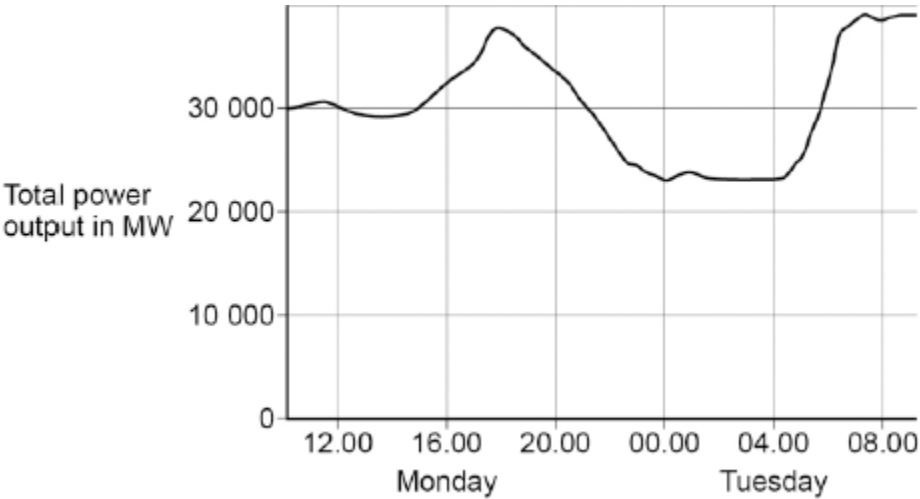


1

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.

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(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)

2

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.

.....

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.....

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.

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(1)

(Total 6 marks)

3

(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.

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(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.

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(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.

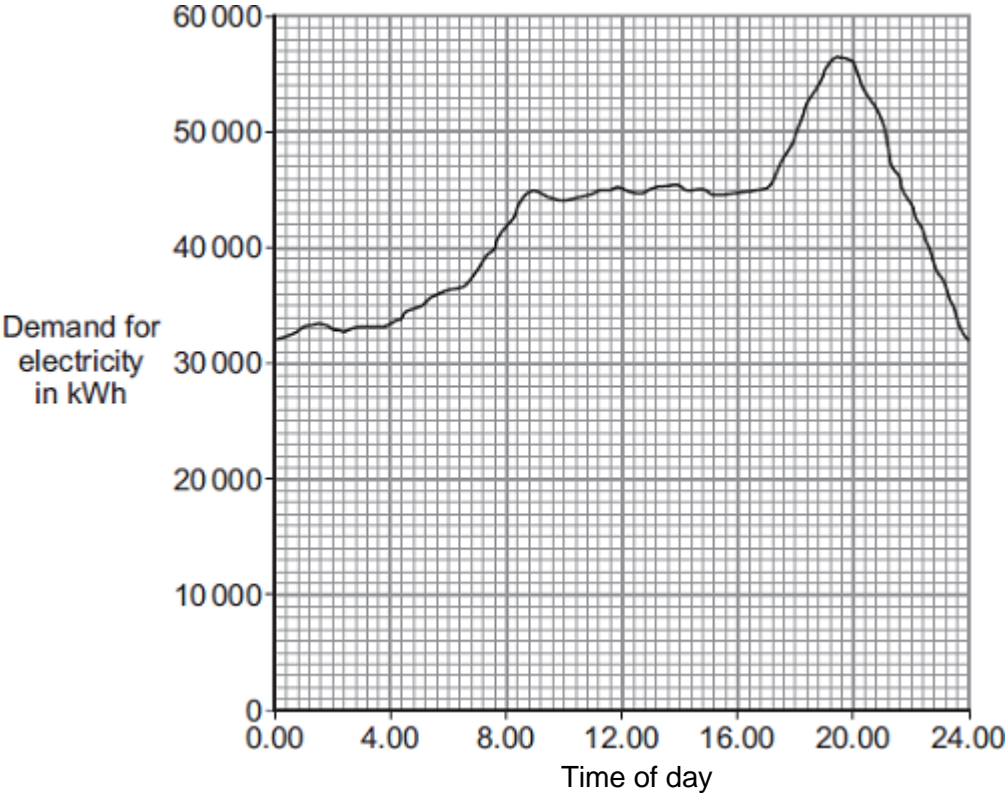
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(1)
(Total 8 marks)

4

(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?

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(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.

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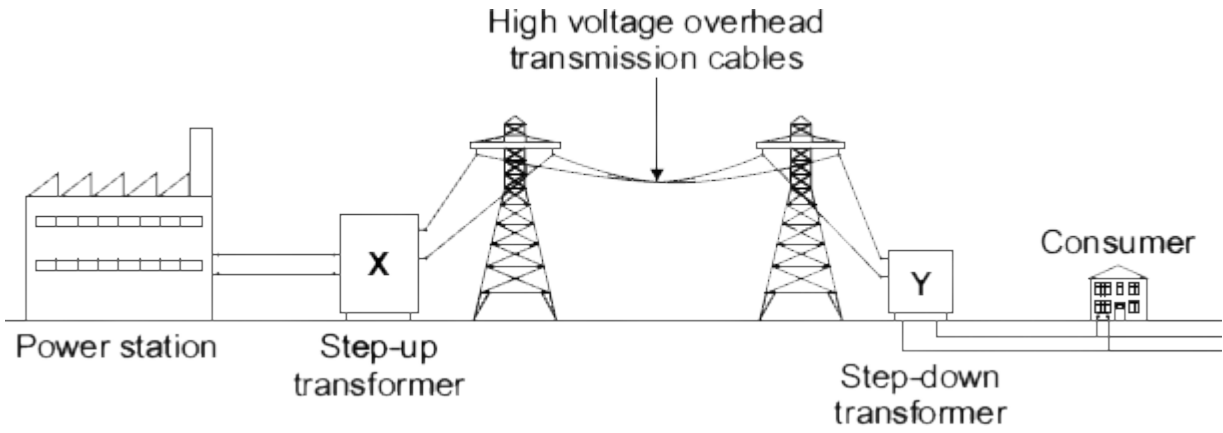
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(6)
(Total 9 marks)

5

The diagram shows the National Grid system.



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

Explain why.

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(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.

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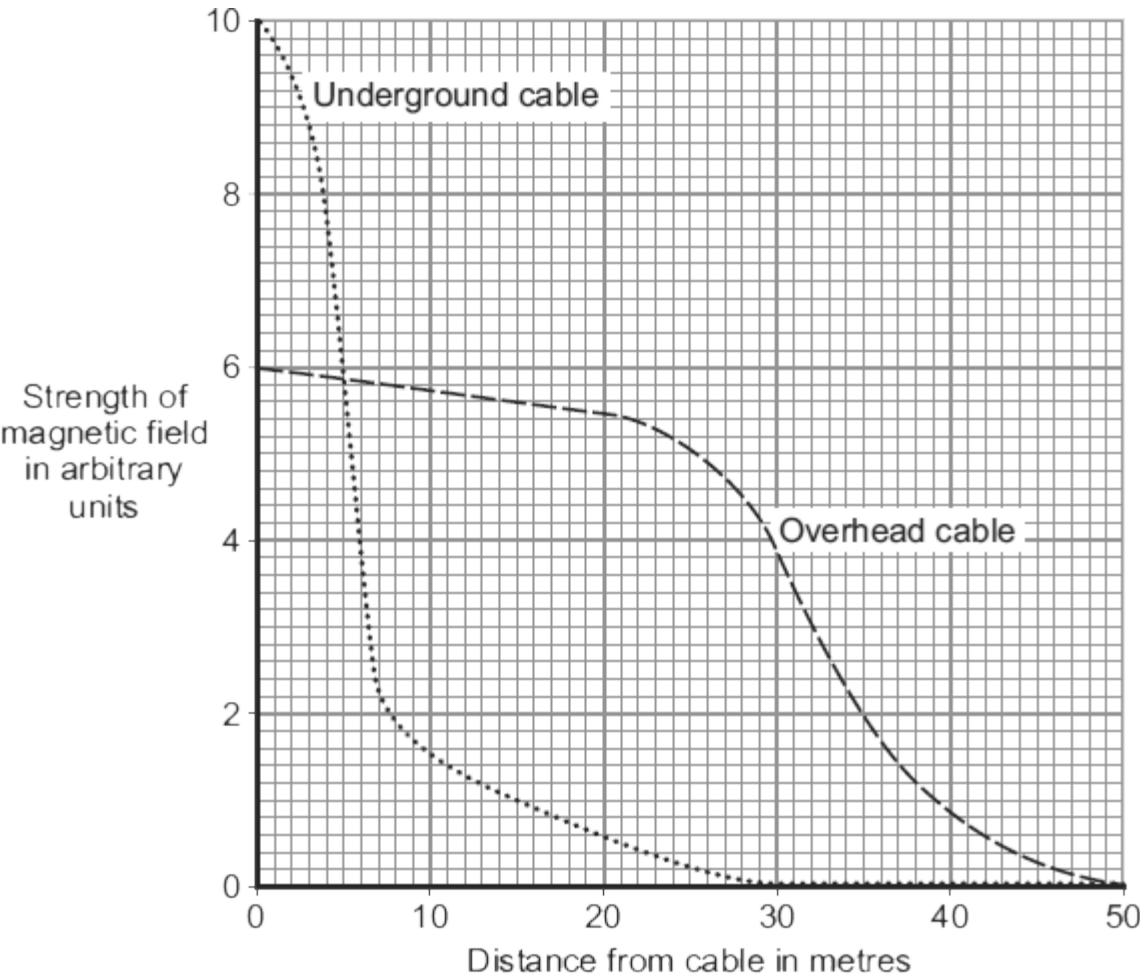
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(6)

(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?

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(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
ethical

 issues.

(1)
(Total 11 marks)

6

- (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.

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(2)

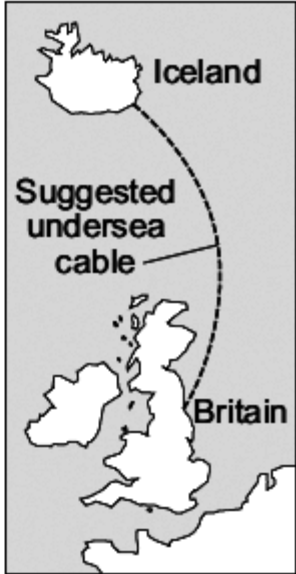
- (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

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.



The map shows the geographical locations of Iceland and Britain. Iceland is located in the North Atlantic, and Britain is to the southwest. A dashed line, labeled 'Suggested undersea cable', curves across the ocean between the two countries. The labels 'Iceland' and 'Britain' are placed next to their respective landmasses. The label 'Suggested undersea cable' has a line pointing to the dashed line.

7

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*?

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.....

(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
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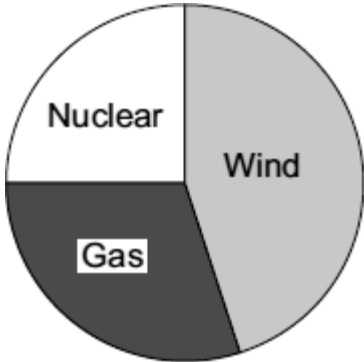
2
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(2)
(Total 5 marks)

8

(a) An electricity company claims to generate all of its electricity from environmentally friendly energy sources.

The energy sources used by the company are shown in the pie chart.



Do you think that the claim made by the company is correct?

Draw a ring around your answer.

Yes No Maybe

Explain the reasons for your answer.

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

(2)

(b) The government is committed to increasing the amount of electricity generated from renewable sources. A newspaper reported that:

More wind farms, wave powered generators, solar generators and nuclear power stations would need to be built

Why is the statement made in the newspaper incorrect?

.....
.....

(1)
(Total 3 marks)

9

(a) By 2023, nearly all of the existing nuclear power stations in the UK will be closed down.

(i) Before a nuclear power station can be demolished, the remaining nuclear fuel, radioactive waste materials and reactor must be carefully removed.

What is this process called?

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

decommissioning

decontaminating

dismantling

(1)

(ii) The workers are exposed to radiation as they remove the reactor. One of the biggest risks is from the isotope cobalt-60, which has a half-life of 5.3 years.

Explain the advantage of waiting 11 years after a nuclear power station has closed down before starting to remove the reactor.

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(2)

- (b) It is almost certain that new nuclear power stations will be built in the UK.

The table shows the results of surveys asking people in the UK whether they were in favour of, or against, the building of new nuclear power stations.

	2001	2005	2007
Percentage (%) in favour	20	41	65
Percentage (%) against	60	28	20
Percentage (%) not sure	20	31	15

- (i) From these surveys, how did public opinion on the building of new nuclear power stations change between 2001 and 2007?

.....
.....

(1)

- (ii) Suggest a reason why some people may think that the results from these surveys are unreliable.

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.....

(1)

- (iii) Give **one** reason in favour of building new nuclear power stations.

.....
.....

(1)

- (c) The government of one Middle Eastern country has decided to build its first nuclear power station. The oil that would have been used to generate electricity can then be sold to other countries.

On what is this decision based?

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

economic issues

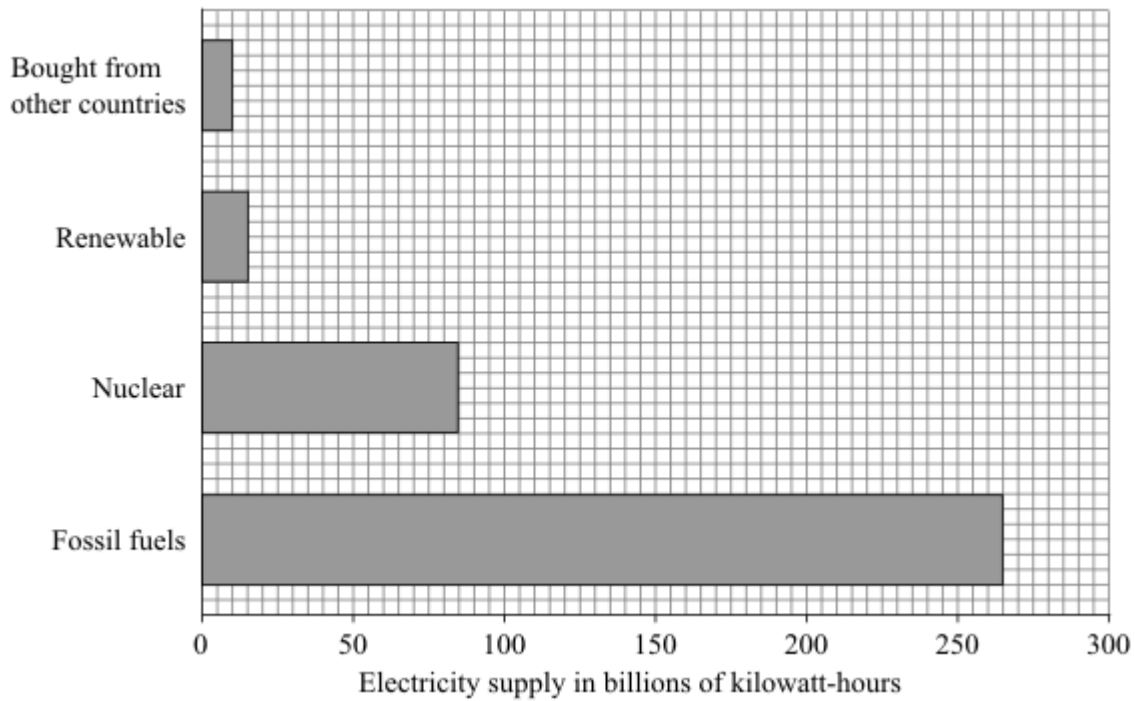
ethical issues

social issues

(1)
(Total 7 marks)

10

The bar chart shows how the UK's electricity demands in 2007 were met.



(a) What proportion of electricity was generated using renewable energy sources?

Show clearly how you work out your answer.

.....

.....

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.....

(2)

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

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

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

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

.....

Give a reason for your answer.

.....

.....

(2)

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

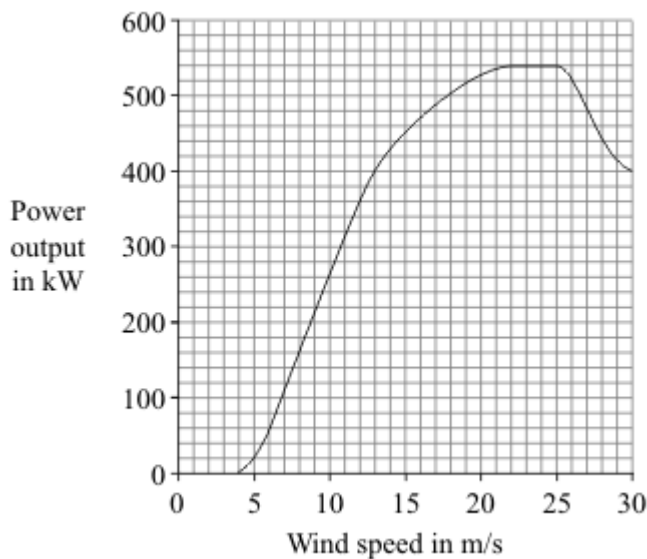
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(1)

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

The graph shows the power curve of a wind turbine.



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

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(3)

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

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(1)
(Total 9 marks)

11

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

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

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.....

(1)

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

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(2)

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

<ul style="list-style-type: none">• Researchers have found that children living close to overhead power cables are more likely to develop leukaemia.• The researchers studied two groups of children. One group had developed leukaemia, the other group was healthy.• Although the researchers found a link, they are unable to explain why it happened. They say that the results may have happened by chance.• Other factors that have not been investigated, such as the environment, the geographical area or the children's genes, could be important.• A cancer research charity said that childhood leukaemia was most likely to be caused by factors that parents were unable to control.
--

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

.....
.....

(1)

(ii) The information does not say how many children were studied.

Why should this data have been included in the article?

.....
.....

(1)

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

Explain why.

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.....

(2)

(iv) The results of the research carried out by scientists may worry some people.

What do you think scientists should do?

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

Scientists should publish their research findings straight away.

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

Give a reason for your choice.

.....
.....

(1)
(Total 8 marks)

12

(a) (i) A student wrote "Coal traps energy from the Sun". Explain what the student means.

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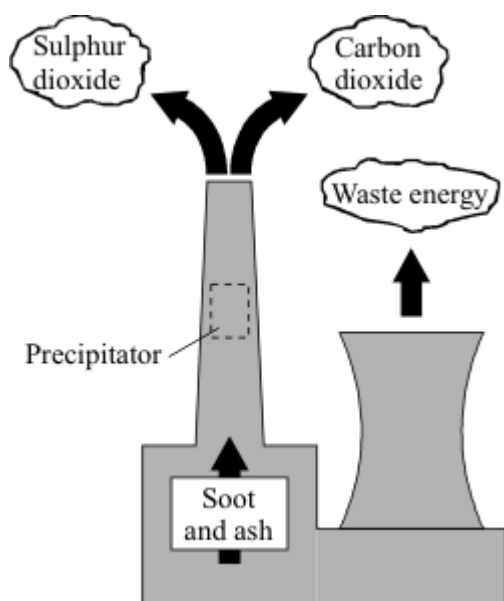
(2)

(ii) How is energy released from coal?

.....
.....

(1)

(b) The diagram shows the waste products from a coal-fired power station.



(i) In what form does the power station waste energy?

.....

(1)

(ii) Carbon dioxide released into the atmosphere will lead to a rise in the Earth's temperature. Why?

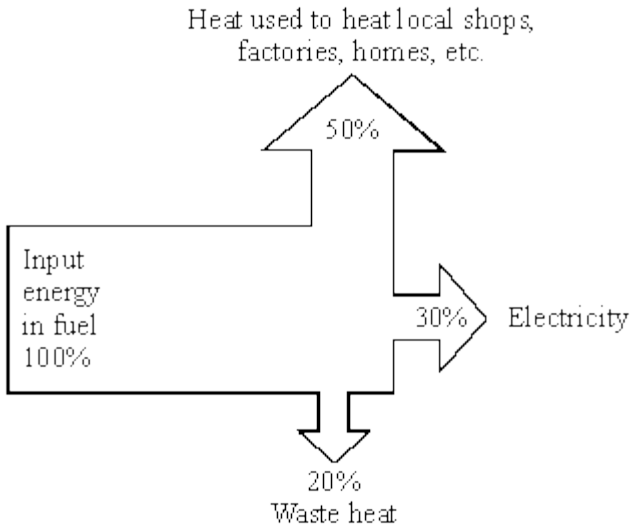
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(1)

(Total 5 marks)

13

In a traditional power station 30% of the energy input is usefully transferred to electricity, the rest is wasted as heat. The diagram shows the energy transfers in a combined heat and power (CHP) station.



Explain why replacing traditional power stations by CHP stations may be beneficial to the environment.

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(Total 2 marks)

14

(a) Coal, gas, oil and wood are all examples of fuels.

(i) What are fuels?

.....

(1)

- (ii) Write the names of these fuels in the table below to show which are renewable and which are non-renewable.

RENEWABLE FUELS	NON-RENEWABLE FUELS

(2)

- (b) The list below shows energy resources which are not fuels.

geothermal nuclear solar tides wind

Write the names of the energy resources in the table below to show which are renewable and which are non-renewable.

RENEWABLE FUELS	NON-RENEWABLE FUELS

(2)

(c) Why is it better to use more renewable energy resources rather than non-renewable resources?

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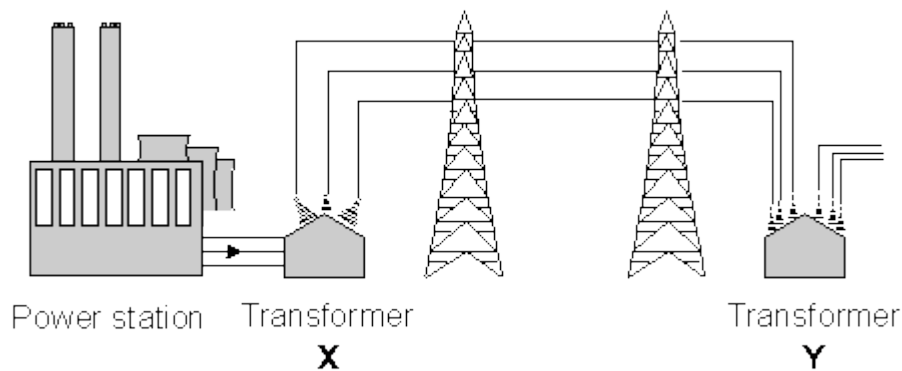
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(2)
(Total 7 marks)

15

The outline diagram below shows part of the National Grid. At **X** the transformer increases the voltage to a very high value. At **Y** the voltage is reduced to 240 V for use by consumers.



(i) At **X** a transformer increases the voltage. What happens to the current as the voltage is increased?

.....

(1)

(ii) Why is electrical energy transmitted at very high voltages?

.....

.....

(1)

(iii) The transformer at Y reduces the voltage before it is supplied to houses. Why is this done?

.....
.....

(1)
(Total 3 marks)

16

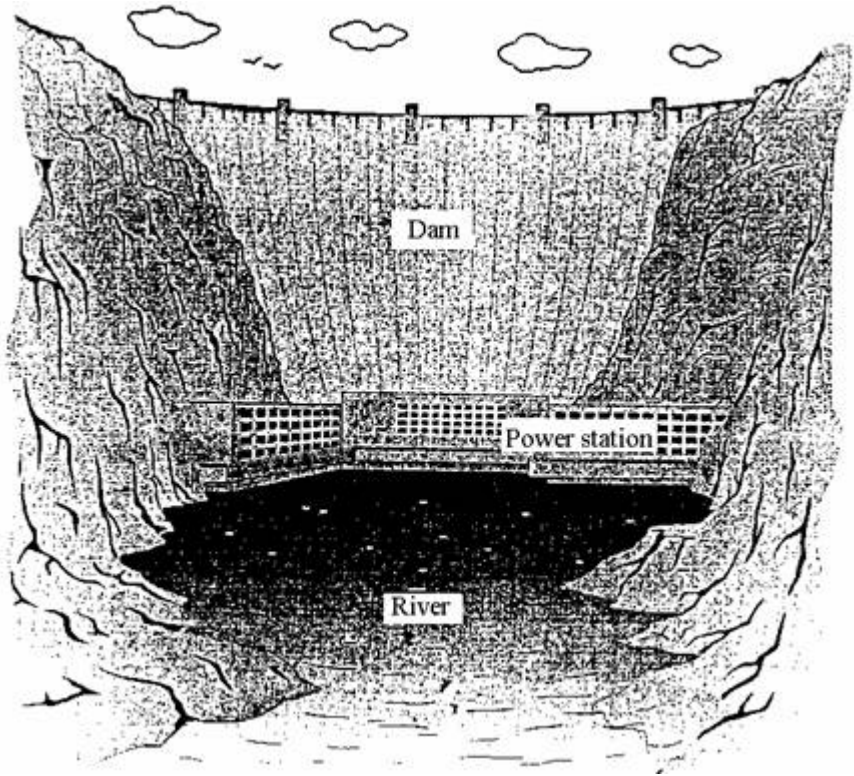
State and explain the advantages and disadvantages of using nuclear power stations to produce electricity.

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(Total 4 marks)

17

The drawing shows a hydro-electric dam. Water from the top of the dam flows through pipes to the power station at the bottom of the dam.



(a) Complete the following boxes to show the **useful** energy transfer which occurs as the water flows through the pipes **to** the power station.



(2)

(b) The electricity generated by the power station is transmitted over long distances. Before this happens its voltage is increased by using a step-up transformer.

State and explain **one** advantage and **one** disadvantage of transmitting electricity at high voltage.

Advantage

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(2)

Disadvantage

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(2)





(Total 6 marks)

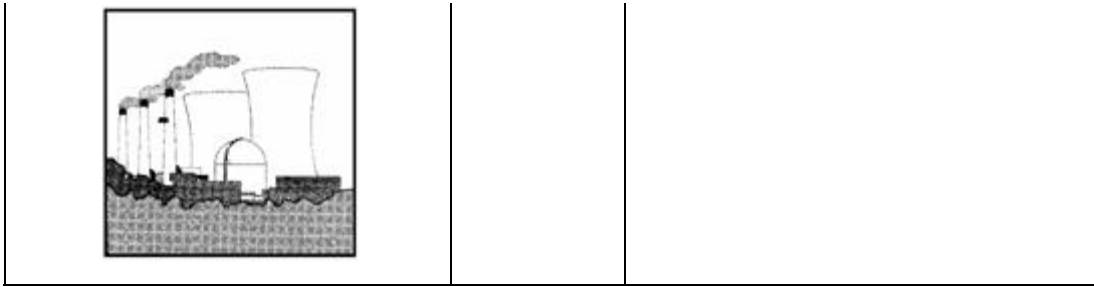
18

Electricity may be produced from a number of different energy resources.

(i) Complete the table below.

The first one has been done for you.

Device	Energy resource	Useful energy transfer from resource
Coal-fired power station 	Coal	Chemical → electrical
Hydroelectric power station 	Stored water → electrical
Solar cell in calculator 	Sun → electrical
Wind turbine 	Wind → electrical
Gas-fired power station	Gas → electrical



(4)

(ii) Give **one** of the five energy resources opposite, which is **not** classified as renewable.

.....

(1)

(iii) State another non-renewable energy resource.

.....

(1)

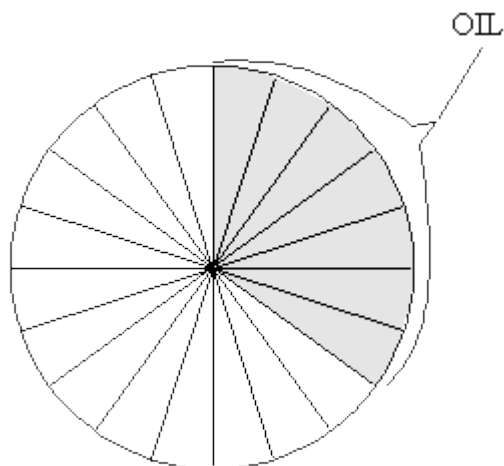
(Total 6 marks)

19

The table shows the main sources of energy used in Britain in 1990.

coal	35%
oil	35%
gas	24%
nuclear	5%
moving water (hydro)	1%

(a) Finish the pie-chart, using the figures in the table.



(4)

(b) Complete the following sentences.

To release energy from coal, gas and oil they must be burned.

Coal, gas and oil are all

(1)

(c) Which **one** of the energy sources in the table is renewable?

Write down the name of **one** other renewable energy source.

(2)

(d) How does the amount of energy obtained from nuclear sources in 1990 compare with the amount obtained from moving water?

.....

.....

(2)

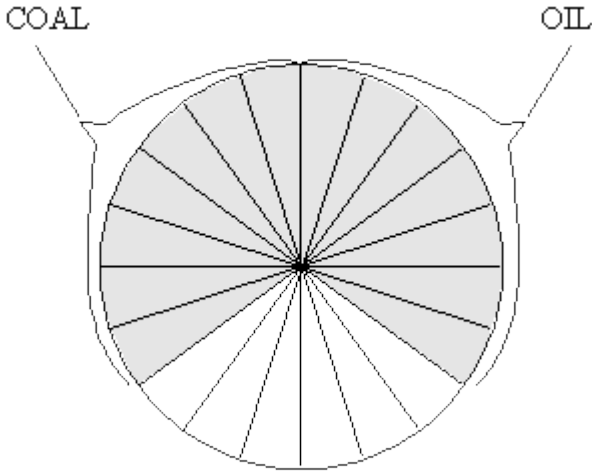
(Total 9 marks)

20

The table shows the main sources of the energy used in Britain in 1990.

coal	35%
oil	35%
gas	24%
nuclear	5%
moving water (hydro)	1%

(a) Finish the pie-chart, using the figures in the table.



(3)

(b) How does the amount of energy obtained from nuclear sources in 1990 compare with the amount obtained from moving water?

.....
.....

(1)

(c) Moving water (hydro) is a renewable energy source.

Write down the name of **one** other renewable energy source.

.....

(1)

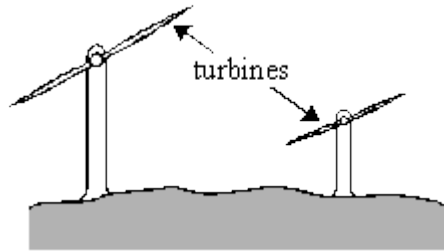
(d) Explain why electricity is **not** included in the table of energy sources.

.....
.....

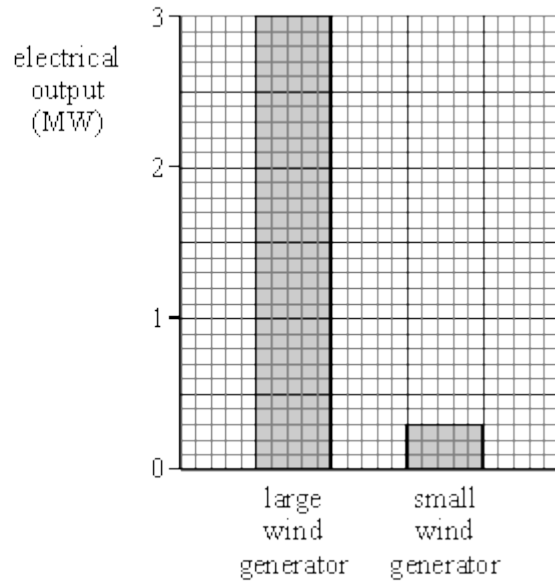
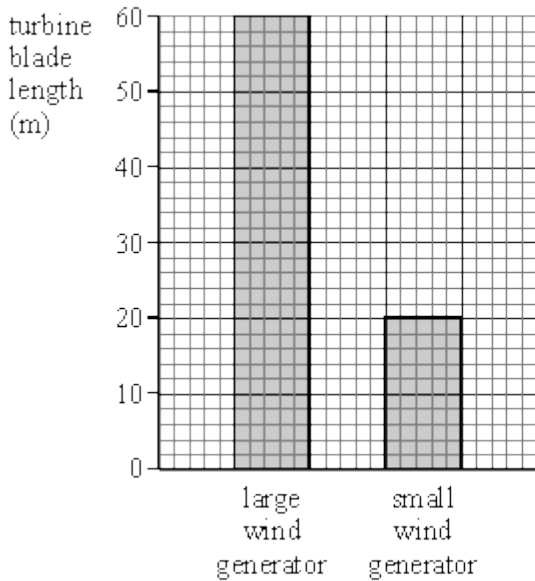
(1)
(Total 6 marks)

21

On a very windy hilltop there are two wind generators side by side.



The bar charts show the lengths of the turbine blades and the electrical outputs of the two wind generators.



Complete the following table.

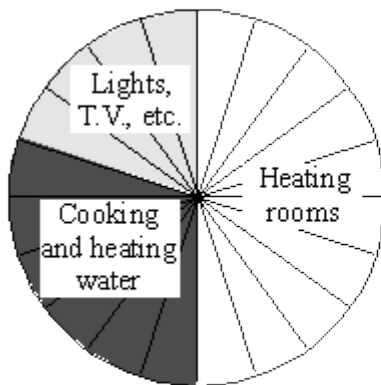
	LENGTH OF TURBINE BLADE (m)	ELECTRICAL OUTPUT (MW)
Large wind generator	60	
Small wind generator		

(Total 3 marks)

22

(a) The pie-chart shows how energy is used in a home.

Complete the table using the information on the pie-chart.

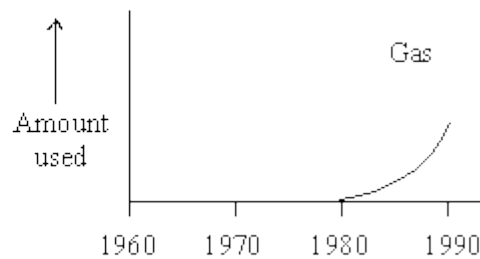
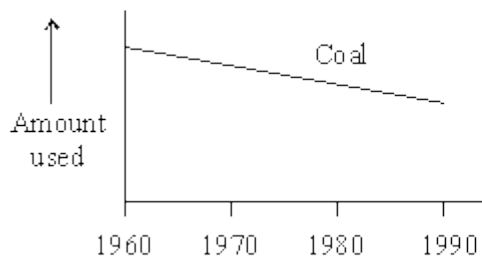


USE OF ENERGY	%
lights, T.V., etc.	20
cooking and heating water	
heating rooms	

(2)

(b) We get some of the energy we need in our homes from electricity.

The graphs show how the amounts of coal and gas used to generate electricity changed between 1960 and 1990.



Describe these changes.

Coal

.....

.....

Gas

.....

.....

(4)

(c) Read the information below.

- More carbon dioxide in the air may change the weather. Farmers may then not be able to produce the food we need.
- Burning coal produces sulphur dioxide. Burning gas does not do this.
- It is cheaper to generate electricity from gas than from coal.
- Sulphur dioxide causes acid rain which can kill fish and damage buildings.
- Two power stations generate the same amount of electricity. The one which burns gas produces less carbon dioxide than the other which burns coal.

Many people say that the change from coal to gas is better for the environment.

Why do you think they say this?

.....

.....

.....

.....

(3)
(Total 9 marks)

Mark schemes

1

- (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]

2

- (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

$$2000 \times 6$$

or

$$2\,000\,000 \times 6$$

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]

3

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

1

transferring GPE to KE	1
rotating a turbine to turn a generator <i>accept driving or turning or spinning for rotating moving is insufficient</i>	1
transferring KE to electrical energy <i>transferring GPE to electrical energy gains 1 mark of the 2 marks available for energy transfers</i>	1
(b) (TVs in stand-by) use electricity <i>accept power / energy</i>	1
generating electricity (from fossil fuels) produces CO ₂ <i>accept greenhouse gas accept sulfur dioxide</i>	1
(CO ₂) contributes to global warming <i>accept climate change for global warming accept greenhouse effect if CO₂ given accept acid rain if linked to sulfur dioxide</i>	1
(c) a factor other than scientific is given, eg economic, political or legal <i>personal choice is insufficient</i>	1

[8]

4

- (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]

5

- (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 electrical 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

(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 both types of cable
if suitably amplified this may score both marks

2

(d) ethical

1

[11]

6

(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 CO₂*
 - 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
- CO₂ 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]

7

- (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 / SO₂ 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]

8

(a) marks are awarded only for the reason but must match the ringed answer
for both marks a **MAYBE** answer should include a **YES** and **NO** response answers in terms of the sources being renewable or non-renewable are insufficient

any **two** from:

YES answers may include:

- wind produces no pollutant gases
accept wind burns no fuel
accept CO₂ / SO₂ / oxides of nitrogen / greenhouse gas for pollutant gases
- nuclear produces no pollutant gases
accept nuclear burns no fuel
- (burning) gas does not produce SO₂
accept gas does not cause acid rain
*do **not** accept they don't / none produce pollutant gases*

NO answers may include:

- nuclear produces radioactive waste
- (burning) gas produces CO₂ / pollutant gases / air pollution
accept contributes to global warming / greenhouse effect

2

(b) nuclear power stations use a non-renewable fuel
accept uranium / plutonium is non-renewable
*do **not** accept some are unrenewable*

1

[3]

9

(a) (i) decommissioning

1

(ii) level of radiation **or** radiation dose (to workers) decreased
accept the isotope / cobalt(-60) has decayed (a lot)
accept the isotope / cobalt(-60) has decayed in 2 half lives
accept exposed to less radiation
*do **not** accept no radiation left*

1

less hazardous / dangerous (to workers' health)

accept safer

*do **not** accept there is no hazard*

accept allows reactor to cool (down)

an answer of radiation levels decrease by 75 % or drops to 25 %

*gains **2** marks*

1

(b) (i) more in favour

or

fewer against

quoting figures alone is insufficient

*do **not** accept it increases*

ignore any reasons given

1

(ii) any **one** from:

- sample too small
- do not know how many (people) were asked
- different people asked (in different years)
- sample not representative (of population)
- people did not understand the questions
- do not know who carried out the surveys
*do **not** accept they are biased unless acceptable reason for bias given*
- do not know if surveys asked same questions

1

(iii) any **one** from:

- no / less pollutant gases produced
accept a named gas
accept does not contribute to global warming
- reliable source (of energy / electricity)
- running out of fossil fuels
accept a named fossil fuel
- conserve fossil fuels
accept fossil fuels won't have to be used
- meet increasing demand
- less reliance on imported fossil fuels / electricity
accept named fossil fuel
- concentrated energy source(s)
- lower transportation costs for fuel
- to replace old nuclear power stations
ignore references to efficiency / job creation / local economy / selling electricity

1

(c) economic issues

1

[7]

10

(a) 1/25 or 1:25 or 0.04

accept 4 % or $\frac{15}{375}$ or $\frac{3}{75}$ or 1 in 25 for both marks

allow 1 mark for total of 375

allow 1 mark for a clearly correct method using a clearly incorrect total

*do **not** accept 1:26*

2

(b) (i) **B**

do **not** credit reason if **B** is not chosen

1

(only) burning fossil fuels produces carbon dioxide / carbon (emissions)

or nuclear fuels don't produce carbon dioxide

insufficient – smallest amount of fossil fuels

accept less carbon dioxide

1

(ii) accept anything reasonable eg

increased level of insulation

use energy efficient light bulbs

do not leave appliances on standby

switch thermostats down (1°C)

generate own electricity

install solar panels

accept insulate

accept specific examples eg loft

1

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

- no power output until wind speed exceeds 4m/s
 - output rises rapidly after 4m/s
 - output begins to level out / rises less rapidly at / after 13m/s
 - output peaks at 21 / 22m/s
 - output constant between 21 / 22 and 25 / 26 m/s
 - output falls (rapidly) after 25 / 26m/s
- accept for 1 mark goes up then comes down*

3

(ii) any **one** from:

- unreliable energy source
- dilute energy source
- take up too much land
accept wind does not always blow
accept need thousands / lots of turbines
ignore reference to visual / noise pollution
ignore reference to kill birds

1

[9]

11

(a) (i) small proportion of energy / power is wasted
accept little / less energy / power / heat is wasted
*do **not** accept it wastes no energy / power*

or transfers most / more / a lot of energy power usefully

1

(ii) it decreases the current / uses low current

or *it* increases the voltage / potential difference
accept pd for potential difference

1

or uses high voltage / potential difference

smaller the current the smaller the energy loss
accept power / heat for energy

1

(b) (i) as a control

accept to make a comparison
*do **not** accept fair test on its own*

1

(ii) so people know how much data the link was based on
accept idea that larger numbers are better

or

people can judge the significance / reliability of the link
*do **not** accept significance / reliability on its own*
ignore reference to accuracy

1

- (iii) other possible factors may be responsible 1
- or** have not been investigated
- named factor eg environment / genetic 1
- (iv) first box ticked plus reason
- acceptable reason such as so people know there may be a risk as soon as possible / so that other scientists can use findings*
- or** second box plus reason
- acceptable reason such as no point to worry / confuse / panic people (until the research has been confirmed)*
- accept idea that it may lead to wrong advice*
- do **not** accept in case they are wrong* 1

[8]

12

- (a) (i) photosynthesis for growth
- accept plants require sunlight for growth* 1
- plants change into coal
- any mention of animals negates second mark* 1
- (ii) burning
- do **not** accept heating*
- accept combustion* 1
- (b) (i) heat 1
- (ii) less heat radiated into space
- accept increased insulation round earth*
- accept reflects heat back to earth*
- accept greenhouse effect*
- accept traps heat **or** energy* 1

[5]

13

any **one** from:

*basic idea of reduced use of fuels to heat homes **or** offices **or** shops for 1st mark*

less (heat) energy wasted (to the environment)

reduced demand for fuels to heat homes etc

simply re-quoting figures gets no credit

1

any **one** from:

idea of less pollution for the 2nd mark

reduced (air) pollution

*do **not** accept no pollution*

fewer power stations required **or** less electricity needs to be produced

less (fossil) fuels being burnt (in power stations)

reduced greenhouse effect

reduced global warming

1

[2]

14

(a) (i) sources of energy

for 1 mark

(ii) wood coal
 oil
 gas

all correct gains 2 marks

3 correct gains 1 mark

3

(b) geothermal nuclear

tides

wind

solar

all correct gains 2 marks

4 correct gains 1 mark

2

- (c) non-renewable fuels cause pollution (or reverse)
 conserve/limit use of coal/gas/oil;
 so supplies last longer/renewable sources can be replaced
any 2 from 4 for 1 mark each

2

[7]

15

- (i) reduces
for 1 mark

1

- (ii) less heat/energy/power wasted (in power lines)
for 1 mark

1

- (iii) for safety
for 1 mark

1

[3]

16

Read all the answer first. See below.

Mark the first two advantages and disadvantages (✓ or X) ignoring

neutral answers. Only allow a third advantage if there is only one disadvantage given. Only allow a third disadvantage if only one advantage is given.

max. 3 advantages (e.g. cheap fuel, good availability, saving fossil fuels, low running costs, reliable, more energy / kg, less fuel needed, no greenhouse gases emitted, no SO₂ causing acid rain)

max. 3 disadvantages (e.g. danger to health of local community, non renewable, high cost of decommissioning, long half life of waste materials, need for safe storage of waste, high cost of commissioning, danger involved in transporting fuel / waste)

max. 4 marks

[4]

17

(a) mark independently

(from) gravitational

*accept potential
do not credit stored*

1

(to) kinetic

accept movement

1

(b) **advantage**

* the current can be low (for the same power)

* less energy **or** heat loss **or** power loss

*accept the cables do not have to be (so) thick
accept less cost to support higher (rather than heavier) cables
accept aluminium can be used and aluminium is cheaper than copper
do not credit efficient **or** cheaper
do not credit no loss of energy
do not credit electricity loss*

2

disadvantage

* it is difficult to insulate high voltage

* pylons have to be taller and so more expensive

*...to give a good separation between them and the ground
/people/high vehicles
or ... to prevent/reduce the danger of electric shock **or** lethal
do not credit dangerous
do not credit get a shock
do not credit reference to step down transformers **or**
electromagnetic field*

2

[6]

18

- (i) gravitational **or** potential
do not accept stored 1

- light
credit solar 1

- kinetic **or** movement
credit moving 1

- chemical 1

- (ii) any **one** from
 - gas
 - coal1

- (iii) any **one** from
 - oil
*do not accept petrol **or** paraffin*
 - peat **or** turf
 - nuclear
*credit coal **or** gas if not given as answer to part (ii)*
*do not accept wood **or** fossil fuel **or** chemical*1

[6]

19

- (a) sectors nearer to correct value than to 1% either side

coal	35%
nuclear	5%
gas	24%
moving water	1%

*each for 1 mark -
to a maximum of 3 marks
deduct 1 mark if sector left blank*

three sectors labelled correctly w.r.t. rank order of size
for 1 mark

4

- (b) (fossil) fuels (*allow* combustible/flammable/non renewable) 1
- (c) moving water/hydro
wind/waves/tides/solar (*allow* geothermal/
wood/biomass)
each for 1 mark 2
- (d) any indication that we get more (energy from nuclear sources)
gains 1 mark
- but**
5 times as much/more
gains 2 marks 2
- [9]**

20

- (a) *sectors closer to correct value than $\pm 1\%$ nuclear (5%)*
gas 24% moving water 1%
each for 1 mark
maximum of 2 marks 3
- sectors labelled correctly w.r.t. rank order of size*
for 1 mark
- But** deduct 1 mark if not all sectors used
- (b) 5 x as much (do **not** credit simply more/4% more)
4 x as much 1
- (c) wind/waves/solar/tides
(allow geothermal/wood/biomass)
any one for 1 mark 1
- (d) *idea that*
electricity is a secondary/man made source/needs another
source to produce it
for 1 mark 1
- [6]**

21

20

3
0.3

each for 1 mark

[3]

22

- (a) cooking and heating water 30
heating rooms 50

each for 1 mark

2

- (b) coal
idea that amount used fell/declined/line goes down
gains 1 mark

but *idea that* fall/decline is steady/gradually/approx halved
gains 2 marks

gas
ideas that
amount used rose/increased
in/from 1980/more used before 1980/ref to 1980
as an important date/*rapid* increase in use
(*credit idea that* gas > coal from c.1990
in either part with 1 mark (to maximum 4)
each for 1 mark

max 4

- (c) • *less* carbon dioxide produced
- less change to weather/food production/gained warming/water levels (no mark for “greenhouse gas” alone)
- no/less sulphur dioxide produced/coal produces sulphur dioxide
- less acid rain/damage to fish/buildings/trees/crops/animals/tumours etc
(do not credit reference to cost unless : cheaper so can spend more on environment)
(“It” used in an answer will refer to “gas”) any 3 for 1 mark each

3

[9]