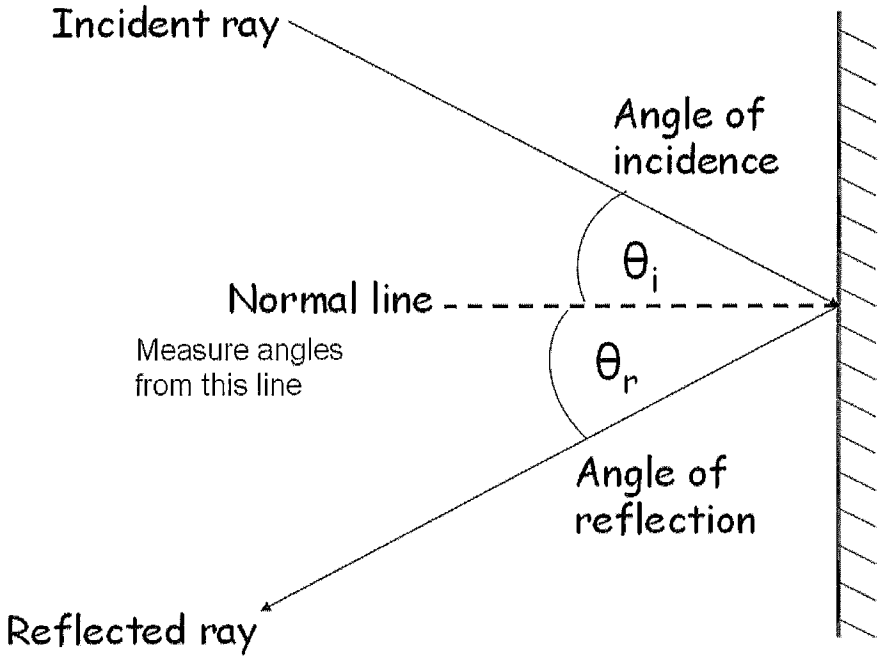
You can calculate the speed of a wave (measured in metres per second [m/s]) if you know the frequency and the wavelength.

$$Wave\ speed\ (m/s) = Frequency\ (Hz) \times Wavelength\ (m)$$



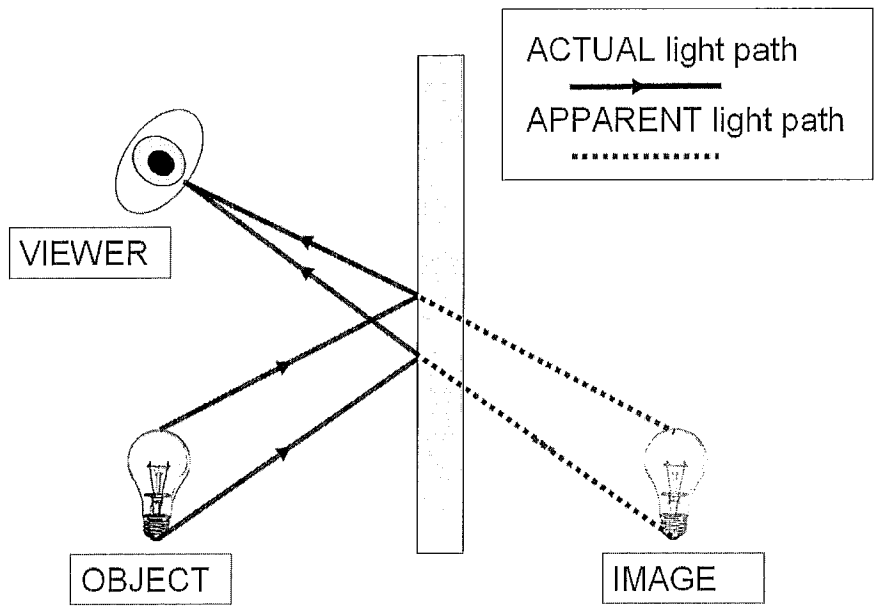
Waves can be reflected, refracted and diffracted

<u>Reflection:</u> This can happen when waves strike a smooth flat surface.



When light hits a plane (flat) mirror we measure the incoming incident ray from the normal. This is a line that comes out perpendicular (right angles) to the surface of the mirror. For any reflected ray, the angle of incidence is equal to the angle of reflection.

<u>Forming images</u>



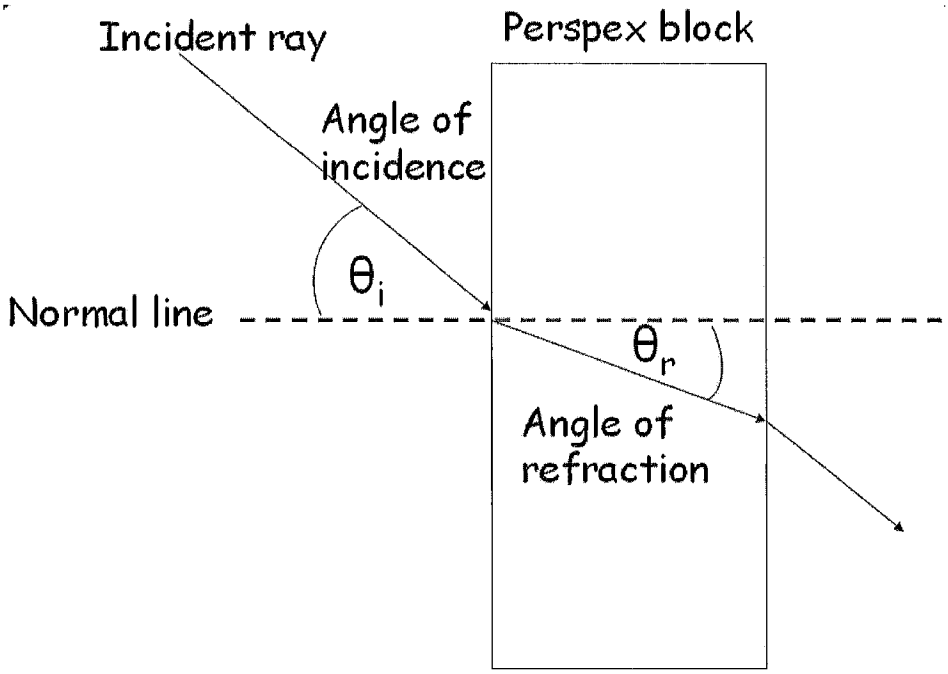
Images formed in a plane mirror are

- Same size as object
- Upright
- Same distance behind the mirror as the object is in front
- Laterally inverted (left is right, right is left)
- virtual

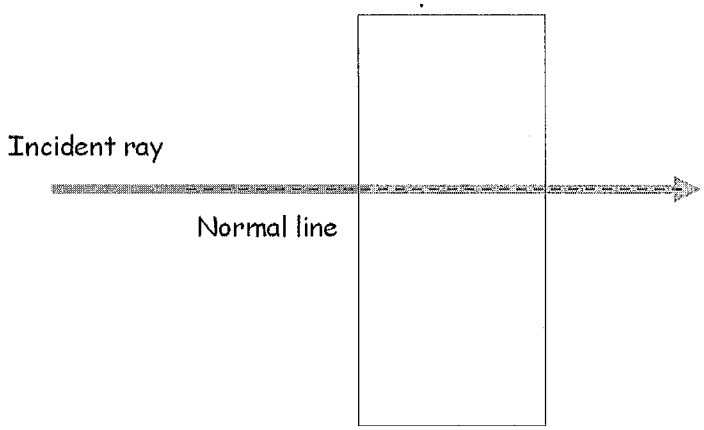
A Virtual image is one that is not made from real light rays. Virtual images cannot be projected onto a screen.

Refraction

Refraction is when a wave changed direction when entering a more/less dense medium.



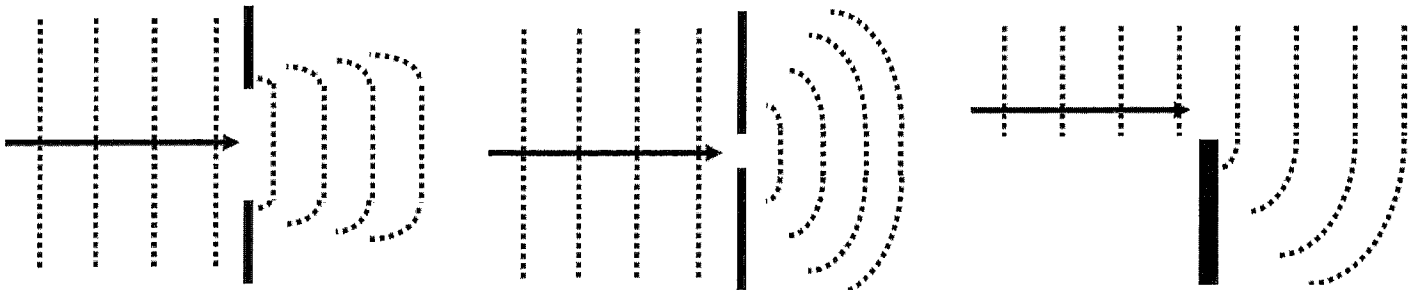
Using the example of light, when the ray enters the Perspex block from air it gets slowed down as Perspex is denser. This also causes the ray to change direction (bends towards normal). When the light is leaving the block it speeds up as air is less dense. The ray will then bend away from the normal line.



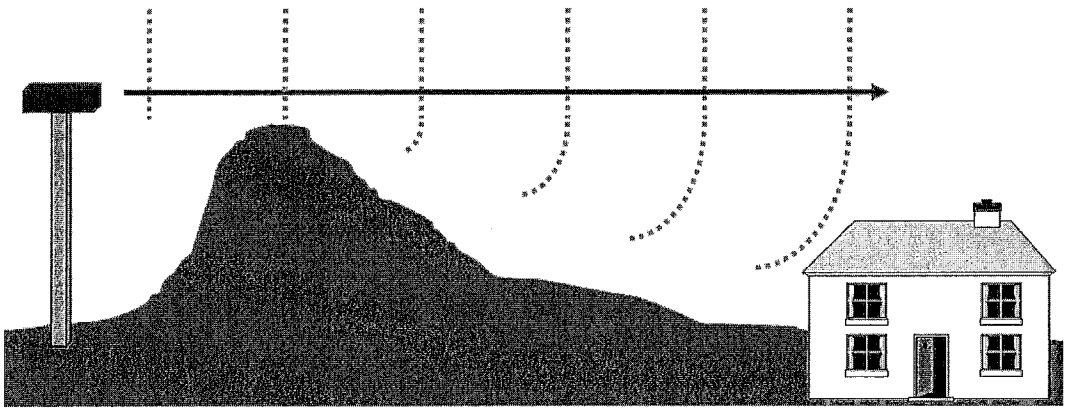
If the light enters along the normal line i.e. perpendicular to the surface of the material then no refraction occurs. The light will still be slowed down as it is travelling through a denser material but the light will not change direction.

Diffraction

This is when a wave gets spread out when passing through a gap or round an obstacle



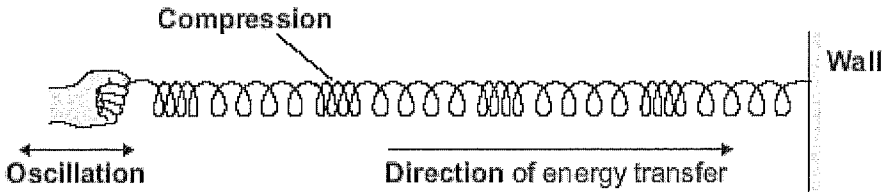
More diffraction occurs if the size of the gap/obstacle is of a similar size to the wavelength



If you live in a hilly or mountainous area then certain TV signals may be poor if they aren't diffracted enough by the obstacle.

Sample Question 18

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



(i) 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.

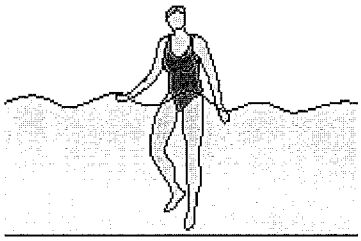
(2)

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

.....

(1)

(b) The diagram shows water waves made by a wave machine in a swimming pool.



Every second, two waves go past a person standing in the swimming pool.

The waves have a wavelength of 0.8 metres.

Calculate the speed of the water waves.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

.....

.....

.....

.....

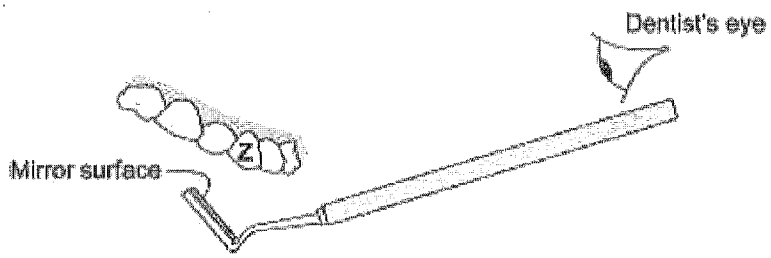
Wave speed = ... m/s

(2)

(Total 5 marks)

Sample Question 19

The diagram shows a plane mirror used by a dentist to see the back of a patient's tooth.



(a) Use a ruler to draw a ray of light on the diagram to show how the dentist is able to see the tooth labelled **Z**.

(3)

(b) Describe the image formed by a plane mirror.

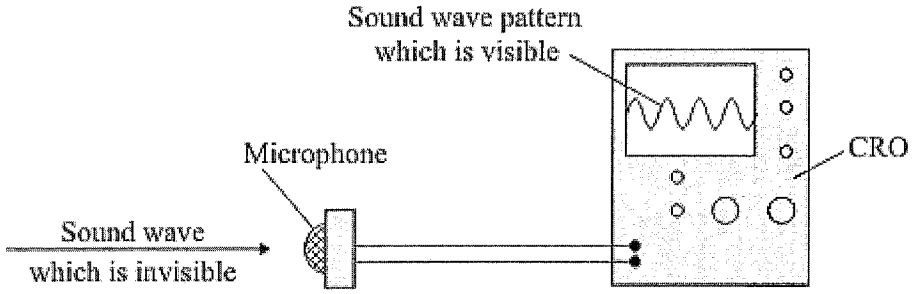
.....

.....

(2)
(Total 5 marks)

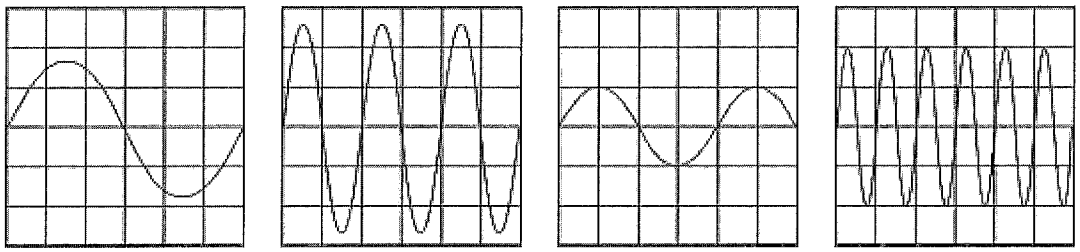
Sample Question 20

A microphone and a cathode ray oscilloscope (CRO) can be used to show the pattern of a sound wave.



Four sound wave patterns, **A**, **B**, **C** and **D**, are shown.

They are all drawn to the same scale.



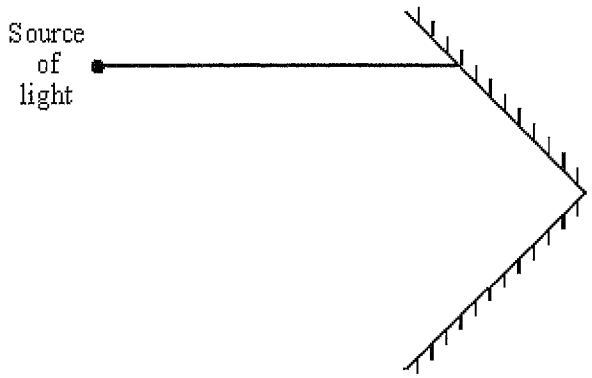
(a) Which **one** of the patterns has the smallest amplitude? .....

(b) Which **one** of the patterns has the lowest frequency? .....

(Total 2 marks)

Sample Question 21

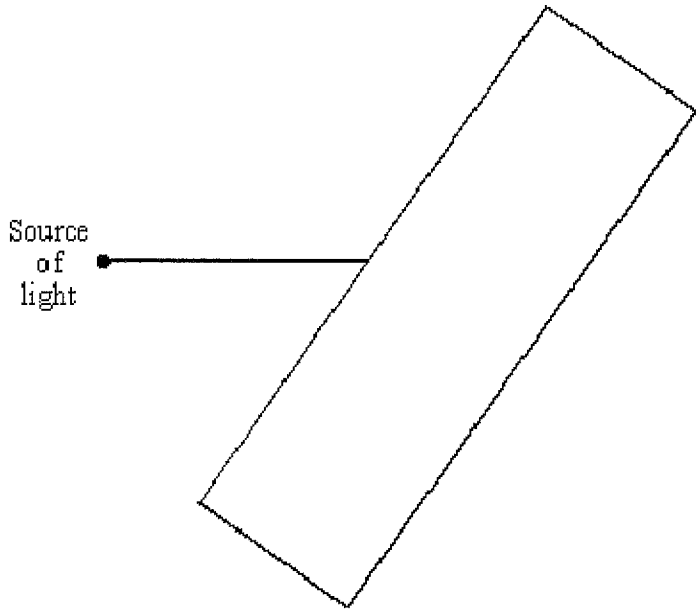
(a) The diagram shows two mirrors at right angles to each other. A ray of light shines onto one mirror as shown.



Carefully draw the path of the ray which is reflected from both mirrors. Draw an arrow on the ray to show the direction of the light.

(3)

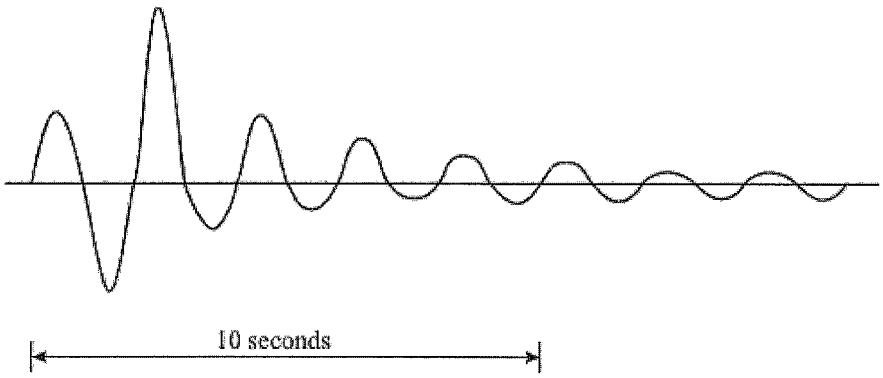
(b) Light can also be made to change direction as it passes into and out from a block of glass. Complete the ray diagram below.



(2)
(Total 5 marks)

Sample Question 22

The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic chart.



(i) How many waves are produced in one second?

..... **(1)**

(ii) Write down the equation which links frequency, wavelength and wave speed.

..... **(1)**

(iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

.....

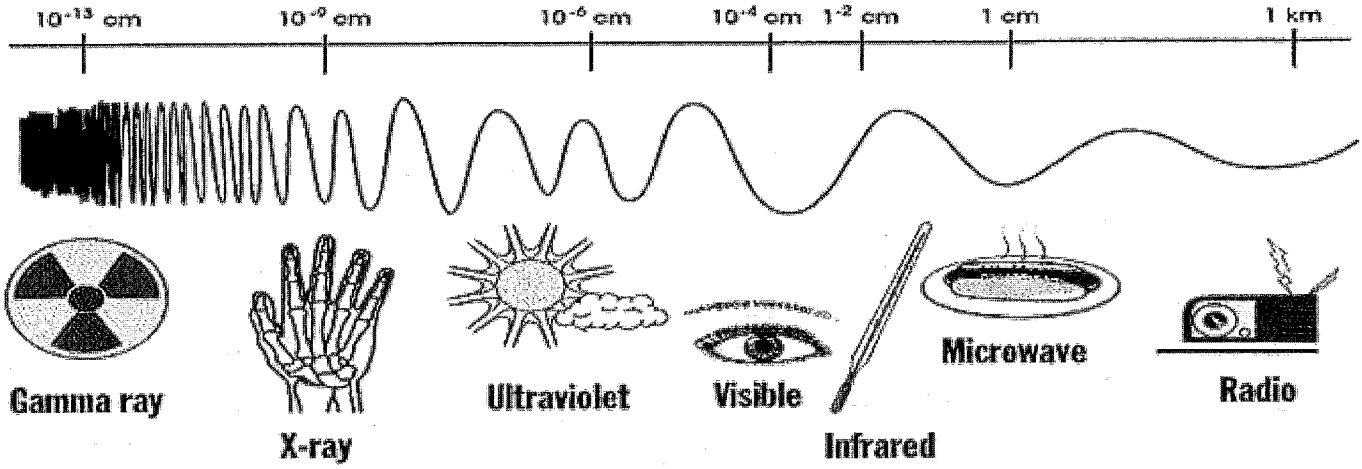
.....

.....

Wavelength = ...

(2)
(Total 4 marks)

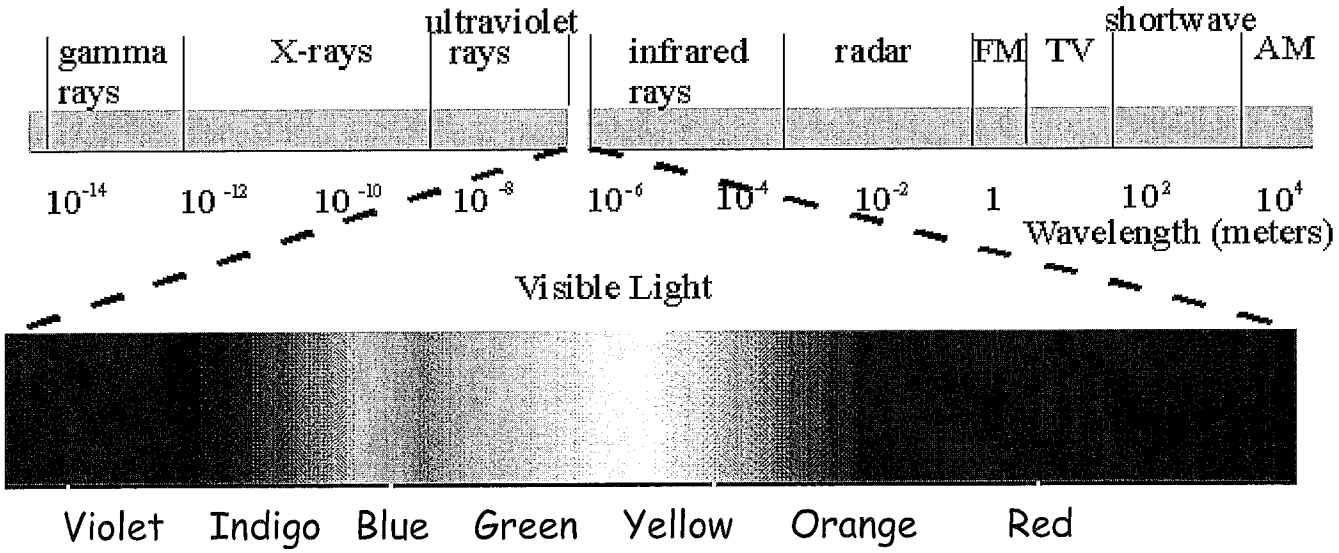
Electromagnetic spectrum



Part of the spectrum	Frequency (Hz)	Wavelength (m)
Gamma	Highest	Shortest
X-ray		
Ultraviolet		
Visible		
Infrared		
Microwave		
Radio	Lowest	Longest

The electromagnetic spectrum is energy that travels by waves. The only part of the spectrum that we can see is visible light. The electromagnetic spectrum has different properties, namely frequency and wavelength. All electromagnetic waves travel at the same speed in a vacuum (empty space).

The visible part of the spectrum can be separated into the colours that compose white light. This can be done by passing light through a prism.

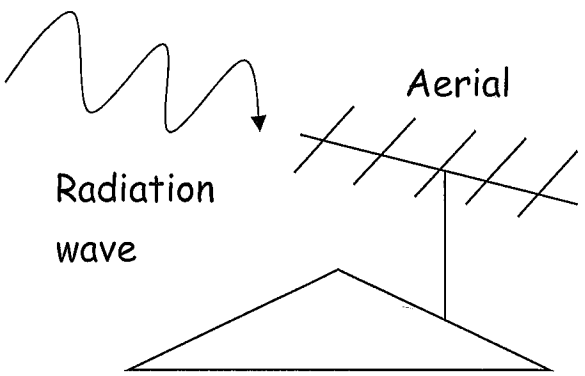


There are advantages and disadvantages to the different parts of electromagnetic spectrum

Part of the spectrum	Advantages	Disadvantages
Gamma	• To sterilise surgical instruments • To kill cancer cells	• High doses can kill cells • Low doses can cause cancer
X-ray	• To see bones • To kill cancer cells	• High doses can kill cells • Low doses can cause cancer
Ultraviolet	• In sun beds to give a tan • Identifying forgeries in money	• High doses can kill cells • Low doses can cause cancer (skin)
Visible	• For seeing and communication - photography	• Blindness
Infrared	• Communication e.g. Broadband and remote control for TV • For cooking e.g. toaster	• Absorbed by skin and felt as heat • Excessive amounts cause burns
Microwave	• For communication in mobile phones and with satellites • Cooking food	• Absorbed by water in the cells, releasing heat, this can damage or kill the cells
Radio	• For communication without the use of satellites, TV and radio	• High levels can lead to tissue damage, particularly the ears • Large doses can cause cancer and leukaemia

Communication

The most common waves used for communication are radiowaves, microwaves, infared and visible light.



When radiation is absorbed the energy that it carries will cause the material to heat up. It can create an alternating current in the metal which will have the same frequency as the radiation itself.

Sample Question 23

The table shows the electromagnetic spectrum.
Three types of wave have been missed out.

Gamma rays		Ultraviolet rays	Visible light		Micro-waves	

Shortest wavelength ← → Longest wavelength

(i) Use words from the box to complete the table.

infra red rays	**radio waves**	**X-rays**

(2)

(ii) Which **one** of the following gives a use of gamma rays?

Put a tick (✓) in the box next to your choice.

to communicate with satellites ☐

to see objects ☐

to kill cancer cells ☐

(1)

(iii) Complete the following sentence by drawing a ring around the correct word in the box.

All electromagnetic waves move [energy / gases / particles] from one place to another.

(1)
(Total 4 marks)

Sample Question 24

(a) The new Tetra communications system to be used by the police transmits *digital signals* using microwaves of wavelength 75 cm.

(i) Use the following equation to calculate the frequency of the microwaves used by the Tetra system. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Frequency = ... hertz

(2)

(b) Read the following extract from a newspaper and then answer the questions that follow.

> Residents of Stag Hill Court, a luxury block of flats, are shocked at the plans to site a mobile phone mast on the roof of the flats. They oppose the mast on health grounds, quoting research in Germany that has found a possible increase in cases of cancer around mobile phone masts.
>
> A spokesperson for the telecoms company said, 'The residents should not worry. The research carried out by our own scientists has found no link between ill health and mobile phone masts'.
>
> This has not reassured the residents, who argue that new independent research is urgently needed.

(i) Explain why living near a mobile phone mast could cause ill health.

.....

.....

.....

.....

.....

.....

(3)

(ii) Suggest **two** reasons why the residents have **not** been reassured by the research carried out by the telecoms company.

1 .....

.....

2 .....

.....

(2)

(Total 7 marks)

Sample Question 25

(a) Microwaves are one type of electromagnetic wave.

(i) Which type of electromagnetic wave has a lower frequency than microwaves?

.....

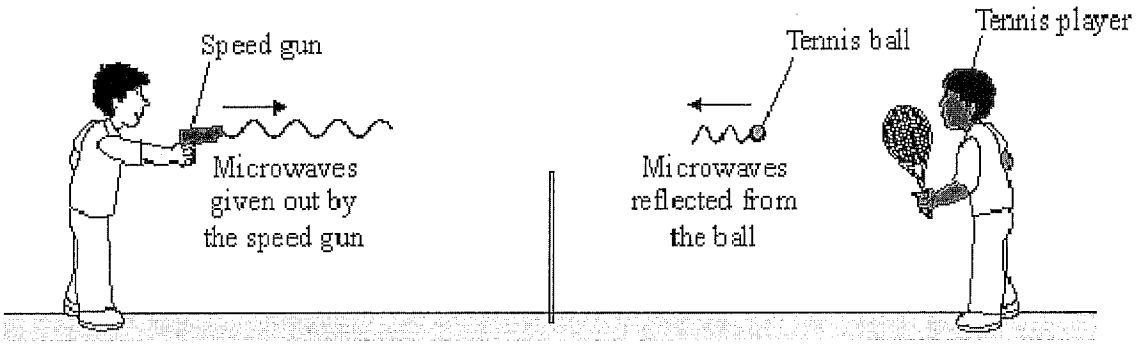
(1)

(ii) What do all types of electromagnetic wave transfer from one place to another?

.....

(1)

(b) The picture shows a tennis coach using a speed gun to measure how fast the player serves the ball.



(i) The microwaves transmitted by the speed gun have a frequency of 24 000 000 000 Hz and travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the wavelength of the microwaves emitted from the speed gun.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2)

(ii) Some of the microwaves transmitted by the speed gun are absorbed by the ball.

What effect will the absorbed microwaves have on the ball?

.....

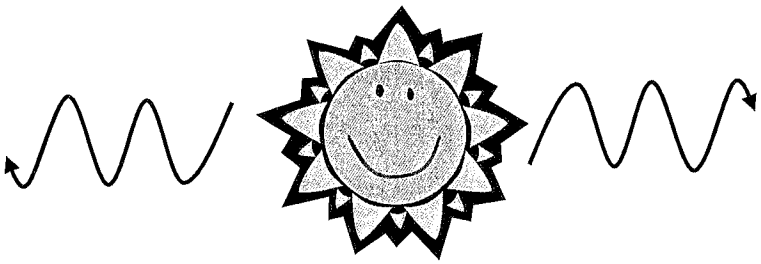
.....

(1)

(Total 5 marks)

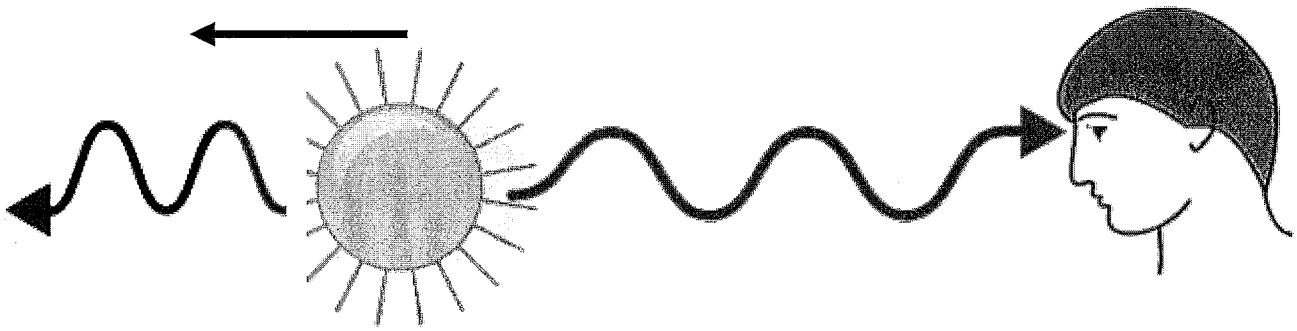
Space

Everything thing in the universe began 14 billion years ago with what is called the **Big Bang**. The universe began as a small hot dense point and then began to rapidly expand.

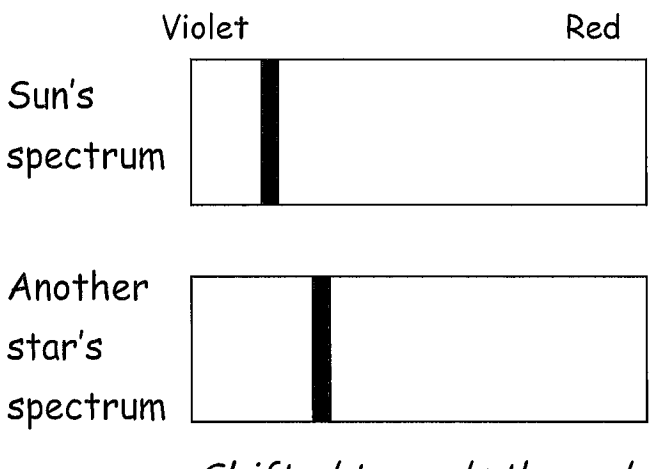


There is evidence for this. When an object which emits light is stationary then the light it emits will be the same in all directions.

However, if an object is moving away from us the light waves get spread out which decreases the frequency. This makes the light appear red, we call this **red shift.** The bigger the red shift the further away the object is. If an object was moving towards us it would appear blue because frequency would be increased.



The way we can observe red shift more effectively is by looking at the spectrum of light given off by astronomical objects.

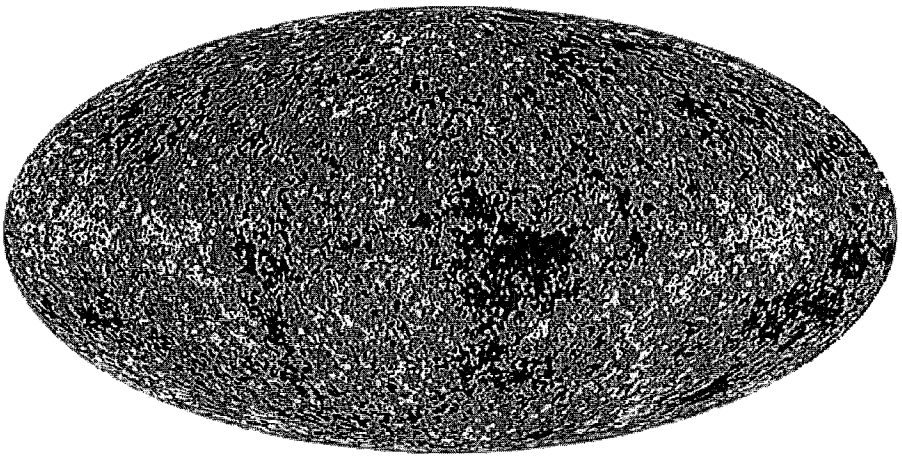


Shifted towards the red

The spectrum from stars for example will have dark line appearing in them. These dark lines indicate what elements the star is composed of e.g. Hydrogen. So, since the Sun is so close to use we can consider it to be stationary. So we can compare the dark lines from other objects to the sun's spectrum and if these dark lines

are more towards the red end of the spectrum, then the object is moving away from us. If it is towards the violet end then it is moving towards us.

Cosmic microwave background

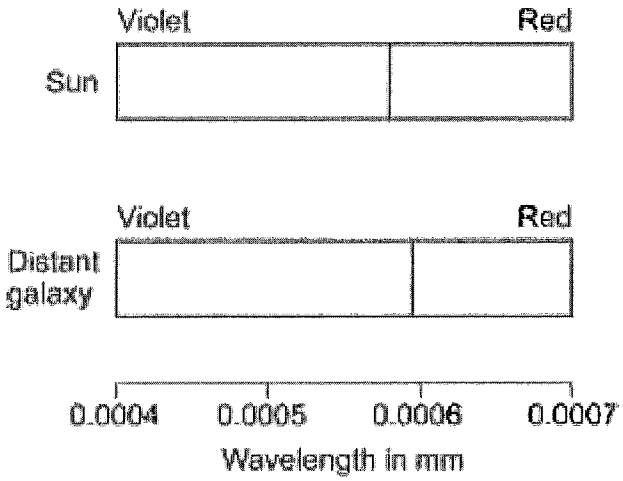


The cosmic microwave background radiation is radiation left over from the big bang. This is radiation that is distributed throughout the universe and is evidence that the big bang happened

Sample Question 26

The visible part of the electromagnetic spectrum from a star includes a dark line. This line is at a specific wavelength.

The diagram shows the position of the dark line in the spectrum from the Sun and in the spectrum from a distant galaxy.



(a) Explain how the spectrum 'shift' of the dark line supports the theory that the Universe began from a very small initial point.

.....

.....

.....

.....

.....

(3)

(b) Name **one** other piece of evidence that supports the theory that the Universe began from a very small initial point.

.....

(1)
(Total 4 marks)

Sample Question 27

The Big Bang theory attempts to explain the origin of the Universe.

(i) What is the Universe?

.....

.....

(1)

(i) What are the main ideas of the Big Bang theory?

.....

.....

.....

(2)

(iii) What is thought to be happening to the size of the Universe?

.....

(1)
(Total 4 marks)

Sample Question 28

The 'steady state' theory was once a popular alternative to the 'big bang' theory.

The 'steady state' theory suggested that the universe, although expanding, had no origin and it has always existed. As the universe expands, a small amount of matter is created to keep the universe looking exactly the same all of the time.

(a) When considering the origin of the universe, what is the difference between the 'big bang' theory and the 'steady state' theory?

.....

.....

.....

.....

(2)

(b) The light from distant galaxies shows a *red-shift*.

(i) What is *red-shift*?

.....

.....

(1)

(ii) Why does red-shift provide evidence to support both the 'big-bang' theory and the 'steady state' theory?

.....

.....

.....

.....

(2)

(c) The 'steady state' theory was important in encouraging new research into the universe.

Suggest a reason why scientists were keen to carry out new research.

.....

.....

(1)

(d) Scientists can answer many questions about the universe, but not the question:

'Why was the universe created?'

Suggest a reason why this question cannot be answered by scientists.

.....

.....

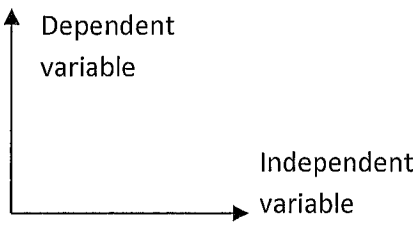
(1)
(Total 7 marks)

How science works

When carrying out experiments and answering questions based on interpreting experiments you need to know the following.

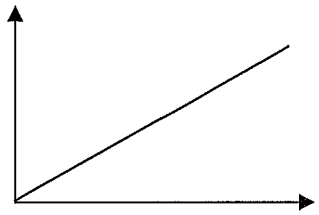
The independent variable is what is changed during an experiment
Remembering Tip: Independent starts with I so it is the variable that I change
The dependent variable is what you measure in the experiment i.e. the results
The control variables are the things you want to keep the same during an experiment.

When plotting a graph for your results you generally plot the dependent variable along the y-axis and the independent variable along the x-axis



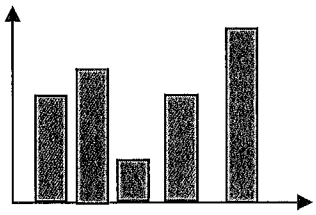
Your independent/dependent variable can either be continuous or categoric.

Continuous variables can be any number 5, 1.2, 5.76, 3.0, 7, 94 etc



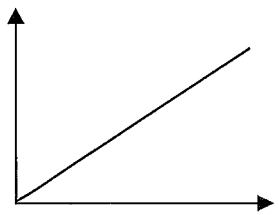
- You plot a line graph for continuous variables

Categoric variables are things such as colours e.g. red, blue, green.



- You plot a bar graph for categoric variables

Describing results



- This graph is showing a positive correlation, i.e. as one variable increases so does the other and the line goes up.
- A negative correlation is when one variable goes up the other goes down, the line would go downwards.

Experimental procedure

Prediction: What you think will happen
Plan: How you are going to carry out your experiment
Conclusion: What you have found out from the experiment
Fair test: When you make sure each experiment is set up the same way
Repeatable: In experiments you usually repeat measurements and take a mean (average). This is to ensure you are getting the same results.
Reproducible: If another experimenter can get the same results as you using their equipment then your finding are correct.

Solutions to sample questions

Sample question 1

question	answers	extra information	mark
2(a)(i)	kinetic	do **not** accept movement	1
2(a)(ii)	thermal sound	accept heat for thermal do **not** accept noise for sound	1
2(b)	transferred to surroundings / surrounding molecules / atmosphere **or** becomes dissipated / spread out	both answers required in either order 'it escapes' is insufficient accept warms the surroundings accept degraded / diluted accept a correct description for surroundings eg to the washing machine do **not** accept transformed into heat on its own	1

Sample question 2

question	answers	extra information	mark
(ii)	0.3	accept 30% if **2** marks not awarded then: allow **1** mark for 30 (without %) allow **1** mark for 0.3 with a unit or % allow 1 mark for identification of energy input and output eg 20 sq input and 6 sq output **or** 4 sq input and 1.2 sq output **or** 40 sq input and 12 sq output even if subsequent working incorrect allow 1 mark for correct expression of 1.2 over 4 **or** 12 over 40 **or** 6 over 20 (squares)	2

Sample question 3

(a) solid

1

(b) gas

1

(c) solid

1

[3]

Sample question 4

(a) the marbles model / act as molecules

accept atoms / particles for molecules

1

molecules leaving a liquid = evaporation
or
marbles leaving tray = evaporation

1

(b) to evaporate the alcohol requires energy

1

this energy is taken from the skin and the skin feels cold

accept heat for energy

1

(c) there are attractive forces between molecules

1

only the fastest molecules have enough energy to break away from other molecules

1

these molecules escape from the surface of the liquid

1

therefore the average speed / energy of the remaining molecules goes down

1

the lower the average speed / energy of molecules the lower the temperature of the liquid

1

[9]

Sample question 5

question	answers	extra information	mark
(a)	any **three** from: • (air) particles / molecules / atoms gain energy • (air) particles / molecules / atoms move <u>faster</u>	ignore reference to skewer do **not** accept move more do **not** accept move with a bigger amplitude / vibrate more	3
	• (air) particles / molecules / atoms move apart • air expands • air becomes less dense • warm / hot air rises	 do **not** accept particles expand do **not** accept heat rises if credit is to be given for answers in terms of particles it must be clear they are air particles **not** gas particles	
(b)	conduction	accept conductor	1

(c)	any **one** from: • temperature of the potato • temperature of the surroundings / room / surface / atmosphere • size / mass / weight / volume of the potato • shape of the potato • surface area of the potato • nature of the surface of the potato • type of surface it is placed on • in a draught • type of potato • whether the skewers are left in or taken out	do **not** accept heat for temperature accept how hot the potato / room is potato cut open insufficient	1
(d)	(foil) reflects heat (back towards potato) **or** (foil) is a poor emitter (of heat radiation)	reduces heat loss is insufficient do **not** accept reflects hot air accept reduces / stops heat loss by <u>radiation</u> do **not** accept heat is trapped	1

Sample question 6

question	answers	extra information	mark

	conduction	convection	radiation
vacuum	✓	✓	
silvered surfaces			✓ (1)
plastic cap	✓	✓	(1)

1(a)(ii)		any mention of air or any other substance in a vacuum scores zero	1
	because there are no particles in a vacuum	accept atoms / molecules for particles accept vacuum is empty space accept there is nothing in a vacuum accept there is no air / gas in the vacuum	
	conduction **and** convection need particles / medium	need reference to both conduction **and** convection accept correct descriptions	1

1(b)(i)	less heat lost (to air above the heater)	do **not** accept **no** heat lost	1
	light shiny surfaces are poor emitters (of radiation) **or** dull, matt surfaces are good emitters (of radiation)	accept radiators for emitters references to reflection are neutral do **not** credit answers which infer reflection from the underside of the hood ignore correct reference to absorption	1
1(b)(iii)	energy cannot be destroyed	accept (principle of) conservation of energy do **not** accept because energy cannot be lost without clarification	1

Sample question 7

(a) conduction

*do **not** accept conductor*

1

(b) the freezer

both parts needed

greater temperature difference (between freezer and room)

*do **not** accept because it is the coldest*

1

(c) any **two** from:

- poor absorber of heat / radiation
  accept does not absorb heat poor emitter of heat / radiation is neutral
- reflects heat / radiation (from room away from fridge-freezer)
- reduces heat transfer into the fridge-freezer
- reduces power consumption of fridge-freezer
  *do **not** accept it is a bad conductor / good insulator*

2

[4]

Sample question 8

(a) (i) £150

gets 2

Else 1000 – (250 + 350 + 100 + 150) or 1000 – 850

gets 1

2

(ii) (Named) floor covering
OR Insulation under floor

for 1 mark

1

(b) (i) Draught proof doors or fibre glass in loft or in cavity
For draught proofing

gains 1 mark

Very low cost/easy to install
Repays for itself quickly/cost recuperated quickly
Reasonable energy saving

any 2 for 1 mark each

For loft insulation

Second lowest installation cost/easy to install
Reasonable large energy savings for this cost
Reasonable payback time

gains 1 mark

For foam filled cavity
Biggest energy/cash saving
Cost effective

any 2 for 1 mark each

3

(ii) **Double glazing**

gains 1 mark

Costs most
Saves least energy
Least cost effective

any 2 for 1 mark each

3

[9]

Sample question 9

(a) **1**

1

(b) **3** and **4**
or
1 and **2**

1

(c) U-values for the 20 mm windows are the same or higher than those for the 16 mm windows

1

therefore the 20 mm windows are no more energy efficient than 16 mm windows

accept so the 16 mm windows are as energy efficient as 20 mm windows

1

(d) **1** and **2**

must have both and no other

1

(e) Type B glass transmits less infrared than Type A glass

accept radiation / heat for infrared

accept Type B glass absorbs more infrared than Type A glass

1

and as infrared has a heating effect the conservatory will remain cooler

1

[7]

Sample question 10

(a) Dull black surface

1

Because black surfaces are good absorbers of heat / radiation

OR

Because silver surfaces are bad absorbers of heat / radiation

1

(b) converting 100g to 0.1kg

1

Showing calculation 0.1 x 4200 x 60

Accept 100 x 4200 x 60

1

Answer of 25 200

Accept 25 200 000

1

Correct units J OR Joules

1

Sample question 11

(a) because black is a good absorber of radiation

1

there will be a faster transfer of energy

allow the temperature of the water rises faster

1

(b) 16 800 000

*allow **1** mark for substitution into correct equation*
ie 100 × 4200 × 40

2

(c) 7 allow

ecf from part (b)

1

Sample question 12

(a) 9

*allow **1** mark for correct substitution (1.8 × 5)*
*an answer of 9000 gains **1** mark*
*an answer of 2 or 15 gains **1** mark*

2

(b) (3kW) fan heater *accept 3kW*
accept the middle one

1

(c) features common to more than one heater, treat as neutral

<u>oil-filled</u>

low level heat

cannot be knocked over / space saving / no trailing wires

*do **not** accept just wall-mounted*

or more control over heat output

*do **not** accept just 3 heat settings*

1

<u>fan</u>

warms (office) rapidly **or** can be used to cool air (in summer)

accept can be used as a fan
accept cool air fan (setting)
accept 'it has a cool air setting in case it gets too hot'
*do **not** accept a specific reference to cooling the heater*

1

<u>ceramic</u>

can be switched on for set periods of time

*do **not** accept just has a timer*

***or** can be switched on before office is used / switched off automatically at night*

1

[6]

Sample question 13

(a) £15

*allow **1** mark for use of 125 (kWh)*
*allow **1** mark for an answer 1500*
*allow **both** marks for 1500 pence / p*
*allow **1** mark for correct calculation of annual cost for either freezer (£27 and £42)*

2

(b) £45

or their (a) × 3
*allow **1** mark for correct use of 3*
*allow **1** mark for 12 – 9 = 3*

2

(c) any **two** from:
the marks are for the explanation

yes **plus** explanation

- less electricity / energy needed / used
  accept less energy wasted
- less (fossil) fuels burned
  accept a named fossil fuel
  *do **not** accept conserving (fossil) fuels*
- less polluting gases emitted
  accept a named polluting gas / greenhouse gases / carbon emissions / reduce global warming
  accept an answer in terms of nuclear fuel
  eg less nuclear fuel required (1)
  less nuclear waste (1)

2

or no **plus** explanation

- old freezer must be disposed of
- hazardous chemicals inside freezer
  accept CFC gases
- (lot of) energy used in producing new freezer

[6]

Sample question 14

	answers	extra information	mark
(a)(i)	national grid		1
(ii)	increases voltage / potential difference	accept decrease current accept step-up / boosts the voltage do **not** accept increases energy / power / current ignore reference to voltage going through	1
(iii)	any **two** from: • reduce current • reduces energy loss / power loss (from cables) • increases efficiency (of distribution)	ignore increased voltage / pd accept reduces heat loss do **not** accept stops energy loss	2

Sample question 15

question	answers	extra information	mark
(a)(i)	replaced faster than it is used	accept replaced as quick as it is used accept will never run out do **not** accept can be used again	1
(a)(ii)	any **two** from: • wind • waves • tides • fall of water • biomass • geothermal	**two** sources required for the mark do **not** accept water / oceans accept OTEC accept hydroelectric accept a named biomass / biofuel eg wood	1

Sample question 16

question	answers	extra information	mark
5(a)(i)	(dismantle and) remove radioactive waste / materials / fuels	accept nuclear for radioactive do **not** accept knock down / shut down	1
5(a)(ii)	increases it	do **not** accept it has a negative effect	1

Sample question 17

question	answers	extra information	Mark
3(b)(i)	**B**	do **not** credit reason if **B** is not chosen	1
	(only) burning fossil fuels produces carbon dioxide / carbon (emissions) **or** nuclear fuels don't produce carbon dioxide	insufficient – smallest amount of fossil fuels accept less carbon dioxide	1
3(b)(ii)	accept anything reasonable eg increased level of insulation use energy efficient light bulbs do not leave appliances on standby switch thermostats down (1 °C) generate own electricity install solar panels	accept insulate accept specific examples eg loft	1

3(c)(i)	any **three** from: • no power output until wind speed exceeds 4 m/s • output rises rapidly after 4 m/s • output begins to level out / rises less rapidly at / after 13 m/s • output peaks at 21 / 22 m/s • output constant between 21 / 22 and 25 / 26 m/s • output falls (rapidly) after 25 / 26 m/s	accept for **1** mark goes up then comes down	3
3(c)(ii)	any **one** from: • unreliable energy source • dilute energy source • take up too much land	accept wind does not always blow accept need thousands / lots of turbines ignore reference to visual / noise pollution ignore reference to kill birds	1

Sample question 18

(a) (i) oscillation **1**

direction **1**

correct order only

(ii) sound **1**

(b) 1.6

*allow **1** mark for correct substitution into correct equation ie 2 x 0.8*

2

Sample question 19

(a) ray drawn from tooth to mirror to eye

1

angle I = angle R

judged by eye

1

at least one arrow in correct direction

*do **not** credit conflicting arrows*

1

*if no ruler used maximum mark is **2***

(b) virtual 1

Upright 1

[5]

Sample question 20

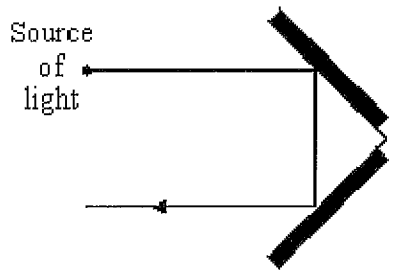
(a) C (only) 1

(b) A (only) 1

[2]

Sample question 21

(a) first reflection vertically down to the fourth hatch line or just to the left of it reaching mirror (must come from incident ray given)



1

second reflection back parallel to incident ray must be linked to first part of ray

1

appropriate arrow on a part of the ray (may be given if lines wrong)

(must come from source of light)

maximum of one mark to be lost for poor diagrams not using a ruler for straight lines

first time you come across wavy line, it is penalised

1

(b) ray in block bent downwards, not beyond the normal

do not credit if exactly on normal

1

emergent ray parallel to incident ray

do not credit a continuation of the line straight through the block these are independent

1

[5]

Sample question 22

(i) 0.5

1

(ii) wave speed = frequency × wavelength

accept $v = f \times \lambda$

accept s for v

accept m/s = Hz × m

accept

providing subsequent method correct

1

(iii) 15.2 km

both numerical answer and unit are required for both marks

numerical answer and unit must be consistent

*allow **1** mark for 15.2 with incorrect or no unit*

*allow **2** marks for an answer of 1.52 km if the answer to (b)(i) was given as 5*

***r** 1 mark for correct transformation*

***or** 1 mark for correct use of speed = distance/time*

unit on its own gains no credit

2

[4]

Sample question 23

(i) X-rays

infra red (rays)

radio (waves)

all three in correct order

*allow **1** mark for **1** correct*

2

(ii) to kill cancer cells

1

(iii) energy

1

[4]

Sample question 24

(a) (i) 400 000 000

or

correct equivalent

*allow **1** mark for correct transformation **and** substitution (of 75)*

*answer 4 000 000 gains **1** mark only*

2

(b) (i)

*any mention of alpha, beta, gamma waves scores **0** marks*

emit / uses / transmit / receive microwaves
accept radiation for microwaves throughout
ignore radio waves

1

some microwave / energy absorbed by / enters the body
ecf for their given electromagnetic wave
*do **not** accept goes through the body*

1

raises temperature of (body) cells / tissue / water
accept reference to water molecules vibrating faster
accept it could cause mutation / harm / kill cells
*do **not** accept answers in terms of ionisation*
ignore references to cancer

1

(ii) any **two** from:

- research (may be) biased
  or may have been misled in the past
  accept not independent
  ***or** may be lying*
- some research suggests a link
- long-term effect not proven / studied
  accept not studied for long enough
- residents may not have seen the research

2

[7]

Sample question 25

(a) (i) radio(waves)

1

(ii) energy
correct answer only

1

(b) (i) 0.0125 (m)
*allow **1** mark for correct transformation and substitution*

2

(ii) make it hot(ter)
*do **not** accept cook it*
accept (air) particles inside ball will move faster
accept water in the ball gets hotter

1

[5]

Sample question 26

(a) the observed wavelength of the dark line from the distant galaxy has increased

1

therefore the distant galaxy must be moving away from the Earth

1

suggesting the Universe is expanding outwards from a small initial point

1

(b) existence of cosmic microwave background radiation

accept existence of CMBR

1

[4]

Sample question 27

(i) an innumerable collection of galaxies

accept any word meaning a large number for innumerable
accept all the galaxies
*do **not** accept everything*

1

(ii) all matter concentrated at a (single) point

accept all matter part of a single 'superatom'

1

single (massive) explosion (sending matter outwards)

1

(iii) increasing or expanding

1

[4]

Sample question 28

(a) big bang theory – universe started at one point (then expanded)

1

steady state theory – universe has no origin / has always existed

accept an answer in terms of mass
eg steady state theory mass is created

1

(b) (i) wavelength (of light) increases

accept answers in terms of frequency decrease
*accept wavelength stretched but **not** wave stretched*

or wavelength / light moves to red end of spectrum

*do **not** accept galaxy moves to the red end of the spectrum*
*do **not** accept light becomes red / redder*

1

(ii) red-shift is evidence / supports idea of expanding universe

accept prove for support

1

both theories use the idea / accept / explain why the universe is expanding

1

(c) to find evidence to support one or both theories

accept prove for support

accept to gain more knowledge about the universe

or to find evidence to disprove one or both theories

1

(d) answer involves (religious) belief

accept it cannot be tested

or no / insufficient evidence

1

[7]

P1 REVISION – CHAPTER 1a – Energy Tfr by Heating

Infrared Radiation

What gives off infrared radiation?

What is a vacuum?

Surfaces & Radiation

What surfaces are good absorbers of infrared radiation?

What surfaces are slow to emit infrared radiation?

What surfaces are good reflectors of infrared radiation?

States of Matter

Draw and label the 3 states of matter.

Give an explanation of how they differ to each other.

Conduction/Convection

Where does conduction occur?

Where does convection occur?

What is a poor conductor called?

Why does a fluid become less dense when it is heated?

Evaporation & Condensation

What 3 things can increase the rate of evaporation

What 2 things can increase the rate of condensation?

KEY WORDS:

Absorbers
Emitters
Reflectors
Conduction
Conductor
Insulator

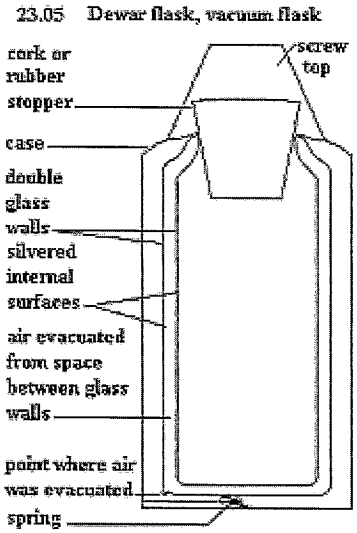
ASSESSMENT:

P1 REVISION - CHAPTER 1b - Energy Tfr continued.

The greater the temperature difference between an object and its surroundings, the greater the rate at which energy is transferred. What else does the rate at which energy is transferred depend on?

How can we maximise the rate of energy transfer to keep things cool?

How can the structure of the vacuum flask minimise energy transfer by conduction, convection and radiation?



Specific Heat Capacity

The specific heat capacity of a substance is the amount of energy required to raise the temperature of 1 kilogram of the substance by 1 degree celsius.

The equation for specific heat capacity is:

$E = m \times c \times \theta$

What do the symbols stand for and what are the units for each?

The specific heat capacity of water is 4200J/kg°C.

How much energy is needed to raise the temperature of 2kg of water by 1°C?

KEY WORDS:

Specific heat capacity
Mass
Temperature difference
Maximise
minimise

ASSESSMENT:

P1 REVISION – CHAPTER 2 – Using Energy

Conservation of energy?
What does this mean?

What can you not do to energy?

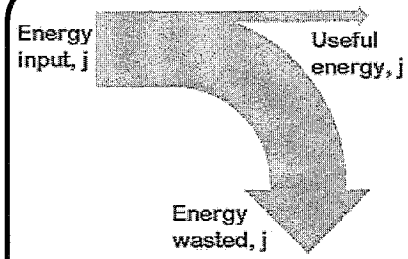
Useful Energy.

Name the useful energy of a light bulb.

What is the wasted energy of a light bulb?

Forms of Energy

Type	Example
Chemical	Food/fossil fuels



Energy & Efficiency

What does this diagram show?

What is it called?

$$\text{Efficiency} = \frac{\textit{useful energy transferred by the appliance}}{\textit{total energy supplied to the appliance}} \quad (\times 100\%)$$

Does efficiency have a unit?

In a light bulb, for 25 joules of energy that are supplied to the bulb, 5 joules area usefully transferred into light energy. What is the efficiency of the bulb?

How can you make machines more efficient?

KEY WORDS:
Joule
Efficiency
Sankey Diagram
Useful energy
conservation

ASSESSMENT:

P1 REVISION - CHAPTER 3 - Electrical Energy

Fill in the box with at least 4 more electrical appliances.

Electrical Appliance	Type of energy produced
Lamp	Light

Electrical Power

What is the equation for power?

An electric motor transfers 48J of electrical energy into kinetic energy in 2 mins. What is the useful power output of the motor?

Useful Electrical Energy

What is a kilowatt-hour?

E = P x t

E =
P =
t =

Total cost = number of kWh x cost per kWh

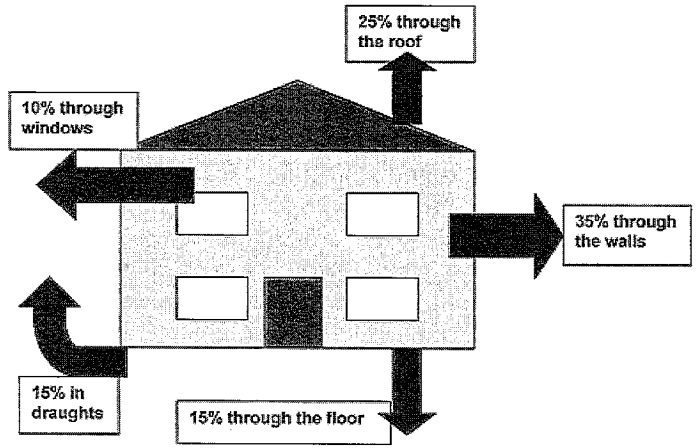
The price of 1kWh of electrical energy is 9p. How much does it cost to use a 60W electric light for 4hrs?

Cost Effectiveness Matters

What costs are involved in different appliances?

What is payback time?

Loft insulation costs £600.00 including installation. It saves £80.00 per year on the fuel bill. How long is the payback time?



KEY WORDS:

Kilowatt-hour (kWh)
Power
Electrical appliance
Payback time
watt

ASSESSMENT:

P1 REVISION – CHAPTER 4 – Generating Electricity

Nuclear

What fuel is used in a Nuclear power station?

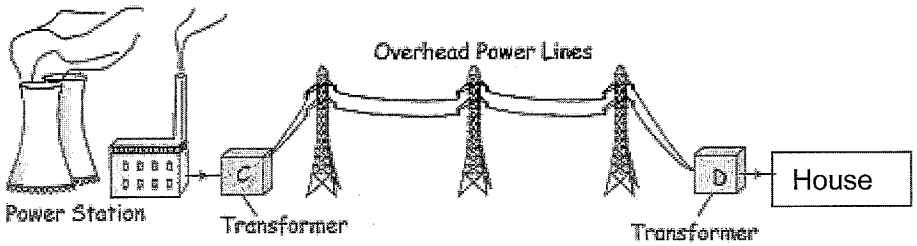
What process releases the energy?

Does it produce green house gases?

Draw a flow diagram to show how a power station produces electricity.

	BENEFITS	DRAWBACKS
Fossil fuels		
Biofuel		
Water		
Sun		
Wind		

National Grid



What do the transformers C and D do and why?

KEY WORDS:
Turbine
Generator
Nuclear Fission
Non-renewable
renewable
transformers

ASSESSMENT:

P1 REVISION - CHAPTER 5a - Waves

What do we use waves for?

With a transverse wave the oscillation (vibration) of the particle is _____ to the direction in which the wave travels.

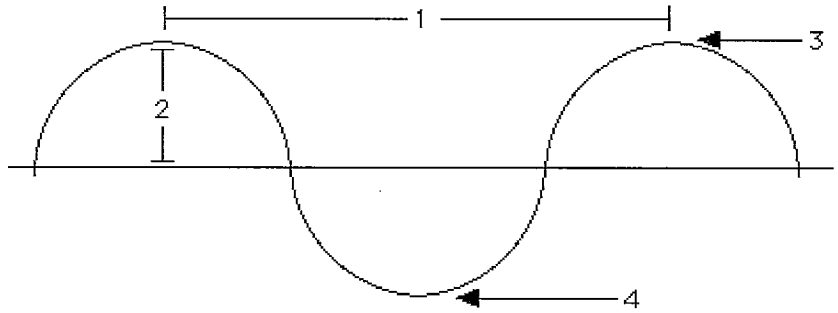
Mechanical Waves

Give an example.

Are they transverse, longitudinal or both?

What type of wave can be produced on a stretched string?

Measuring Waves



Label the above diagram with Amplitude, wavelength, peak and trough.
Then give an explanation on the following three terms including the units:
Amplitude:

Wavelength:

Frequency:

Speed = $v = f \times \lambda$
What is the speed of waves with a frequency of 5Hz and a wavelength of 2m?

Longitudinal Wave

The oscillation of the particles is _____to the direction of the travel of the wave.

A longitudinal wave is made up of c_____ and r_____.

Give an example of a longitudinal wave.

Electromagnetic waves

Give two examples:

Are they transverse or longitudinal?

Can they travel through a vacuum?

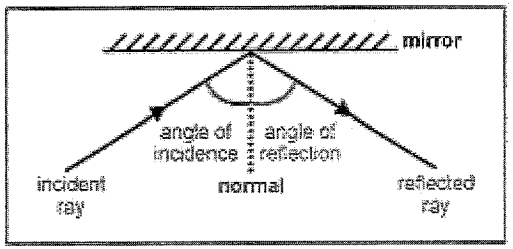
KEY WORDS:

Amplitude
Frequency
Wavelength
Oscillation
Transverse
Longitudinal

ASSESSMENT:

P1 REVISION – CHAPTER 5b – Wave Properties

Reflection



What is the normal?

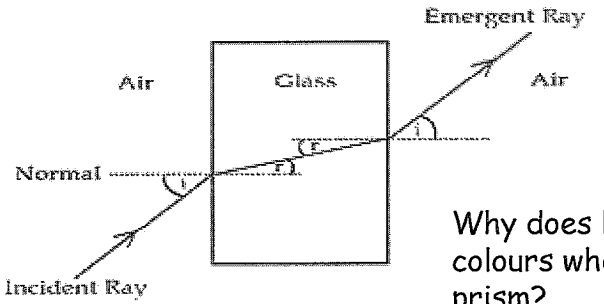
Where are angles always measured between?

What does the law of reflection state?

What is a real image?

What is a virtual image?

Refraction



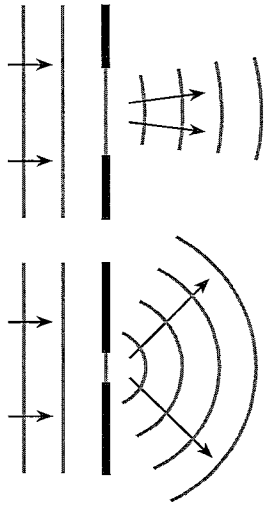
Refraction of light is the change of direction of a light ray when it crosses a boundary between two transparent substances.

Why does light split up into different colours when it passes through a triangular prism?

If the speed is reduced refraction is towards the normal. Give an example:

If the speed is increased refraction is away from the normal. Give an example:

Diffraction



Diffraction is the spreading out of waves when they pass through a gap or round the edge of an obstacle.

Write down the difference when the wave goes through a narrow gap or a wide gap.

Why might people living in hilly areas have poor radio reception?

KEY WORDS:

Incidence
Reflection
Real image
Virtual image
Normal
Refraction

ASSESSMENT:

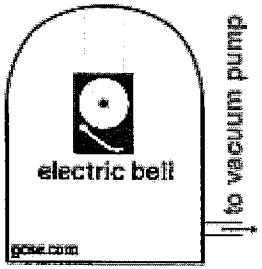
P1 REVISION - CHAPTER 5b - Sound

Sound

What is the frequency range for the normal human ear?

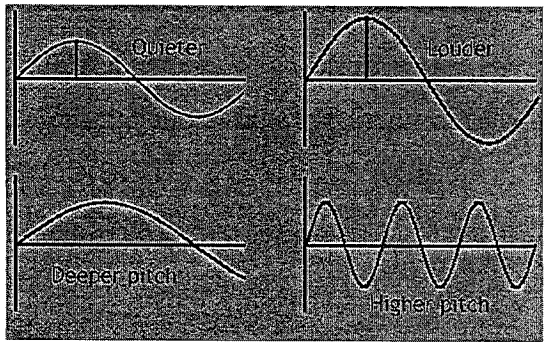
Sound waves are what type of wave?

What are reflections of sound called?



Explain why you will not be able to hear this electric bell.

Musical Sounds



What does the pitch of a note depend on?

What does the loudness of a note depend on?

Practice sketching waveforms, eg. Sketch a wave with twice the frequency and half the amplitude of your original wave.

KEY WORDS:

Sound
Echo
Pitch
Frequency
Amplitude

ASSESSMENT:

P1 REVISION – CHAPTER 6 – Electromagnetic Waves

Visible Light

What is white light?

What are the colours of white light?

What waves are all used for communication?

Communications

How are radio waves produced?

What is an optical fibre?

Remember

Electromagnetic waves transfer e_____ not matter.

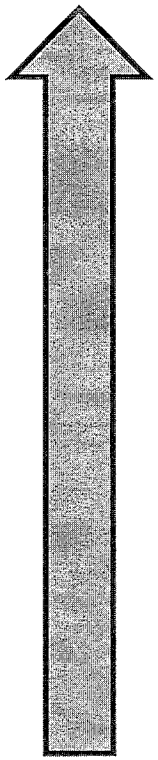
V = f x λ can be used to calculate the f_____ or wavelength of electromagnetic waves.

Research is needed to evaluate whether or not m_____ p_____ are safe to use.

R_____ w_____ of different frequencies are used for different purposes.

All electromagnetic waves can travel through space at the same s_____ but they have different wavelengths and frequencies.

Electromagnetic Spectrum



Gamma — Shortest wavelength, Highest frequency, High Energy

You will need to know the order of the electromagnetic spectrum as it can be asked for in either decreasing or increasing wavelength, frequency or energy.

Microwaves

Radio waves — Longest wavelength, Lowest frequency, Low energy

Complete the electromagnetic spectrum

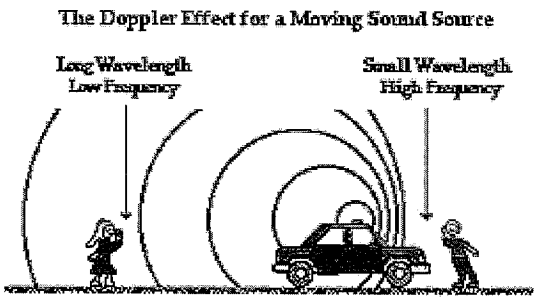
KEY WORDS:

Optical fibre
Electromagnetic
Gamma
Radiation
Spectrum

ASSESSMENT:

P1 REVISION – CHAPTER 6b – Universe

Doppler Effect



When the source moves away from the observer the observed wavelength _____ and the frequency_____.

When the source moves towards the observer the observed wavelength _____ and the frequency _____.

For example a fire engine siren will sound different depending on whether it is moving towards you (pitch is higher) or away from you (pitch is lower).

Red-Shift

Light observed from distant galaxies has been 'shifted' towards the red end of the spectrum. This is known as red-shift and means that the frequency has d_____ and the wavelength has i_____.

Which galaxies are moving fastest?

How does red-shift show that the universe is expanding?

What would a blue-shift indicate?

The Big Bang

What is the Big Bang Theory?

What has been expanding ever since the Big Bang?

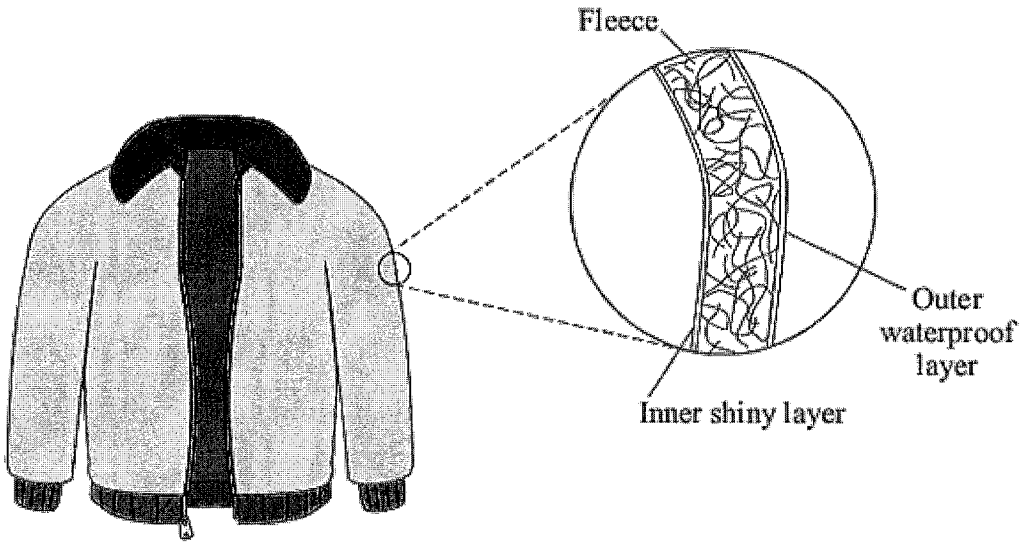
What is Cosmic microwave background radiation (CMBR)?

What can CMBR be explained by?

KEY WORDS:
Doppler Effect
Galaxies
Cosmic
Big Bang
Red-shift
Blue-shift

ASSESSMENT:

Q1. (a) The diagram shows a ski jacket that has been designed to keep a skier warm. The jacket is made from layers of different materials.



(i) The inner layer is shiny to reduce heat transfer.

Which process of heat transfer will it reduce?

.....

(1)

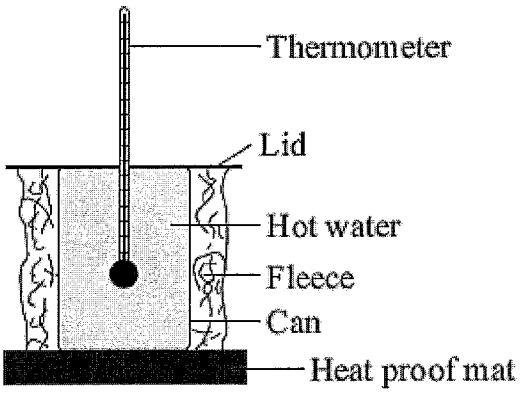
(ii) Why is the layer of fleece good at reducing the transfer of heat from a skier's body?

.....

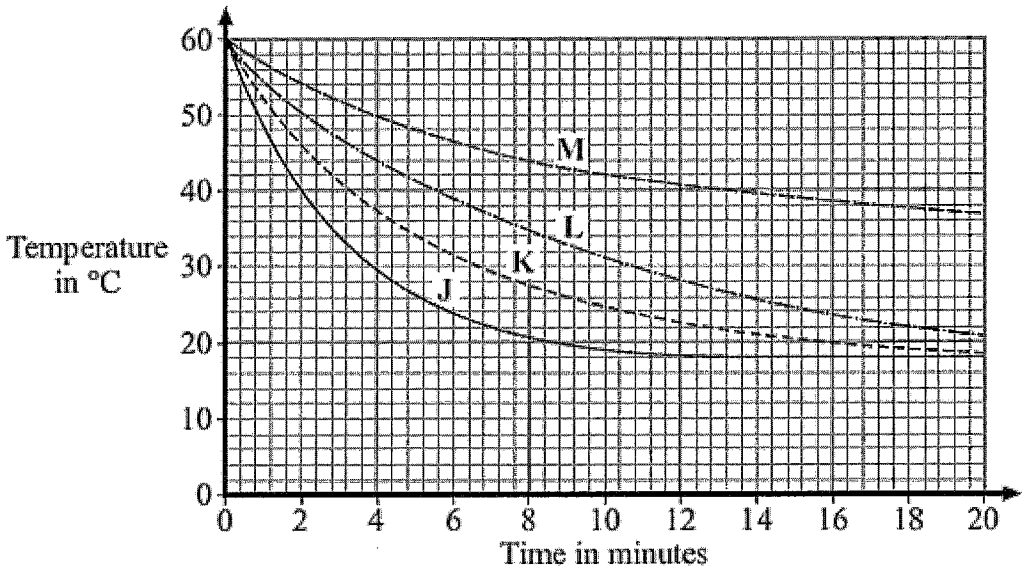
.....

(1)

(b) A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water.
The temperature of the water was taken every two minutes for 20 minutes.



The graph shows the student's results.



(i) In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

.....

.....

(1)

(ii) To be able to compare the results, it was important to use the same volume of water in each test.

Give **one** other quantity that was the same in each test.

.....

.....

(1)

(iii) Look at the graph line for fleece **K**.

Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

.....

(1)

(iv) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

.....

Give a reason for your answer.

.....

.....

.....

.....

(2)
(Total 7 marks)

Q2. Warm air inside a house contains water in the form of a gas. The water condenses onto cold surfaces such as windows. This leaves liquid water on the inside of the glass.

(a) Explain what happens to the particles when water changes from a gas to a liquid.

.....

.....

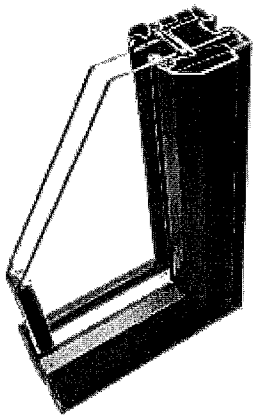
.....

.....

(2)

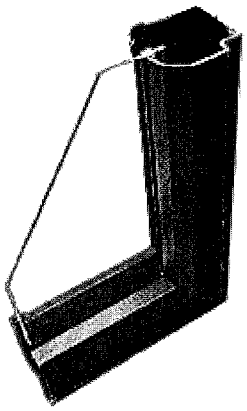
(b) Many houses in the UK have double-glazed windows.

Section through double-glazed window



U-value = 2.8 W/m^2 °C

Section through single-glazed window



U-value = 5.0 W/m^2 °C

Photograph supplied by iStockphoto/Thinkstock

If the window is double-glazed rather than single-glazed there is less condensation on the inside of the glass.

Explain why.

.....

.....

.....

.....

(2)

(c) Double glazing can be made using two pieces of normal glass with an air gap between them. Better insulating glass (Superglaze or G-type) can be used instead of normal glass. The size of the air gap can also be increased to improve insulation.

A company making double glazing provides some information about their products.

U-values for different types of double glazing

	Normal glass	Superglaze	G-type
6 mm air gap	3.1	2.7	2.6
12 mm air gap	2.8	2.2	2.0
16 mm air gap	2.7	2.0	1.8

For the same size window, under the same temperature conditions, the energy loss halves if the U-value is halved.

Cost of double glazing in £ per m^2

	Normal glass	Superglaze	G-type
6 mm air gap	90	110	160
12 mm air gap	100	130	185
16 mm air gap	110	155	210

(i) The data the double glazing company produced is checked and confirmed independently by other scientists.

Suggest why it is important to confirm the data independently.

.....

.....

(1)

(ii) A homeowner is going to replace his old single-glazed windows with new double-glazed windows.

Discuss the cost of fitting double glazing using better insulating glass compared with double glazing using normal glass.

Use the information given in the tables.

.....

.....

.....

.....

.....

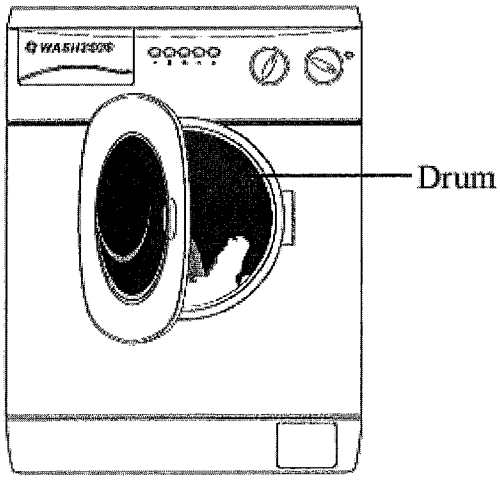
.....

.....

.....

(3)
(Total 8 marks)

Q3. The picture shows a new washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



(a) Complete the following sentences.

(i) An electric motor is designed to transform electrical energy into

..... energy.

(1)

(ii) Some of the electrical energy supplied to the motor is wasted as

..... energy and ..... energy.

(1)

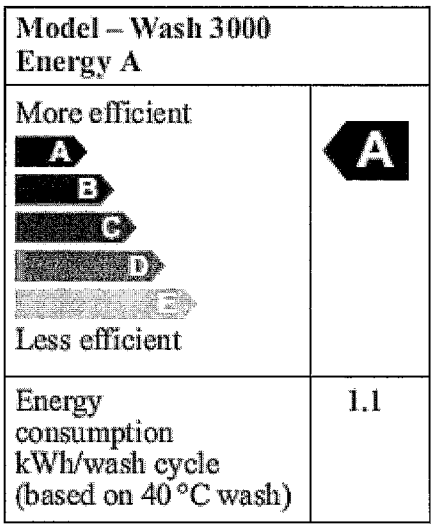
(b) What happens to the energy wasted by the electric motor?

.....

.....

(1)

(c) The diagram shows the label from the new washing machine.



An 'A' rated washing machine is *more energy efficient* than a 'C' rated washing machine.

Explain what being *more energy efficient* means.

.....

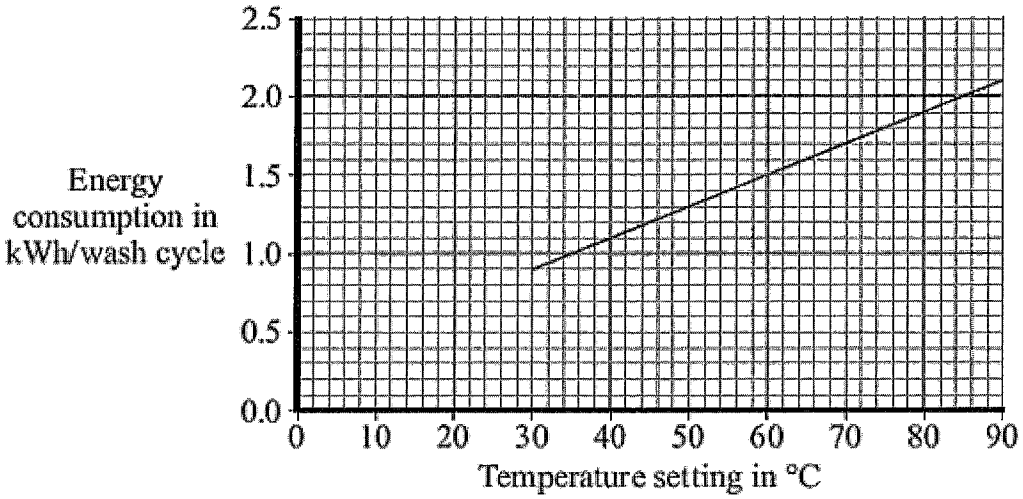
.....

.....

.....

(2)

(d) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.



(i) Electricity costs 12 p per kilowatt-hour (kWh).
The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

total cost = number of kilowatt-hours × cost per kilowatt-hour

Show clearly how you work out your answer.

.....

.....

Money saved = ... p

(2)

(ii) Suggest why reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

.....

.....

(1)
(Total 8 marks)

Q4. A homeowner had a new gas boiler installed.

(a) The following information is an extract from the information booklet supplied with the boiler.

Fuel	Natural Gas
Water temperature	60 °C
Energy supplied to gas boiler	8.0 kJ/s (8.0 kW)
Efficiency	0.95

(i) Use the equation in the box to calculate the energy transferred each second by the gas boiler to the water inside the boiler.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

.....

.....

Energy transferred by the gas boiler each second = ... kJ

(2)

(ii) The energy value of the gas used in a home is measured in kilowatt-hours (kWh).

The homeowner has a pre-payment meter and pays £30 into his account. With a pre-payment meter, gas costs 15p per kilowatt-hour.

Use the equations in the box to calculate the total number of hours that the gas boiler would operate for £30.

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$$

Show clearly how you work out your answer.

.....

.....

.....

.....

Number of hours = ...

(2)

(b) Although the gas boiler is very efficient, some energy is wasted.

Explain what happens to the waste energy.

.....

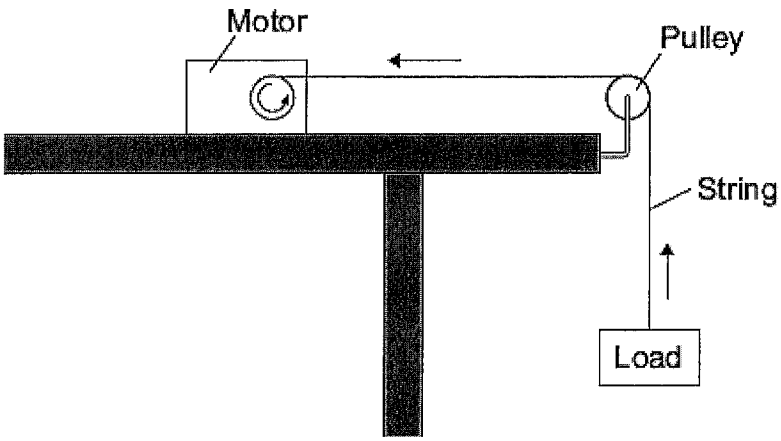
.....

.....

.....

(2)
(Total 6 marks)

Q5. A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

(a) (i) Name the useful energy output from the electric motor.

.....

(1)

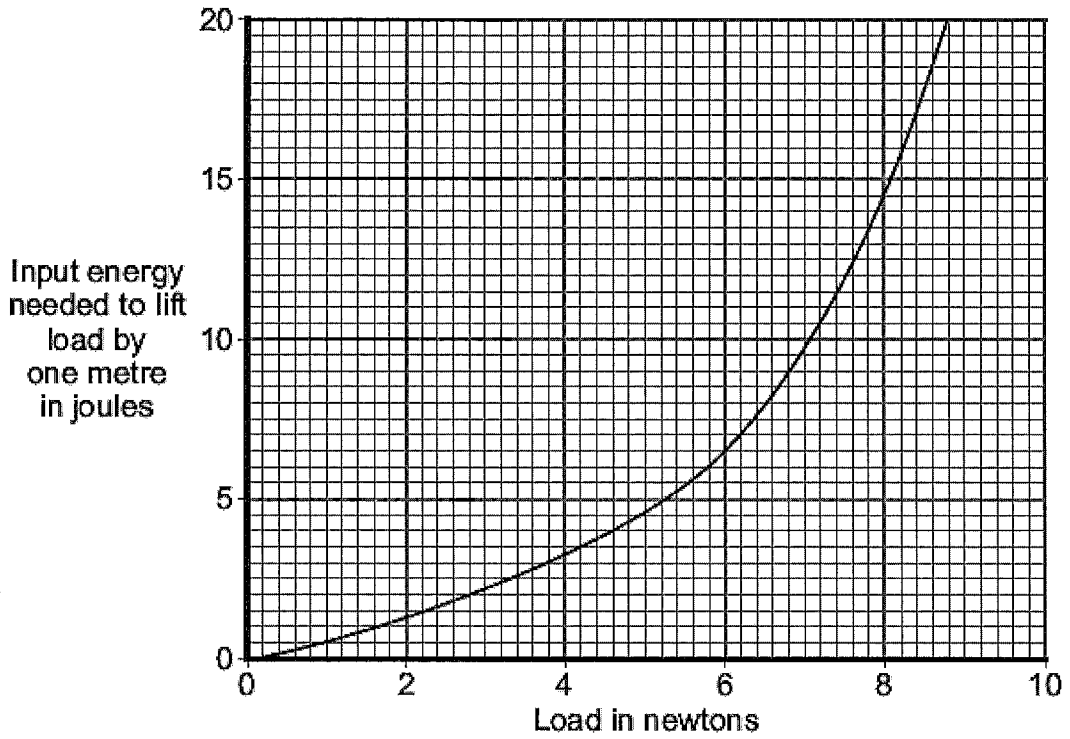
(ii) What eventually happens to the wasted energy?

.....

.....

(1)

(b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

.....

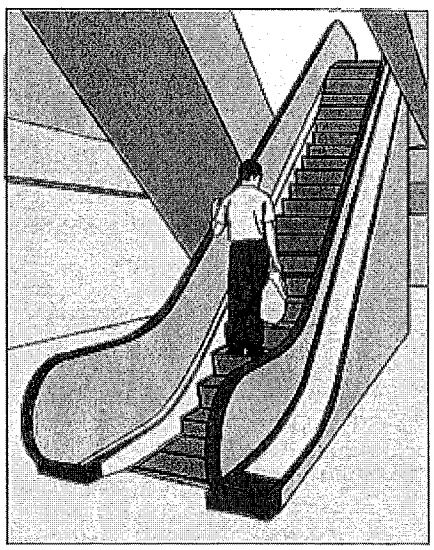
.....

.....

.....

(2)

(c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off. A sign tells the customers that the escalators are turned off to save energy.



(i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

.....

.....

Cost = ... pence

(3)

(ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

.....

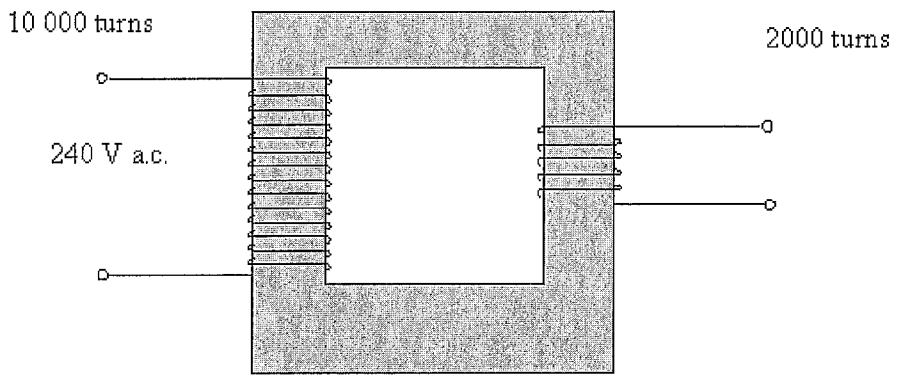
.....

(1)

(Total 8 marks)

Q6. (a) An appliance in a house has a transformer. The transformer is used to reduce the voltage to the level needed by the appliance.

The diagram shows the transformer.



(i) Name the material used for the core of the transformer.

.....

(1)

(ii) The transformer has 10 000 turns on the input side and 2000 turns on the output side. If the mains voltage of 240 volts is applied to the input, calculate the output voltage. You may find the following information helpful:

$$\frac{\text{output voltage}}{\text{input voltage}} = \frac{\text{number of turns on output coil}}{\text{number of turns on input coil}}$$

.....

.....

.....

.....

(3)

(b) Explain, in terms of magnetic fields, how a transformer works.

.....

.....

.....

.....

.....

.....

(4)

(c) A 12 V car battery is connected to the input leads of the transformer. It is hoped to reduce the voltage to 2.4 V in order to run a small motor. When the output voltage is measured it is found to be zero.

Explain why the output voltage is zero.

.....

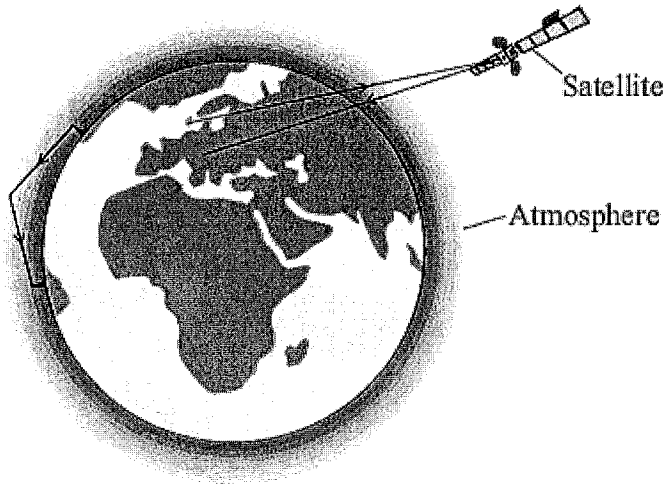
.....

.....

.....

(2)
(Total 10 marks)

Q7. (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



(i) What type of wave is used to send information to and from satellites?

.....

(1)

(ii) What property of this type of wave makes it suitable for satellite communications?

.....

(1)

(b) The diagram shows two types of signal that can be used to send information. One of the signals is an analogue signal. The other is a digital signal.

Describe the differences between an analogue signal and a digital signal.

.....

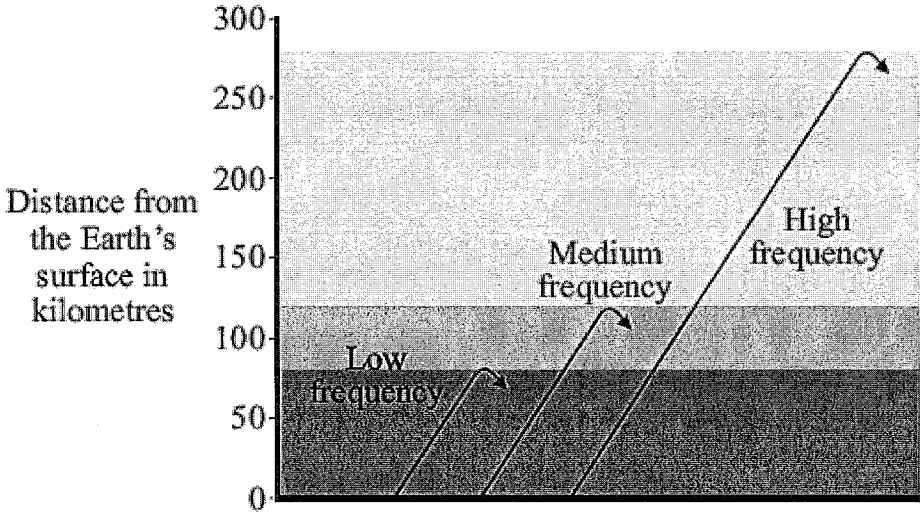
.....

.....

.....

(2)

(c) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

.....

.....

(1)

(d) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Use the equation in the box to calculate the frequency, in kilohertz (kHz), of these waves.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

.....

.....

Frequency = ... kHz

(2)

(Total 7 marks)

Q8. (a) The wavelengths of four different types of electromagnetic wave, including visible light waves, are given in the table.

Type of wave	Wavelength
Visible light	0.0005 mm
A	1.1 km
B	100 mm
C	0.18 mm

Which of the waves, **A**, **B**, or **C**, is an infra red wave?

.....

(1)

(b) A TV station broadcasts at 500 000 kHz. The waves travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the wavelength of the waves broadcast by this station.

wave speed = frequency x wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2)

(c) What happens when a metal aerial absorbs radio waves?

.....

.....

.....

.....

(2)

(d) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Why would an X-ray telescope based on Earth **not** be able to detect X-rays emitted from distant stars?

.....

.....

(1)
(Total 6 marks)

Q9. (a) Background radiation is all around us all the time.

(i) Radon is a natural source of background radiation.

Name another natural source of background radiation.

.....

(1)

(ii) X-rays are an artificial source of background radiation.

Name another artificial source of background radiation.

.....

(1)

(iii) An atom of radon-222 decays by emitting an alpha particle.
The equation representing the decay is shown below.

$$^{222}_{86}Rn \longrightarrow {}^{218}_{84}X + \text{alpha particle}$$

How can you tell from the equation that 'X' is not an atom of radon?

.....

.....

(1)

(b) Having an X-ray taken increases your exposure to radiation.

The table gives:

- the radiation doses received for 6 different medical X-rays;
- the number of days' of exposure to natural background radiation each dose is equivalent to.

Medical X-ray	Radiation dose received (in arbitrary units)	Equivalent number of days of exposure to natural background radiation
Chest	2	2.4
Skull	7	8.4
Pelvis	22	26.4
Hip	44	52.8
Spine	140	
CT head scan	200	240

A hospital patient has an X-ray of the spine taken.
Calculate the number of days of exposure to natural background radiation that an X-ray of the spine is equivalent to.

Show how you work out your answer.

.....

.....

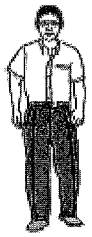
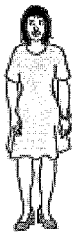
.....

Equivalent number of days = ...

(2)

(c) Scientists have shown that X-rays increase the risk of developing cancer.
The scientists came to this conclusion by studying the medical history of people placed in one of two groups, **A** or **B**.
The group into which people were put depended on their X-ray record.

(i) Person **J** has been placed into group **A**.
Place each of the people, **K**, **L**, **M**, **N** and **O**, into the appropriate group, **A** or **B**.

Person	**J** 	**K** 	**L** 	**M** 	**N** 	**O** 
Medical X-ray record	3 arm	None	None	2 skull	None	4 leg

Group A	**Group B**
J	

(1)

(ii) To be able to make a fair comparison, what is important about the number of people in each of the two groups studied by the scientists?

.....

.....

(1)

(iii) What data would the scientists have compared in order to come to the conclusion that X-rays increase the risk of developing cancer?

.....

.....

(1)

(iv) The chance of developing cancer due to a CT head scan is about 1 in 10 000.
The chance of developing cancer naturally is about 1 in 4.

A hospital patient is advised by a doctor that she needs to have a CT head scan.
The doctor explains to the patient the risks involved.

Do you think that the patient should give her permission for the CT scan to be taken?

Draw a ring around your answer.

Yes **No**

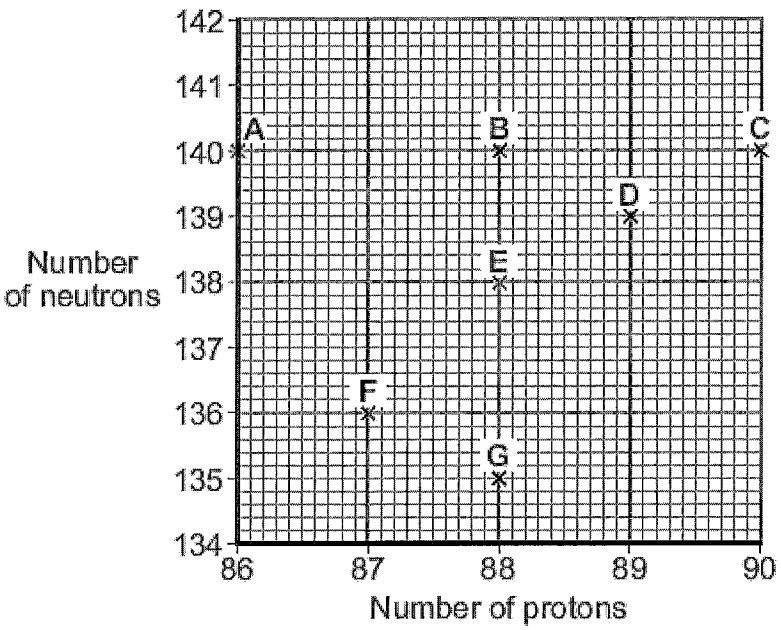
Give a reason for your answer.

.....

.....

(1)
(Total 9 marks)

Q10. (a) The chart gives the number of protons and neutrons within the nuclei of 7 different atoms, **A – G**.



Which of these atoms are isotopes of the same element?

.....

Give a reason for your answer.

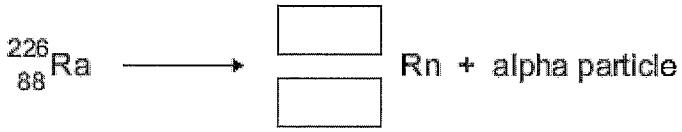
.....

.....

(2)

(b) Radium-226 is a radioactive isotope that decays into radon gas by emitting alpha particles.

The decay can be represented by the equation below.



(i) Complete the equation by writing the correct number in each of the boxes.

(2)

(ii) A sample of radium-226 has a count rate of 400 counts per second.
The half-life of radium-226 is 1600 years.

How long will it be before the count rate has fallen to 50 counts per second?

Show clearly how you work out your answer.

.....

.....

.....

Length of time = ... years

(2)

(c) In 1927, a group of women who had been employed to paint watch faces with a luminous paint sued their former employer over the illnesses caused by the paint. The women had been told that the paint, which contained radium, was harmless.

The company owners and the scientists working for the company knew that radium was harmful and took precautions to protect themselves from the radiation. The women were given no protection.

What important issue did the treatment of the women by the company owners and scientists raise?

Draw a ring around your answer.

economic **environmental** **ethical** **social**

Give a reason for your answer.

.....

.....

(2)

(d) In the 1920s, many people, including doctors, thought that radium could be used as a treatment for a wide range of illnesses. Medical records that suggested radium could be harmful were generally ignored. When some of the women who had used the luminous paint died, their deaths were not blamed on radium.

Suggest a reason why the evidence suggesting that radium was harmful was generally ignored.

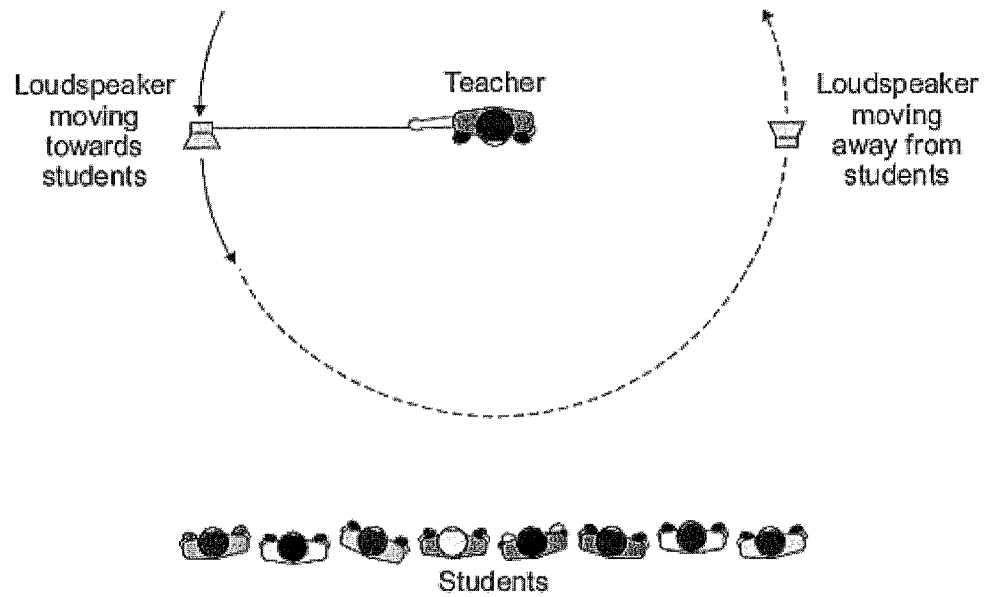
.....

.....

.....

(1)
(Total 9 marks)

Q11. The diagram shows a teacher using a loudspeaker to demonstrate an important effect. The loudspeaker produces a note of constant frequency and is swung around in a circle.



(a) As the loudspeaker moves towards the students, the frequency of the note heard by the students increases.

What happens to the note heard by the students as the loudspeaker moves away from them?

.....

.....

(1)

(b) The teacher is using the demonstration to model the red-shift in light observed from most distant galaxies.

(i) Which part of the demonstration:

represents a moving galaxy?

.....

is like the red-shift?

.....

(2)

(ii) Which **one** of the following statements gives the main reason why models are used in science?

Put a tick (✓) in the box next to your answer.

Models can help to explain an effect or theory. ☐

Models can prove that a theory is correct. ☐

Models can prove that a theory is wrong. ☐

(1)

(c) Red-shift provides evidence to support the theory that the Universe began from a very small initial point.

What name is given to this theory?

.....

(1)
(Total 5 marks)

Q12. The 'Big Bang' theory is one theory of the origin of the Universe.

(a) (i) Explain what is meant by the 'Big Bang' theory.

.....

.....

.....

.....

(2)

(ii) The light arriving from distant galaxies provides scientists with evidence to support the 'Big Bang' theory.

Explain how.

.....

.....

.....

.....

(2)

(b) At a meeting held in 2005, a group of scientists claimed that new data had been collected that showed the 'Big Bang' theory to be wrong. Other scientists said that there was no reason to doubt the 'Big Bang' theory.

What should scientists do when a theory does **not** appear to be supported by new data?

.....

.....

.....

.....

(2)

(c) Scientists can answer many questions about the Universe, but not the question:

Why was the Universe created?

Suggest a reason why this question **cannot** be answered by scientists.

.....

.....

(1)
(Total 7 marks)

M1. (a) (i) radiation

1

(ii) traps (small pockets of) air

*do **not** accept it's an insulator*

*do **not** accept reduces conduction and / or convection*

*do **not** allow it doesn't allow heat to escape*

1

(b) (i) bigger temperature difference (between the water and surroundings) at the start (than at the end)

*do **not** accept water is hotter*

1

(ii) starting temperature (of the water)

accept thickness of fleece

*do **not** accept same amount of fleece*

*do **not** accept thermometer / can*

*do **not** accept time is the same*

1

(iii) 18 (°C)

correct answer only

1

(iv) **M**

1

smallest temperature drop (after 20 mins)

*cannot score if **M** is not chosen*

accept it's the best insulator

accept smallest loss in heat

accept keeps heat / warmth in for longer

1

[7]

M2. (a) (kinetic) energy (of the particles) is reduced

accept slow down

accept transfer energy to (cold) glass / surface

accept energy is lost

*do **not** accept vibrate less*

1

move closer together

1

(b) double glazing provides (better) insulation

accept double glazing has a lower U-value

accept less energy / heat transfer through double glazing

1

(inside of) glass is not as cold

accept window stays warm(er)

1

(c) (i) any **one** from:

- to avoid bias
- to make sure results are reproducible

accept repeatable / reliable for reproducible

1

(ii) any **three** from:

accept Superglaze or G-type for 'better insulating glass' throughout

- the lower the U-value, the better the insulator

'better insulating glass' has a lower U-value is insufficient

- better insulating glass costs more money
- increasing the (width of) air gap increases cost
- additional cost of better insulating glass offset by energy savings

3

[8]

M3. (a) (i) kinetic

*do **not** accept movement*

1

(ii) thermal

accept heat for thermal

sound

*do **not** accept noise for sound*

both answers required in either order

1

(b) transferred to surroundings / surrounding molecules / atmosphere

'it escapes' is insufficient

or

becomes dissipated / spread out

accept warms the surroundings

accept degraded / diluted

accept a correct description for surroundings eg to the washing machine

*do **not** accept transformed into heat on its own*

1

(c) a smaller <u>proportion / percentage</u> of the energy supplied is wasted

owtte

*accept a statement such as 'less energy is wasted' for **1** mark*

*do **not** accept costs less to run*

ignore references to uses less energy

2

(d) (i) 2.4 (p)

accept 2 p if it is clear from the working out this is rounded from 2.4 p

*allow **1** mark for correct substitution of correct values*

ie 0.2 × 12

*allow **1** mark for calculating cost at 40 °C (13.2 p)*

or

cost at 30 °C (10.8 p)

2

(ii) any **one** from:

- less electricity needed

  ignore answers in terms of the washing machine releasing less energy

  an answer in terms of the washing machine releasing CO_2 negates the mark

  *do **not** accept less energy is produced*

- fewer power stations needed

- less fuel is <u>burned</u>

  accept a correctly named fuel

  *do **not** accept less fuel is needed*

1

[8]

M4. (a) (i) 7.6

*allow **1** mark for correct substitution and / or transformation*

ie $0.95 = \frac{x}{8}$

95 × 8.0

2

(ii) 25 (hours)

*allow **1** mark for obtaining number of kWh = 200*

an answer of 26(.3) gains both marks

2

(b) any **two** from

- transferred to the surroundings / air / atmosphere
- becomes spread out
- shared between (many) molecules
- (wasted as) heat / sound

2

[6]

M5. (a) (i) kinetic (energy)

allow gravitational potential (energy) / gpe
movement is insufficient

1

(ii) dissipates into the surroundings

allow warms up the surroundings / air / motor
accept lost to the surroundings
accept lost as heat
ignore reference to sound
it is lost is insufficient

1

(b) energy (required) increases with load

accept positive correlation
*do **not** accept (directly) proportional*

1

further amplification eg increases slowly at first (or up to 4 / 5 N), then increases rapidly

simply quoting figures is insufficient
an answer that only describes the shape of the line gains no marks

1

(c) (i) $E = P \times t$

2880

*accept £28.80 for all **3** marks*
*an answer £2880 gains **2** marks*
*allow **1** mark for obtaining 48 h **or** converting to kW*
*allow **2** marks for correct substitution*
ie 4 × 48 × 15
note: this substitution may be shown as two steps
*an answer 2 880 000 gains **2** marks*
*an answer £4.80 / 480 gains **2** marks*
*an answer of 192 (ie calculation of energy without subsequent calculation of cost) gains **1** mark)*

3

(ii) any sensible suggestion eg

conserves fossil fuels

less (fossil) fuels burned

less pollutant gas (produced)
accept a named pollutant gas

less greenhouse gas (produced)
saves energy is insufficient

1

[8]

M6. (a) (i) Iron
for 1 mark

1

(ii) V/240 = 2000/10 000
V = 48
V
for 1 mark each

3

(b) changing current in primary causes changing (magnetic) field in core links to secondary inducing voltage (emf) in secondary (**NOT** current) secondary voltage/current is alternating
for 1 mark each

4

(c) magnetic field not changing/no electromagnetic induction because direct current
for 1 mark each

2

[10]

M7. (a) (i) microwaves

1

(ii) can pass through the ionosphere
accept travels in a straight line
accept atmosphere for ionosphere
*do **not** accept air for ionosphere*

1

(b) any **two** from:

- analogue is continuously varying
  *do **not** accept analogue has many values*
- digital has only discrete values
  accept digital is on or off
  accept digital is 1 or 0
  accept digital is binary
- digital is less prone to interference (than analogue)
  accept digital is easier to restore
- digital can be processed more easily (than analogue) by a computer

2

(c) higher the frequency, further the wave travels
(into the atmosphere before reflection)

1

(d) 15 000

*allow **1** mark for correct transformation and substitution*

ie $\frac{300\,000\,000}{20}$

*an answer of 15 000 000 only gains **1** mark*
allow both marks for an answer of 15 MHz (unit must be changed)
an answer of 15 gains no credit

2

[7]

M8. (a) C or 0.18 mm

1

(b) 0.6 (m)

*allow **1** mark for correct substitution and/or transformation **or 1** mark for changing frequency to Hz*
*answer 600 gains **1** mark*

2

(c) creates an alternating current

accept 'ac' for alternating current
accept alternating voltage

1

with the same frequency as the radio wave

accept signal for radio wave
*accept it gets hotter for **1** mark provided no other marks scored*

1

(d) X-rays cannot penetrate the atmosphere

accept atmosphere stops X-rays

*do **not** accept atmosphere in the way*

or

X-rays are absorbed (by the atmosphere) before reaching Earth

ignore explanations

1

[6]

M9. (a) (i) any **one** from:

- food / drink
- rocks / building materials
- cosmic rays / rays from space

accept correctly named example

1

(ii) any **one** from:

- nuclear power / coal power (stations)

accept nuclear waste

- nuclear accidents

accept named accident eg Chernobyl

- nuclear weapons testing

accept named medical procedure which involves a radioactive source

accept radiotherapy

nuclear activity / radiation is insufficient

*do **not** accept CT scans*

1

(iii) different number of / fewer protons

accept does not have 86 protons

accept only has 84 protons

or

different atomic number

*do **not** accept bottom number different*

reference to mass number negates this mark

1

(b) 168

accept 169 if clear, correct method is shown

*allow **1** mark for a correct dose ratio involving the spine*

eg 2:140 etc

***or** ratio of days to dose is 1.2*

***or** ratio of dose to days is 0.83*

2

(c) (i)

Group A	Group B
J M O	K L N

all correct
any order within each group

1

(ii) similar (number) / same (number) / large (number)
accept the same specific number in each group eg three
reference to other factors such as age is neutral

1

(iii) how many people in each group developed cancer
a clear comparison is required

1

(iv) *there are no marks for **Yes** or **No** the mark is for the reason*

Yes
the benefit of having the scan is greater than the risk
or
the risk is (very) small (compared to the chance from natural causes)
accept the risk is much greater from natural causes

No
no additional risk is acceptable

1

[9]

M10. (a) **B E G**
all 3 required and no other
any order

1

same number of / 88 protons (and different numbers of neutrons)
same number of electrons is insufficient

1

(b) (i) 222

1

86

1

(ii) 4800
*allow **1** mark for obtaining 3 half-lives*

2

(c) ethical

1

deceived / lied to (about safety of working conditions)

accept (women) not warned of the dangers

given no protection is insufficient

or

value own / scientists' lives more than women

or

did not treat women humanely

1

(d) accept any sensible suggestion

eg

too many interests in continued use of radium

evidence may cause public unrest

*do **not** accept not enough evidence*

doctors not want to be blamed for illnesses (caused by radium)

accept doctors not wanting to be sued (for harm caused by using radium)

doctors thought (possible) benefits outweighed (possible) risks

*do **not** accept did not know radium could be harmful*

believe radium could treat illnesses is insufficient

1

[9]

M11. (a) frequency / pitch decreases

accept wavelength increases

accept it / the note becomes deeper / lower

it / the note decreases is insufficient

quieter is neutral

1

(b) (i) (moving) loudspeaker

1

change in sound as loudspeaker moves away

1

(ii) models can help to explain an effect or theory

1

(c) big bang

1

[5]

M12. (a) (i) Universe began at a (very) small (initial) point

'it' refers to Universe

1

'explosion' sent matter outwards
or
'explosion' causing Universe to expand
accept gas / dust for matter
accept rapid expansion for explosion
1

(ii) light shows a red shift
owtte
the term red shift on its own does not score a mark
1

galaxies moving away (from the Earth)
'it' refers to light
'they' refers to galaxies
accept star for galaxy
*do **not** accept planet for galaxy*
1

(b) check reliability / validity of data
accept check data
accept collect more data
1

amend theory
or
discount the data
accept replace old theory with new theory
1

(c) answer involves (religious) belief
or
no / insufficient evidence
accept it cannot be tested
1

[7]