

1

Solar panels are often seen on the roofs of houses.

(a) Describe the action and purpose of a solar panel.

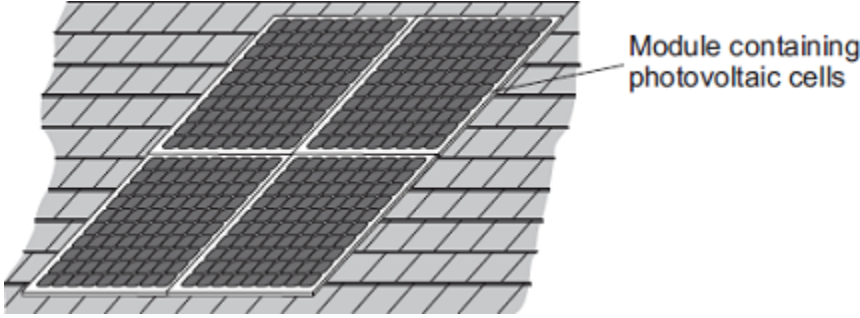
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(2)

(b) Photovoltaic cells transfer light energy to electrical energy.

In the UK, some householders have fitted modules containing photovoltaic cells on the roofs of their houses.

Four modules are shown in the diagram.



The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is $1.4 \times 10^3 \text{ W}$.

How long, in minutes, does it take to transfer 168 kJ of energy?

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..... Time = minutes

(3)

- (c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.
- (i) The diagram shows two readings of this electricity meter taken three months apart. The readings are in kilowatt-hours (kWh).

21 November	0	0	0	4	4
21 February	0	0	1	9	4

Calculate the energy transferred by the photovoltaic cells during this time period.

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Energy transferred = kWh

(1)

- (ii) The electricity company pays 40p for each kWh of energy transferred.
Calculate the money the electricity company would pay the householder.

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Money paid =

(2)

- (iii) The cost of the four modules is £6000.
Calculate the payback time in years for the modules.

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Payback time = years

(3)

- (iv) State an assumption you have made in your calculation in part (iii).

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(1)

- (d) In the northern hemisphere, the modules should always face south for the maximum transfer of energy.

State **one** other factor that would affect the amount of energy transferred during daylight hours.

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(1)
(Total 13 marks)

2

- (a) In the UK, over 70% of the electricity is generated in power stations that burn fossil fuels.

- (i) Explain **one** effect that burning fossil fuels has on the environment.

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(2)

- (ii) Give **one** way the effect on the environment described in part (a)(i) could be reduced.

Assume the amount of fossil fuels burnt stays the same.

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(1)

- (b) Electricity can also be generated in a pumped storage hydroelectric power station.

An advantage of pumped storage hydroelectric power stations is the short start-up time they have.

- (i) What is the importance of the short start-up time?

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(1)

- (ii) Give **one** other advantage of a pumped storage hydroelectric power station.

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(1)

(c) Read the extract below from a newspaper article.

In the future it may not be possible to have constant electricity. Families will have to get used to using power when it is available.

(i) In the UK, the proportion of electricity generated using wind turbines is due to increase a lot. Some opponents of wind turbines think this increase will cause big fluctuations in the electricity supply.

Suggest **one** reason why this may be true.

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(1)

(ii) Between 2002 and 2008 the amount of electricity used for lighting in homes in the UK decreased.

Suggest **one** reason why.

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(1)
(Total 7 marks)

3

About half of the UK's electricity is generated in coal-burning power stations and nuclear power stations.

(a) Coal-burning power stations and nuclear power stations provide a reliable way of generating electricity.

What is meant by a *reliable way of generating electricity*?

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(1)

(b) Over the next few years, most of the older nuclear power stations in the UK will be closed down, and the process of decommissioning will start.

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

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.....

(1)

(c) Climate change has been strongly linked to the emission of carbon dioxide. Many governments around the world are committed to reducing carbon dioxide emissions.

Generating electricity can increase carbon dioxide emissions.

The companies generating electricity could reduce carbon dioxide emissions.

Give **two** ways the companies could do this.

1

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2

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(2)

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

The voltage across the overhead cables of the National Grid needs to be much higher than the output voltage from the power station generators.

Explain why.

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(3)

(Total 7 marks)

4

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

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

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(1)

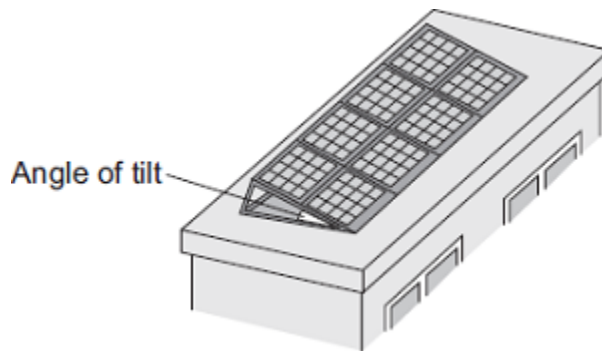
(ii) Name **two** other renewable energy sources used to generate electricity.

1

2

(1)

- (b) A householder uses panels of solar cells to generate electricity for his home. The solar cells are tilted to receive the maximum energy input from the Sun.



The data in the table gives the average energy input each second (in J/s), to a 1 m² area of solar cells for different angles of tilt and different months of the year.

Month	Angle of tilt			
	20°	30°	40°	50°
February	460	500	480	440
April	600	620	610	600
June	710	720	680	640
August	640	660	640	580
October	480	520	500	460
December	400	440	420	410

- (i) Use the data in the table to describe how the average energy input to the solar cells depends on the angle of tilt.

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(2)

- (ii) The total area of the solar cell panels used by the householder is 5 m².

The efficiency of the solar cells is 0.18.

Calculate the average **maximum** electrical energy available from the solar cell panels each second in June.

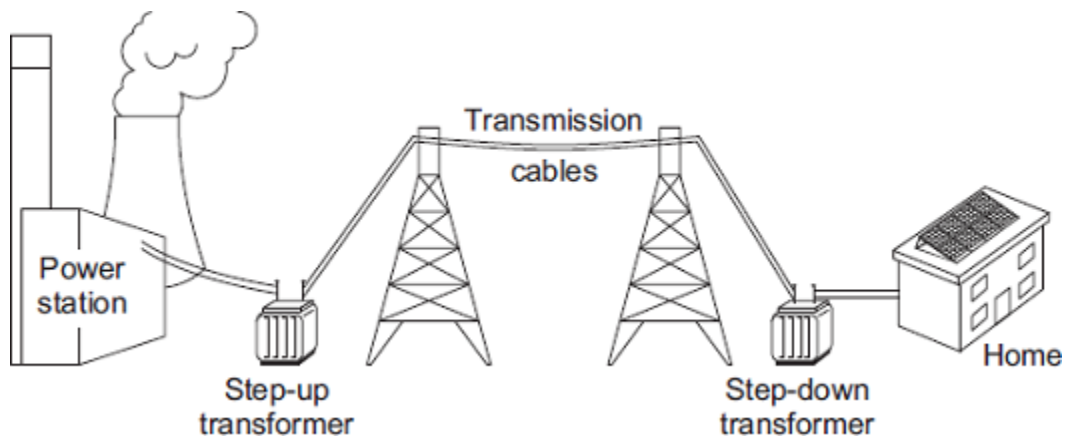
Show clearly how you work out your answer.

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Maximum energy = joules/second

(3)

- (c) The diagram shows part of the National Grid.



- (i) Even though the householder uses solar cells to generate electricity for his home, the home stays connected to the National Grid.

Give **one** reason why the householder should stay connected to the National Grid.

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(1)

- (ii) The step-up transformer increases the efficiency of the National Grid.

Explain how.

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(2)

(Total 10 marks)

5

(a) Nuclear fuels and the wind are two of the energy sources used to generate electricity in the UK.

Explain the advantages of using energy from nuclear fuels to generate electricity rather than using energy from the wind.

Include in your answer a brief description of the process used to generate electricity from nuclear fuels.

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(4)

(b) In the UK, most electricity is generated in power stations that emit carbon dioxide into the atmosphere. The impact of these power stations on the environment could be reduced by the increased use of 'carbon capture' technology.

Describe how 'carbon capture' would prevent the build-up of carbon dioxide in the atmosphere.

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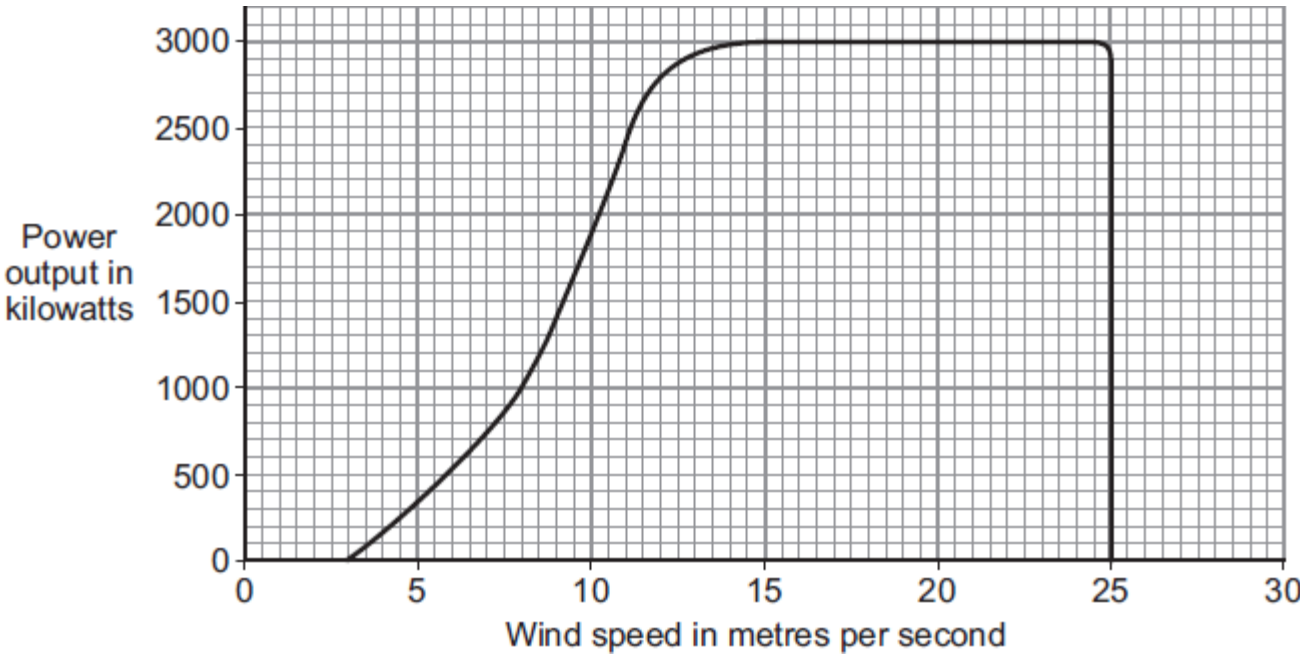
(2)

(Total 6 marks)

6

The world's biggest offshore wind farm, built off the Kent coast, started generating electricity in September 2010.

(a) The graph shows how wind speed affects the power output from one of the wind turbines.



In one 4-hour period, the wind turbine transfers 5600 kilowatt-hours of electrical energy.

Use the data in the graph to calculate the average wind speed during this 4-hour period.

Show clearly how you work out your answer.

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Average wind speed = m/s

(3)

(b) The wind turbines are linked to the National Grid by underwater cables.

(i) What is the National Grid?

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(1)

(ii) How is the National Grid designed to reduce energy losses during transmission?

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(1)

(c) Read this extract from a newspaper.

Power crisis as island basks in sunshine
The population of a small island off the coast of Scotland decided to generate all their electricity from water and wind. However, they did not predict having a long period of warm, dry weather. A combination of low water levels and hardly any wind has drastically reduced the output from the hydroelectric power station and wind turbines.

Explain **one** way in which the islanders could try to ensure that a similar power crisis does **not** happen in the future.

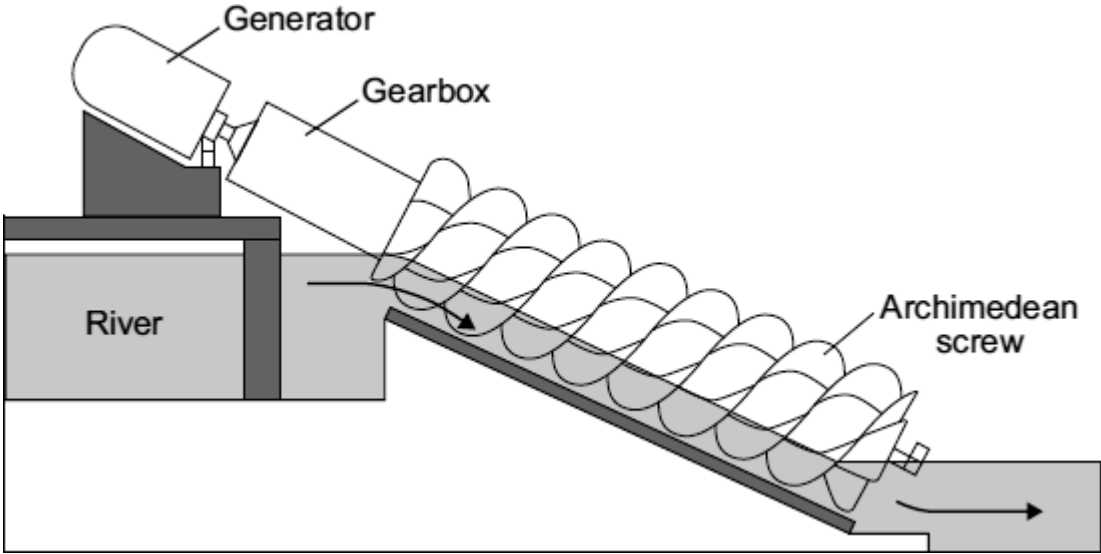
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(2)
(Total 7 marks)

7

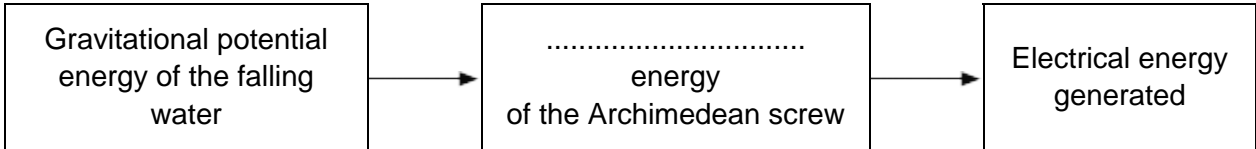
The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate.

The Archimedean screw is linked to the generator by a gearbox.



(a) Each second, the *micro-hydroelectricity* generator transforms 80 000 joules of gravitational potential energy into 60 000 joules of electrical energy.

(i) Fill in the missing word to complete the energy transformation diagram.



(1)

(ii) Use the equation in the box to calculate the efficiency of the *micro-hydroelectricity* generator.

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

Show clearly how you work out your answer.

.....

Efficiency =

(2)

- (b) The power output from a conventional large-scale hydroelectric power station is 100 000 times more than the power output from a micro-hydroelectric system.

Give **one** disadvantage of a conventional large-scale hydroelectric power station compared to the micro-hydroelectric system.

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(1)

- (c) The electricity generated by a micro-hydroelectric system is transferred via a transformer directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to the National Grid, which distributes the electricity to homes anywhere in the country.

- (i) What is the National Grid?

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(1)

- (ii) Explain why transferring the electricity directly to local homes is more efficient than using the National Grid to distribute the electricity.

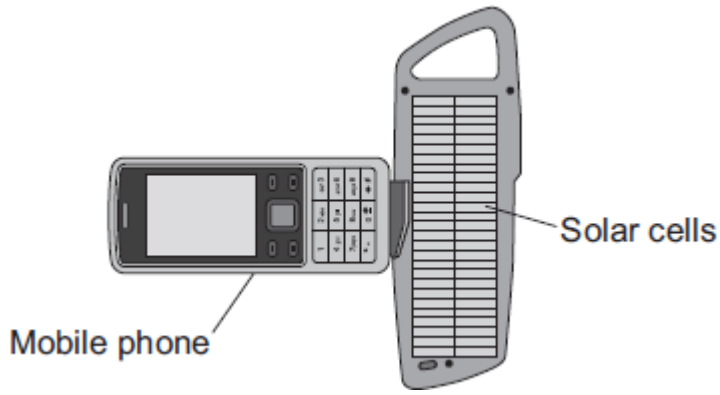
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(2)

(Total 7 marks)

8

(a) The diagram shows a solar powered device being used to recharge a mobile phone.



On average, the solar cells produce 0.6 joules of electrical energy each second. The solar cells have an efficiency of 0.15.

(i) Calculate the average energy input each second to the device.

Show clearly how you work out your answer.

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Average energy input each second = J/s

(2)

(ii) Draw a labelled Sankey diagram for the solar cells. The diagram does **not** need to be drawn to scale.

(1)

(b) Scientists have developed a new type of solar cell with an efficiency of over 40 %. The efficiency of the solar cell was confirmed independently by other scientists.

Suggest why it was important to confirm the efficiency independently.

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(1)

(c) The electricity used in homes in the UK is normally generated in a fossil fuel power station.

Outline some of the advantages of using solar cells to generate this electricity.

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(2)
(Total 6 marks)

9

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?

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(1)

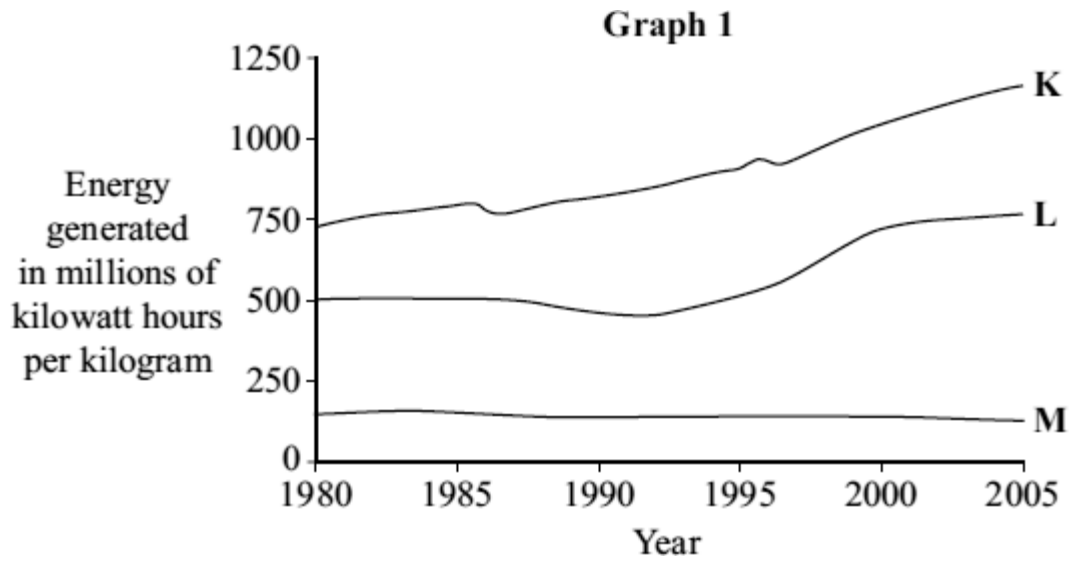
(ii) How does *decommissioning* affect the overall cost of electricity generated using nuclear fuels?

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(1)

(b) Uranium is a fuel used in nuclear power stations to generate electricity.

Graph 1 compares how the electricity generated from one kilogram of nuclear fuel changed between 1980 and 2005 in three different types of nuclear power station.



(i) Compare the efficiency of the three types of power station, **K**, **L** and **M**, between 1980 and 2005.

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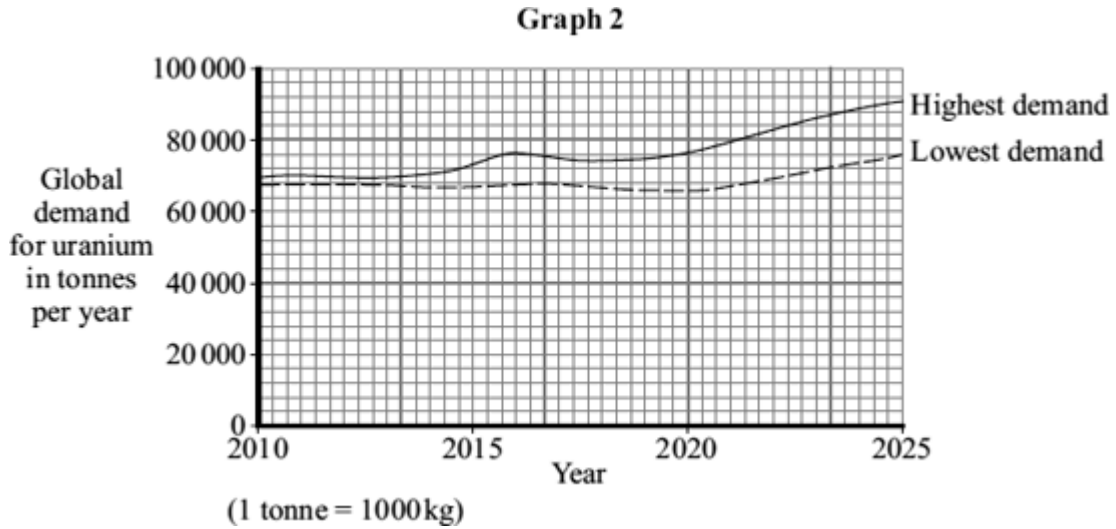
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Graph 2 shows two different predictions for the global growth in uranium demand over the next few years.



(ii) Suggest reasons why it is **not** possible to predict accurately how much uranium will be needed in 2025.

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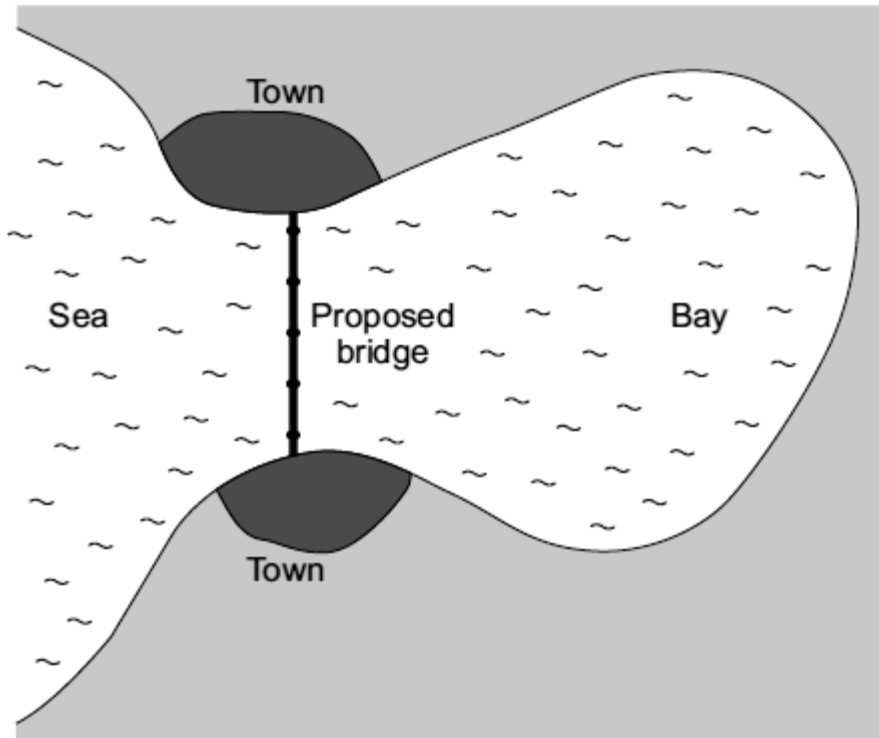
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(2)
(Total 6 marks)

10

The map shows the positions of two towns on either side of a very large coastal bay in England. The map also shows where a bridge may be built to link the towns. The road journey from one town to the other is about 60 kilometres at present.



(a) It is estimated that building turbines and generators inside the legs of the bridge would produce enough electricity for both towns. In addition, enough electricity would be generated to run electric buses over the bridge between the two towns.

(i) If the bridge is built, what form of renewable energy will be used to generate the electricity?

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(1)

(ii) Most people living in the area are in favour of the proposed bridge.

Suggest **three** reasons why people would be in favour of building the bridge and the associated electricity generating scheme.

Reason 1

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Reason 2

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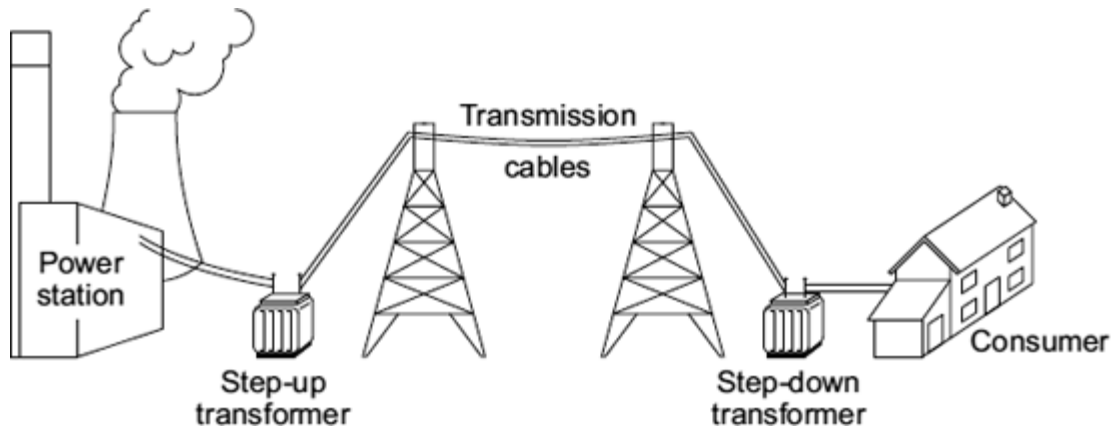
Reason 3

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(3)

- (b) Even with the proposed bridge, the two towns will need to stay connected to the National Grid.

The diagram shows part of the National Grid.



- (i) Give **one** reason why the towns need to stay connected to the National Grid.

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(1)

- (ii) Explain how the step-up transformer increases the efficiency of the National Grid.

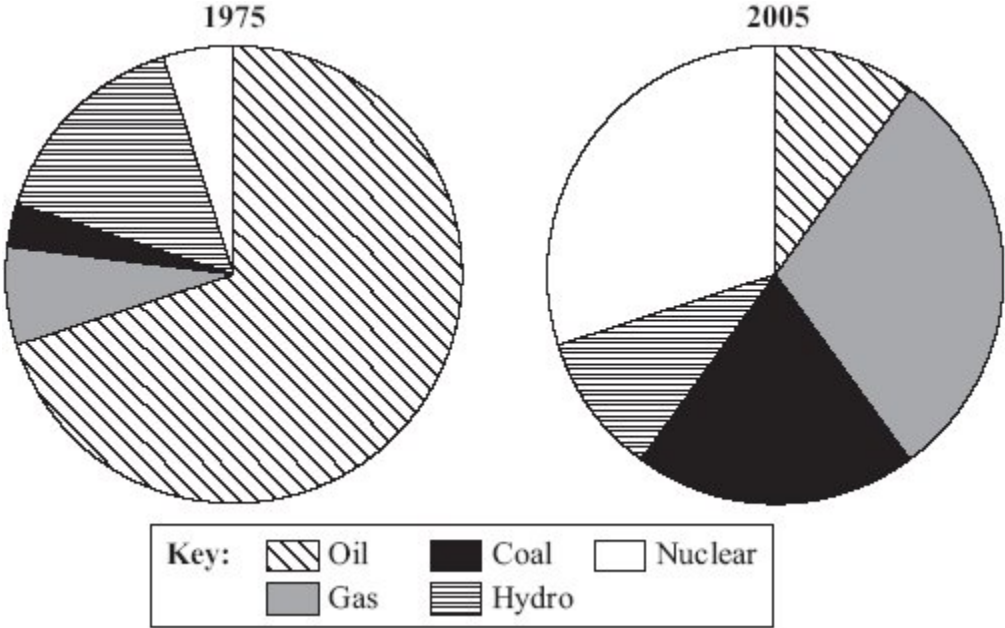
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(2)

(Total 7 marks)

11

The pie charts show the relative proportions of electricity generated in Japan from different energy sources in 1975 and 2005.



(a) Describe the main differences in the energy sources used in 2005 compared with 1975.

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(1)

(b) In the UK, nuclear fuels are used to generate about 21% of the total electricity supply.

(i) What is the name of the process by which a nuclear fuel produces heat?

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(1)

(ii) Explain how the heat released from a nuclear fuel is used to generate electricity in power stations.

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(2)

(iii) Some people have suggested that more nuclear power stations should be built in the UK.

Give **two** reasons to support this suggestion.

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(2)

(iv) Nuclear power stations create dangerous waste.

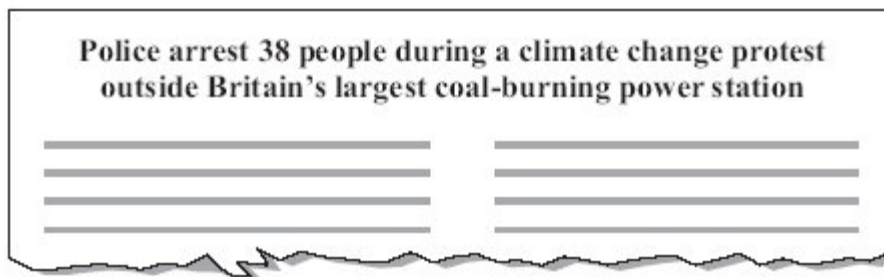
Why is the waste from a nuclear power station dangerous?

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(1)

(c) A headline from a newspaper article is shown below.



Explain the possible link between *climate change* and *coal-burning power stations*.

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(2)
(Total 9 marks)

12

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

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

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(1)

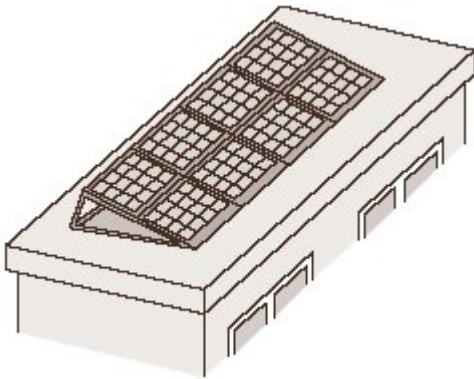
(ii) Name **two** further renewable energy sources used to generate electricity.

1

2

(1)

(b) A householder uses a bank of solar cells to generate electricity for his home. The solar cells are tilted to receive the maximum energy input from the Sun.



The data in the table gives the average energy input each second (in J/s), to a 1 m² area of solar cells for different angles of tilt and different months of the year.

Month	Angle of tilt			
	20°	30°	40°	50°
February	460	500	480	440
April	600	620	610	600
June	710	720	680	640
August	640	660	640	580
October	480	520	500	460
December	400	440	420	410

- (i) Use the data in the table to describe how the average energy input to the solar cells depends on the angle of tilt.

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(2)

- (ii) The bank of solar cells used by the householder has an area of 8 m².

The efficiency of the solar cells is 0.15

Calculate the average **maximum** electrical energy available from the bank of solar cells each second in June.

Show clearly how you work out your answer.

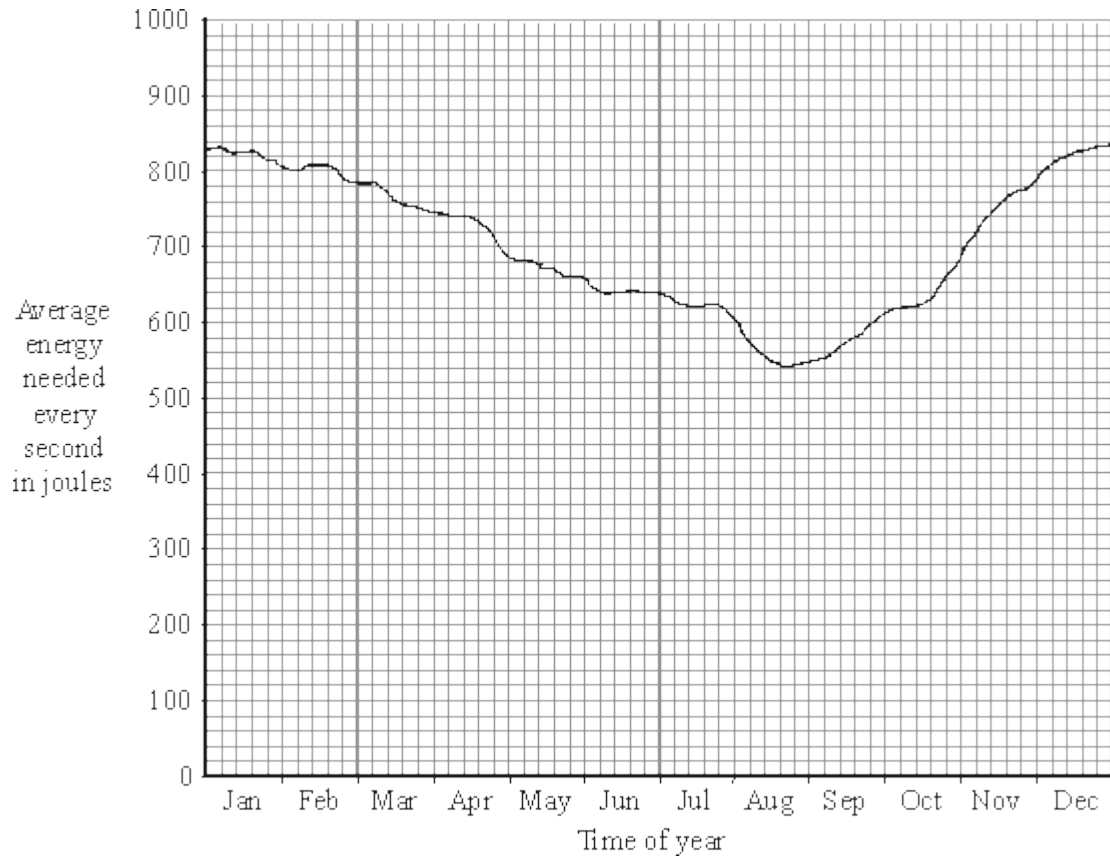
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Maximum energy = joules/second

(3)

(c) The graph shows how the householder's electrical energy needs change over one year.



Why would it be advisable for the householder to remain connected to the National Grid?

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(1)
(Total 8 marks)

13

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.

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(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.

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(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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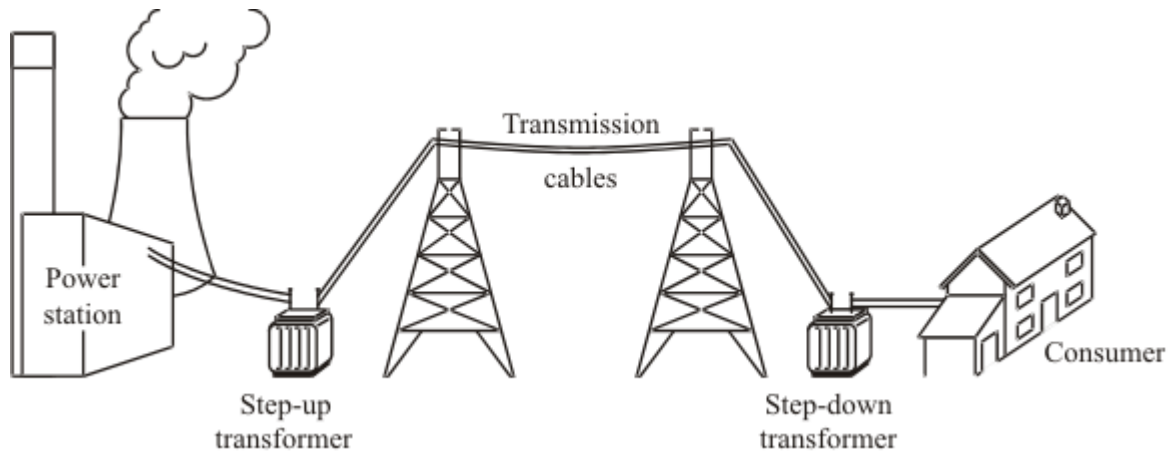
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(3)
(Total 7 marks)

14

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?

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(1)

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

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(1)

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

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(2)

(b) Most of the world's electricity is generated in power stations that burn fossil fuels.

State **one** environmental problem that burning fossil fuels produces.

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(1)

(c) Electricity can be generated using energy from the wind. A company wants to build a new wind farm. Not everyone thinks that this is a good idea.



(i) What arguments could the company give to persuade people that a wind farm is a good idea?

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(2)

(ii) What reasons may be given by the people who think that wind farms are **not** a good idea?

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(2)
(Total 9 marks)

15

(a) Explain how energy is produced in the Sun.

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(3)

(b) Read the following article that appeared in a magazine.

“Conservation of energy is important in today’s society. Energy sources, such as oil and coal, which have been used for the development of an industrial society, cannot be relied upon as heavily in the future. Renewable energy sources cannot provide such large quantities of energy for society without causing problems.”

(i) Give **two** reasons why oil should not be relied on as a major source of energy for the future.

1

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2

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(2)

(ii) Energy from the wind is a renewable energy resource. State **three** problems which may arise if the wind were to be used to meet the energy requirements of a large industrial city in Britain.

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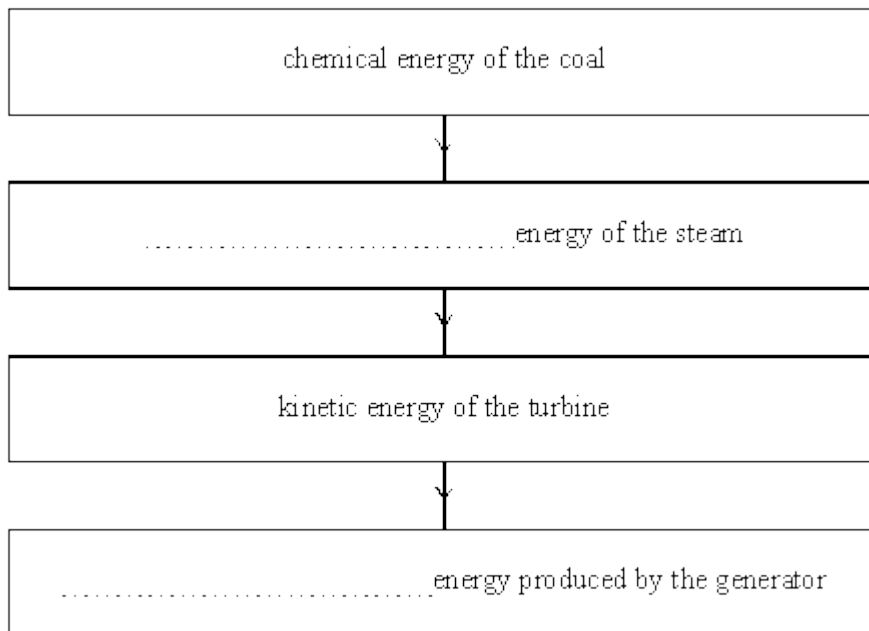
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(3)
(Total 8 marks)

16

(a) Most electricity in Britain is generated by coal fired power stations.

Complete the sequence of useful energy transfers which take place in the power station.



(1)

(b) The diagram shows a wind turbine which is used to produce electricity using energy from the wind.



(i) What is the source of energy which creates winds?

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(1)

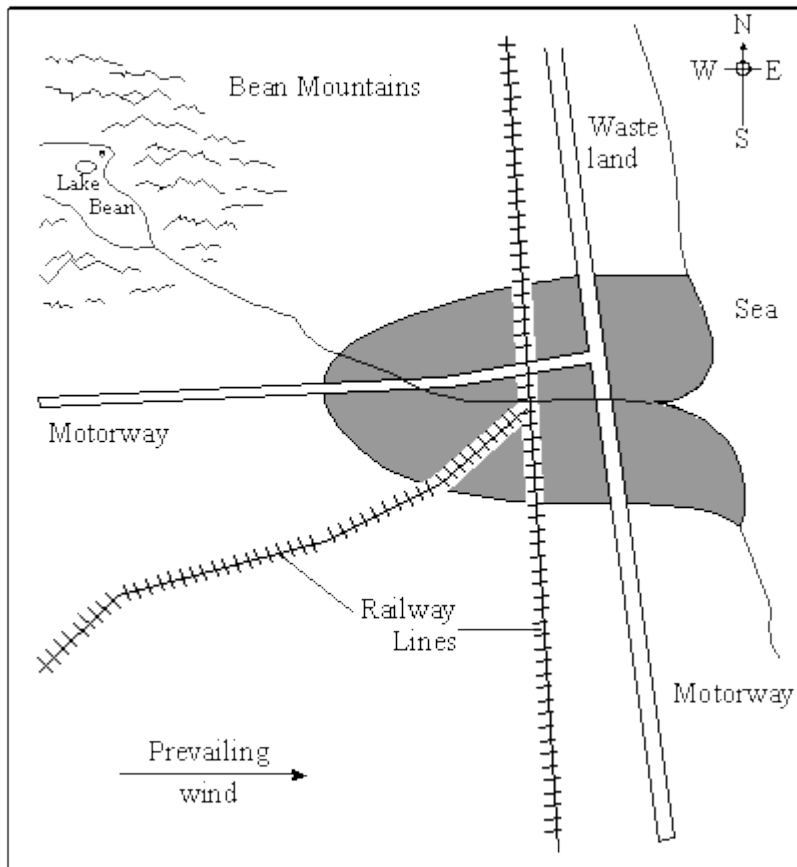
(ii) Explain the advantage of using a wind turbine to produce electricity.

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(2)
(Total 4 marks)

17

The map below shows an industrial region (shaded).



The prevailing wind is from the west. There is a nearby mountainous area, from which a river flows through the region. The major road and rail links are shown.

A power station is to be built to supply electrical energy to the region. The energy will be for a range of domestic and industrial uses.

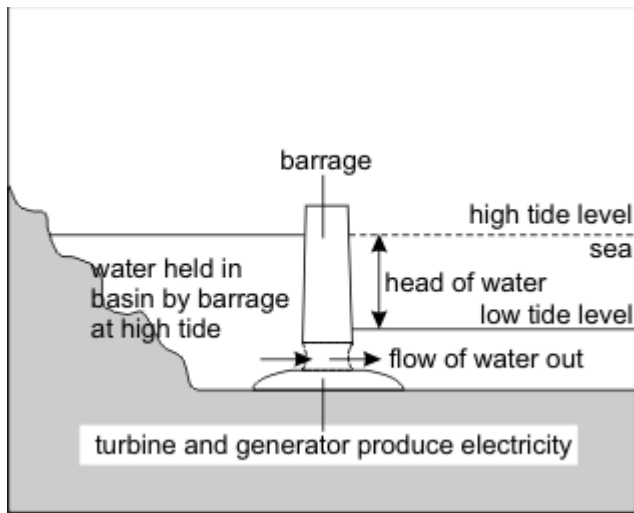
The choice is between a coal fired power station, wind turbines and a hydroelectric scheme.

Three local groups each support a different option. Choose which option you would support and justify your choice by making reference to the financial, social and environmental implications of your choice compared with those of the alternative systems.

(Total 8 marks)

18

The outline diagram below shows a tidal power generating system.



Gates in the barrage are open when the tide is coming in and the basin is filling to the high tide level. The gates are then closed as the tide begins to fall.

Once the tide outside the barrage has dropped the water can flow through large turbines in the barrage which drive generators to produce electrical energy.

In one second 1.2×10^9 kg of water flows through the turbines at a speed of 20 m/s.

- (a) When used with a water speed of 20 m/s the system has an efficiency of 90% in converting the kinetic energy of the water into electrical energy. Calculate the power output of the generators.

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(2)

- (b) The power output of a coal fired power station is 1000 MW (1×10^9 W).

- (i) Suggest **two** advantages of coal fired power stations over tidal power generating systems.

1.
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2.
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(ii) Suggest **two** advantages of tidal power generating systems over coal fired power stations.

1.

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2.

.....

(iii) Suggest and explain **one** disadvantage of a tidal power generating system.

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(6)
(Total 8 marks)

19

Describe, in as much detail as you can, how the energy stored in coal is transferred into electrical energy in a power station.

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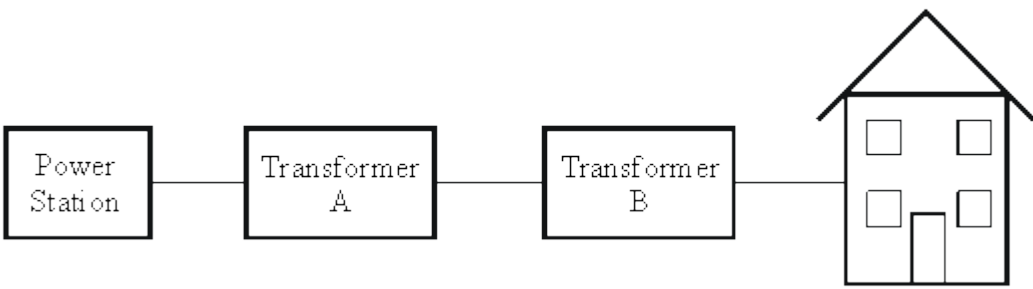
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(Total 5 marks)

20



Transformer A produces a very high voltage to transmit the electrical energy through the National Grid.

Explain why electrical energy is transmitted at a very high voltage.

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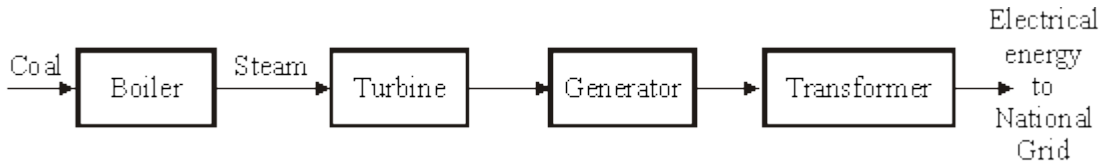
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(Total 3 marks)

21

The diagram below shows four stages in the production of electricity by a coal-fired power station.



(a) (i) Write down **two** environmental problems which are caused by burning coal to generate electricity.

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(ii) How may these environmental problems be reduced?

1

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2

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(4)

(b) Some data for Didcot coal-fired power station is given below.

Number of generators	4
Maximum continuous power rating of a generator	500 MW at 23 500 V
Energy content of coal used	2.66×10^{10} J per tonne
Total quantity of coal used each day	18 289 tonnes

Use the given data to calculate:

(i) the total electrical energy output each day.

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AnswerJ/day

(ii) the total input of coal energy each day.

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AnswerJ/day

(iii) the efficiency of the power station.

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Answer %

(8)

(c) Energy is conserved.

(i) Choose **one** of the stages in the diagram at the start of the question.
State what happens to the wasted energy during this stage.

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(ii) Explain what happens to all wasted energy during energy transfers.

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(3)
(Total 15 marks)

22

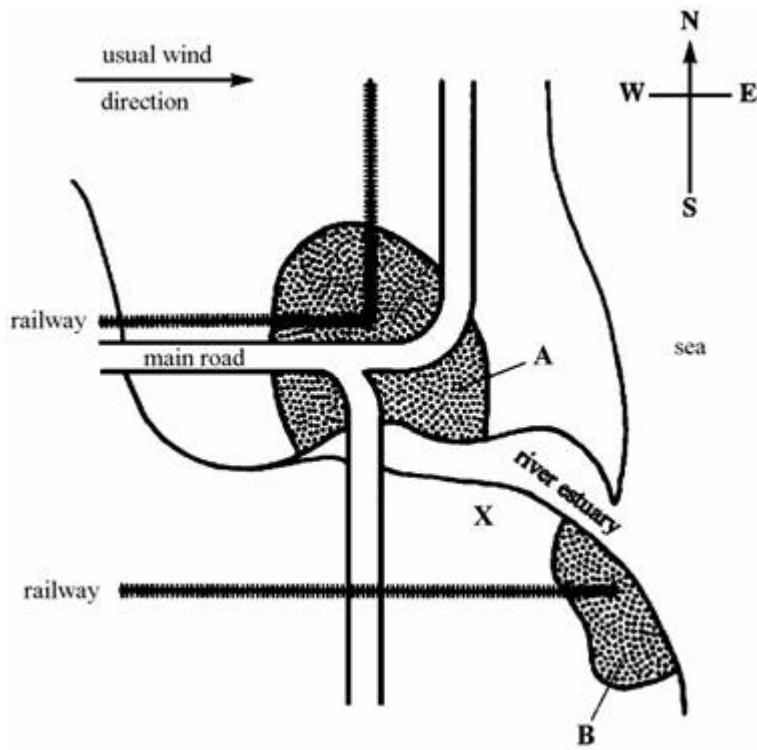
The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

A is an important fishing and ferry port.

The wind usually blows from the west. The major roads and railways are shown.

A power station is to be built in area X to generate electricity for the region.

The choice is between a nuclear power station and a coal fired power station.



(a) State the advantages and disadvantages of the two methods of generating electrical energy.

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(6)

(b) Which method would you choose for this site?

.....

Explain the reason for your choice.

.....

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(3)
(Total 9 marks)

23

Use of renewable sources of energy is expected to increase. The table shows the comparative costs of producing 1 kWh of electricity from different energy sources.

Types of energy sources used in the UK	Cost of producing 1 kWh of electrical energy	
Fossil fuels(non-renewable)	Coal	1.0 p
	Gas	1.4 p
	Oil	1.5 p
Nuclearfuels (non-renewable)	Nuclear	0.9 p
Renewable	Hydroelectric	0.2 p
	Wind	0.9 p
Installation and decommissioning costs are notincluded		

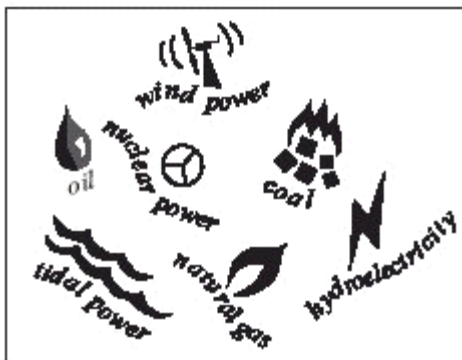
At present about 2% of electricity generated in the UK uses renewable energy sources. Consider the three types of energy sources in the table and give **one** advantage and **one** disadvantage for each (other than installation and decommissioning costs).

Advantage	Disadvantage
Using fossilfuels	Using fossilfuels
Usingnuclear fuels	Usingnuclear fuels
Usingrenewable sources	Usingrenewable sources

(Total 6 marks)

24

Different energy sources are shown in the box.



An 'Eco-home' is one which is friendly to the environment. Imagine you are designing an 'Eco-home' which can use any of the energy sources above to generate electricity

- (a) Choose **one** non-renewable energy source from the box above that could provide the electricity supply to your 'Eco-home', but which would be **unsuitable**.

Write the energy source in the table and explain, as fully as you can, why it is **unsuitable** for an 'Eco-home'.

Non-renewable energy source	Unsuitable for an 'Eco-home' because
.....

(2)

(b) Choose **two** suitable renewable energy sources from the box opposite that could provide an electricity supply to your 'Eco-home'.

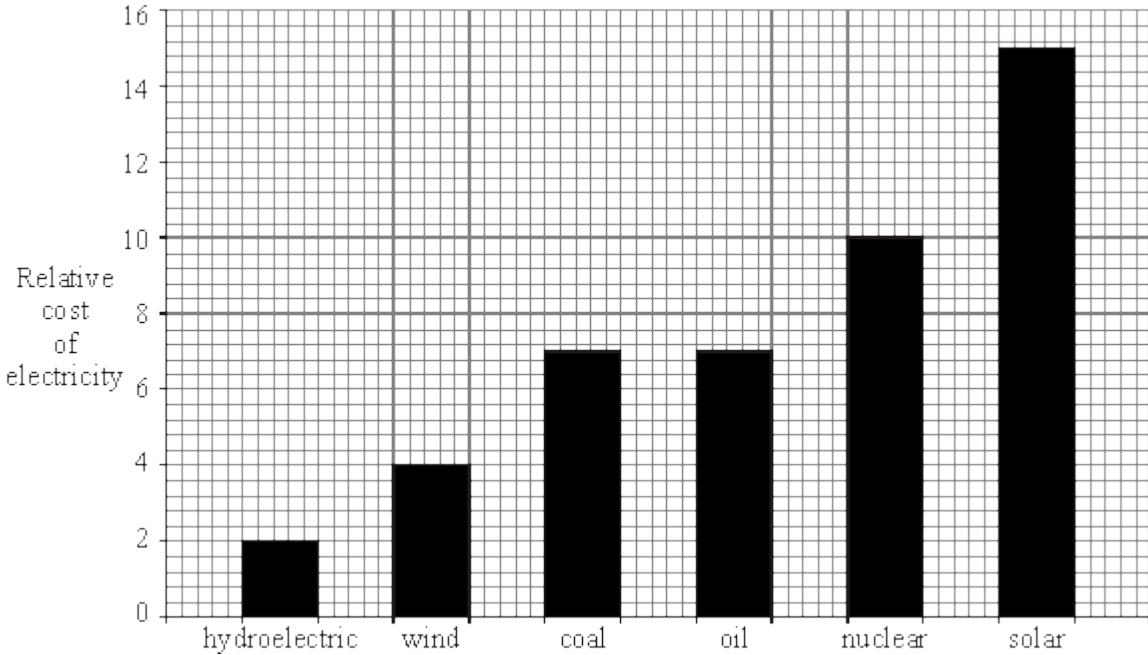
Write the two energy sources in the table and describe, in as much detail as you can, the undesirable environmental effects of using these.

Renewable energy source	Undesirable environmental effects
1
2

(4)
(Total 6 marks)

25

The bar chart shows the relative costs of some different energy sources that are used to generate electricity.



(a) Apart from cost, give **two** advantages that a hydroelectric power station has compared with a wind farm.

1

.....

2

.....

(2)

(b) Apart from cost, give **one** advantage and **one** disadvantage that a nuclear power station has compared with a coal-fired power station.

Advantage

.....

Disadvantage

.....

(2)

- (c) State and explain **one** situation where it is better to use solar energy, rather than any of the other energy sources, to generate electricity.

.....

.....

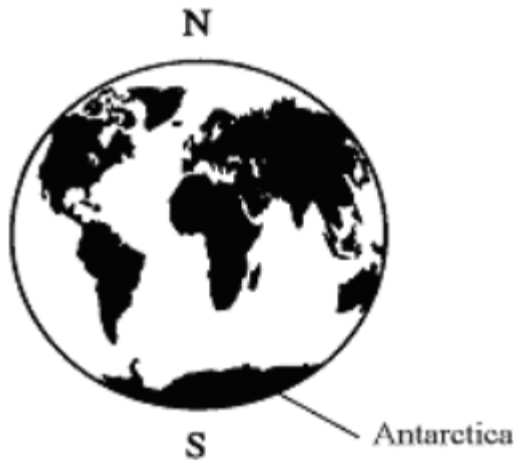
.....

.....

(2)
(Total 6 marks)

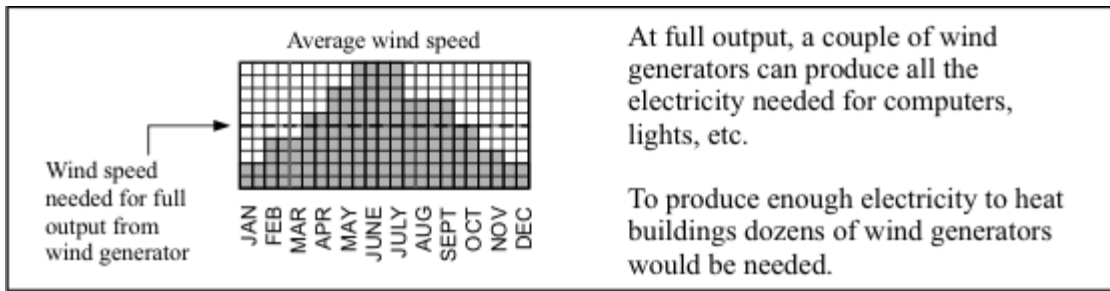
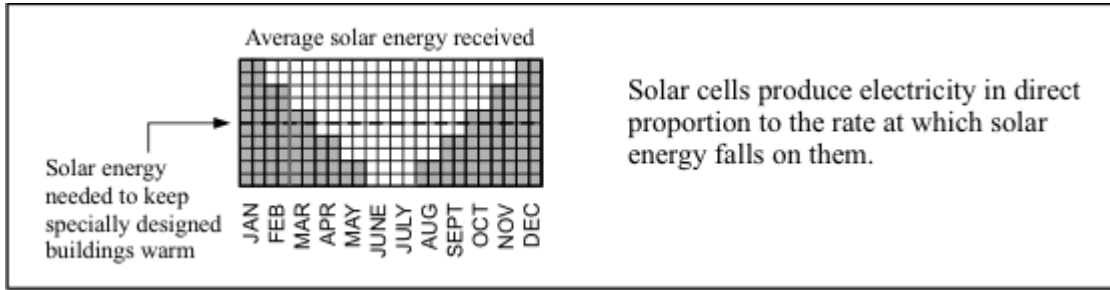
26

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.

Discuss the advantages and disadvantages of using the following energy sources to meet the scientists' needs:

- solar energy
- energy from the wind
- natural gas (present in large quantities deep down in the Antarctic land mass)
- diesel oil (which would have to be imported)

.....

.....

.....

.....

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.....

.....

(Total 10 marks)

Mark schemes

1

- (a) water heated by radiation (from the Sun)
accept IR / energy for radiation

1

water used to heat buildings / provide hot water

allow for 1 mark heat from the Sun heats water if no other marks given

references to photovoltaic cells / electricity scores 0 marks

1

- (b) 2 (minutes)

$$1.4 \times 10^3 = \frac{168 \times 10^3}{t}$$

gains 1 mark

calculation of time of 120 (seconds) scores 2 marks

3

- (c) (i) 150 (kWh)

1

- (ii) £60(.00) or 6000 (p)

an answer of £6000 gains 1 mark

allow 1 mark for $150 \times 0.4(0)$ 150×40

allow ecf from (c)(i)

2

- (iii) 25 (years)

an answer of $6000 / 240$

or

$6000 / \text{their (c)(ii)} \times 4$

gains 2 marks

an answer of $6000 / 60$

or

$6000 / \text{their (c)(ii)}$ gains 1 mark, ignore any other multiplier of (c)(ii)

3

- (iv) any **one** from:

- will get £240 per year
accept value consistent with calculated value in (c)(iii)
- amount of light is constant throughout the year
- price per unit stays the same
- condition of cells does not deteriorate

1

(d) any **one** from:

- angle of tilt of cells
- cloud cover
- season / shade by trees
- amount of dirt

1

[13]

2

(a) (i) produces carbon dioxide / nitrogen oxides

accept greenhouse gases

ignore pollutant gases

1

that (may) contribute to global warming

accept causes global warming

damages ozone layer negates this mark

accept alternative answers in terms of: sulfur dioxide / nitrogen oxides causing acid rain

1

(ii) carbon capture / storage

answer must relate to part (a)(i)

collecting carbon dioxide is insufficient

or

plant more trees

or

remove sulfur (before burning fuel)

1

(b) (i) (power station can be used) to meet surges in demand

accept starts generating in a short time

can be switched on quickly is insufficient

1

(ii) can store energy for later use

accept renewable (energy resource)

accept does not produce CO₂ / SO₂ / pollutant gases

1

(c) (i) turbines do not generate at a constant rate

accept wind (speed) fluctuates

accept wind is (an) unreliable (energy source)

1

(ii) any **one** from:

- energy efficient lighting (developed / used)
use less lighting is insufficient
- increased energy cost (so people more likely to turn off)
accept electricity for energy
- more people becoming environmentally aware

1

[7]

3

(a) any **one** from:

- energy / source is constant
- energy / source does not rely on uncontrollable factors
accept a specific example, eg the weather
- can generate all of the time
will not run out is insufficient

1

(b) (dismantle and) remove radioactive waste / materials / fuel

- accept nuclear for radioactive*
- knock down / shut down is insufficient*

1

(c) any **two** from:

- reduce use of fossil fuelled power stations
accept specific fossil fuel
accept use less fossil fuel
- use more nuclear power
accept build new nuclear power stations
- use (more) renewable energy sources
accept a named renewable energy source
do not accept natural for renewable
- make power stations more efficient
- (use) carbon capture (technology)
do not accept use less non-renewable (energy) sources

2

(d) (by increasing the voltage) the current is reduced

1

this reduces the energy / power loss (from the cable)

accept reduces amount of waste energy

accept heat for energy

*do **not** accept stops energy loss*

1

and this increases the efficiency (of transmission)

1

[7]

4

(a) (i) replaced faster than it is used

accept replaced as quick as it is used

accept it will never run out

*do **not** accept can be used again*

1

(ii) any **two** from:

***two** sources required for the mark*

- wind
- waves
- tides
- fall of water

*do **not** accept water / oceans*

accept hydroelectric

- biofuel
accept a named biofuel eg wood
- geothermal

1

(b) (i) any **two** from:

- increases from 20° to 30°
- reaches maximum value at 30°
- then decreases from 30°
- same pattern for each month
*accept peaks at 30° for **both** marks*
*accept goes up then down for **1** mark*
ignore it's always the lowest at 50°

2

(ii) 648

an answer of 129.6 gains 2 marks
allow 1 mark for using 720 value only from table
allow 2 marks for answers 639, 612, 576, 618(.75)
allow 1 mark for answers 127.8, 122.4, 115.2, 123.75

3

(c) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)

accept cloudy weather, night time affects supply

or

can sell (excess) electricity (to the National Grid)

1

(ii) decreases the current

accept increases the voltage

1

reducing energy loss (along cables)

accept less heat / thermal energy lost / produced

1

[10]

5

(a) *answers must be in terms of nuclear fuels*

concentrated source of energy

idea of a small mass of fuel able to generate a lot of electricity

1

that is able to generate continuously

accept it is reliable

or *can control / increase / decrease electricity generation*

idea of available all of the time / not dependent on the weather

ignore reference to pollutant gases

1

the energy from (nuclear) fission

1

is used to heat water to steam to turn turbine linked to a generator

1

(b) carbon dioxide is not released (into the atmosphere)

1

but is (caught and) stored (in huge natural containers)

1

[6]

6

(a) 9

allow 2 marks for power = 1400 (kW)

if a subsequent calculation is shown award 1 mark only

or

allow 1 mark for correct substitution and transformation

$$\text{power} = \frac{5600}{4}$$

allow 1 mark for using a clearly incorrect value for power to read a corresponding correct value from the graph

3

(b) (i) system of cables and transformers

both required for the mark

ignore reference to pylons

inclusion of power stations / consumers negates the mark

wire(s) is insufficient

1

(ii) (uses step-up transformer to) increase pd / voltage

accept (transfers energy / electricity at) high voltage

or

(uses step-up transformer to) reduce current

accept (transfers energy / electricity at) low current

ignore correct references to step-down transformers

1

(c) build a power station that uses a non-renewable fuel or biofuel

accept a named fuel

eg coal or wood

or

buy (lots of) petrol / diesel generators

1

stockpile supplies of the fuel

accept fuel does not rely on the weather

or

fuel provides a reliable source of energy

accept as an alternative answer idea of linking with the National Grid (1)

and taking power from that when demand exceeds supply (1)

or

when other methods fail

or

when it is needed

answers in terms of using other forms of renewables is insufficient

1

[7]

7

(a) (i) kinetic

accept KE

*do **not** accept movement*

1

(ii) 0.75

allow 1 mark for correct substitution ie $\frac{60\,000}{80\,000}$

or

75 %

*an answer 0.75 % **or** 0.75 with a unit gains 1 mark only*

an answer 75 with or without a unit gains 1 mark only

2

(b) any **one** from:

- large areas of land are flooded
uses large areas of land / takes up large areas of land is insufficient
- people's homes may be destroyed
- habitat (of animals and plants) lost / damaged
construct is neutral
very noisy is neutral

1

- (c) (i) system of cables and transformers
both required for the mark
accept power lines / wires for cables
ignore reference to pylons
inclusions of power stations / consumers negates answer 1
- (ii) less energy loss / wasted (in the cables)
accept heat for energy
*do **not** accept no energy loss*
*do **not** accept electricity for energy* 1
- as the cables are shorter 1

[7]

8

- (a) (i) 4
allow 1 mark for correct transformation and substitution
ie $\frac{0.6}{0.15}$
substitution only scores if no subsequent steps are shown 2
- (ii) diagram showing two output arrows with one arrow wider than the other with the narrower arrow labelled electrical / electricity / useful 1
- (b) any **one** from:
 - to check reliability / validity / accuracy
 - to avoid bias 1

(c) any **two** from:

- produce no / less (air) pollution
accept named pollutant
accept produces no waste (gases)
- energy is free
accept it is a free resource
*do **not** accept it is free*
- (energy) is renewable
- conserves fossil fuel stocks
- can be used in remote areas
- do not need to connect to the National Grid

2

[6]

9

(a) (i) (dismantle and) remove radioactive waste / materials / fuels

accept nuclear for radioactive
*do **not** accept knock down / shut down*

1

(ii) increases it

*do **not** accept it has a negative effect*

1

(b) (i) *if efficiency is not mentioned it must be implied*

answers in terms of energy
generated only gains no credit

K most efficient

or

M least efficient

*accept **K** and / or **L** are more efficient than **M***

1

(efficiency) of **K** and **L** increases, (efficiency) of **M** (almost) constant / slightly reduced

all 3 power stations must be mentioned to get this mark

1

(ii) any **two** from:

- do not know how many (nuclear) power stations there will be
- power stations may continue to increase in efficiency
- do not know what type of power station new ones will be
accept new methods may be found to generate electricity / energy
accept other ways of generating energy may be expanded
- do not know future energy / electricity demands
accept we may become more energy efficient
- may be new uses for uranium

2

[6]

10

(a) (i) tidal / tides

*do **not** accept water / waves*

1

(ii) any **three** from:

- shorter journey time
accept easier to go from town to town
accept less petrol / fuel used
- less pollution from traffic
accept CO₂ / carbon emissions reduced
- energy source is free
- energy source / tides are predictable
- produces less / no pollutant gases (than fuel burning power stations)
accept no CO₂ / greenhouse gases produced
accept air pollution for pollutant gases
- conserves supplies of fossil fuels
- uses renewable energy (to generate electricity)
- provides employment
- no visual / noise pollution
less harm to the environment is insufficient
the electricity is cheaper is insufficient
*do **not** accept produces no radioactive waste*
the pollution mark scores twice only if it is clear one reference is to traffic and the other is to electricity generation

3

(b) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)

accept in case turbines / generators fail

or

can sell (excess) electricity (to the National Grid)

1

(ii) decreases the current

accept increases the voltage

1

reducing energy loss (along cables)

accept less heat / thermal energy lost / produced

1

[7]

11

(a) decrease in oil

PLUS

any **one** from:

- increase in (proportion of) coal
- increase in (proportion of) nuclear
- increase in (proportion of) gas
must have decrease in (proportion of) oil and increase in (proportion of) coal / nuclear / gas

1

(b) (i) (nuclear) fission

accept fission

*do **not** accept any answer that looks like fusion*

1

(ii) water heated to produce (high pressure) steam

1

steam turns turbine which drives generator

1

(iii) any **two** from:

- produces no pollutant gases
accept named gas or greenhouse gases
accept no atmospheric pollution
accept harmful for pollutant
accept does not contribute to global warming
*do **not** accept no pollution on its own*
*do **not** accept better for the environment unless qualified*
- it is reliable **or** can generate all of the time
- concentrated energy source **or** produces a lot of energy from a small mass
- produces only small volume of (solid) waste
- fossil fuels will last longer
accept a named fossil fuel
accept fossil fuels are running out
*do **not** accept fossil fuels are non-renewable unless qualified*
- will need to buy less fuel from other countries
accept no new fossil fuel power stations needed
*do **not** accept it is cheap*
*do **not** accept import less electricity*

2

(iv) it is / can be radioactive
*do **not** accept answers in terms of kills cells / cancer*

or emits radiation (from the nuclei)
accept emits gamma (rays)

1

(c) coal (burning) power stations / burning coal produces carbon dioxide
they refers to coal-burning power stations
accept sulfur dioxide / nitrogen oxides for CO₂

1

(increased) CO₂ increases / contributes to / causes global warming /
greenhouse effect

mention of ozone layer negates this mark
*do **not** accept CO₂ warms atmosphere*

1

[9]

12

(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

(ii) any **two** from:
***two** sources required for the mark*

- wind
- waves(*)
- tides(*)
()do **not** accept water / oceans*
accept OTEC

- fall of water
accept hydroelectric

- biomass

- geothermal
accept a named biomass / biofuel eg wood

1

(b) (i) any **two** from:

- increases from 20° to 30°
- reaches maximum value at 30°
- then decreases from 30°
- same pattern for each month
*accept peaks at 30° for **both** marks*
*accept goes up then down for **1** mark*
ignore it's always the lowest at 50°

2

(ii) 864

*an answer of 108 gains **2** marks*
*allow **1** mark for using 720 value only from table*
*allow **2** marks for answers 852, 816, 768, 825*
*allow **1** mark for answers 106.5, 102, 96, 103 (.125)*

3

(c) the solar cells will not meet demand at all times of the year / day
accept to maintain a constant supply of electricity / energy

or to make up the shortfall in energy required at certain times of the year

or to be able to sell surplus electricity (to the National Grid)

accept to provide energy at night
*do **not** accept because it's cloudy on it's own*

1

[8]

13

(a) only accept answers in terms of the argument of the nuclear power scientist any **three** from:

- produces a lot of energy for a small mass of fuel **or** is a concentrated energy source
accept amount for mass
- it is reliable **or** it can generate all of the time
- produces no pollutant gases
*accept named gas or greenhouse gases do **not** accept no pollution*
- produces only a small volume of (solid) waste
accept amount for volume
- advances in technology will make fuel reserves last much longer
accept an argument in terms of supply and demand

3

(b) any **one** from:

- may leak into the ground / environment
- geological changes
accept earthquakes etc
- may get into the food chain
*do **not** accept answers in terms of property prices or 'damages the environment'*
- over time if location not correctly recorded it may be excavated

1

(c) any **three** from:

- overall add no carbon dioxide to the environment
accept do not add to global warming
accept they are carbon neutral
- power companies can sell electricity at a higher price
accept power companies make more profit
- opportunity to grow new type crop
accept specific examples e.g. growing plants in swamps
accept extends the life of fossil fuel reserve
- more jobs
- more land cultivated **or** different types of land utilised

3

[7]

14

(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
ignore increased voltage / pd
- reduces energy loss / power loss (from cables)
accept reduces heat loss
*do **not** accept stops energy loss*
- increases efficiency (of distribution)

2

(b) any **one** from:

- produces pollutant gases
accept produces carbon dioxide / sulfur dioxide / nitrogen oxides
accept global warming / greenhouse effect / carbon emissions / air pollution / acid rain
ignore ozone layer
*do **not** accept carbon monoxide*
- produces solid waste / ash / smoke
accept global dimming
ignore produces pollution

1

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

any two valid points gains the marks

- using renewable energy
accept don't use up non-renewable / fossil fuels
accept named fuels
- non-renewable fuels can be used for other processes
- no pollutant gases produced
accept the opposite of (b)
ignore no pollution
- land can still be used for farming
ignore economic issues

2

(ii) any **two** from:

- cause noise pollution
- cause visual pollution
accept spoils the landscape
accept sunlight flicker
- may interfere with TV / radio / mobile phone signals
- need to put in new infrastructure
accept new roads needed
- not reliable owtte
- dangerous to birds
- lots of concrete needed for the bases
or
producing cement is environmentally damaging
accept reduces house prices
ignore any references to cost / jobs / number required
ignore takes up a lot of land
accept reference to obstruction of shipping etc. if clear reference to offshore wind farm

2

[9]

15

(a) hydrogen converted to helium

1

(nuclear) fusion

1

((small) loss in mass) which is converted to large amount of energy

1

(b) (i) any **two** from

it is running out/ takes millions of years/finite

not non renewable

allow acid rain do not allow waste

pollution **or** problem with CO₂ production

allow a specific example

more responsible to use fossil fuels for
(important) chemical functions

2

(ii) any **three** from

need lots of land for generators **or** many generators needed

generators may not be conveniently located

uncertainty of supply

accept the wind may not always blow

social resistance **or** visual pollution

noise pollution

high initial costs

(possible) interference with (local) radio and TV signals

3

[8]

16

(a) internal **or** thermal **or** heat **or** kinetic **or** movement

electrical

*both answers required for **one** mark*

1

(b) (i) Sun **or** solar

*do **not** accept sunshine*

1

(ii) any **one** of the follow:

- wind turbines produce no (gaseous) pollutants

- wind turbines use renewable energy

- wind turbines produce no (solid) waste

- reduced running costs

*do **not** allow safety*

1

a supporting statement **or** comparison **or** explanation

1

[4]

17

To gain marks the candidate must

1. Select one option Advantages) Max 4
2. State 8 valid advantages/disadvantages/relevant comparisons with either of the alternatives Disadvantages) Min 1 Comparisons)
If no A or D or C then Max 4
No option then Max 4

Look for As, Ds for chosen scheme.

Then for Cs compared with A/D for chosen scheme.

Below are listed some of the relevant mark scoring points.

	Advantages	Disadvantages
Wind	Land available to North No pollution Close/low transmission costs No fuel costs Renewable energy resource	Initial cost Many windmills/much land Calm day problem Few long term jobs
Coal	Waste land to North Prevailing wind to East Good road/rail transport Close/low transmission costs Save coal industry Overall labour intensive	Pollution Initial costs Fuel costs Non-renewable energy Resource
Hydroelectric	No pollution Mountains/lake/river nearby No fuel costs Renewable energy source	Possible drought Distant/transmission costs Few jobs created Possible expensive underground transmission cable Construction of dam affects environment

[8]**18**

- (a) 90% of 2.1011
2.16.1011

2

- (b) (i) Can be located anywhere
Continuous output
Sustain coal industry
any 2 for 1 mark each
- (ii) Low running cost
No atmospheric pollution
Gives calm coastal waters
any 2 for 1 mark each

- (iii) High installation costs – built in sea
 - Coast environmental damage – wildlife disturbance
 - Time dependence – need dropping tide
- any 2 for 1 mark each*
(1 for a valid disadvantage, 1 for reason)

6

[8]

- 19** coal has chemical energy
 when burnt heat/energy produced longest
 used to boil water/make steam sequence
 used to turn turbine(s)
 which now have ke
 turbine(s) turn generator(s)
 (where (ke) transferred electrical energy)
 (or electrical energy produced)
- any 5 for 1 mark each*

[5]

- 20** the higher the voltage the smaller the current
 small current gives small energy loss
 in the form of heat
 (or efficiency greater, or energy/heat losses low – gets 1)
- for 1 mark each*

[3]

- 21** (a) (i) much ash produced
 acid rain
 global warming/greenhouse effect
- any 2 for 1 mark each*
- (ii) landscaping/road building*
 removal of exhaust gases*
 use alternative source not producing
 CO₂* (*sequential (i))
- for 1 mark each*

2

2

- (b) (i) $E = 5 \times 10^8 \times 3600 \times 24 \text{ J/day}$
 $\times 4$ (for 4 generators) (sequential on $P \times t$) = 1.73×10^{14} (J/day)
for 1 mark each 3
- (ii) $2.66 \times 10^{10} \times 18\,829 = 4.86 \times 10^{14}$
for 1 mark each 2
- (iii) Eff = output/input
 Eff = $1.73/4.86$
 Eff = 0.36 or worked to a percentage
for 1 mark each 3
- (c) (i) boiler – heat to surroundings
 turbine – not all steam energy used/heat/sound lost to surroundings
 generator – heat in wires/coils/heat to surroundings
 transformer – heat in wires/coils/heat to surroundings
any 1 for 1 mark 1
- (ii) energy spread out/diluted
 as surroundings become warmer/energy lost as heat
 difficult to use for further useful energy/transfers
any 2 for 1 mark each 2

[15]

22

- (a) *must give one advantage and one disadvantage of each to get 4 marks and 2 further scoring points*

Advantages and disadvantages relevant to:

- (1) health risk
 - (5) cost
 - (6) environmental factors
 - (7) transport/ storage
- e.g. common coal / nuclear – high cost of building both

anti-nuclear examples

nuclear fuel transported on roads/rail in region
 possible effects on public health in surrounding area
 high cost of de-commissioning
 long life very active waste materials produced
 how waste materials stored safely for a long time

anti-coal examples
unsightly
pollution
supplies of fuel limited
acid rain
non-renewable

pro-nuclear examples
fuel cheap
no foreseeable fuel shortage

pro-coal examples
safe
reliable
large coal reserves
disposal of solid waste is easier
to max 6

6

(b) choice 0 marks

any three valid reasons each with explanation, which may or may not be comparisons with other fuel

But

at least two of which must be relevant to this site

3

[9]

23

do **not** give any credit for renewable **or** non-renewable **or** installation **or** decommissioning costs

fossil fuel advantage

1

a reliable source of energy

fossil fuel disadvantage

pollution by carbon dioxide /

accept causes acid rain

accept highest costs / more expensive than nuclear / more expensive than renewable

1

nuclear advantage

do not produce gases that increase the greenhouse effect **or** cause acid rain

accept nuclear is cheaper than fossil

1

nuclear disadvantage

accidents / waste can release very dangerous radioactive material radiation

*accept it produces waste that stays dangerously radioactive for thousands of years **or** radioactive waste has to be stored safely for thousands of years*

1

renewable advantage

there are no fuel costs

*almost pollution free (apart from noise and visual)
accept cheaper than fossil*

1

renewable disadvantage

not a reliable source of energy except for hydroelectric

*accept (most) require large areas of land
accept visual / noise pollution*

1

[6]

24

(a) **(oil / natural gas / coal)**

no marks are given for choosing the correct non-renewable energy source

burning releases carbon dioxide (1) greenhouse effect (1)

OR

allow 2 effects for 2 marks

burning (releases sulphur dioxide (1) acid rain (1)

OR

(nuclear power)

no marks given for choosing the correct non-renewable energy source

accidents can release very dangerous radioactive material (1)

produces waste that stays dangerously radioactive for thousands of years **or**
radioactive waste has to be stored safely for thousands of years (1)

accept the cost of installation and decommissioning is high

2

(b) any four from:

(wind power)

no marks are given for choosing the correct non-renewable energy source

- considered unsightly / visual pollution (1) very large areas of land (1)
- noisy for people living nearby / noise pollution (1)

(tidal power)

no marks are given for choosing the correct non-renewable energy source

- barrages / visual pollution (1)
- destroys the habitat of many living organisms (1)

(hydroelectricity)

no marks are given for choosing the correct non-renewable energy source

- damming / visual pollution (1)
- very large areas of land (1) flooding (1)

4

[6]

25

(a) any **two** from

reliable

accept it is not always windy

can be used as storage for surplus electricity

generates more electricity

accept would need hundreds of wind turbines to generate this electricity

takes less space is neutral

no noise pollution

*do **not** accept can be started up quickly*

2

(b) advantage :

does not produce greenhouse gases / carbon dioxide / water
or acid rain / sulphur dioxide

1

disadvantage :

danger from radioactive materials if accidents **or** waste radioactive materials
accept slower start-up time

1

(c) any **one** situation with a suitable explanation

satellite

weigh less **or** work for many years **or** remote

remote places on Earth pump water **or** operate phones **or** road signs / lights **or**
weather stations **or** too expensive / impractical

calculators / watches small amount of electricity needed

2

[6]

26

ideas that

- direct solar radiation will provide enough energy to heat the (specially designed) buildings during the period Oct-Mar / summer
- solar cells will produce plenty of electricity in Oct-Mar / summer (when wind generators produce little)
- a couple of wind generators will produce all electricity needed (for all but heating) Apr-Oct / winter
- number required makes wind generators unsuitable for heating / buildings
- no solar energy in June and July / little in winter
- solar / wind have little effect on environment
- **or** cause no air pollution
- solar and wind complement each other

- **or** together provide energy all year
- fuel / gas / diesel can provide energy all the time / at any time
- fuel / gas / diesel needed for transport
- fuel / gas / diesel needed for heating in winter
- diesel has to be imported
- diesel likely to freeze
- gas wouldn't have to be imported
- drilling for gas difficult / harms environment
- but atmospheric pollution a global rather than local matter so any produced in Antarctic doesn't matter much

(deduct 1 mark (to min^m. zero) for incorrect claims about destroying ozone layer)

- gas produces less carbon dioxide (for the same energy released) than diesel*
- gas produces less sulphur dioxide (for the same energy released than diesel*

(these ideas met by candidates in Q.16 so must be allowed, though not required)
any ten for 1 mark each*

[10]