EXAM PAPERS PRACTICE

Conservation and Dissipation of Energy

These practice questions can be used by students and teachers and is

Suitable for GCSE AQA Physics Topic Questions 8463

Level: GSCE AQA 8463

Subject: Physics

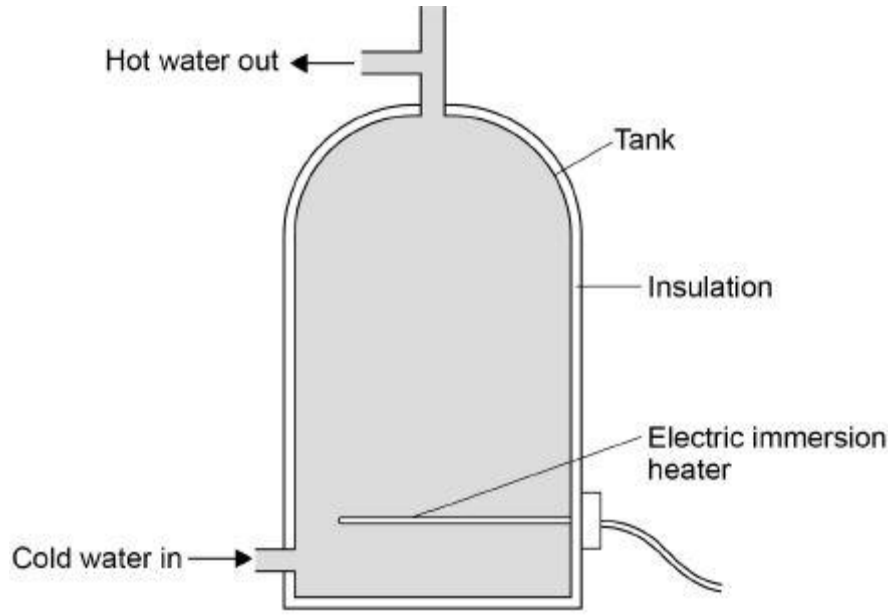
Exam Board: GCSE AQA

Topic: Conservation and Dissipation of Energy

Q1.

Figure 1 shows a hot water tank made of copper.

Figure 1



(a) Copper has a higher thermal conductivity than most metals.

How does the rate of energy transfer through copper compare with the rate of energy transfer through most metals?

Tick **one** box.

Higher ☐

Lower ☐

The same ☐

(1)

(b) The tank is insulated. When the water is hot, the immersion heater switches off.

Complete the sentences.

Compared to a tank with no insulation, the rate of energy transfer from the

water in an insulated tank is _____ .

This means that the water in the insulated tank stays _____

for longer.

(2)

Figure 2 shows how temperature varies with time for water in a tank heated with an immersion heater.

Figure 3 shows how temperature varies with time for water in a tank heated with a solar panel.

Figure 2

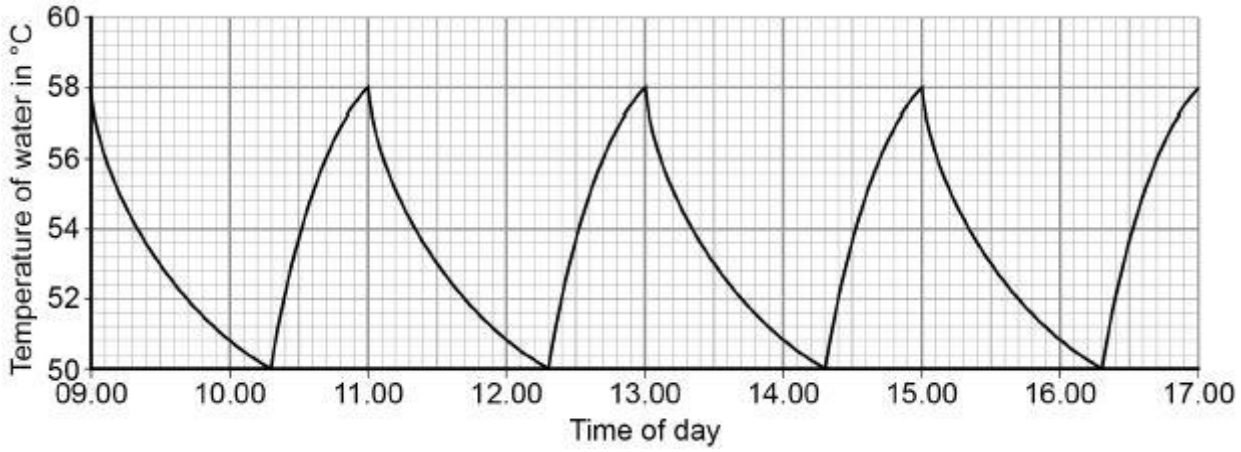
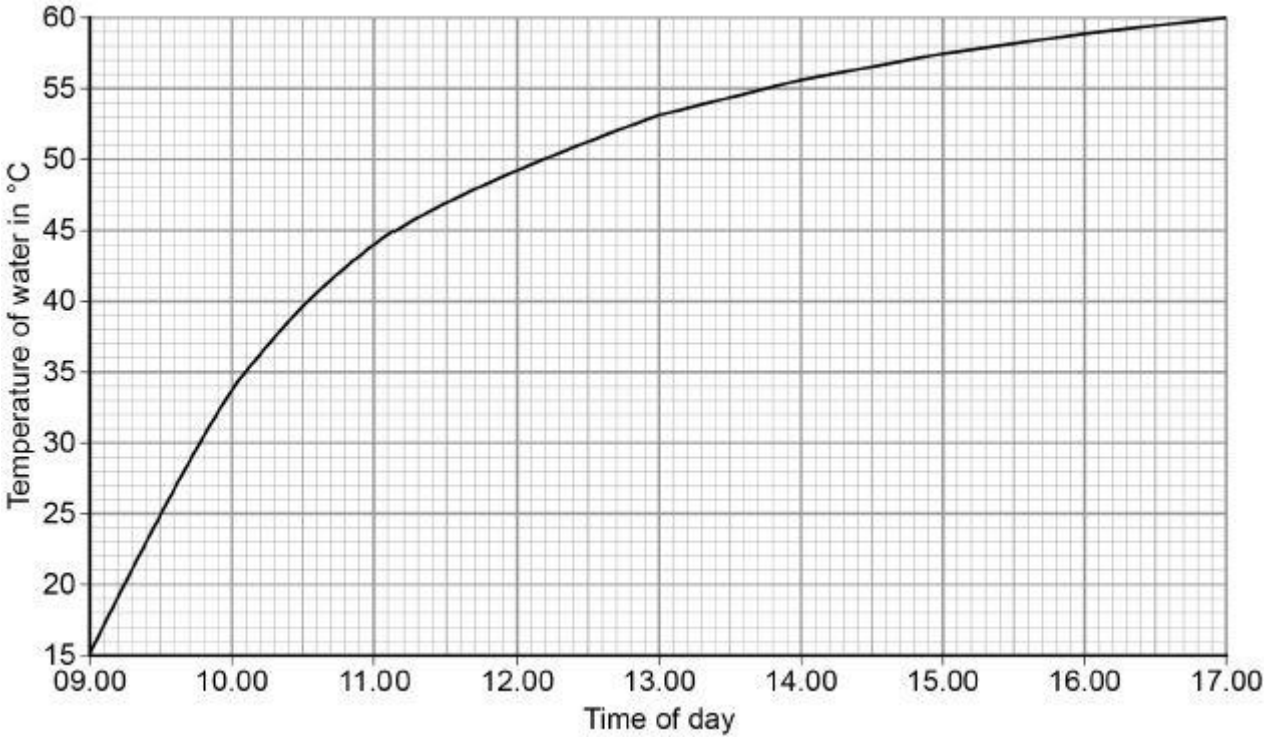


Figure 3



(c) Give **one** advantage and **one** disadvantage of heating the water using solar panels rather than an immersion heater.

Use only information from **Figure 2** and **Figure 3**.

Advantage of solar panels _____

_____

_____

Disadvantage of solar panels _____

_____

_____

(2)

(d) During one morning, a total of 4 070 000 J of energy is transferred from the electric immersion heater.

4 030 000 J of energy are transferred to the water.

Calculate the proportion of the total energy transferred to the water.

_____

_____

_____

_____

Proportion of total energy = _____

(2)

(e) Write down the equation that links energy transferred, power and time.

_____

(1)

(f) The power output of the immersion heater is 5000 W.

Calculate the time taken for the immersion heater to transfer 4 070 000 J of energy.

Give the unit.

_____

_____

_____

_____

Time = _____ Unit _____

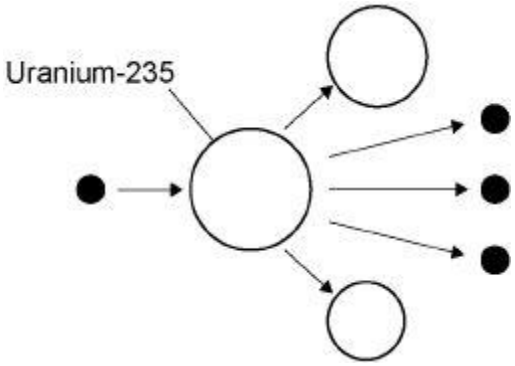
(4)
(Total 12 marks)

Q2.

Nuclear power can be used to generate electricity through nuclear fission.

Figure 1 shows the process of nuclear fission.

Figure 1



(a) Complete the sentences.

Choose answers from the box.

gamma rays	**light rays**	**proton**	**neutron**	**nucleus**	**X-rays**

During the process of nuclear fission, a uranium _____

absorbs a _____ .

Electromagnetic radiation is released in the form of _____ .

(3)

(b) The UK needs at least 25 000 000 kW of electrical power at any time.

A nuclear power station has an electrical power output of 2 400 000 kW

Calculate how many nuclear power stations are needed to provide 25 000 000 kW of electrical power.

_____

_____

_____

_____

Number of nuclear power stations = _____

(2)

(c) State **two** environmental issues caused by generating electricity using nuclear power stations.

1. _____

_____

2. _____

_____

(2)

(d) The UK currently generates a lot of electricity by burning natural gas. This process releases carbon dioxide into the atmosphere.

Figure 2 shows how the concentration of carbon dioxide in the atmosphere has changed over the past 115 years.

Figure 2

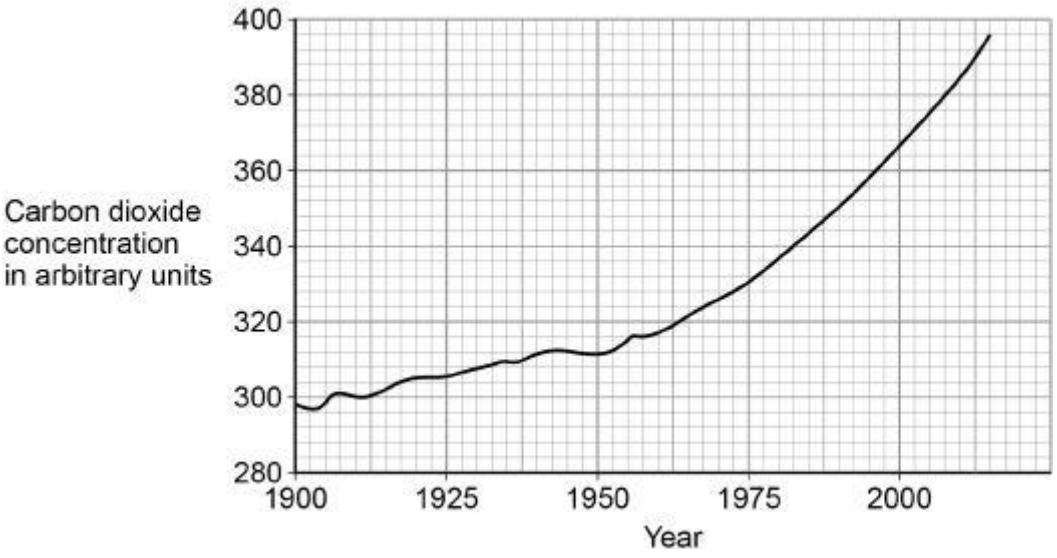
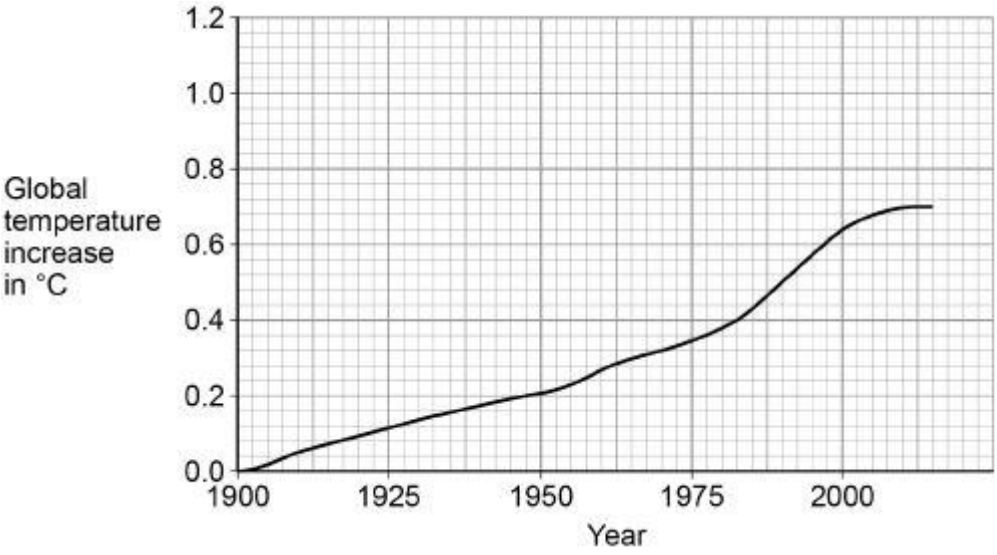


Figure 3 shows how the global temperature has changed over the past 115 years.

Figure 3



Give **one** similarity and **one** difference between the data in **Figure 2** and **Figure 3**.

Similarity _____

_____

_____

Difference _____

_____

_____

(2)

(Total 9 marks)

Q3.

Nuclear power stations generate electricity through nuclear fission. Electricity can also be generated by burning shale gas.

(a) Shale gas is natural gas trapped in rocks. Shale gas can be extracted by a process called fracking. There is some evidence that fracking causes minor earthquakes. Burning shale gas adds carbon dioxide to the atmosphere.

Describe the advantages of nuclear power compared with the use of shale gas to generate electricity.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(b) What is the name of **one** fuel used in nuclear power stations?

_____

(1)

(c) Describe the process of nuclear fission.

_____

_____

_____

_____

_____

_____

_____

_____

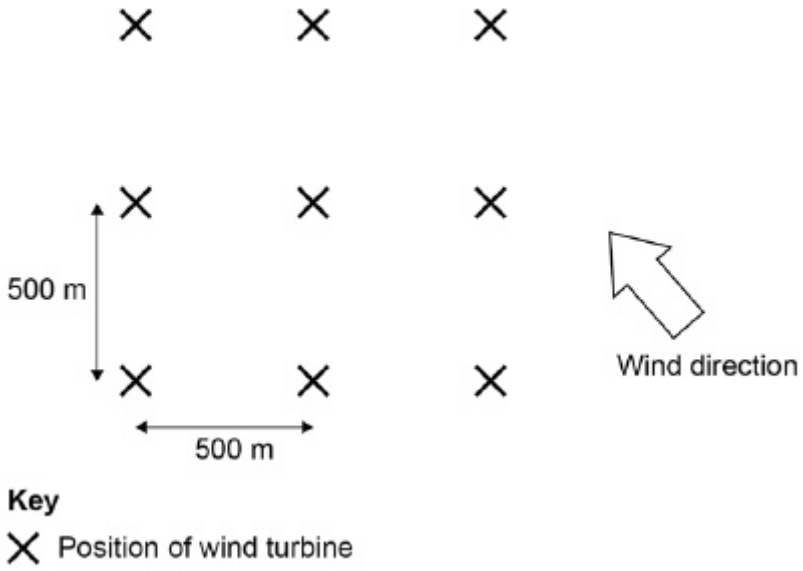
(4)

(Total 8 marks)

Q4.

The wind turbines in a wind farm must have a minimum distance of 500 m between them for maximum efficiency.

The diagram shows the position of nine wind turbines in a wind farm.



(a) Suggest **one** way in which the layout of this wind farm ensures maximum efficiency when the wind direction changes.

_____

_____

_____

(1)

The average mass of air passing through the blades of one wind turbine is 51 000 kg per second.

The density of air is 1.2 kg / m^3

(b) Write down the equation that links density, mass and volume.

_____

(1)

(c) Calculate the volume of air passing through the blades of one wind turbine in one second.

Give the unit.

Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

_____

Volume in one second = _____ Unit _____

(5)

(d) The average power output from one of the wind turbines in the diagram is 1.6×10^6 W

The average power output of a nuclear power station is 2.4×10^9 W

Calculate the number of wind turbines needed to generate power equal to one nuclear power station.

_____

_____

_____

Number of wind turbines = _____

(2)

(e) The UK requires a minimum electrical power of 2.5×10^{10} W at any time.

Give **two** reasons why wind turbines alone are unlikely to be used to meet this requirement.

1. _____

_____

2. _____

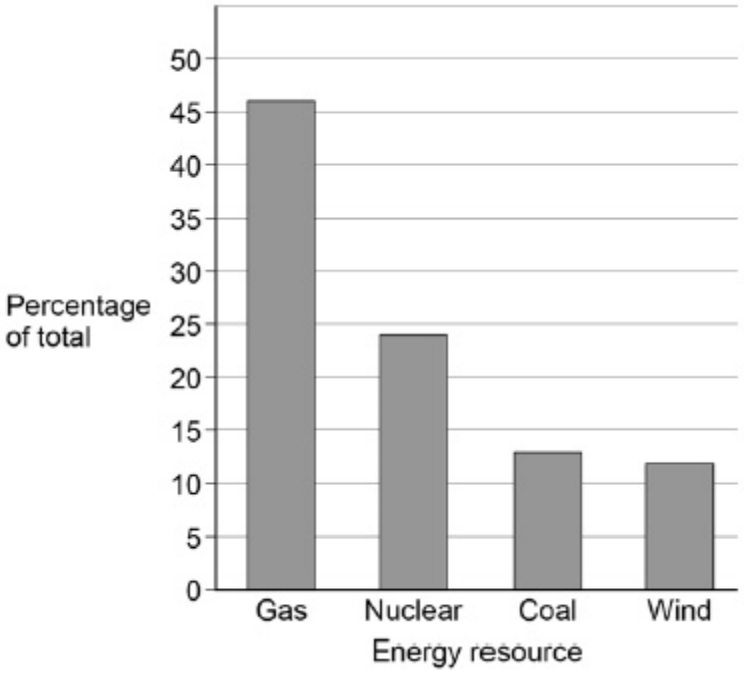
_____

(2)

(Total 11 marks)

Q5.

The graph gives information about the production of electricity in the UK in 2016.



(a) The UK government signed the Paris Climate Agreement in April 2016.

The agreement commits the UK to reduce the amount of carbon dioxide released into the atmosphere.

Explain which energy resources in the graph should be used to meet the UK's commitment to the Paris Climate Agreement.

(4)

(b) On average, there is enough wind in the UK each year to supply all of the UK's electricity needs.

Explain why the UK may still need power stations that use fuel to generate electricity.

_____

_____

_____

_____

(2)

(c) All European countries signed the Paris Climate Agreement in 2016.

In the future, some European countries will only allow electric vehicles.

Suggest how this is likely to affect methods of electricity generation in these countries.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q6.

Energy resources can be renewable or non-renewable.

(a) Coal is a non-renewable energy resource.

Name **two** other non-renewable energy resources.

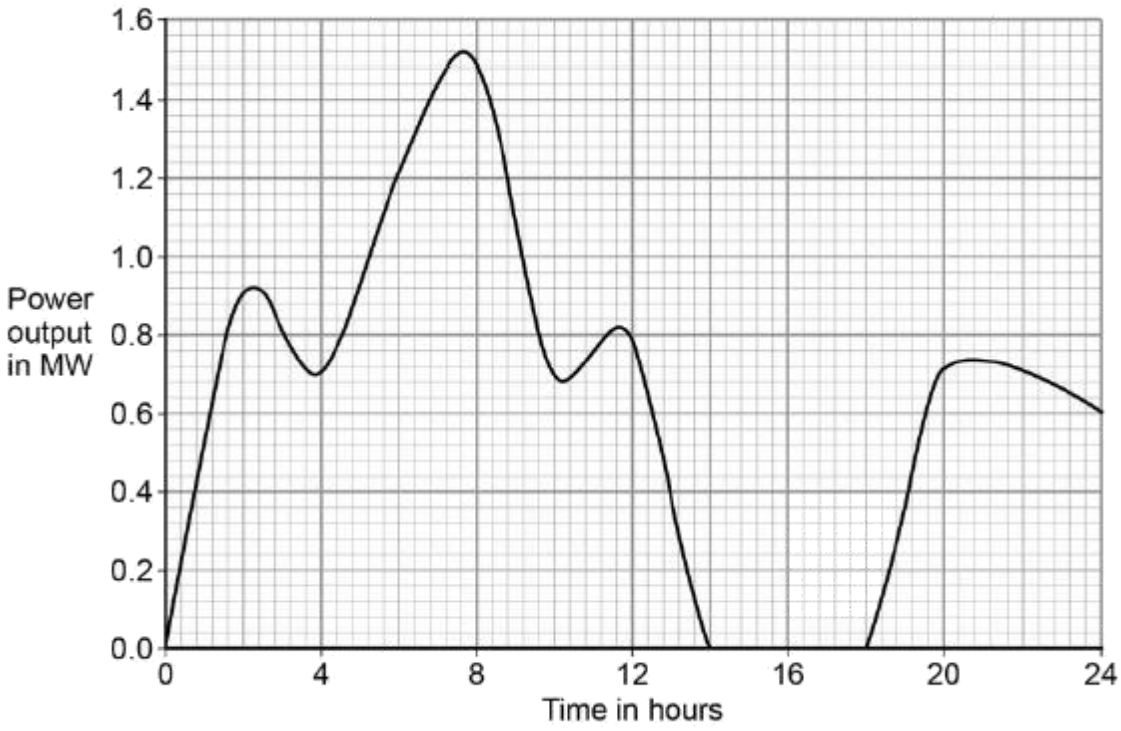
1. _____

2. _____

(2)

(b) Wind turbines are used to generate electricity.

The graph below shows how the power output of a wind turbine changes over one day.



A wind turbine does not generate electricity constantly.

For how many hours did the wind turbine generate no electricity?

Time = _____ hours

(1)

(c) Electrical power is transferred from power stations to the National Grid.

What is the National Grid?

Tick **one** box.

a system of cables and pylons ☐

a system of cables and transformers ☐

a system of cables, transformers and power stations ☐

(1)

(d) An island has a large number of wind turbines and a coal-fired power station.

The island needs to use the electricity generated by the coal-fired power station at certain times.

Choose **one** reason why.

Tick **one** box.

Wind is a renewable energy resource. ☐

Wind turbine power output is constant. ☐

The power output of wind turbines is unpredictable. ☐

The fuel cost for wind turbines is very high. ☐

(1)

(e) A wind turbine has an average power output of 0.60 MW.

A coal-fired power station has a continuous power output of 1500 MW.

Calculate how many wind turbines would be needed to generate the same power output as one coal-fired power station.

_____

_____

Number of wind turbines = _____

(2)

(f) It is important that scientists develop new energy resources.

Choose **one** reason why.

Tick **one** box.

All energy resources are running out. ☐

All energy resources are used to generate electricity. ☐

Most energy resources have negative environmental effects. ☐

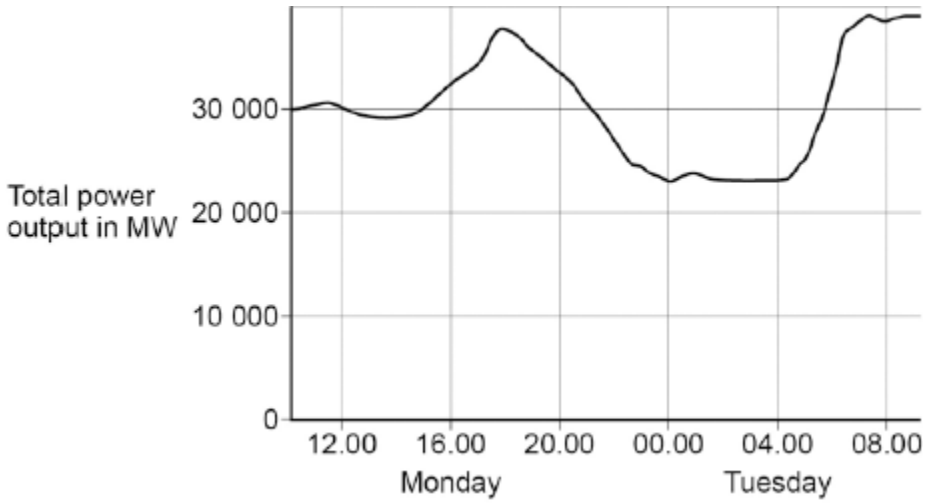
(1)

(Total 8 marks)

Q7.

The National Grid ensures that the supply of electricity always meets the demand of the consumers.

The figure below shows how the output from fossil fuel power stations in the UK varied over a 24-hour period.



(a) Suggest **one** reason for the shape of the graph between 15.00 and 18.00 on Monday.

_____

_____

(1)

(b) Gas fired power stations reduce their output when demand for electricity is low.

Suggest **one** time on the figure above when the demand for electricity was low.

_____

_____

(1)

(c) The National Grid ensures that fossil fuel power stations in the UK only produce about 33% of the total electricity they could produce when operating at a maximum output.

Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q8.

Different energy sources are used to generate electricity.

(a) Use words from the box to match the correct energy source to each of the descriptions given in the table.

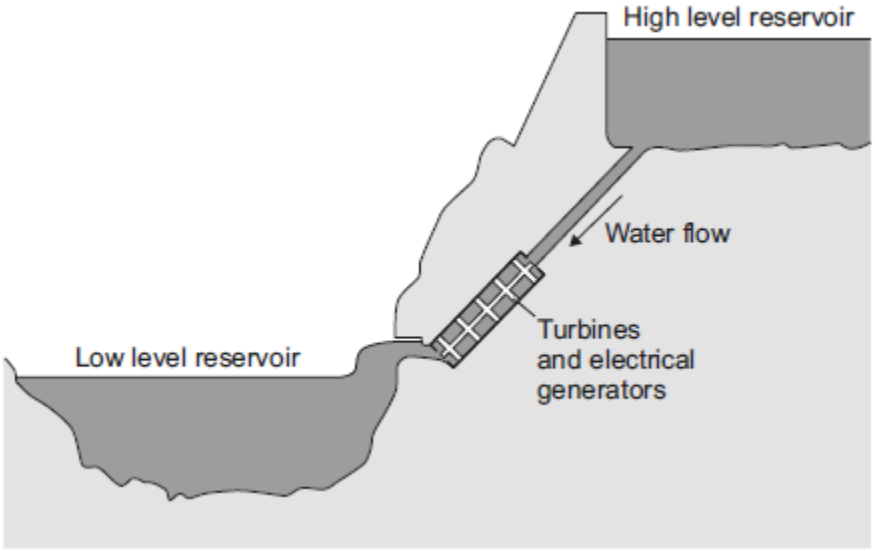
biofuel	**coal**	**geothermal**	**nuclear**	**waves**

Description	**Energy source**
Energy from the Earth's core is used to heat water.	
Fission of uranium nuclei is used to heat water.	
Gases from rotting plant material are burned to heat water.	

(3)

(b) Energy can be stored in a pumped storage power station.

The figure shows a pumped storage power station.



When electricity is needed, the water in the high level reservoir is allowed to flow to the low level reservoir. The flowing water generates electricity.

Use the correct answer from the box to complete each sentence.

electrical	**gravitational potential**	**kinetic**	**nuclear**	**sound**

The water in the high level reservoir stores _____ energy.

The flowing water has _____ energy.

The water turns the turbine which is connected to the generator.

The generator produces some _____, this is wasted energy.

(3)

(c) The total power input to a pumped storage power station is 600 MW.

The useful power output is 540 MW.

(i) Calculate the efficiency of this pumped storage power station.

_____

_____

_____

Efficiency = _____

(2)

(ii) Calculate how much power is wasted by the pumped storage power station.

_____

Power = _____ MW

(1)

(iii) How is the temperature of the surroundings affected by the energy wasted by the pumped storage power station?

_____

(1)

(Total 10 marks)

Q9.

A small community of people live in an area in the mountains.
The houses are not connected to the National Grid.

The people plan to buy an electricity generating system that uses either the wind or the flowing water in a nearby river.

Figure 1 shows where these people live.

Figure 1

(a) It would not be economical to connect the houses to the National Grid.
Give **one** reason why.

_____

_____

_____

_____

(1)

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Information about the two electricity generation systems is given in **Figure 2**.

Figure 2

The wind turbine costs £50 000 to buy and install.
The hydroelectric generator costs £20 000 to buy and install.
The average power output from the wind turbine is 10 kW.
The hydroelectric generator will produce a constant power output of 8 kW.

Compare the advantages and disadvantages of the two methods of generating electricity.

Use your knowledge of energy sources as well as information from **Figure 2**.

(6)

(Total 7 marks)

Q10.

All European Union countries are expected to generate 20% of their electricity using renewable energy sources by 2020.

The estimated cost of generating electricity in the year 2020 using different energy sources is shown in **Table 1**.

Table 1

Energy source	Estimated cost (in the year 2020) in pence per kWh
Nuclear	7.8
Solar	25.3
Tidal	18.8
Wind	10.0

France generated 542 billion kWh of electricity using nuclear power stations in 2011. France used 478 billion kWh of electricity and sold the rest of the electricity to other countries in 2011.

(a) France may continue generating large amounts of electricity using nuclear power stations instead of using renewable energy resources.

Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) Give **two** disadvantages of generating electricity using nuclear power stations.

1. _____

_____

2. _____

_____

(2)

(c) A panel of solar cells has an efficiency of 0.15.

The total power input to the panel of solar cells is 3.2 kW.

Calculate the useful power output of this panel of solar cells in kW.

_____

Useful power output = _____ kW

(2)

(d) **Table 2** shows the manufacturing cost and efficiency of different types of panels of solar cells.

Table 2

Type of Solar Panel	Cost to manufacture a 1 m^2 solar panel in £	Efficiency in %
A	40.00	20
B	22.50	15
C	5.00	10

Some scientists think that having a low manufacturing cost is more important than improving the efficiency of solar cells.

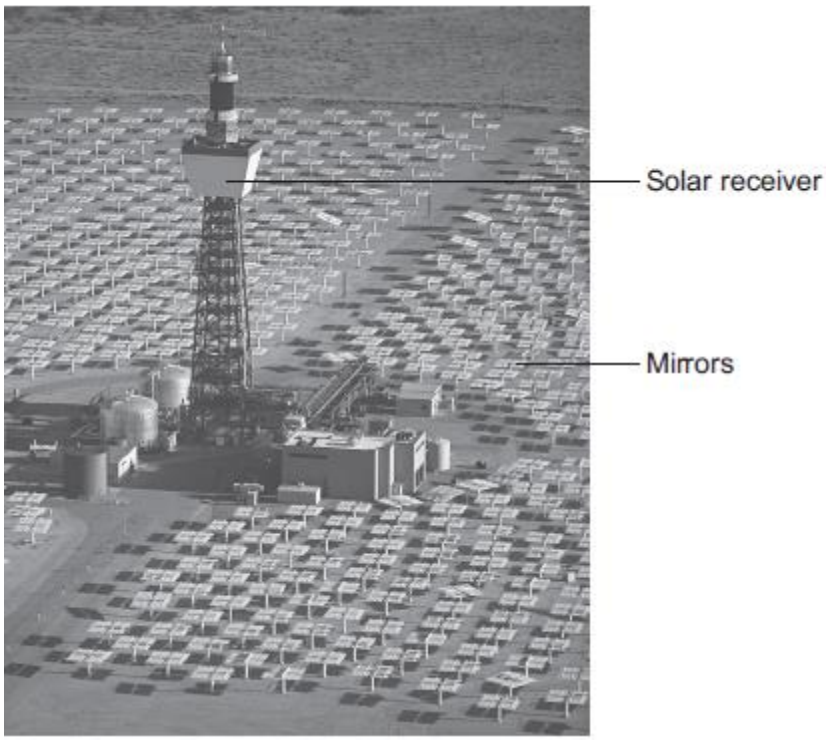
Use information from **Table 2** to suggest why.

(2)

(Total 8 marks)

Q11.

The image shows a solar thermal power station.



Energy from the Sun is directed at the solar receiver by many mirrors.

@

(a) (i) Suggest **one** reason why a solar thermal power station is built in a hot desert.

_____

_____

(1)

(ii) Complete the following sentence to describe how the mirrors direct energy from the Sun towards the solar receiver.

Energy from the Sun is _____ by the mirrors

towards the solar receiver.

(1)

(iii) Heated water is used to generate electricity in the solar thermal power station. Choose the correct answer from the box to complete each sentence.

boiler	**motor**	**transformer**	**turbine**

At the solar receiver, water is heated in a _____

which turns the water into steam. The steam turns a

_____which is connected to a water into steam. The

steam turns a _____ which is connected to a generator.

The generator produces electricity. A _____ is used

to change the voltage for transmission along power lines.

(3)

(b) A solar storage power station is a new type of solar power station.
It is able to store energy from the Sun to generate electricity at night.

The solar storage power station can supply a town with a maximum electrical power of 140 000 kW for 15 hours.

Calculate the maximum energy, in kWh, stored by the solar storage power station.

_____

_____

_____

Energy = _____ kWh

(2)

(c) A different method of generating electricity uses wind turbines.
A student researching a wind farm wrote the following.

> Top Hill Wind Farm has 25 wind turbines.
> Last week, one of the wind turbines generated electricity for only 42 hours out of a possible 168 hours.
> My conclusion is that all wind turbines operate for only 25% of the time.

(i) Give **two** reasons why the student is **not** correct in reaching his conclusion.

1. _____

_____

2. _____

_____

(2)

(ii) Give **one** reason why wind turbines do not generate electricity all the time.

_____

_____

(1)

(iii) Give **one** advantage of using wind turbines to generate electricity compared with using fossil fuel power stations.

_____

_____

(1)

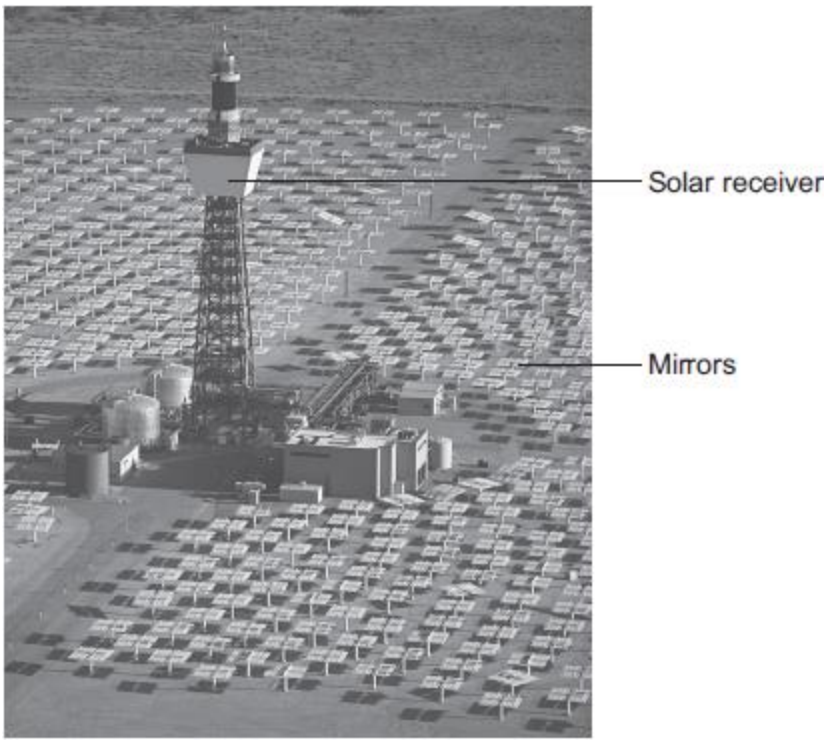
(Total 11 marks)

Q12.

The image below shows a solar thermal power station that has been built in a hot desert.

The power station uses energy from the Sun to heat water to generate electricity.

Energy from the Sun is reflected towards a solar receiver using many mirrors.



(a) (i) Which part of the electromagnetic spectrum provides most of the energy to heat the water in a solar thermal power station?

_____

(1)

(ii) Describe how heated water is used to generate electricity by this solar thermal power station.
The process is the same as in a fossil fuel power station.

_____

_____

_____

_____

_____

_____

(3)

(b) A new type of solar power station, called a solar storage power station, is able to store energy from the Sun by heating molten chemical salts.
The stored energy can be used to generate electricity at night.

(i) It is important that the molten chemical salts have a high specific heat capacity.
Suggest **one** reason why.

_____

_____

(1)

(ii) The solar storage power station can store a maximum of 2 200 000 kWh of energy.
The solar storage power station can supply a town with a maximum electrical power of 140 000 kW.

Calculate for how many hours the energy stored by the solar storage power station can supply the town with electrical power.

Give your answer to 2 significant figures.

_____

_____

_____

Time = _____ hours

(3)

(iii) **Table 1** gives information about the place where the solar storage power station has been built.

Table 1

Season	Mean number of daylight hours	Mean power received from the Sun per

		square metre in kW
Spring	11.5	0.90
Summer	13.5	1.10
Autumn	12.0	0.95
Winter	10.5	0.71

The solar storage power station does not operate at the maximum possible electrical output every day of the year.

Suggest why.

_____

_____

_____

_____

(2)

(c) Power stations do not work at maximum possible electrical output all the time.The 'capacity factor' of a power station is calculated using the equation:

$$\text{Capacity factor} = \frac{\text{actual electrical output per year}}{\text{maximum possible electrical output per year}}$$

Table 2 shows capacity factors for different types of power station.

Table 2

Type of power station	Renewable energy source	Capacity factor
Coal	No	0.41
Natural gas	No	0.48
Nuclear	No	0.66
Solar thermal	Yes	0.33
Tidal	Yes	0.26
Wind turbine	Yes	0.30

(i) Compare the capacity factors of the renewable power stations with those of the non-renewable power stations in **Table 2**.
Explain the reason for the difference between the capacity factors.

_____

_____

_____

_____

_____

_____

(3)

(ii) The capacity factor of a solar storage power station is higher than for all other renewable power stations.
Suggest **one** reason why.

_____

_____

(1)

(Total 14 marks)

Q13.

Iceland is a country that generates most of its electricity using geothermal power stations and hydroelectric power stations.

(a) (i) Complete the following sentences to describe how some geothermal power stations work.

In regions where volcanoes are active, the ground is hot.

Cold _____ is pumped down into the ground

and is _____ by hot rocks.

It returns to the surface as steam. The steam is used to turn a turbine.

The turbine drives a _____ to produce electricity.

(3)

(ii) Which **one** of the following statements about geothermal power stations is true?

Tick (✓) **one** box.

Geothermal power stations use fossil fuels. ☐

Geothermal power stations produce carbon dioxide. ☐

Geothermal power stations provide a reliable source of electricity. ☐

(1)

(b) What is needed for a hydroelectric power station to be able to generate electricity?

Tick (✓) **one** box.

Falling water ☐

A long coastline ☐

Lots of sunny days ☐

(1)

(Total 5 marks)

Q14.

Electricity can be generated using various energy sources.

(a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage _____

_____

Disadvantage _____

_____

(2)

(b) (i) A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

_____

_____

_____

Energy output = _____ kWh

(2)

(ii) Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

_____

_____

(1)

(c) An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

_____

_____

(1)

(Total 6 marks)

Q15.

(a) Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) The UK produces most of its electricity from fossil fuels.

Many people in the UK leave their televisions in 'stand by' mode when not in use, instead of switching them off.

It is better for the environment if people switch off their televisions, instead of leaving them in 'stand by' mode.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(c) A scientist wrote in a newspaper:

'Appliances that do not automatically switch off when they are not being used should be banned.'

Suggest why scientists alone cannot make the decision to ban these appliances.

_____

_____

(1)

(Total 8 marks)

Q16.

Solar panels are often seen on the roofs of houses.

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

_____

_____

_____

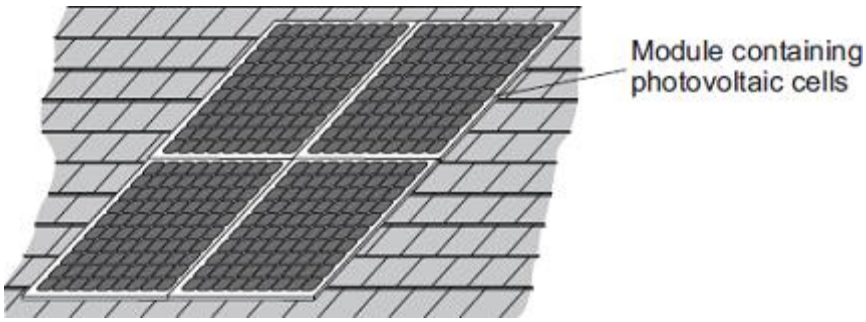
_____

(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 1.4×10^3 W.

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

_____

_____

_____

_____

_____

_____ 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.

_____

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.

_____

_____

Money paid = _____

(2)

(iii) The cost of the four modules is £6000.

Calculate the payback time in years for the modules.

_____

_____

Payback time = _____ years

(3)

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

_____

_____

(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.

_____

_____

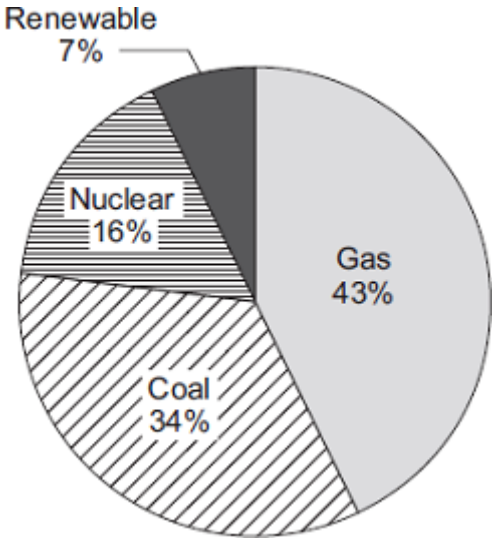
(1)

(Total 13 marks)

Q17.

(a) The pie chart shows the proportions of electricity generated in the UK from different

energy sources in 2010.



(i) Calculate the percentage of electricity generated using fossil fuels.

_____

Percentage = _____ %

(1)

(ii) The pie chart shows that 7% of electricity was generated using renewable energy sources.

Which **one** of the following is **not** a renewable energy source?

Tick (✓) **one** box.

Oil ☐

Solar ☐

Wind ☐

(1)

(b) Complete the following sentence.

In some types of power station, fossil fuels are burned to heat _____ to produce steam.

(1)

(c) Burning fossil fuels releases carbon dioxide into the atmosphere.

Why do many scientists think adding carbon dioxide to the atmosphere is harmful to the environment?

Tick (✓) **one** box.

Carbon dioxide is the main cause of acid rain. ☐

Carbon dioxide causes global warming. ☐

Carbon dioxide causes visual pollution. ☐

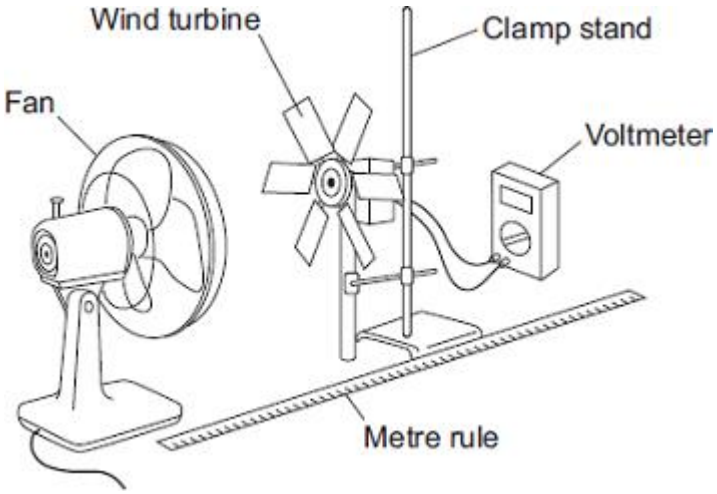
(1)

(Total 4 marks)

Q18.

(a) A student investigated how the number of blades on a wind turbine affects the output voltage of the turbine.

The student used the apparatus shown in the diagram.



The fan was used to turn the wind turbine.

(i) The fan was always the same distance from the wind turbine.

Why?

_____

_____

(1)

(ii) After switching the fan on, the student waited 20 seconds before taking the voltmeter reading.

Suggest why.

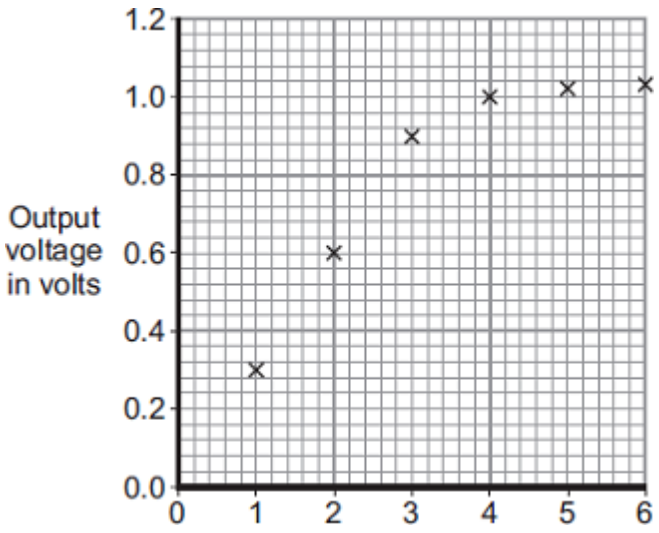
_____

_____

(1)

(iii) The student changed the number of blades on the wind turbine.

The student's results are shown in the scatter graph.



What conclusion can be made from the results in the scatter graph?

_____

_____

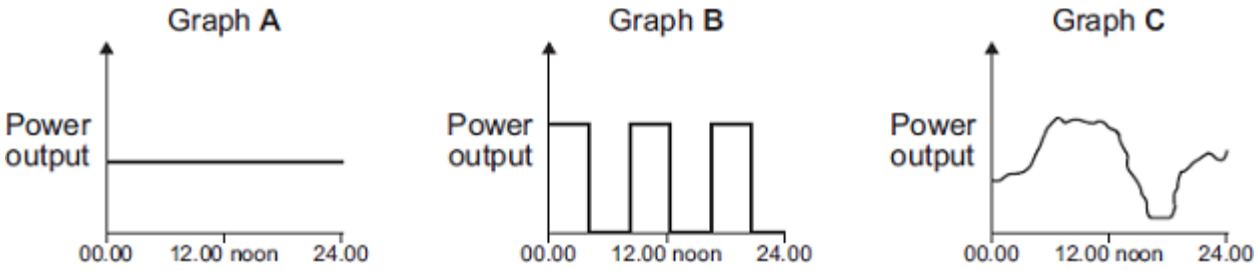
_____

_____

(2)

(b) The amount of electricity generated using wind turbines is increasing.

Which graph, **A**, **B** or **C**, is most likely to show the electrical power output from a wind turbine over one day?



TimeTimeTime

Write the correct answer, **A**, **B** or **C**, in the box. ☐

Give a reason for your answer.

_____

_____

_____

(2)

(Total 6 marks)

Q19.

(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.

_____

_____

_____

_____

(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.

_____

_____

(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?

_____

_____

(1)

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

_____

_____

(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.

_____

_____

(1)

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

Suggest **one** reason why.

_____

_____

(1)

(Total 7 marks)

Q20.

Three energy sources used to generate electricity are given in **List A**.

Statements about the energy sources used to generate electricity are given in **List B**.

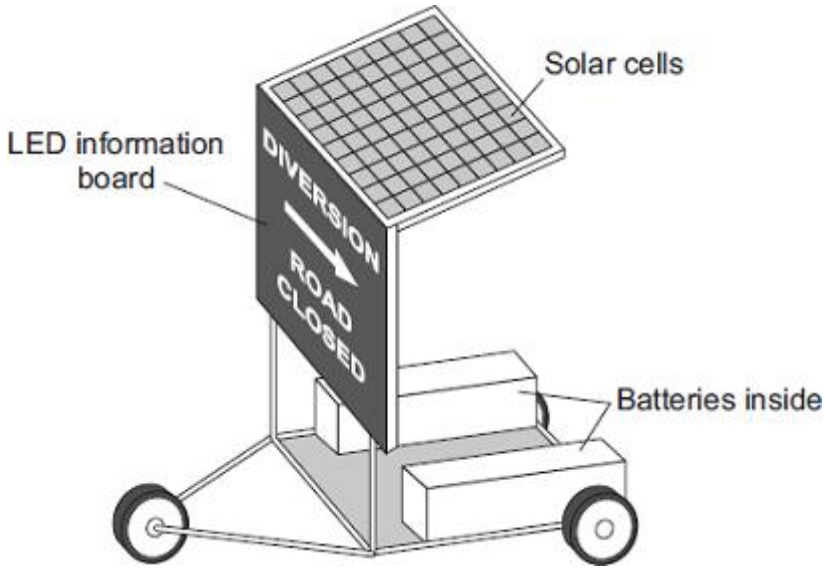
Draw **one** line from each energy source in **List A** to the statement about the energy source in **List B**.

List A **Energy source**	**List B** **Statement about energy source**
	Uses energy from falling water
Geothermal	
	Uses energy from inside the Earth
Hydroelectric	
	Is unpredictable
Nuclear	
	Produces dangerous waste

(Total 3 marks)

Q21.

The picture shows a temporary road traffic information board.



The batteries power the LEDs used in the information board.
The solar cells keep the batteries charged.

(a) Use words from the box to complete each of the following sentences.

chemical	electrical	light	sound

The solar cells transfer light energy to _____ energy.

The batteries transfer _____ energy to electrical energy.

The LEDs transfer electrical energy to _____ energy.

(3)

(b) When the total energy input to the solar cells is 200 joules, the useful energy output from the solar cells to the batteries is 50 joules.

Calculate the efficiency of the solar cells.

_____

_____

_____

Efficiency = _____

(2)

(c) Which **one** of the following statements gives the reason for using solar cells to charge the batteries?

Tick (✓) **one** box.

Solar cells will charge the batteries day and night. ☐

The information board can be used anywhere it is needed. ☐

A small number of solar cells produce a lot of electricity. ☐

(1)

(Total 6 marks)

Q22.

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*?

_____

_____

(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?

_____

_____

(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. _____

_____

2. _____

_____

(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.

_____

_____

_____

_____

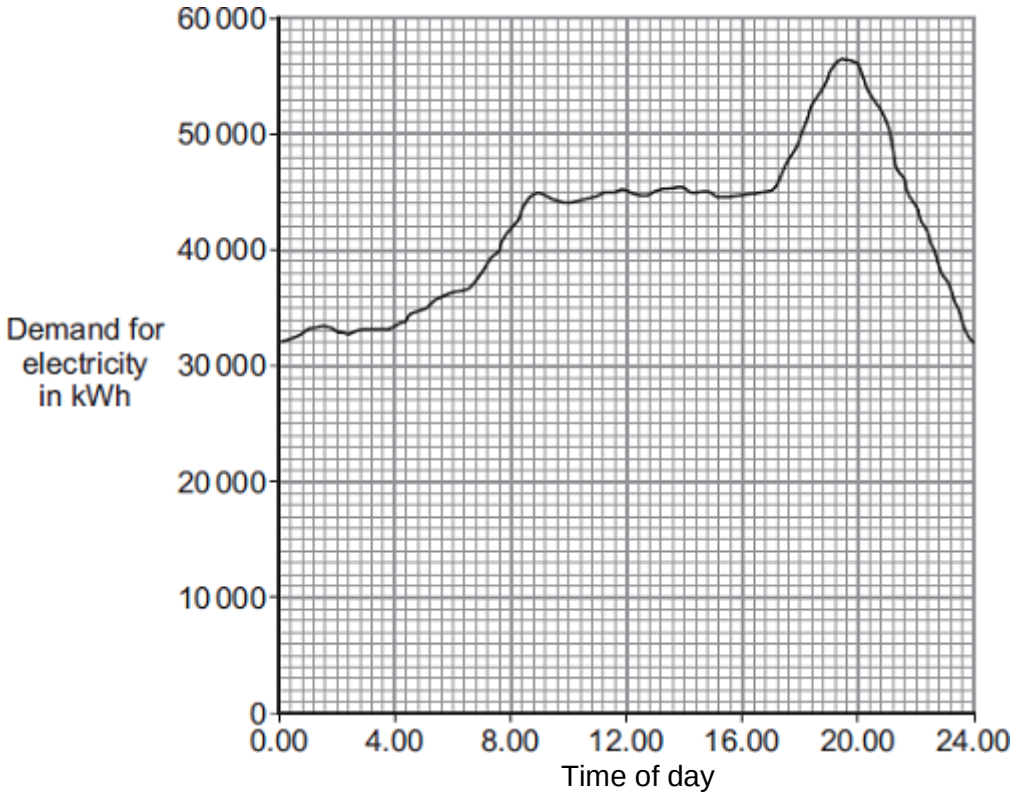
_____

_____

(3)
(Total 7 marks)

Q23.

(a) The graph shows how the demand for electricity in the UK changes during one 24-hour period.



The table gives the start-up times for two types of power station.

Type of power station	Start-up time
Gas	A few minutes
Nuclear	Several days

How would these two types of power station be used to meet the demand for electricity during this 24-hour period?

_____

_____

_____

_____

_____

_____

(3)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate*.

A farmer plans to generate all the electricity needed on her farm, using either a biogas generator or a small wind turbine.

The biogas generator would burn methane gas. The methane gas would come from rotting the animal waste produced on the farm. When burnt, methane produces carbon dioxide.

The biogas generator would cost £18 000 to buy and install. The wind turbine would cost £25 000 to buy and install.

The average power output from the wind turbine would be the same as the continuous output from the biogas generator.

Evaluate the advantages and disadvantages of the two methods of generating electricity.

Conclude, with a reason, which system would be better for the farmer to buy and install.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 9 marks)

Q24.

Wind and tides are energy sources that are used to generate electricity.

(a) Complete each sentence by putting a tick (✓) in the box next to the correct answer.

(i) The wind is

a non-renewable energy source. ☐

a constant energy source. ☐

an unreliable energy source. ☐

(1)

(ii) The tides are

a renewable energy source. ☐

a constant energy source. ☐

an unreliable energy source. ☐

(1)

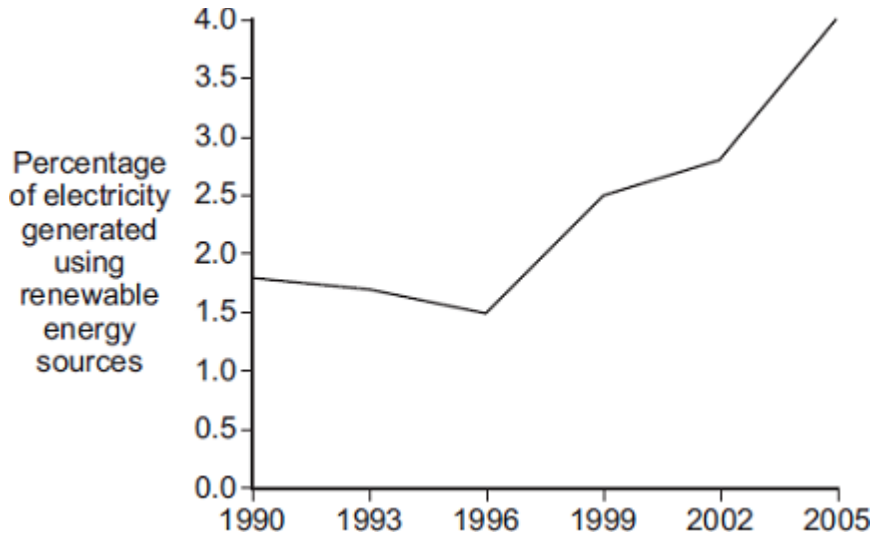
(b) If wood is to be used as a renewable energy source, what must be done each time a tree is chopped down?

_____

_____

(1)

(c) In the UK, electricity is generated using renewable and non-renewable energy sources. The graph shows the percentage of electricity generated using renewable energy sources between 1990 and 2005.



Complete the following sentence by drawing a ring around the correct answer in the box.

In 2015, the percentage of electricity generated using renewable energy sources

is most likely to be

greater than 4 %.
equal to 4 %.
less than 4 %.

(1)

(Total 4 marks)

Q25.

The picture shows a solar-powered aircraft. The aircraft has no pilot.

By NASA/Nick Galante [Public domain], via Wikimedia Commons

(a) Use words from the box to complete the following sentence.

electrical	**heat**	**light**	**sound**

Solar cells are designed to transform _____ energy into _____ energy.

(2)

(b) On a summer day, 175 000 joules of energy are supplied to the aircraft's solar cells every second. The useful energy transferred by the solar cells is 35 000 joules every second.

Use the equation in the box to calculate the efficiency of the solar cells.

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

Show clearly how you work out your answer.

_____

_____

Efficiency = _____

(2)

(c) The aircraft propellers are driven by electric motors.

Give **one** environmental advantage of using electric motors to drive the aircraft propellers rather than motors that burn a fuel.

_____

_____

(1)

(Total 5 marks)

Q26.

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

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

_____

_____

(1)

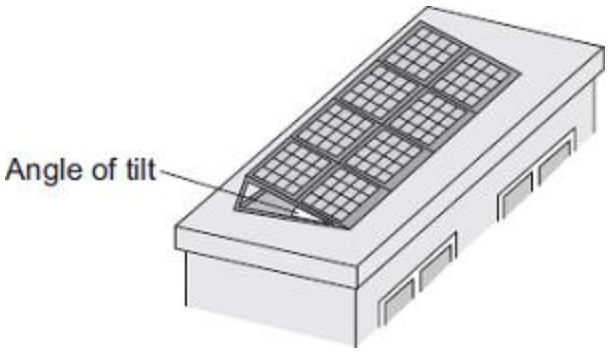
(ii) Name **two** other renewable energy sources used to generate electricity.

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 m^2 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.

_____

_____

_____

_____

(2)

(ii) The total area of the solar cell panels used by the householder is 5 m^2.

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.

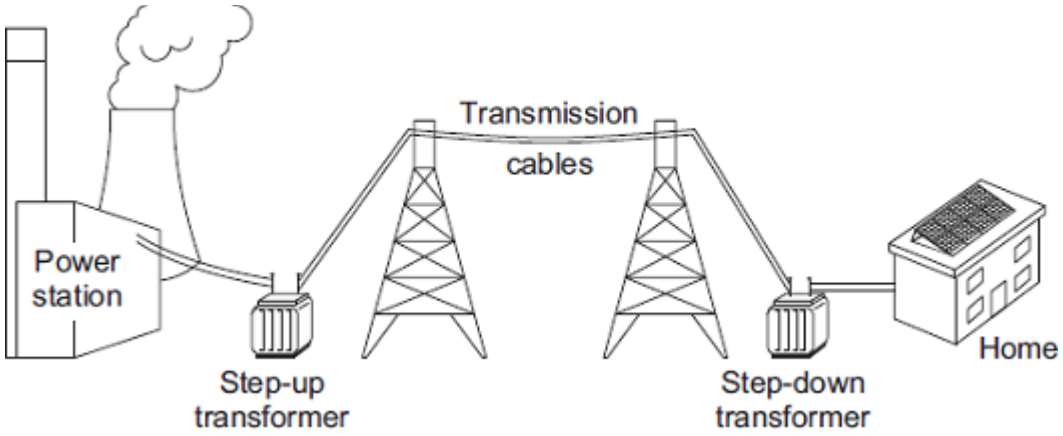
_____

_____

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.

_____

_____

(1)

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

Explain how.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q27.

Electricity is generated in power stations. It is then sent to all parts of the country through a network of cables.

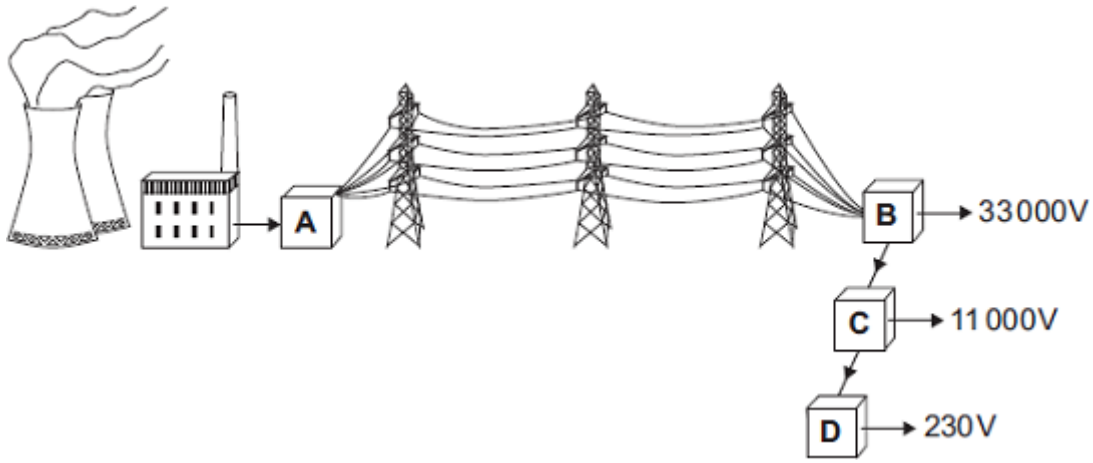
(a) Complete the following sentence by using **one** of the words in the box.

Grid	**Power**	**Supply**

The network is called the National _____ .

(1)

(b) In the diagram, **A**, **B**, **C** and **D** are transformers.



(i) Which transformer, **A**,**B**,**C** or **D**, is a step-up transformer?

Transformer _____

(1)

(ii) Which transformer, **A**, **B**, **C** or **D** will supply homes, offices and shops?

Transformer _____

(1)

(c) Complete the following sentence by drawing a ring around the correct line in the box.

In a step-up transformer, the potential difference (p.d.) across the

primary coil is

less than
the same as
more than

the p.d. across the secondary coil.

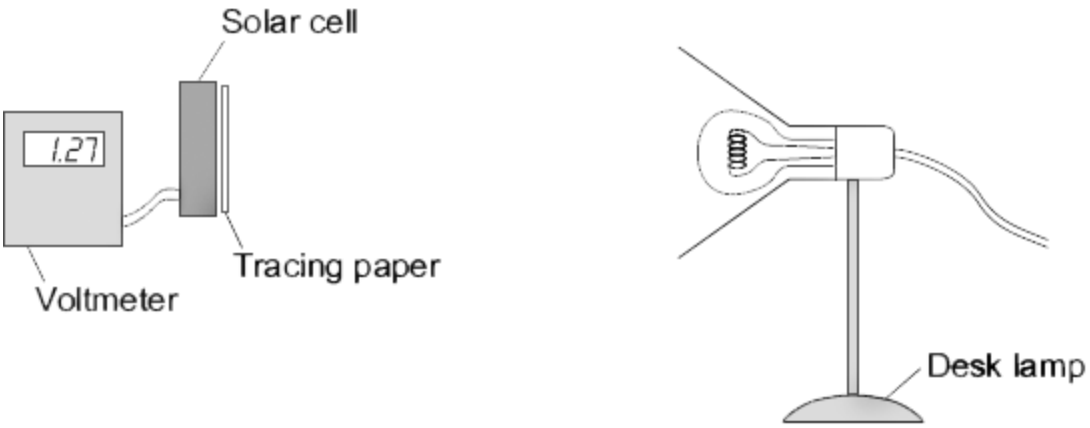
(1)

(Total 4 marks)

Q28.

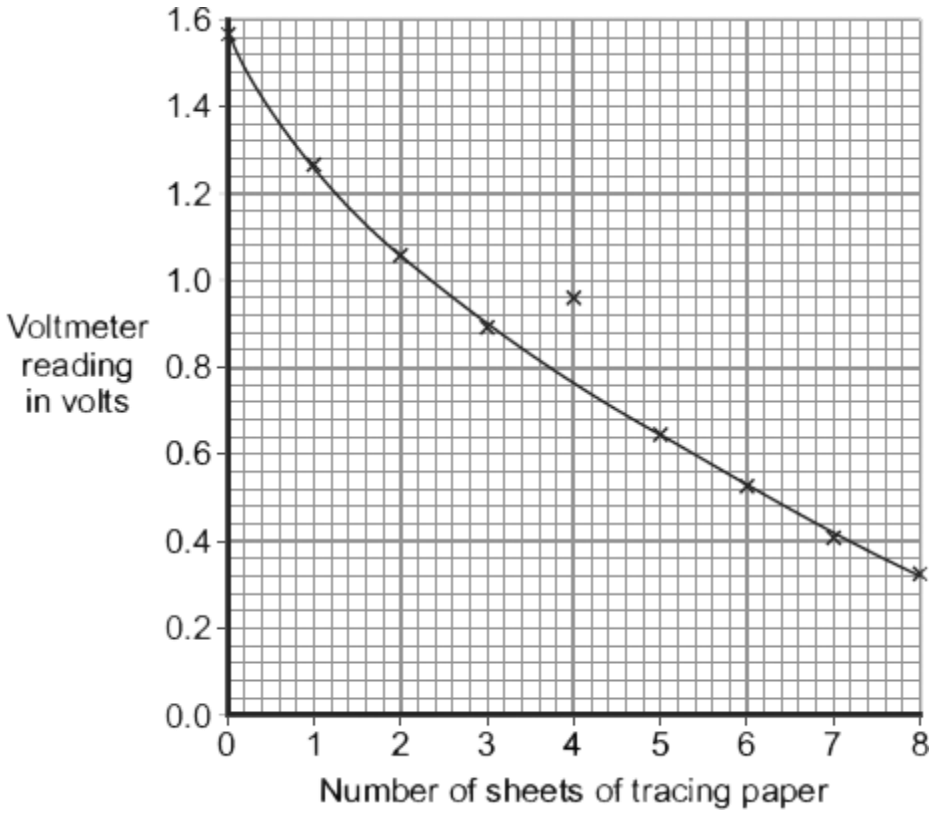
A student has read that a solar cell with a dirty surface will not work as well as a solar cell with a clean surface.

To test the effect of a dirty surface on a solar cell, the student set up the following equipment.



The student put the desk lamp a fixed distance from the solar cell. To represent the effect of a dirty surface, the student covered the surface of the solar cell with pieces of tracing paper. Each time the student added a piece of paper, she measured the output voltage of the solar cell.

(a) The results taken by the student have been used to draw the graph below.



(i) One of the results seems to be anomalous.

Draw a ring around the anomalous data point on the graph.

(1)

(ii) The larger the number of sheets of tracing paper used, the lower the intensity of the light reaching the solar cell.

Draw a ring around the correct answer in the box to complete the sentence.

A decrease in the intensity of the light reaching the solar cell

causes

a decrease in
no change to
an increase in

the output voltage from the solar cell.

(1)

(b) People can buy panels of solar cells to generate electricity for their homes. Any surplus electricity can be sold to the electricity supply company.

(i) Give **one** environmental advantage of generating electricity using solar cells rather than generating electricity in a coal-burning power station.

_____

_____

(1)

(ii) A homeowner pays £7600 to have solar panels fitted on the roof of their house. The homeowner expects to save £950 each year from reduced energy bills and from selling the electricity.

Assuming these figures to be correct, calculate the pay-back time for the solar panels.

Show clearly how you work out your answer.

_____

_____

_____

Pay-back time = _____ years

(2)

(iii) Draw a ring around the correct answer in the box to complete the sentence.

Allowing the surface of the solar panels to become very dirty

will

decrease
not change
increase

the pay-back time.

(1)

(iv) Explain your answer to part (b)(iii).

_____

_____

_____

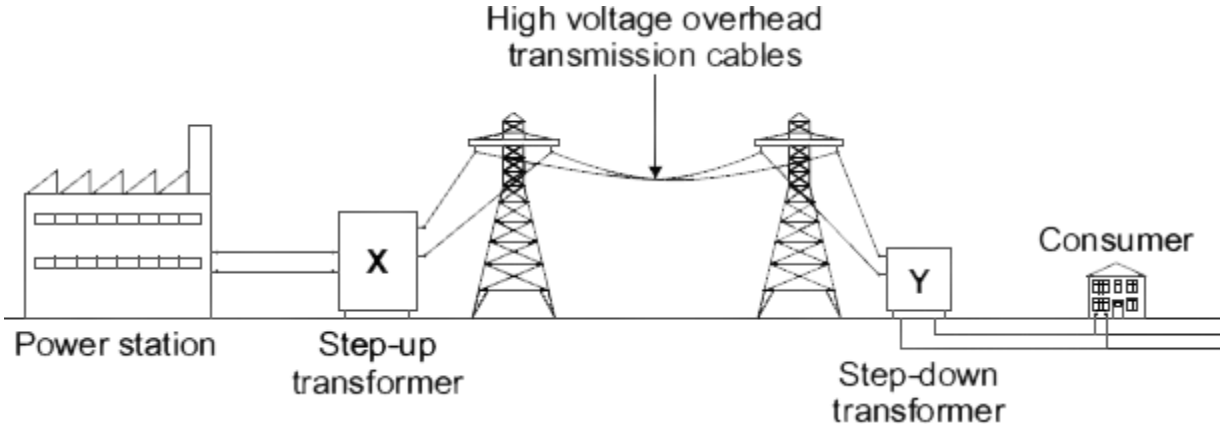
_____

(2)

(Total 8 marks)

Q29.

The diagram shows the National Grid system.



(a) The National Grid includes step-up transformers.

Explain why.

_____

_____

_____

_____

(2)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

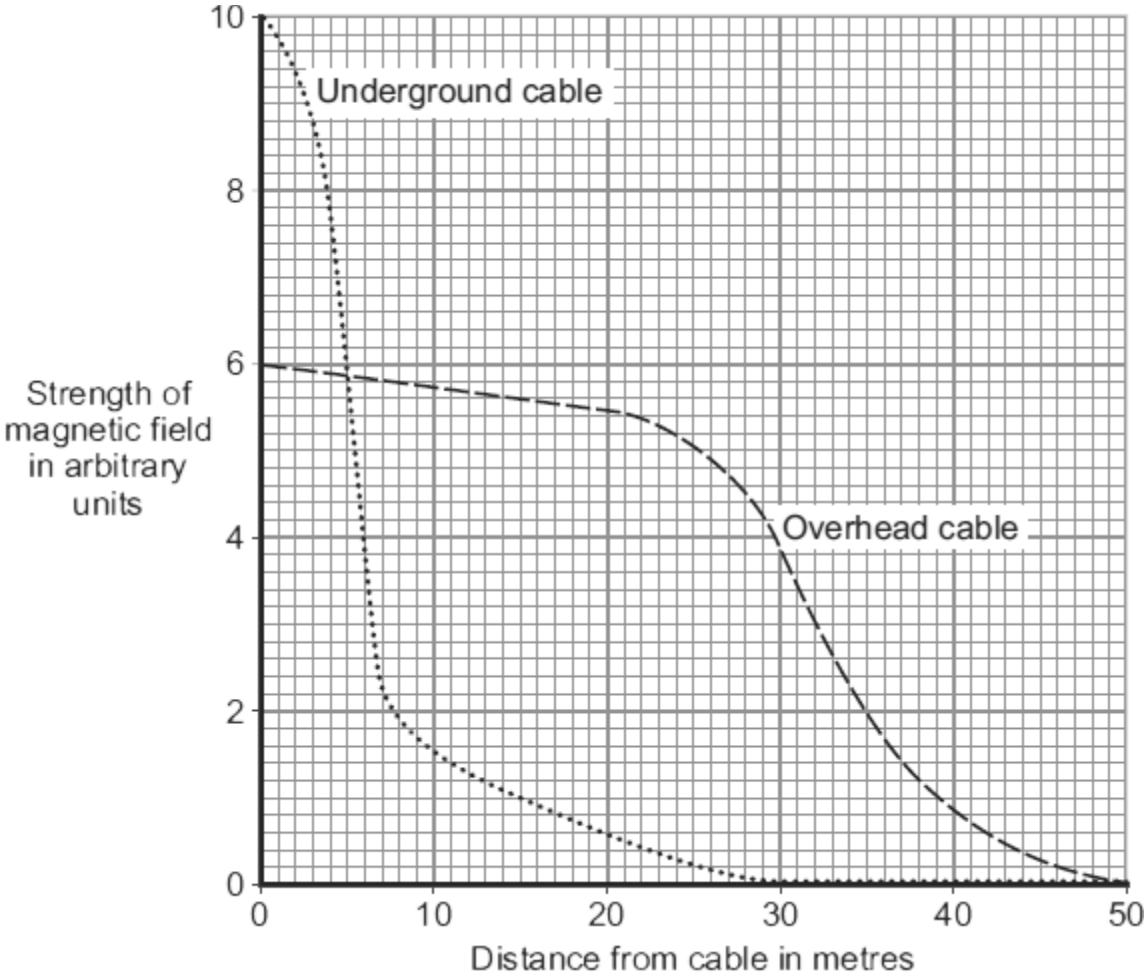
Over the next 10 years, more than 300 kilometres of new high voltage transmission cables are to be added to the National Grid. Most of the new cables will be suspended from pylons and run overhead while the rest will be buried underground.

Outline the advantages and disadvantages of both overhead transmission cables and underground transmission cables.

(6)

(c) When an electric current flows through a transmission cable, a magnetic field is produced.

The graph shows how the strength of the magnetic field varies with distance from both overhead and underground transmission cables that carry the same current.



What conclusions may be drawn from this graph?

_____

_____

_____

_____

(2)

(d) Some people think that, because of the magnetic fields, living close to transmission cables is dangerous to health. Laboratory studies on mice and rats exposed to magnetic fields for two or more years found that the magnetic fields had no effect on the animals' health.

Draw a ring around the correct answer in the box to complete the sentence.

Using animals in scientific research raises | economic / environmental | issues.

ethical

(1)

(Total 11 marks)

Q30.

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

(a) One advantage of using the wind to generate electricity is that it is a renewable energy source.

(i) Give **one** other advantage of using the wind to generate electricity.

_____

_____

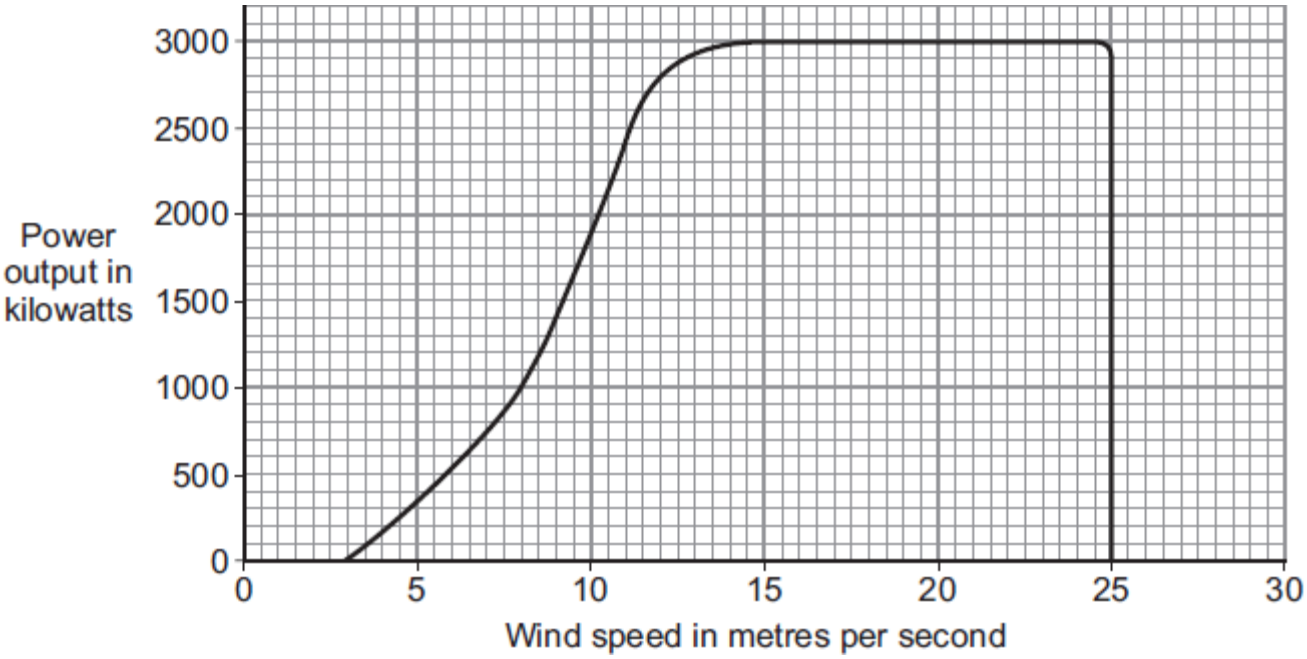
(1)

(ii) Name **one** other renewable energy source used to generate electricity.

_____

(1)

(b) The graph shows how wind speed affects the power output from a large wind turbine.



(i) What is the maximum possible power output from this wind turbine?

_____

(1)

(ii) Read this part of a newspaper article.

Cold weather stops wind turbines

For the past two weeks, most of the UK's wind turbines have been generating less than one sixth of their maximum power output. To avoid major power cuts in the future, some experts have said that more nuclear power stations need to be built to provide a reliable source of energy.

Use the graph to explain why the power output from the wind turbines was less than one sixth of the maximum.

_____

_____

_____

_____

(2)

(iii) Having more nuclear power stations will help to avoid power cuts in the future.

Which **two** of these reasons explain why?

Put a tick (✓) in the boxes next to your answers.

A small amount of nuclear fuel generates a large amount of electricity. ☐

The radioactive waste produced must be stored for many years. ☐

Nuclear power stations do not depend on the weather to generate electricity. ☐

(1)

(Total 6 marks)

Q31.

(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.

(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.

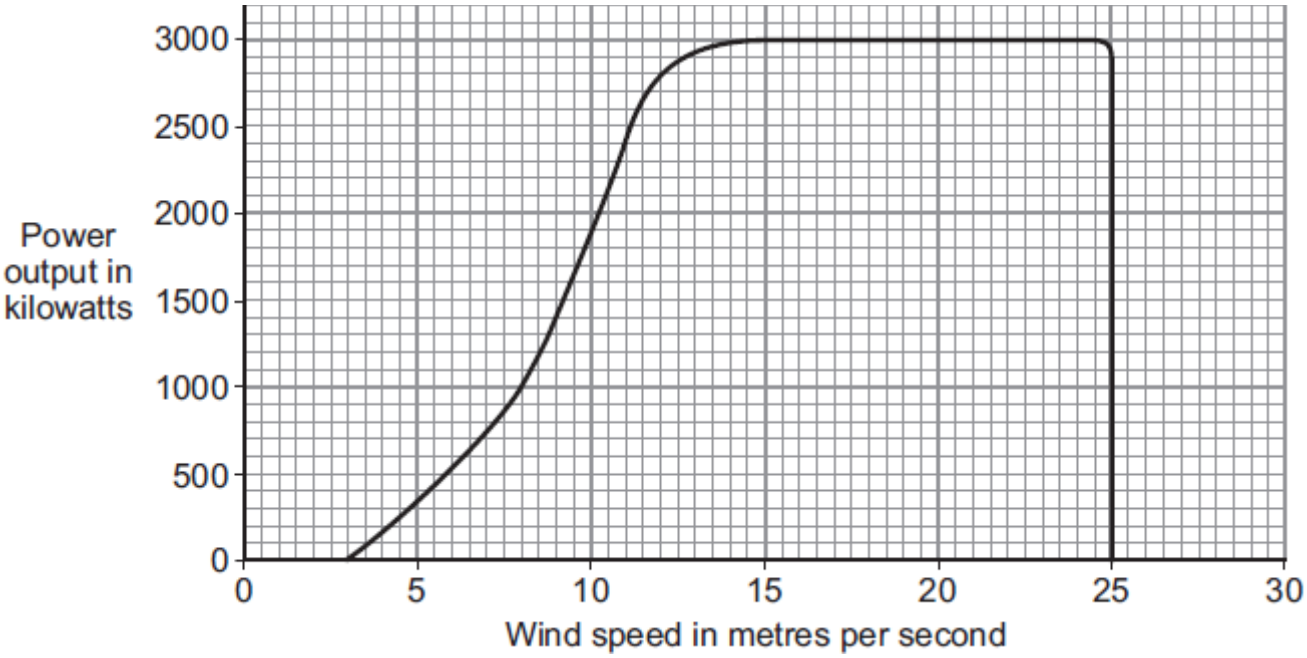
(2)

(Total 6 marks)

Q32.

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.

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?

(1)

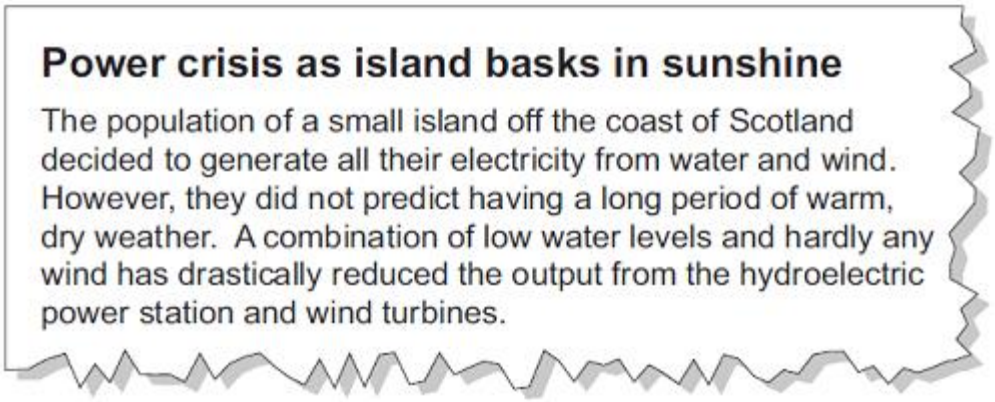
(ii) How is the National Grid designed to reduce energy losses during transmission?

_____

_____

(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.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q33.

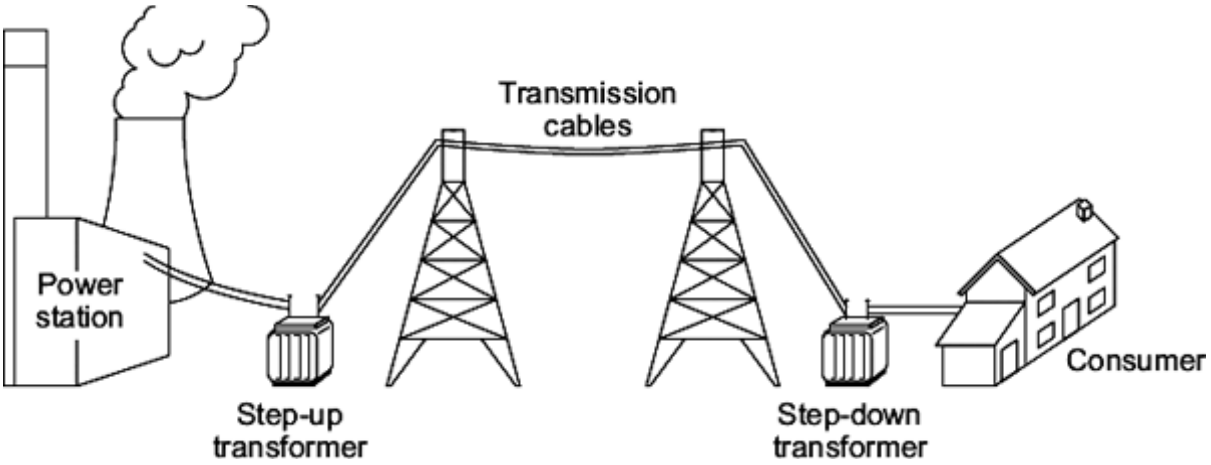
In the UK, most electricity is generated in power stations that burn fossil fuels.

(a) Which type of fossil fuel power station has the shortest start-up time?

_____

(1)

(b) The diagram shows how electricity is distributed around the UK.



(i) Which of the parts labelled in the diagram form the National Grid?

_____

(1)

(ii) A step-up transformer is used near the power station.

Draw a ring around the correct answer in each box to complete each sentence.

A step-up transformer increases the

current.
power.
voltage.

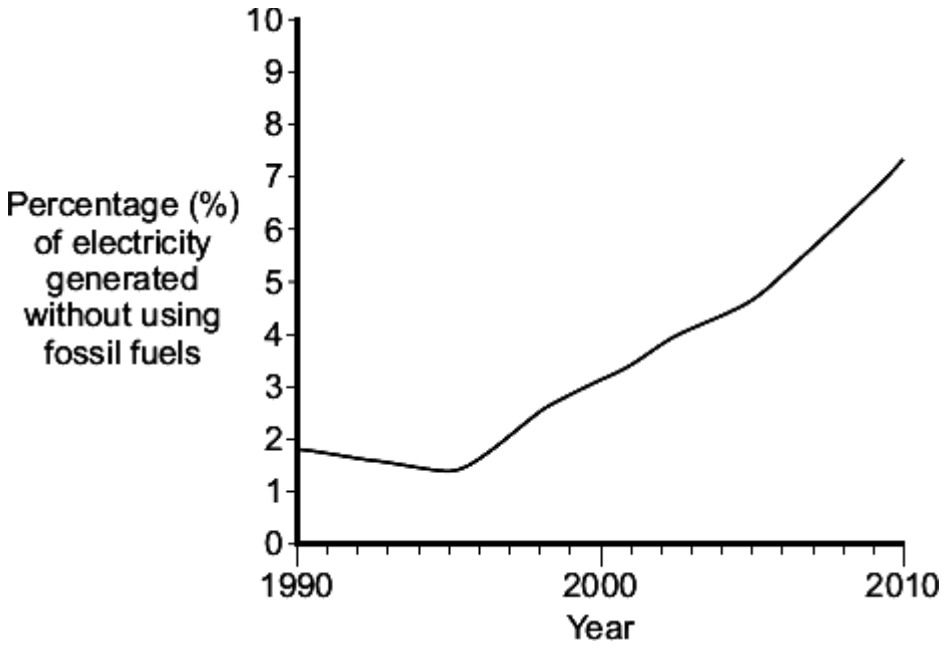
Using a step-up transformer makes the distribution of electricity

less dangerous.
more efficient.
work faster.

(2)

(c) Electricity in the UK is also generated without using fossil fuels.

The graph shows how the percentage of electricity generated in the UK without using fossil fuels changed between 1990 and 2010.



What does the data in the graph suggest will probably happen to the percentage of electricity generated in the UK without using fossil fuels over the next 10 years?

_____

_____

(1)

(Total 5 marks)

Q34.

(a) Geothermal energy and the energy of falling water are two resources used to generate electricity.

(i) What is geothermal energy?

_____

_____

(1)

(ii) Hydroelectric systems generate electricity using the energy of falling water.

A pumped storage hydroelectric system can also be used as a way of storing energy for future use.

Explain how.

_____

_____

(2)

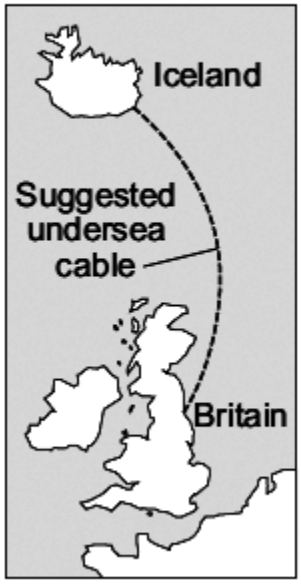
(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Read the following extract from a newspaper.

Britain may be switched on by Iceland

Iceland is the only country in the world generating all of its electricity from a combination of geothermal and hydroelectric power stations. However, Iceland is using only a small fraction of its energy resources. It is estimated that using only these resources, the amount of electricity generated could be increased by up to four times.

To help supply the future demand for electricity in Britain, there are plans to build thousands of new offshore wind turbines. It has also been suggested that the National Grid in Britain could be linked to the electricity generating systems in Iceland. This would involve laying a 700 mile undersea electricity cable between Iceland and Britain.



Discuss the advantages and disadvantages of the plan to build thousands of offshore wind turbines around Britain **and** the suggested electricity power link between Britain and Iceland.

(6)

(Total 9 marks)

Q35.

A farmer has installed a biogas electricity generator on his farm. This device generates electricity by burning the methane gas produced from rotting animal waste. Methane is a greenhouse gas. When methane burns, carbon dioxide and water are produced.

The animal waste rots in an anaerobic digester. The digester and the generator are kept inside a farm building and cannot be seen from the outside.

(a) The animal waste used in the anaerobic digester is a *renewable* energy source.

What is meant by an energy source being *renewable*?

(1)

(b) Suggest **one** reason why farmers have been encouraged to install their own biogas generators.

(1)

(c) The farmer's monthly electricity bill using the mains electricity supply was £300. The biogas generator cost the farmer £18 000 to buy and install.

Assuming the biogas generator provides all of the farmer's electricity, what is the pay-back time for the generator?

_____

Pay-back time = _____

(1)

(d) It would have been cheaper for the farmer to have bought and installed a small wind turbine.

Give **two** advantages of using the biogas generator rather than a wind turbine, to generate the electricity used on the farm.

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)

Mark schemes

Q1.

(a) higher

1

(b) low(er)

1

hot(ter)

allow warm(er)

1

(c) advantage:

- water heated continuously (by the Sun)

1

one disadvantage from:

- temperature of water is lower (for most of the time than water heated by immersion heater)
- water may not be hot enough

allow less control over water temperature

- it takes longer to heat the water

1

(d) $\frac{4\,030\,000}{4\,070\,000}$

1

0.99

*an answer of 99% scores **2** marks*

*an answer of 99 or 0.99% scores **1** mark*

1

*an answer of 0.99 scores **2** marks*
*allow an answer that rounds to 0.99 for **2** marks*

(e) power = energy transferred / time

allow P = E / t

1

(f) $5000 = \frac{4\,070\,000}{t}$

1

$t = \frac{4\,070\,000}{5000}$

1

t = 814

1

seconds

other units of time must be consistent with numerical value

1

*an answer of 814 seconds scores **4** marks*

*an answer of 13.57 minutes scores **4** marks*

[12]

Q2.

(a) nucleus

1

neutron

1

gamma rays

1

in this order only

(b) $\frac{25\,000\,000}{2\,400\,000}$

1

11

*an answer of 10.4 with no working scores **1** mark*

1

*an answer of 11 scores **2** marks*

(c) any **two** from:

- waste is radioactive

  allow nuclear waste

- waste has a long half-life

  allow waste remains dangerous for a long time

- waste is toxic
- waste needs to be buried

  allow waste is difficult to dispose of

- risk of catastrophic accidents

  allow named accident e.g. Fukushima, Chernobyl, Three Mile Island

- fuel is non-renewable

2

(d) **similarity:**
(carbon dioxide concentration and global temperature have) both increased

allow they both show a positive correlation

1

difference:
the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off

allow carbon dioxide (concentration) increases more quickly than temperature (increase)

1

[9]

Q3.

(a) any **three** from:

- no carbon dioxide emitted (to produce electricity)

  no greenhouse gases is insufficient

- doesn't cause global warming

  allow climate change or greenhouse effect for global warming

- nuclear power doesn't cause earthquakes
- more energy released per kg of fuel (compared to shale gas)

3

(b) uranium
or
plutonium

ignore any numbers given

1

(c) a neutron is absorbed by a (large) nucleus

a description in terms of only atoms negates first two marking points

1

the nucleus splits into two (smaller) nuclei

1

releasing energy (and gamma rays)

1

and (two / three) neutrons

1

[8]

Q4.

(a) minimum distance between wind turbines is at least 500 m in all directions

turbines can rotate to face into wind and still maintain the

minimum distance

1

(b) density = mass/volume

allow ρ = m / V

1

(c) $1.2 = \frac{51000}{V}$

1

$V = \frac{51000}{1.2}$

1

V = 42 500

1

V = 43 000

1

m^3

*an answer of 43 000 scores **4** marks*
*an answer of 42 500 scores **3** marks*

1

(d) $2.4 \times 10^9 / 1.6 \times 10^6$

1

1500

*an answer of 1500 scores **2** marks*

1

(e) wind power is unreliable

1

(very) large numbers of wind turbines would need to be constructed

allow calculation of this (15 625)

1

[11]

Q5.

(a)

Level 2: Relevant reasons are identified, given in detail and logically linked to form a clear account.	3-4
Level 1: Relevant reasons are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1-2
No relevant content	0

Indicative content **nuclear** • no carbon dioxide released (when generating electricity) **or** doesn't release greenhouse gases • reliable • high energy density • power stations already built • other power stations being built **wind** • no carbon dioxide released (when generating electricity) **or** doesn't release greenhouse gases • renewable energy resource • no fuel cost	

4

(b) wind power is unreliable

1

(so) will be unable to meet demand when wind speed is low
or
when there is no wind
or
unable to maintain base load at all times

1

(c) electricity generation will need to increase (to meet higher demand)

1

(using)
nuclear power
or
wind power
or
other renewables

1

so that carbon dioxide emissions don't increase
or
reference to Paris Climate agreement

1

[9]

Q6.

(a) any **two** from:

- nuclear
- oil

- (natural) gas

2

(b) 4 (hours)

1

(c) a system of cables and transformers

1

(d) The power output of wind turbines is unpredictable

1

(e) 1500 / 0.6

1

2500 (wind turbines)

1

*allow 2500 with no working shown for **2** marks*

(f) Most energy resources have negative environmental effects.

1

[8]

Q7.

(a) power output increases (to meet demand) due to people returning home from work / school

accept many electrical appliances are switched on (which increases demand)

1

accept other sensible suggestions

(b) 00.00

accept midnight

1

allow answers between 00.00 and 04.00

(c) any **two** from:

- conserves fuel reserves
- spare capacity to compensate for unreliable renewable resources
- provides spare capacity in case of power station emergency shut-down
- so as to not make unnecessary environmental impact

2

[4]

Q8.

(a) geothermal

1

nuclear

1

biofuel

1

(b) gravitational (potential)

1

kinetic

1

sound

1

(c) (i) 90% or 0.9(0)

*an answer of 0.9(0) with a unit gains **1** mark*

2

(ii) 60 (MW)

allow 10%

1

(iii) increased

1

[10]

Q9.

(a) any **one** from:

- high cost of installing overhead power lines or underground cables or pylons
- high cost as (very) long cables needed
- amount of electricity required is too low

allow not enough (surplus) electricity would be generated

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
clear comparison of advantages **and** disadvantages of **each** method

Level 2 (3 – 4 marks):
at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method

Level 1 (1 – 2 marks):
at least **one** advantage **or one** disadvantage of either method

Level 0 (0 marks):
No relevant information

examples of physics points made in the response

Advantages of both methods:
- both renewable sources of energy
- both have no fuel (cost)
- both have very small (allow 'no') running costs
- no carbon dioxide produced

accept carbon neutral

accept no greenhouse gases

accept doesn't contribute to global warming

Advantages of wind:
- higher average power output

produces more energy is insufficient

Advantages of hydroelectric:
- constant / reliable power (output)
- lower (installation) cost

Disadvantages of wind:
- higher (installation) cost
- variable / unreliable power output
- (may) kill birds / bats

Disadvantages of hydroelectric:
- lower power output
- (may) kill fish or (may) damage habitats
- more difficult to set up (within river)

Disadvantages of both methods:
- (may be) noisy
- visual pollution

ignore payback time unless no other relevant points made

ignore time to build for both

6

[7]

Q10.

(a) any **two** from:

- cost per kWh is lower (than all other energy resources)

allow it is cheaper

ignore fuel cost

ignore energy released per kg of nuclear fuel

- infrastructure for nuclear power already exists

accept cost of setting up renewable energy resources is high

accept many renewable power stations would be needed to replace one nuclear power station

accept (France in 2011 already had a) surplus of nuclear

energy, so less need to develop more renewable capacity for increased demand in the future

accept France benefits economically from selling electricity

- more reliable (than renewable energy resources)

  accept (nuclear) fuel is readily available

  ignore destruction of habitats for renewables

2

(b) any **two** from:

- non-renewable

  allow nuclear fuel is running out

- high decommissioning costs

  accept high commissioning costs

- produces radioactive / nuclear waste

  allow waste has a long half-life

- long start-up time

- nuclear accidents have widespread implications

  allow for nuclear accident a named nuclear accident

  eg Fukushima, Chernobyl

  ignore visual pollution

2

(c) 0.48 (kW)

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

ie 0.15 = P / 3.2

*an answer of 480 W gains **2** marks*

*an answer of 48 or 480 scores **1** mark*

2

(d) the higher the efficiency, the higher the cost (per m^2 to manufacture)

accept a specific numerical example

1

more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels

or

(reducing the cost) allows more solar panels to be bought

accept a specific numerical example

1

[8]

Q11.

(a) (i) high levels of infrared radiation (from the Sun)

allow lots of (solar) energy (available)

*do **not** accept 'heat' for infrared*

'it is hot' is insufficient

'lots of sunlight' is insufficient

1

(ii) reflected

1

(iii) boiler

correct order only

1

turbine

1

transformer

1

(b) 2 100 000 (kWh)

*allow **1** mark for correct substitution i.e. 140 000 × 15 provided no subsequent step*

2

(c) (i) only 1 wind turbine was considered

accept only one location is considered

1

or

other wind turbines may have generated more electricity

accept insufficient sample size

only 1 week's weather was reported on

or

wind speed varies from one week to another

'wind speed varies' is insufficient

1

(ii) any **one** from:

- wind speed is too high / low

  allow no wind

  allow too windy
- wind is unreliable.

  allow wind is variable

1

(iii) any **one** from:

- wind is a renewable energy source
- do not use fuel
- energy source is free
- do not release carbon dioxide
- do not release greenhouse gases
- do not release sulfur dioxide

- do not cause acid rain
- do not cause climate change
- do not cause global warming
- do not cause global dimming.

answer must be an advantage of wind, converse answers in terms of fossil fuels are insufficient

accept do not release pollutant gases

'no pollution' is insufficient

1

[11]

Q12.

(a) (i) infrared (radiation)

accept IR (radiation)

1

(ii) (heated) water turns to steam

ignore reference to fossil fuels

*do **not** accept water evaporates to steam*

1

steam turns a turbine

1

turbine turns a generator

accept turbine connected to a generator

1

(b) (i) (so the molten salts) can store large amounts of energy

accept there is a small temperature change for a large energy transfer

accept heat for energy

1

(ii) 16 (hours)

*an answer that rounds to 16 gains **2** marks eg 15.71*

*allow **1** mark for a correct substitution ie 2 200 000 = 140 000 × t*

3

(iii) the number of daylight hours varies

less sunlight is insufficient

1

the (mean) power (received from the Sun per square metre) varies

*accept an answer in terms of maximum possible electrical output only possible during Summer for **1** mark*

1

(c) (i) non-renewable power stations have higher Capacity Factors than

renewable power stations

1

fuel (for non-renewable power stations) is always available

reference to non-renewable power stations operating all the time is insufficient
non-renewable energy sources are reliable is insufficient

1

(most) renewable energy sources are unpredictable / unreliable

accept (most) renewable energy sources depend on the weather

1

(ii) the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources)

1

[14]

Q13.

(a) (i) <u>water</u>

1

heated

accept boiled or turned to steam
*do **not** accept evaporated*

1

<u>generator</u>

1

(ii) geothermal power stations provide a reliable source of electricity

1

(b) falling water

1

[5]

Q14.

(a) advantage

any **one** from:

- produce no / little greenhouse gases / carbon dioxide

allow produces no / little polluting gases
allow doesn't contribute to global warming / climate change
allow produce no acid rain / sulphur dioxide
reference to atmospheric pollution is insufficient
produce no harmful gases is insufficient

- high(er) energy density in fuel

  accept one nuclear power station produces as much power as several gas power stations

  nuclear power stations can supply a lot of or more energy is insufficient
- long(er) operating life

  allow saves using reserves of fossil fuels or gas

1

disadvantage

any **one** from:

- produce (long term) radioactive waste

  accept waste is toxic

  accept nuclear for radioactive
- accidents at nuclear power stations may have far reaching or long term consequences
- high(er) decommissioning costs

  accept high(er) building costs
- long(er) start up time

1

(b) (i) 12 000 (kWh)

*allow **1** mark for correct substitution eg*

2000 × 6

or

2 000 000 × 6

or

$$\frac{12\,000\,000}{1000}$$

*an answer of 12 000 000 scores **1** mark*

2

(ii) any idea of unreliability, eg

- wind is unreliable

  reference to weather alone is insufficient
- shut down if wind too strong / weak
- wind is variable

1

(c) any **one** from:

- cannot be seen
- no hazard to (low flying) aircraft / helicopters
- unlikely to be or not damaged / affected by (severe) weather

  unlikely to be damaged is insufficient
- (normally) no / reduced shock hazard

safer is insufficient
less maintenance is insufficient
installed in urban areas is insufficient

1

[6]

Q15.

(a) water moves (from a higher level to a lower level)

1

transferring GPE to KE

1

rotating a turbine to turn a generator

accept driving or turning or spinning for rotating
moving is insufficient

1

transferring KE to electrical energy

*transferring GPE to electrical energy gains **1** mark of the **2** marks available for energy transfers*

1

(b) (TVs in stand-by) use electricity

accept power / energy

1

generating electricity (from fossil fuels) produces CO_2

accept greenhouse gas
accept sulfur dioxide

1

(CO_2) contributes to global warming

accept climate change for global warming
accept greenhouse effect if CO_2 given
accept acid rain if linked to sulfur dioxide

1

(c) a factor other than scientific is given, eg economic, political or legal

personal choice is insufficient

1

[8]

Q16.

(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 × 0.4(0) 150 × 40*

*allow ecf from **(c)(i)***

2

(iii) 25 (years)

an answer of 6000 / 240
or
*6000 / their **(c)(ii)** × 4*
*gains **2** marks*

an answer of 6000 / 60
or
*6000 / 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]

Q17.

(a) (i) 77

1

(ii) Oil

1

(b) water

accept H_2O

1

(c) Carbon dioxide causes global warming

1

[4]

Q18.

(a) (i) changing the distance may / will affect / change the voltmeter reading

accept so only one independent variable
accept distance affects speed of wind (turbine)
accept it is a control variable
accept to give valid results
fair test is insufficient
to make the results accurate is insufficient

1

(ii) any sensible practical suggestions, eg

- so fan reaches a steady / full speed
  accept power for speed
- so wind (turbine) reaches a steady / full speed
- so voltmeter reaches / gives a steady reading
  accept accurate or valid reading a correct reading is insufficient
  *do **not** accept precise reading*

1

(iii) as the number of blades increases so does the (voltmeter) reading / output / voltage

number of blades affects the reading / output is insufficient

1

further relevant detail, eg

- voltmeter increase is greatest up to 3 blades
- voltmeter reading hardly changes with 4, 5 or 6 blades
  accept does not change between 4 and 6 blades

- increase is directly proportional up to 3 blades
- it reaches a limit
  accept does not change after 4 / 5 blades
- a numerical example giving two pairs of numbers, eg 2 blades = 0.6V, 4 blades = 1V

1

(b) C

reason scores only if C is chosen

1

wind speed / strength varies

*accept wind is **not** constant / reliable*

1

[6]

Q19.

(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 CO_2 / SO_2 / 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

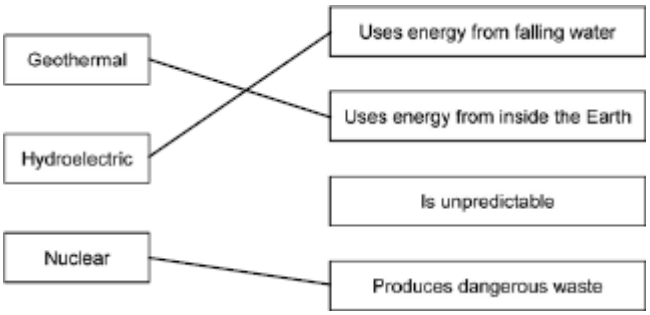
(ii) any **one** from:

- 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]

Q20.



*allow **1** mark for each correct line*
if more than one line goes from an energy source then all lines from that energy source are wrong

[3]

Q21.

(a) electrical

1

chemical

1

light

1

(b) 25% **or** 0.25
*allow **1** mark for correct substitution, ie 50 ÷ 200 provided no*

subsequent step shown
or
answers of 25 with a unit ***or*** *0.25 with a unit gain* ***1*** *mark*
answers of 25 without a unit ***or*** *0.25% gain* ***1*** *mark*

2

(c) the information board can be used anywhere it is needed

1

[6]

Q22.

(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]

Q23.

(a) any **three** from:

- gas can be switched on (and off) quickly but nuclear cannot
  gas has a short start-up time alone is insufficient
- gas can be used to meet surges in demand
  accept specific times from graph, anything from 1700 to 2200
- gas can contribute to / meet the base load
- nuclear provides base load
  or
  nuclear is used to generate all of the time

3

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief description of one advantage **or** disadvantage of using either biogas or wind
or
makes a conclusion with a reason.

Level 2 (3-4 marks)
There is a description of some advantages **and / or** disadvantages for biogas **and / or** wind
or
there is a direct comparison between the two systems **and** at least one advantage / disadvantage
or
a detailed evaluation of one system only with a conclusion.

Level 3 (5-6 marks)
There is a clear and detailed comparison of the two systems.

There must be a clear conclusion of which system would be best with at least one comparative reason given for the choice made.

Examples of the points made in the response

extra information

Biogas

- renewable
- energy resource is free
- reliable energy source
  accept works all of the time
- does not depend on the weather
- uses up (animal) waste products
- concentrated energy source
- cheaper (to buy and install)
  accept once only
- shorter payback-time (than wind)
- adds carbon dioxide to the atmosphere
  when waste burns it produces carbon dioxide is insufficient
- contributes to the greenhouse effect
  or
  contributes to global warming
- no transport cost for fuels

Wind turbine

- renewable
- energy resource is free
- not reliable
- depends on the weather / wind
- will be times when not enough electricity generated for the farm's needs
- dilute energy source
- longer payback-time (than biogas)
- more expensive (to buy and install)

accept once only

- does not produce any carbon dioxide
  accept does not pollute air
  accept pollutant gases for carbon dioxide
  produces visual or noise pollution is insufficient
  harmful gases is insufficient

6

[9]

Q24.

(a) (i) an unreliable energy source

1

(ii) a renewable energy source

1

(b) plant / grow (at least) one new tree

1

(c) greater than 4%

1

[4]

Q25.

(a) light

correct order only

1

electrical

1

(b) 0.2 or 1/5

accept 20% for both marks

*allow **1** mark for correct substitution ie* $\frac{35\,000}{175\,000}$

*answers of 0.2% **or** 20 gain **1** mark only*

2

(c) any **one** from:

- produces no (pollutant) gases
  or
  no greenhouse gases
  accept named gas
  accept no air pollution
  *do **not** accept no pollution*
  accept less global warming

accept harmful for pollutant
accept produces no carbon
*do **not** accept environmentally friendly*

- produces no / less noise
- less demand for fuels

accept any other sensible environmental advantage

1

[5]

Q26.

(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]

Q27.

(a) grid

accept any unambiguous indication

1

(b) (i) A (only)

1

(ii) D (only)

1

(c) less than

1

[4]

Q28.

(a) (i) correct data point identified (4, 0.96)

1

(ii) a decrease in

1

(b) (i) no / less atmospheric pollution

accept specific examples eg no CO_2 / greenhouse gases produced

accept no harmful gases / fumes
accept reduced pollution from transportation (of coal)
accept does not contribute to global warming
it / they refers to solar cells
*do **not** accept no / less pollution*
does not harm the environment is insufficient
it is a renewable energy source is insufficient

1

(ii) 8

*allow **1** mark for showing correct method ie* $\frac{7600}{950}$ *provided that no subsequent step is shown*

2

(iii) increase

1

(iv) ***these marks can score even if (b)(iii) is wrong***

less / no electricity generated
accept energy for electricity
accept reduced power / voltage output

1

(because) lower light intensity (hitting solar panel / cell)
or
so decreases money paid / gained (from selling electricity)
allow less light / sun (hitting solar panel / cell)

1

[8]

Q29.

(a) increases the voltage (across the cables)
or
decreases the current (through the cables)

1

reducing energy losses (in cables)
accept heat for energy
*do **not** accept electricity for energy*
*do **not** accept no energy loss*
accept wires do not get as hot
or
increases efficiency of (electricity / energy) transmission
ignore reference to travel faster

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1-2 marks)
There is a brief description of one advantage or disadvantage of using either overhead or underground cables.

Level 2 (3-4 marks)
There is a description of some of the advantages **and / or** disadvantages for both overhead and underground cables, with a minimum of three points made. There must be at least **one** point for each type of cable.

Level 3 (5-6 marks)
There is a clear and detailed description of the advantages and disadvantages of overhead **and** underground cables, with a minimum of five points made. At least one advantage and one disadvantage for each type of cable.

examples of the points made in the response

marks may be gained by linking an advantage for one type of cable with a disadvantage for the other type of cable

eg

overhead cables are easy to repair = 1 mark

overhead cables are easier to repair = 1 mark

overhead cables are easier to repair than underground cables = 2 marks

Overhead
Advantages

- (relatively) quick / easy to repair / maintain / access
  easy to install is insufficient
  *do **not** accept easy to spot / see a fault*
- less expensive to install / repair / maintain
  less expensive is insufficient
- cables cooled by the air
  accept thermal energy / heat removed by the air
- air acts as <u>electrical</u> insulator
  accept there is no need for electrical insulation (around the cables)
- can use thinner cables
  difficult to reach is insufficient

land beneath cables can still be used is insufficient

Disadvantages

- spoil the landscape
- greater risk of (fatal) electric shock
- damaged / affected by (severe) weather
  accept specific examples eg high winds, ice
  more maintenance is insufficient
- hazard to low flying aircraft / helicopters
  kites / fishing lines can touch them is insufficient
  hazard to aircraft is insufficient

Underground
Advantages

- cannot be seen
- no hazard to aircraft / helicopters
- unlikely to be / not damaged / affected by (severe) weather
  less maintenance is insufficient

(normally) no / reduced shock hazard
installed in urban areas is insufficient

Disadvantages

- repairs take longer / are more expensive
  accept harder to repair / maintain
  have to dig up for repairs is insufficient
- (more) difficult to access (cables)
  hard to locate (cables) is insufficient
  faults hard to find is insufficient
- (very) expensive to install
- thicker cables required
- need cooling systems
- need layers of electrical insulation
- land disruption (to lay cables)
  accept damage to environment / habitat(s)

or

cannot use land either side of cable path
accept restricted land use

6

(c) examples of acceptable responses:
*allow **1** mark for each correct point*

- closest to cables field from underground is stronger
- field from overhead cables stronger after 5 metres
- field from underground cables drops rapidly
- field from overhead cables does not drop much until after 20 metres
accept values between 20 and 30 inclusive
- overhead field drops to zero at / after 50 metres
- underground field drops to zero at / after 30 metres
- (strength of) field decreases with distance for <u>both</u> types of cable
if suitably amplified this may score both marks

2

(d) ethical

1

[11]

Q30.

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

- produces no (air / atmospheric) pollution
accept named pollutant eg CO_2
accept no harmful gases
accept produces no emissions
accept does not add to global warming
environmentally friendly is insufficient
- energy (source) is free
accept no fuel costs
accept the wind / it is free

1

(ii) any **one** from:

- waves
- tides

- falling water
  accept hydroelectric
  *do **not** accept water (flow)*
- solar
  accept Sun / sunlight
  accept solar panels / cells
- geothermal
- biofuel / biomass
  accept a named biofuel

1

(b) (i) 3000 (kilowatts)
accept 3 megawatts / MW
accept 3 000 000 watts / W

1

(ii) (average) wind speed below 6 m/s
answers giving a wind speed greater than 3 but less than 6 m/s gain both marks
*allow **1** mark for calculating the output as 500 kW (maximum)*
and
*allow **1** mark for wind speed too low or wind not strong enough*
*do **not** accept wind above 25 m/s*
*do **not** accept the turbines are frozen*

2

(iii) A small amount of nuclear fuel generates a large amount of electricity.
both required

Nuclear power stations do not depend on the weather to generate electricity.

1

[6]

Q31.

(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]

Q32.

(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*

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

*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]

Q33.

(a) gas (burning)

1

(b) (i) (transmission) cables and (step-up and step-down) transformers

if transformers are named ie step-up transformer then both step-up and step-down must be given

mention of power station or consumer negates mark

1

(ii) voltage

1

more efficient

1

(c) increase

1

[5]

Q34.

(a) (i) energy from hot rocks in the Earth

accept heat that occurs naturally in the Earth

accept steam / hot water rising to the Earth's surface

accept an answer in terms of the energy released by radioactive decay in the Earth

heat energy is insufficient

1

(ii) water is pumped / moved

1

up (to a higher reservoir)

this mark point only scores if first mark point is awarded

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1-2 marks)
There is a brief description of at least one advantage or disadvantage for either the planned wind turbines or the suggested electricity power link.

Level 2 (3-4 marks)
There is a description of advantages and disadvantages for either the planned wind turbines or the suggested electricity power link.
or
A description of the advantages or disadvantages for both the planned wind turbines and the suggested electricity power link.

Level 3 (5-6 marks)
There is a clear and detailed description of at least one advantage and one disadvantage for both the planned wind turbines and suggested electricity power link.

examples of the points made in the response

Offshore wind turbines

advantages

- renewable (energy resource)
- low running costs
- energy is free
- no gas emissions (when in use)
  accept a named gas eg CO_2
  accept no fuel is burned
  accept less dependent on fossil fuels
- land is not used (up)

disadvantages

- unreliable – accept wind does not always blow
  ignore references to destroying or harming habitats

- hazard to birds / bats
- visual pollution – do not accept noise pollution
  *do **not** allow if clearly referring to onshore wind turbines*
  *do **not** accept spoils landscape*
- difficulty of linking turbines to the National Grid
- large initial cost
- difficult to erect / maintain
  accept a lot of maintenance needed
- CO_2 emissions in manufacture (of large number of turbines)

Suggested Link

advantages

- income for Iceland
- using Iceland's (available) energy (resources)
  accept using (Iceland's) renewable energy (resources)
  *do **not** accept reduce the amount of Iceland's wasted energy*
- provide electricity when wind does not blow / reliable
- provide electricity at times of peak demand
- even out fluctuations in supply
- excess electricity from Britain (windy days) to Iceland and used to pump water up to store energy
- Britain less dependent on fossil fuels
  accept Britain needs fewer (new) power stations
  accept conserves fossil fuels

disadvantages

- large initial cost
  accept expensive (to lay cables)
- power loss along a long cable
- (engineering) difficulties in laying / maintaining the cable
  accept difficult to repair (if damaged)

6

[10]

Q35.

(a) can be replaced as fast / faster than it is used

accept will not run out

can be used again negates this mark

1

(b) any **one** from:

- reduce demand on power stations / National Grid (system)
- to increase the amount of electricity generated (from renewable energy)
- to conserve fossil fuels

  accept use less fossil fuels
- plenty of animal waste / fuel (available)

  accept so animal waste can be used usefully
  accept to save money / sell the electricity
  produces less harmful gases / SO_2 is insufficient
  better for environment is insufficient

1

(c) 60 (months) / 5 (years)

ignore any unit given

1

(d) *answers must be in terms of the biogas generator*

any **two** from:

- reliable energy source
  or
  does not depend on the weather

  accept works all of the time
- uses up waste products

  accept animal waste readily available
- not visually polluting
- concentrated energy source
- quieter

  ignore it is renewable
  *do **not** accept generates more electricity (than wind turbine)*

2

[5]