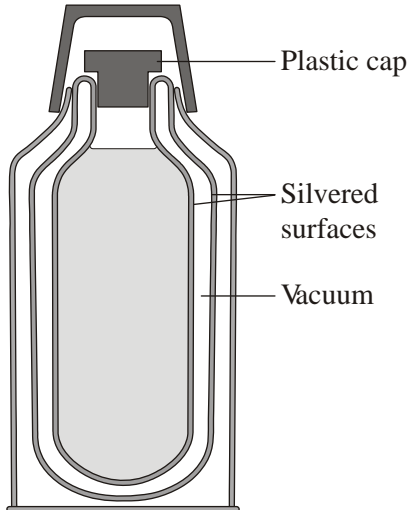


**The transfer of energy by heating processes**

1. 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)

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

.....

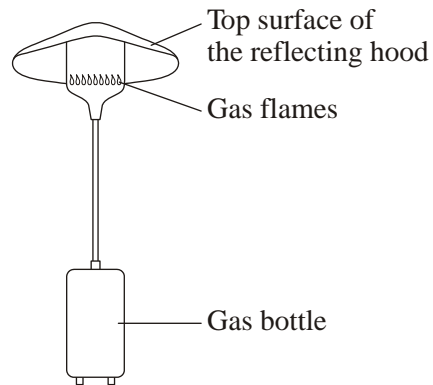
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.....

(2)

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



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

.....

.....

.....

(2)

(ii) Most of the chemical energy in the gas is transformed into heat. A **small** amount of chemical energy is transformed into light.

Draw and label a Sankey diagram for the patio heater.

(2)

(iii) State why the total energy supplied to the patio heater must always equal the total energy transferred by the patio heater.

.....

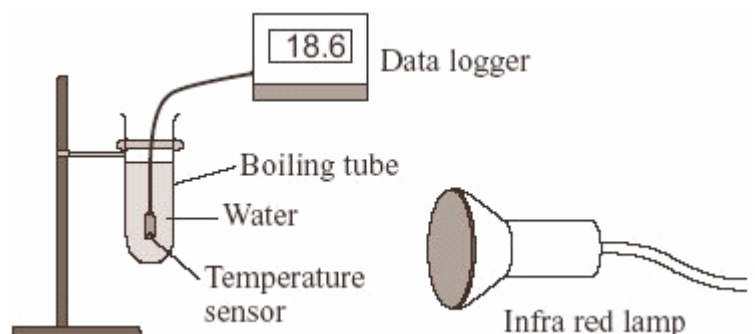
.....

(1)

(Total 9 marks)

2. A student had read about a glacier that had been covered in insulating material. The idea was to slow down the rate at which the glacier melts in the summer.

She investigated this idea using the apparatus shown in the diagram.



(a) These are the steps taken by the student.

- Measure 30 cm<sup>3</sup> of cold water into a boiling tube.
- Place the boiling tube 25 cm from an infra red lamp.
- Record the temperature of the water.
- Switch on the infra red lamp.
- Record the temperature of the water every minute for 5 minutes.
- Repeat with boiling tubes covered in different insulating materials.

(i) Why did she use an infra red lamp?

.....

(1)

(ii) Name **one** control variable in this investigation.

.....

(1)

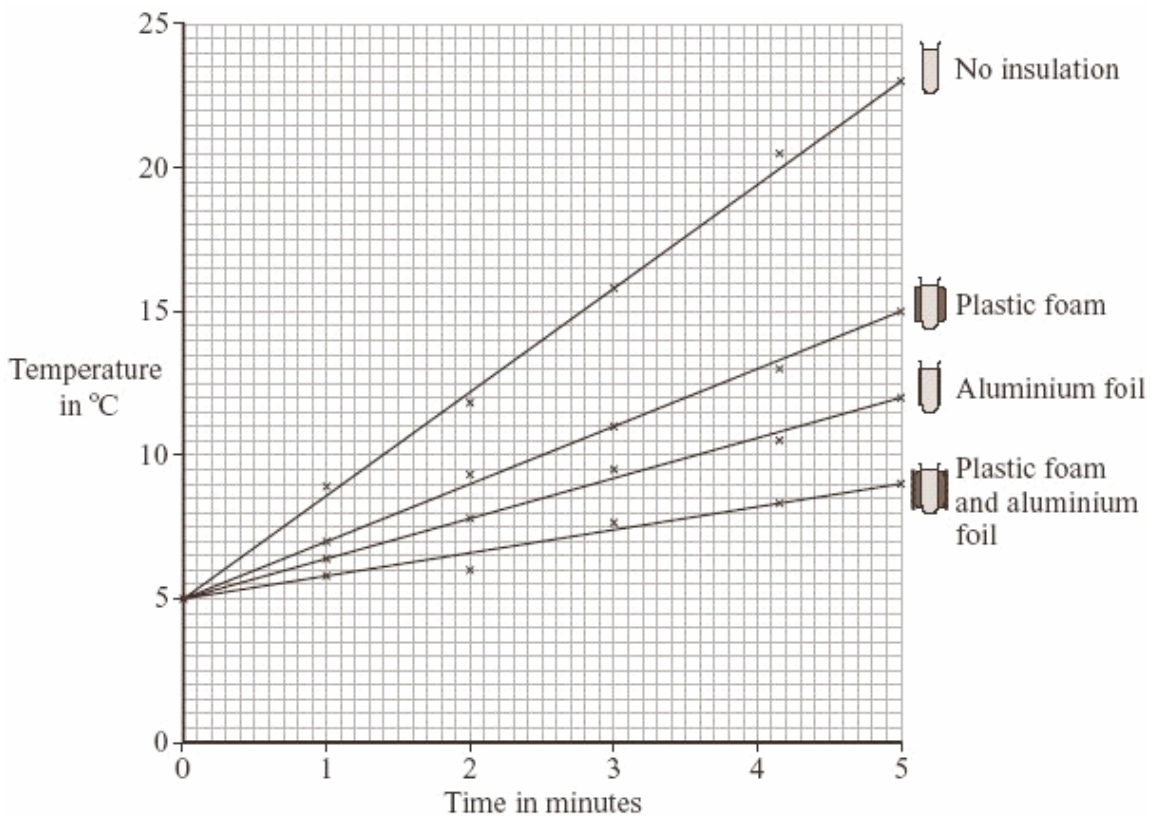
(iii) Give **one** advantage of using a temperature sensor and data logger instead of a glass thermometer to measure temperature.

.....

.....

(1)

(b) The results of the investigation are shown in the graph.



(i) Why did the student use a boiling tube with no insulation?

.....  
.....

(1)

(ii) From her results, what should she recommend is used to insulate the glacier?

.....

(1)

(iii) Explain why the insulation recommended by the student will reduce the heat transfer from the Sun to the glacier.

.....  
.....  
.....  
.....  
.....

(2)

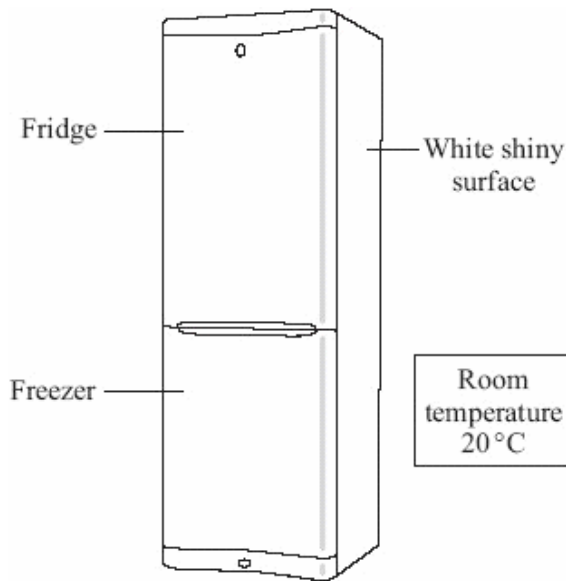
(c) Explain, in terms of particles, how heat is transferred through the glass wall of a boiling tube.

.....  
.....  
.....  
.....

(2)

**(Total 9 marks)**

3. 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.

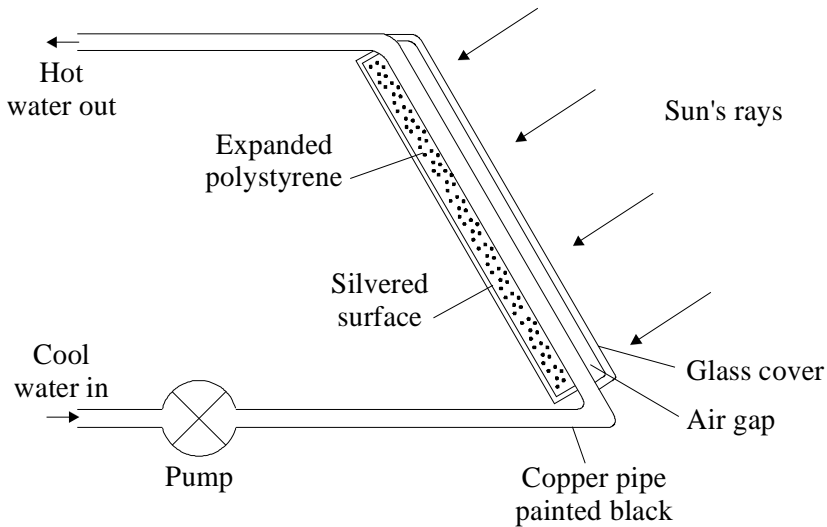
1 .....

2 .....

(2)

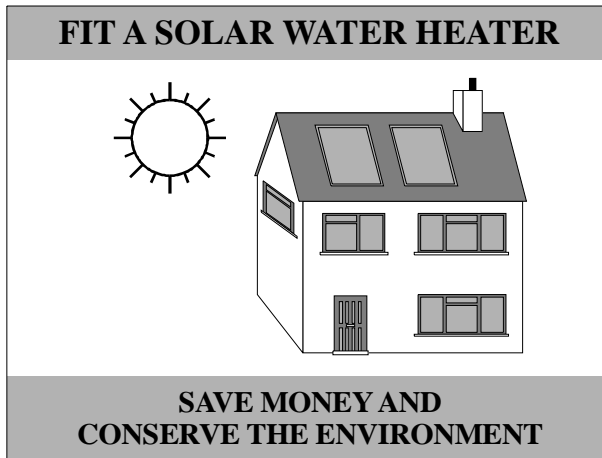
(Total 4 marks)

4. (a) The diagram shows part of a solar water heater. Water circulating through the solar panel is heated by the Sun.



- (i) Complete the following sentence.  
Heat energy is transferred from the Sun to the solar panel by  
..... (1)
- (ii) The pipe inside the solar panel is black. Why?  
.....  
..... (1)
- (iii) There is a layer of expanded polystyrene behind the black pipe. Why?  
.....  
..... (1)
- (iv) A silvered surface is used at the back of the solar panel. Explain why.  
.....  
.....  
..... (2)

(b) The picture shows an advertisement for a solar water heater.



Installing the solar water heater may help to conserve the environment. Explain how.

.....

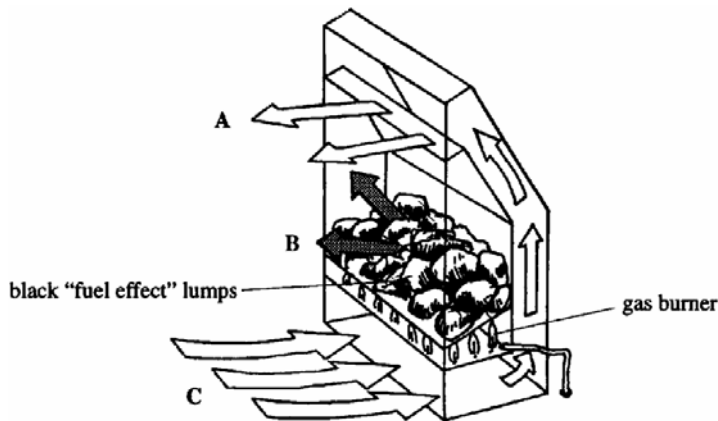
.....

.....

.....

(2)  
(Total 7 marks)

5. The diagram comes from a leaflet about a “coal effect” gas fire. It shows how air circulates through the fire.



###

(a) Explain in detail why the air travels from C to A.

.....

.....

.....

.....

(4)

- (b) The black “fuel effect” lumps become very hot.  
 (i) Name the process by which the lumps transfer thermal energy to the room as shown at **B**.

.....

(1)

- (ii) Suggest **one** feature of the black “fuel effect” lumps which make them efficient at transferring energy.

.....

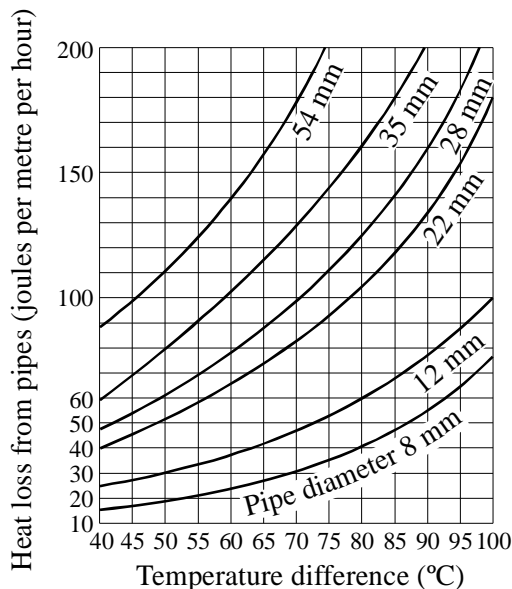
.....

(1)

(Total 6 marks)

6. Many houses are kept warm by water, heated in a boiler, then circulated through the house by copper pipes to radiators.

The graph below gives information about the heat losses from copper pipes in such circumstances.



- (a) One factor which affects the total amount of heat loss from the pipes, is the temperature difference between the pipes and the surrounding air.

What are the other **three** factors indicated on the graph?

1. ....

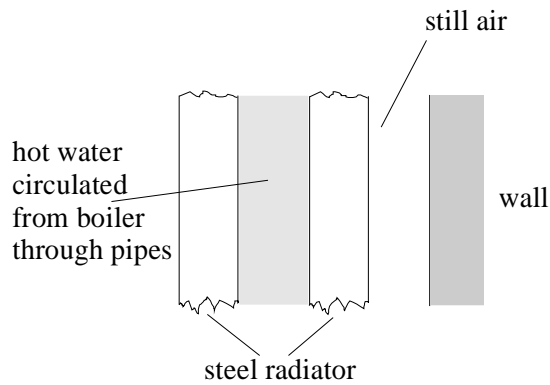
2. ....

3. ....

(3)



(b)



Describe, as fully as you can, how heat from inside the boiler reaches the wall behind a radiator.

.....

.....

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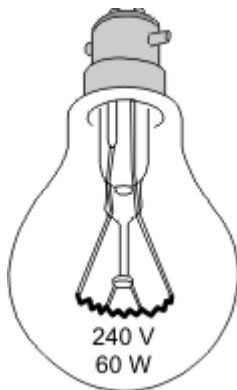
.....

.....

(4)  
(Total 7 marks)

**Energy and efficiency and the usefulness of electrical appliances**

1. The diagram below shows a 60 watt electric light bulb.



(a) 60 W means that 60 joules of energy are transferred into the bulb each second. In use, how much energy is given **out** by the bulb each second?

..... J (1)

(b) Describe the energy transfers which occur as it is used.

..... energy is transferred into ..... energy  
and ..... energy. (2)

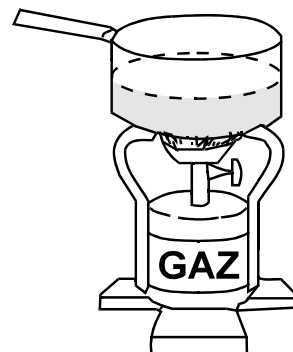
(c) Some of the energy given out is wasted. Why is some of the energy wasted?

.....  
..... (1)  
**(Total 4 marks)**

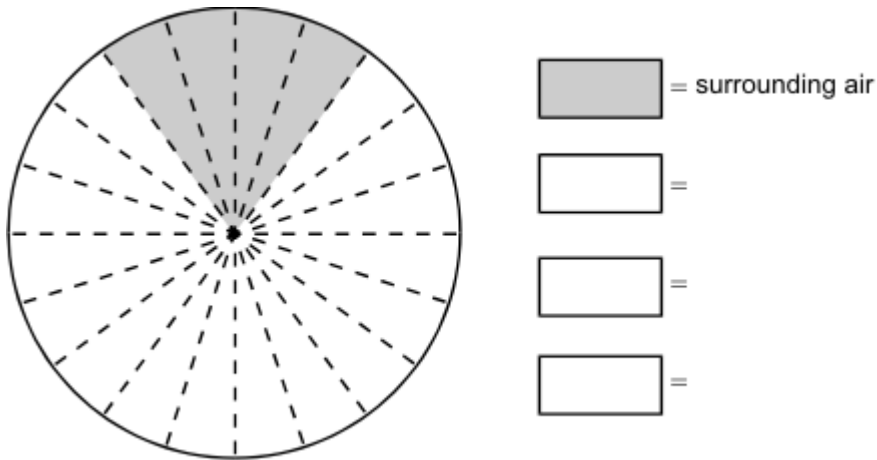
2. A gas burner is used to heat some water in a pan.

Of the energy released by the burning gas by the time the water starts to boil:

- 60% has been transferred to the **water**.
- 20% has been transferred to the **surrounding air**.
- 13% has been transferred to the **pan**.
- 7% has been transferred to the **gas burner** itself.



(a) Use the above information to complete the pie-chart.



(3)

(b) Some of the energy released by the burning gas is wasted.

(i) What happens to this wasted energy?

.....  
 .....

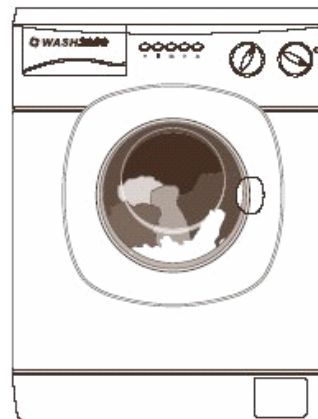
(2)

(ii) What percentage (%) of the energy from the gas is wasted? Answer: ..... %

(1)

**(Total 6 marks)**

3. (a) The picture shows a new washing machine.



Complete the following sentence using **one** of the words in the box.

<b>kinetic</b>	<b>light</b>	<b>sound</b>
----------------	--------------	--------------

A washing machine is designed to transform electrical energy into heat and

..... energy

(1)

(b) The instruction booklet for the washing machine contains the following information.

Wash cycle	Average power during cycle	Time taken to run cycle
<b>HOT</b>	1.5 kW	2 hours
<b>COOL</b>	1.1 kW	1½ hours
<b>FAST</b>	1.0 kW	¾ hour

(i) Use the following equation to calculate the energy transferred, in kilowatt-hours, to the washing machine during the HOT wash cycle. Show how you work out your answer.

energy transferred = power × time

.....  
 .....

Energy transferred = ..... kWh

(2)

(ii) Why does it cost more to use the washing machine on the HOT cycle than on the COOL or FAST cycle?

.....  
 .....

(1)

(Total 4 marks)

4. The diagram shows the label from a new freezer.

<b>Model Energy A</b>	<b>SALE</b> See inside for details
More efficient  Less efficient	
Energy consumption per year	225 kWh

(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. ....

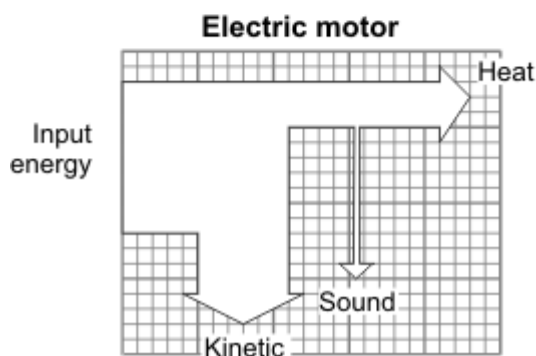
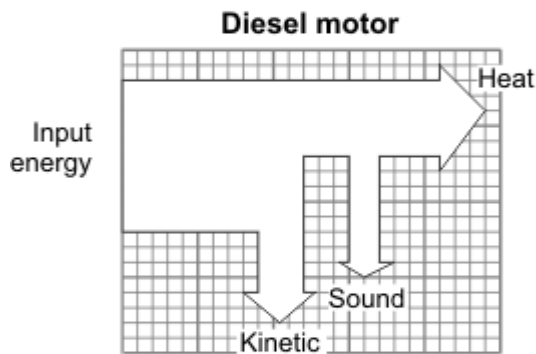
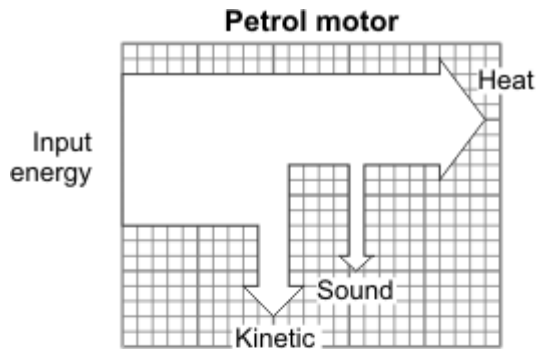
Explain the reasons for your answer.

.....  
.....  
.....  
.....

(2)

(Total 6 marks)

5. (a) The energy transformation (Sankey) diagrams show what happens to the input energy for three different machines.



- (i) Which machine is the most efficient?

.....

Give a reason for your answer.

.....

.....

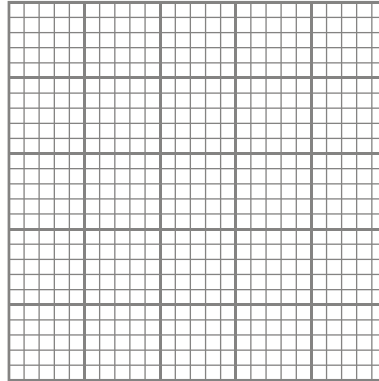
(2)

- (ii) What percentage of the input energy is usefully transformed by the electric motor?  
Show clearly how you get your answer.

.....  
.....

(2)

- (b) (i) Draw on the grid a labelled energy transformation (Sankey) diagram for a filament lamp.



(2)

- (ii) A pupil wrote the following statement.

‘Switching lights off does not save energy. Since energy cannot be destroyed, it will always be there so none is wasted.’

Explain carefully what is wrong with the pupil's statement.

.....  
.....  
.....

(2)

(Total 8 marks)

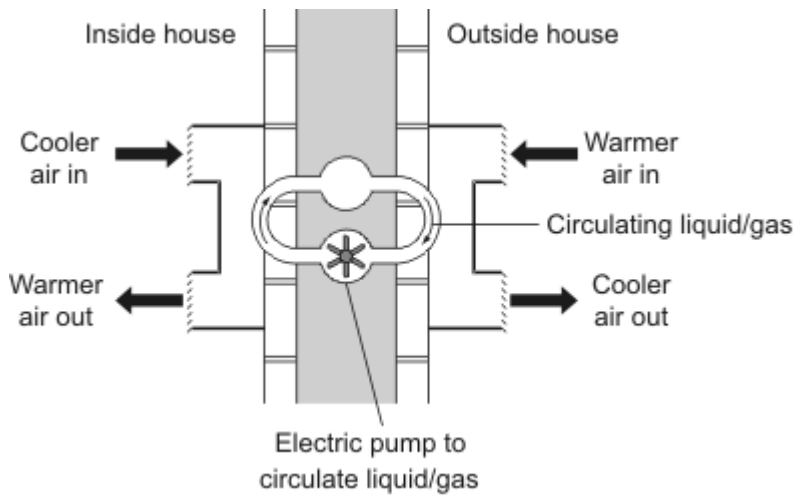
6. (a) In winter, energy is transferred from the warm air inside a house to the air outside.  
 (i) What effect will the energy transferred from the house have on the air outside?

..... (1)

- (ii) What would happen to the energy transfer if the temperature inside the house were reduced? Assume the temperature outside the house does not change.

..... (1)

- (b) To increase energy efficiency, a householder installs a heat exchanger to an outside wall of the house. The heat exchanger uses heat from the air outside to warm the inside of the house. The diagram shows the idea of the heat exchanger.



*Physics Through Applications edited by J Jardine et al (OUP, 1989), copyright © Oxford University Press, reprinted by permission of Oxford University Press.*

- (i) Why does the heat exchanger cost money to run?

..... (1)

- (ii) The heat exchanger is cost effective in reducing energy consumption. Explain why.

.....  
 .....  
 .....  
 .....

(2)  
 (Total 5 marks)



7. (a) The table gives information about some ways of reducing the energy consumption in a house.

Method of reducing energy consumption	Installation cost in £	Annual saving on energy bills in £
Fit a new hot water boiler	1800	200
Fit a solar water heater	2400	100
Fit underfloor heating	600	50
Fit thermostatic radiator valves	75	20

Which way of reducing energy consumption is most cost effective over a 10-year period?

To obtain full marks you must support your answer with calculations.

.....

.....

.....

.....

(3)

- (b) Explain why using an energy-efficient light bulb instead of an ordinary light bulb reduces the amount of carbon dioxide emitted into the atmosphere.

.....

.....

.....

.....

(2)

(Total 5 marks)

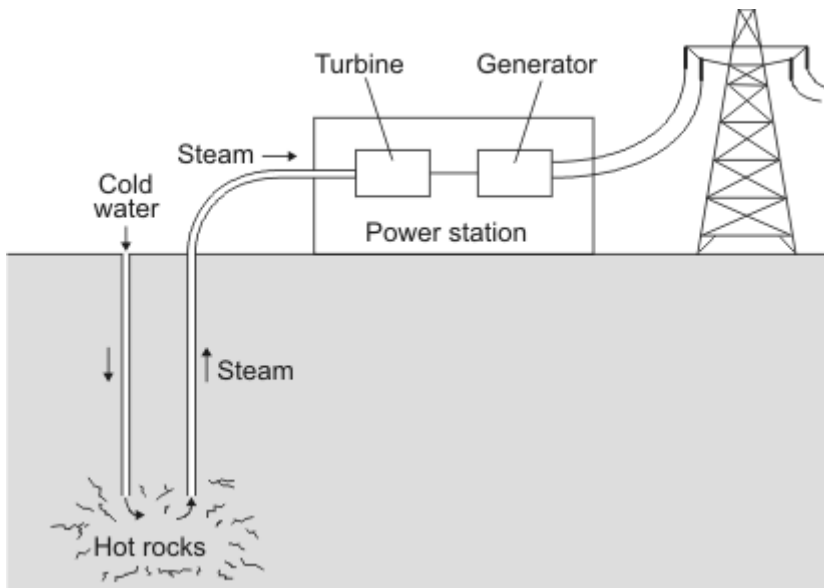
Methods we use to generate electricity

1. (a) Different energy sources are used to generate electricity.  
Which **two** of the energy sources in the box are likely to be used up first?  
Draw a ring around each of your answers.

gas	oil	Sun	tides	waves	wind
-----	-----	-----	-------	-------	------

(2)

- (b) The diagram shows a geothermal power station. Hot rocks in the Earth's crust heat water to produce steam. The steam is used to drive turbines that turn electrical generators.

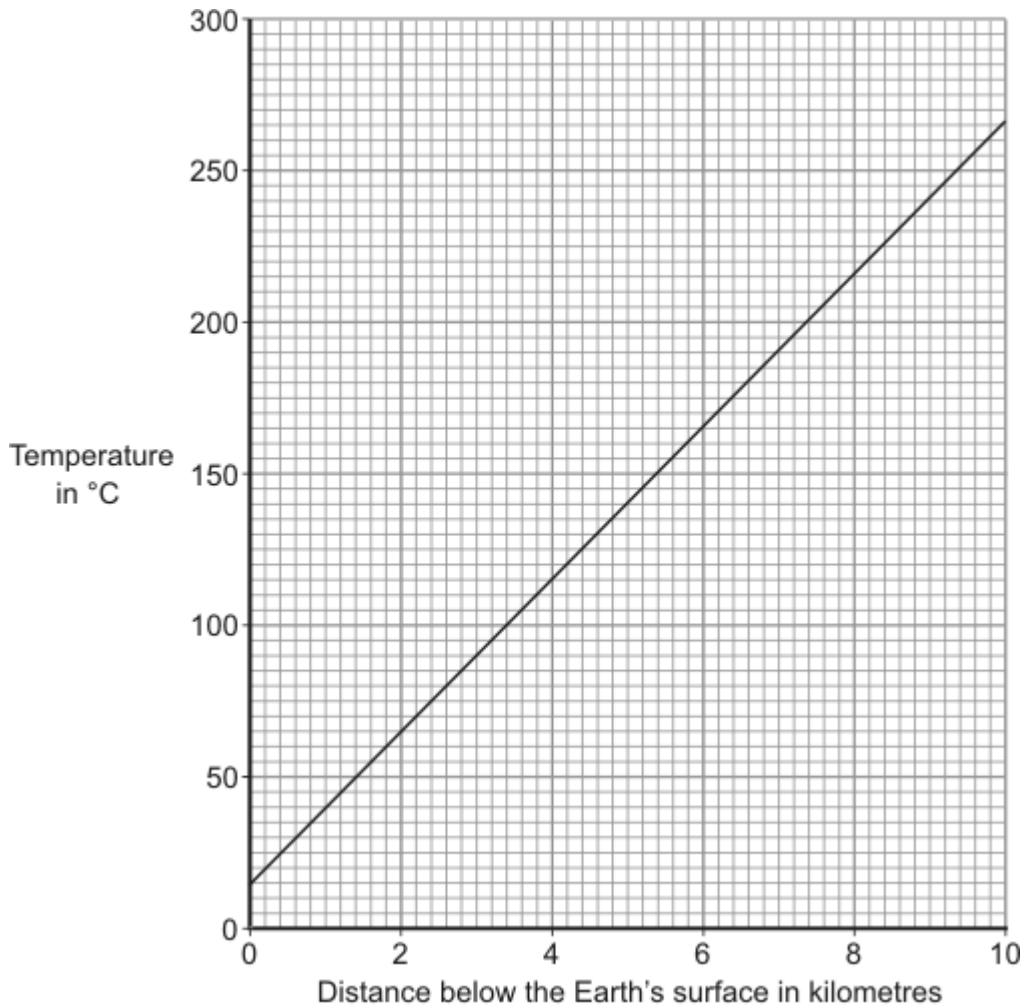


How is the way in which a geothermal power station generates electricity the same as the way in which a coal burning power station generates electricity?

.....  
.....

(1)

- (c) The graph shows how the temperature of the rocks in the Earth's crust depends on how far the rocks are below the Earth's surface.



Estimate the temperature of the rocks 5 kilometres below the Earth's surface.  
Show clearly how you have used the graph to get your answer.

.....  
 .....

Temperature = ..... °C

(2)

- (d) Scientists have estimated that one quarter of the world's electricity could be generated using geothermal energy.

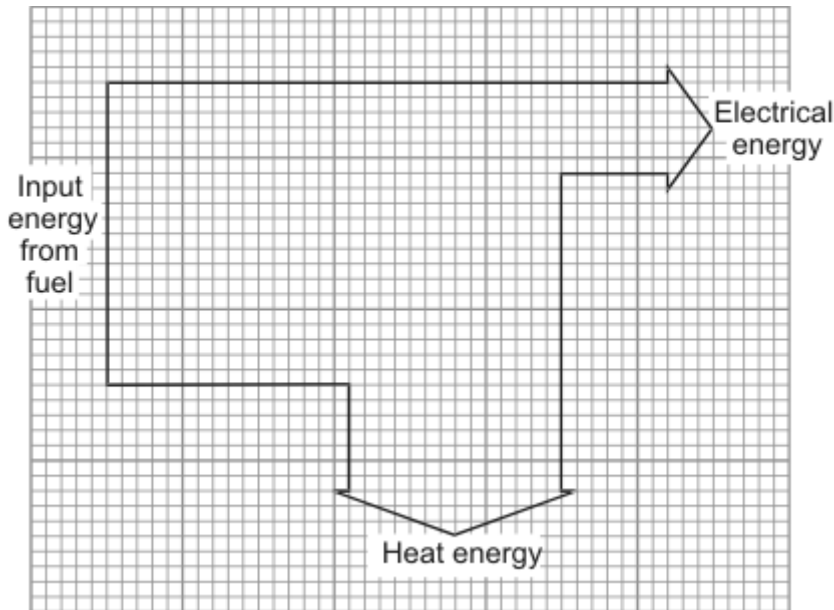
Give **one** reason that scientists might use to persuade a government to spend large amounts of money building geothermal power stations.

.....  
 .....

(1)

(Total 6 marks)

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



(i) Name **one** fuel that is burned to provide the energy source for a power station.

.....

(1)

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

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

Show clearly how you work out your answer.

.....  
 .....

Efficiency = .....

(2)

(iii) Name the process by which a nuclear fuel provides the energy needed to generate electricity in a nuclear power station.

.....

(1)

(b) Electricity is distributed from power stations to consumers along the National Grid.

(i) Transformers are part of the National Grid. Transformers are *efficient* devices. What is meant by a device being *efficient*?

.....  
 .....

(1)

- (ii) When electricity flows through a cable, some energy is transformed into heat. Explain how the National Grid system reduces the amount of energy lost as heat.

.....

.....

.....

.....

(2)

- (c) Read this information taken from a recent newspaper article.

- Researchers have found that children living close to overhead power cables are more likely to develop leukaemia.
- The researchers studied two groups of children. One group had developed leukaemia, the other group was healthy.
- Although the researchers found a link, they are unable to explain why it happened. They say that the results may have happened by chance.
- Other factors that have not been investigated, such as the environment, the geographical area or the children's genes, could be important.
- A cancer research charity said that childhood leukaemia was most likely to be caused by factors that parents were unable to control.

- (i) Why did the researchers study a group of healthy children?

.....

.....

(1)

- (ii) The information does not say how many children were studied. Why should this data have been included in the article?

.....

.....

(1)

- (iii) The researchers could not be certain that the overhead power cables were responsible for the increased chance of children developing leukaemia. Explain why.

.....

.....

.....

.....

(2)

(iv) The results of the research carried out by scientists may worry some people. What do you think scientists should do?

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

Scientists should publish their research findings straight away.

Scientists should not publish their research findings until they have found out as many facts as possible.

Give a reason for your choice.

.....  
.....

(1)  
(Total 12 marks)

3. There is an increasing demand for electricity and the reserve of fossil fuels is decreasing. A way to meet increasing demand for electricity is to build new nuclear power stations. Some people feel that no new nuclear power stations should be built because of the risks associated with nuclear fuels.

(a) Outline the arguments that a scientist working in the nuclear power industry could use to justify the building of more nuclear power stations in the future.

.....  
.....  
.....  
.....

(3)

(b) Nuclear waste is a problem that must be dealt with. One possible solution would be to bury the waste deep underground.

Suggest **one** reason why some people are against burying nuclear waste.

.....  
.....

(1)

(c) Electricity can also be generated using renewable energy sources.

Look at this information from a newspaper report.

- The energy from burning bio-fuels, such as woodchip and straw, can be used to generate electricity.
- Plants for bio-fuels use up carbon dioxide as they grow.
- Farmers get grants to grow plants for bio-fuels.
- Electricity generated from bio-fuels can be sold at a higher price than electricity generated from burning fossil fuels.
- Growing plants for bio-fuels offers new opportunities for rural communities.

Suggest why, apart from the declining reserves of fossil fuels, power companies should use more bio-fuels and less fossil fuels to generate electricity.

.....

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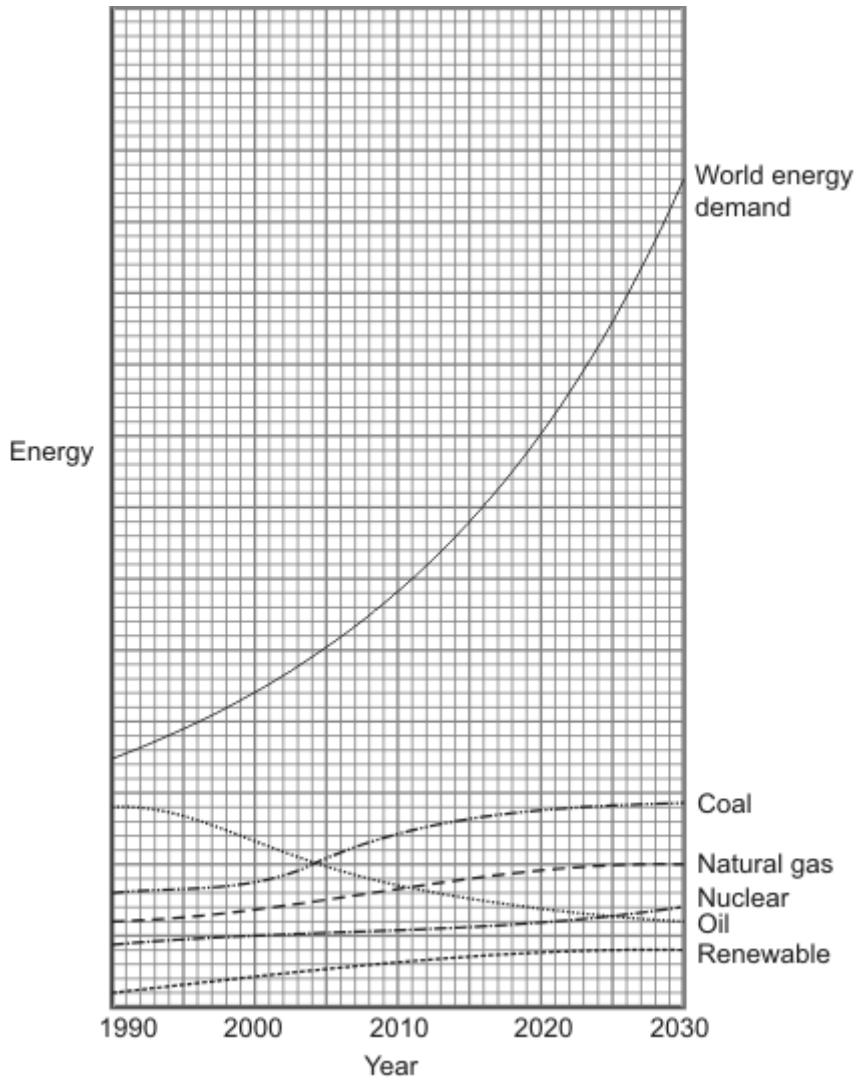
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(3)  
(Total 7 marks)

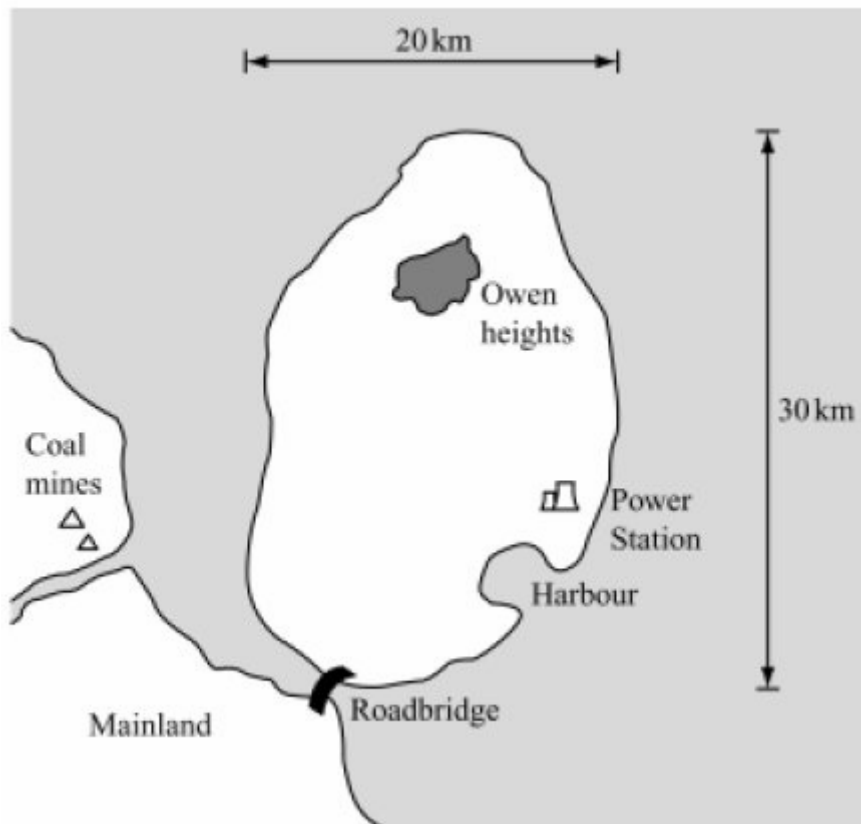
4. The graph shows the expected change in the world demand for energy. It also shows how the supplies of various energy resources are expected to change.



- (a) Use the graph to estimate when supplies from oil and coal are equal.  
..... (1)
- (b) Currently we rely on coal, oil and gas to supply most of our energy needs.  
Use the graph to explain why we must develop alternative energy resources.  
.....  
.....  
.....  
..... (2)
- (c) On average, the energy use of each family in the UK releases over 25 tonnes of carbon dioxide and 4 kilograms of sulfur dioxide into the air every year.
- (i) State **one** environmental effect that is increased by releasing carbon dioxide into the air.  
..... (1)
- (ii) State a different environmental effect caused by the releasing of sulfur dioxide into the air.  
..... (1)
- (d) Nuclear power stations use the energy released by *nuclear fission* to generate electricity.  
Explain what is meant by *nuclear fission*.  
.....  
.....  
..... (2)



- (e) A 200 MW coal burning power station provides all the electrical power for a small island. The coal is bought to the island from the mainland.



The islanders who want to replace the power station with wind turbines have been given the following information.

Maximum output from one turbine	800 kW
Maximum number of turbines on one square kilometre of land	6
Average yearly output as a percentage of the maximum	25%
Percentage of land suitable for a wind turbine	20%
Reduced carbon dioxide emissions per year (in tonnes)	200 000

- (i) Would you recommend that the islanders replace the coal power station with wind turbines? Explain the reasons for your recommendation. To gain full you must support your explanation with relevant calculations.

.....

.....

.....

.....

(3)

- (ii) Some islanders want to find out if it would be possible to generate the electricity they need using solar energy. How could the islanders find the data needed to make an informed decision?

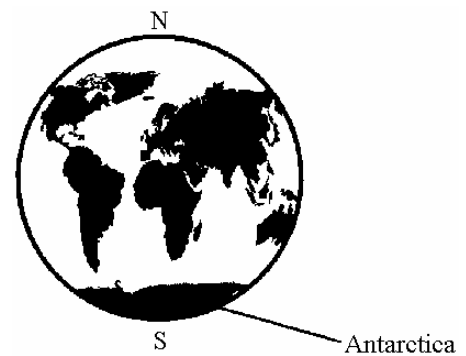
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(1)  
 (Total 11 marks)

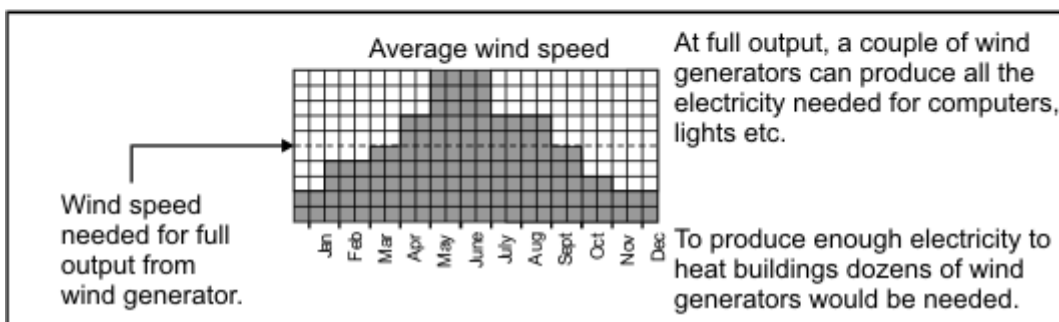
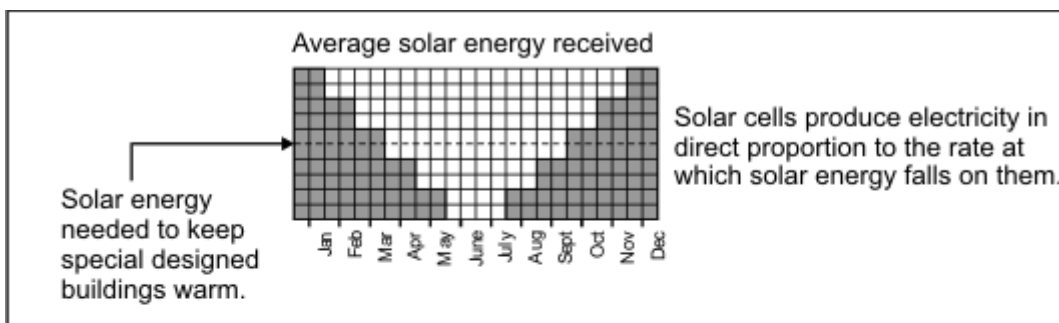
5. The following information is needed for the question below.

Antarctica is a huge land mass surrounding the Earth's south pole. It is covered in a very thick layer of ice and is the only remaining large area of the Earth's surface that has not been affected very much by humans.

There are, however, teams of scientists from various countries studying Antarctica. These scientists need electricity for lighting, for their computers and other scientific instruments and to communicate, via satellite, with the rest of the world. The temperature in Antarctica is always sub-zero, so the scientists need some way of keeping their buildings warm. They also need fuel to be able to get around on their snowmobiles.



Scientists cannot avoid affecting the environment. However, they want to affect it as little as possible.



Atmospheric pollution produced in one country eventually affects the whole of the Earth's atmosphere. The hole that appears each year in the ozone layer above Antarctica, for example, is mainly caused by pollutants such as CFCs from countries in the northern half of the Earth.

- (a) Complete the table to explain **one** advantage and **one** disadvantage of using each energy source to meet the scientist's needs.

You should **not** refer to differences in cost.

Energy Source	Advantage	Disadvantage
Solar Energy		
Energy from Wind		
Natural Gas		
Diesel Oil		

(8)

- (b) Which **one** energy source would you choose to support most of the energy needed by the scientists?

Give the reason for your answer.

.....

.....

.....

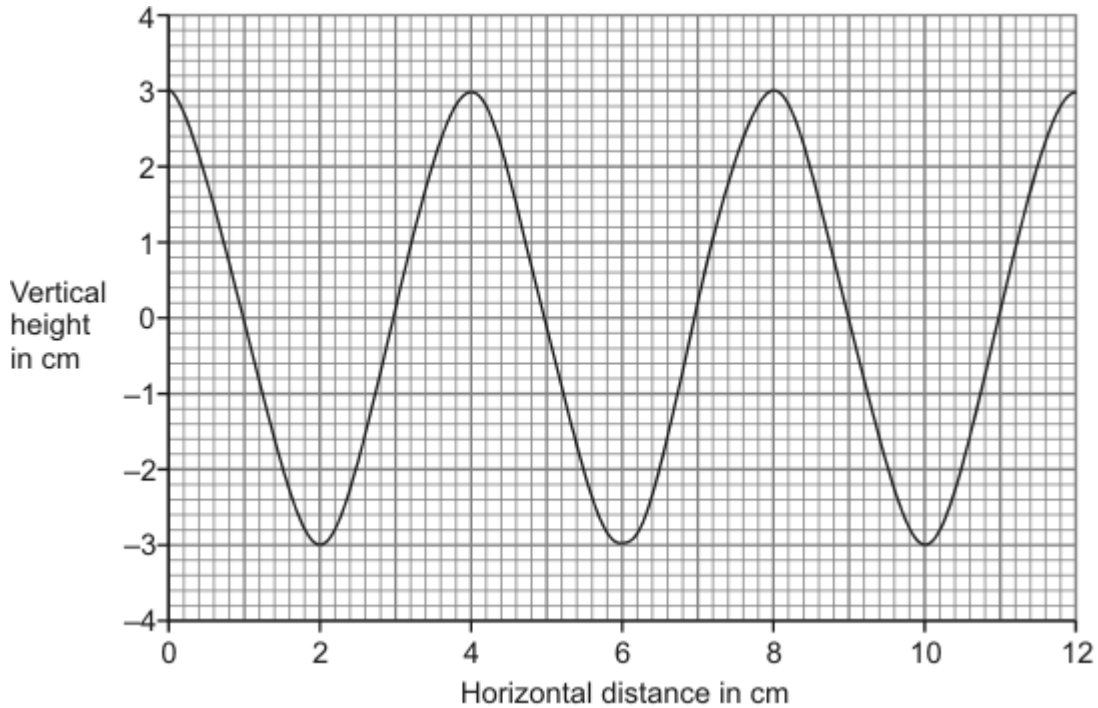
.....

(2)

(Total 10 marks)

**Waves and their uses**

1. The diagram shows a water wave drawn to scale.



(a) What is the wavelength of this water wave? ..... cm (1)

(b) What is the amplitude? ..... cm (1)

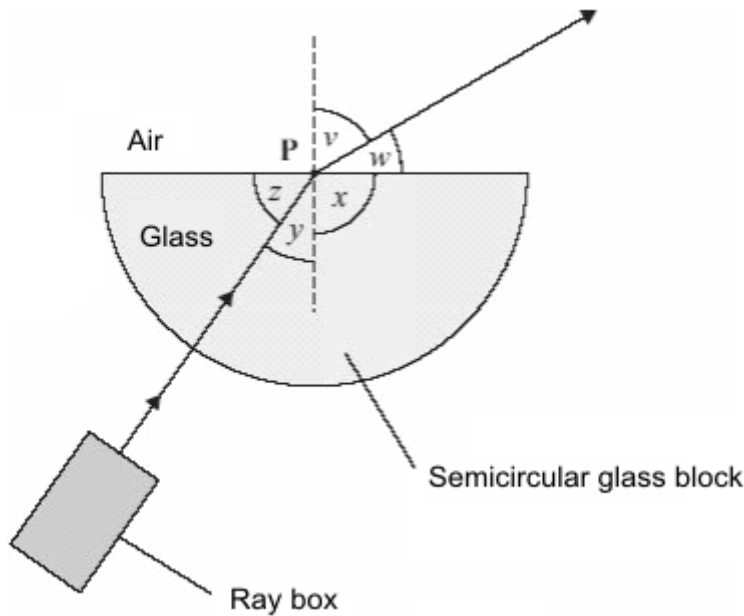
(c) Twelve waves pass an observer in four seconds.  
What is the frequency of the waves? Show clearly how you work out your answer and give the unit.

.....  
.....

Frequency = .....

(3)  
**(Total 5 marks)**

2. A student uses a ray box and a semicircular glass block to investigate refraction.



(a) What is the vertical dashed line called?

.....

(1)

(b) Which angle,  $v$ ,  $w$ ,  $x$ ,  $y$  or  $z$ , is the angle of refraction?

.....

(1)

(c) Why has refraction taken place?

.....

.....

(1)

(d) In an investigation, a student always aims the light from the ray box at point **P**. She moves the ray box to give different values of angle  $v$ . She records angle  $y$  for each of these values. The table shows her results.

Angle $v$ measured in degrees	Angle $y$ measured in degrees
30	19
40	25
50	31
60	35
70	39
80	41

The student studies the data and comes to the following conclusion.

Angle  $y$  is directly proportional to angle  $v$ .

Her friend says that this conclusion is **not** correct.

- (i) Use data from the table to explain why the conclusion is **not** correct.

.....  
 .....

(2)

- (ii) Write a correct conclusion for the experiment.

.....  
 .....

(1)

- (iii) Why is your conclusion only valid when angle  $v$  is between  $30^\circ$  and  $80^\circ$ ?

.....  
 .....

(1)

(Total 7 marks)

3. (a) Read the following information, then answer the questions.

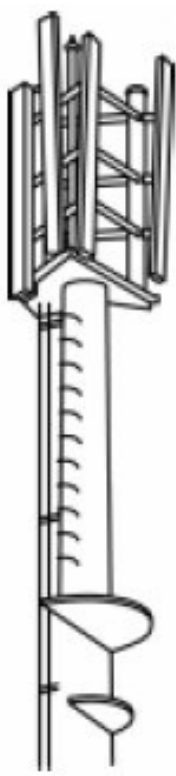
A newspaper article had the heading:  
**‘Are mobiles putting our children at risk?’**

A recent report said that children under the age of nine should not use mobile phones because of potential health risks. Although there is no direct evidence that mobile phones are a health danger, the advice is that young children should use mobiles in emergencies only.

Currently there are over 30 000 mobile phone masts in the UK. The masts transmit microwave signals between mobile phone users.

Objects containing water absorb microwave radiation. This is why humans can absorb microwave radiation. When microwaves are absorbed they produce a heating effect; this is not thought to be a significant health risk.

Some scientists worry that long term exposure to microwave radiation may cause genetic damage and cancer. Other scientists think there is no evidence of this.



- (i) Below which age is it recommended that children use a mobile phone in emergencies only?

..... (1)

- (ii) Why does the human body absorb microwaves?

..... (1)

- (iii) What are the possible effects on a person's body of living too close to a mobile phone mast?

.....  
..... (2)

- (iv) Have these effects been proven?

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

- (b) The microwaves used in microwave ovens have a frequency of 2400 million hertz and a wavelength of 0.125 metres.

- (i) Write down the equation that links frequency, wavelength and wave speed.

..... (1)

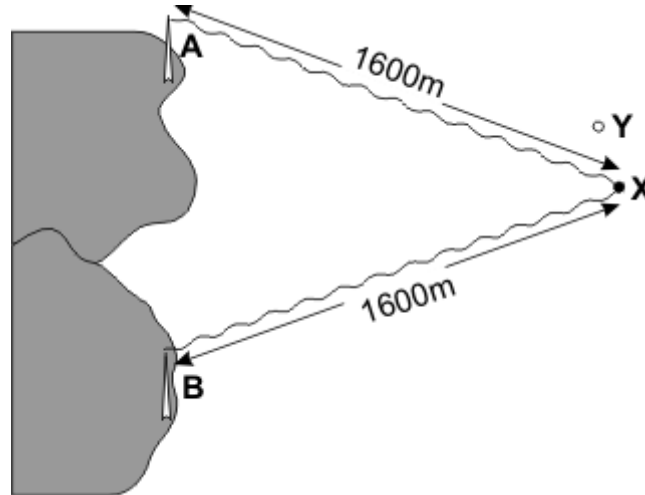
- (ii) Calculate the speed of microwaves. Show clearly how you work out your answer.

.....  
.....

speed of microwaves = ..... m/s

(2)  
**(Total 8 marks)**

4. In the diagram below A and B are two radio navigation beacons. They both transmit at 1.5 MHz. The waves from both A and B have the same amplitude and they are in phase with each other. A ship is at point X, 1600 m away from each beacon.



- (i) Calculate the wavelength of the radio waves.  
(The speed of radio waves is  $3 \times 10^8$  m/s.)

.....  
 .....  
 .....

(3)

- (ii) Calculate the number of wavelengths which is equal to the distance between A and X.

.....  
 .....

(1)

(Total 4 marks)

5. 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)

6. (a) A student listens to the sound waves produced by a car siren. When the car is stationary, the student hears a constant frequency sound.

Describe how the wavelength and frequency of the sound waves heard by the student change when the car is driven away from the student.

.....  
.....  
.....  
.....

(2)

- (b) Satellites fitted with various telescopes orbit the Earth. These telescopes detect different types of electromagnetic radiation.

Why are telescopes that detect different types of electromagnetic waves used to observe the Universe?

.....  
.....

(1)

- (c) In 2005 a space telescope detected a star that exploded 13 billion years ago. The light from the star shows the biggest *red-shift* ever measured.

- (i) What is *red-shift*?

.....  
.....

(1)

- (ii) What does the measurement of its red-shift tell scientists about this star?

.....  
.....

(1)

- (d) Red-shift provides evidence for the 'big bang' theory.

- (i) Describe the 'big bang' theory.

.....  
.....  
.....  
.....

(2)

- (ii) Suggest what scientists should do if new evidence were found that did not support the 'big bang' theory.

.....  
.....

(Total 8 marks)