



Methods of generating electricity (Renewable v non-renewable) + national grid



155 minutes



155 marks

Q1. Use of renewable sources of energy is expected to increase. The table shows the comparative costs of producing 1 kWh of electricity from different energy sources.

Types of energy sources used in the UK	Cost of producing 1 kWh of electrical energy	
Fossil fuels (non-renewable)	Coal	1.0 p
	Gas	1.4 p
	Oil	1.5 p
Nuclear fuels (non-renewable)	Nuclear	0.9 p
Renewable	Hydroelectric	0.2 p
	Wind	0.9 p
Installation and decommissioning costs are not included		

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

Advantage	Disadvantage
Using fossil fuels	Using fossil fuels
Using nuclear fuels	Using nuclear fuels
Using renewable sources	Using renewable sources

(Total 6 marks)

Q2. (a) Water waves are a renewable energy source.

The government wants more electricity to be generated from renewable energy sources. Some people do not think this is a good idea.

What reasons could a government scientist give to show people that using more renewable energy sources is a good idea?

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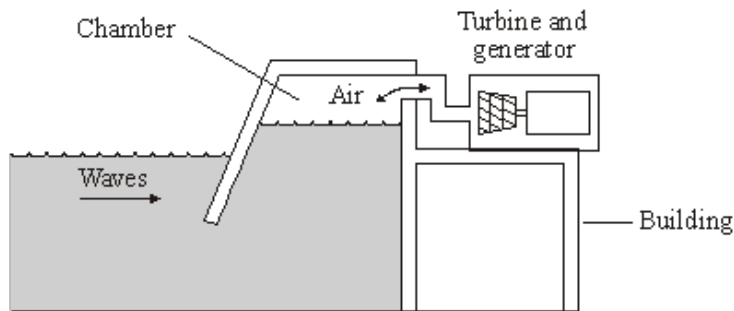
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(2)

(b) The diagram shows a wave-powered generator. The generator transforms kinetic energy from the waves to electrical energy.



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The following sentences describe how the wave generator works. The sentences are in the wrong order.

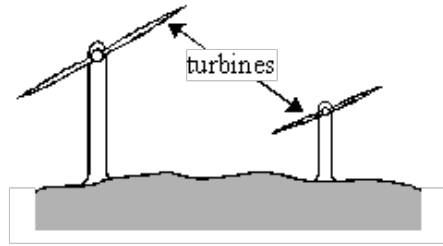
- R** Waves push air up and down a chamber inside the building.
- S** The turbine turns the generator.
- T** The generator transforms kinetic energy to electrical energy.
- U** The air rushes through a turbine making it spin.
- V** Strong waves move towards the wave-powered generator.

Arrange these sentences in the correct order. Start with letter **V**.

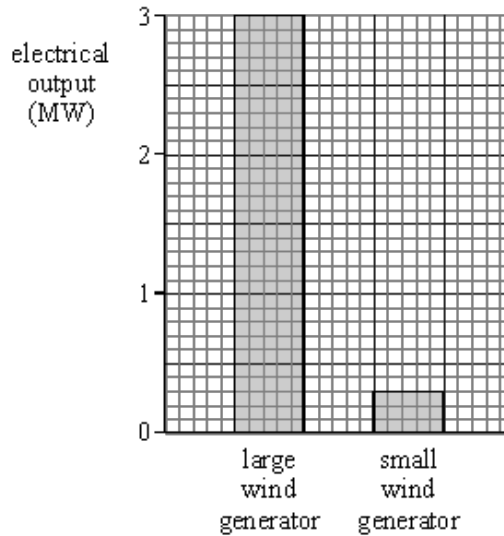
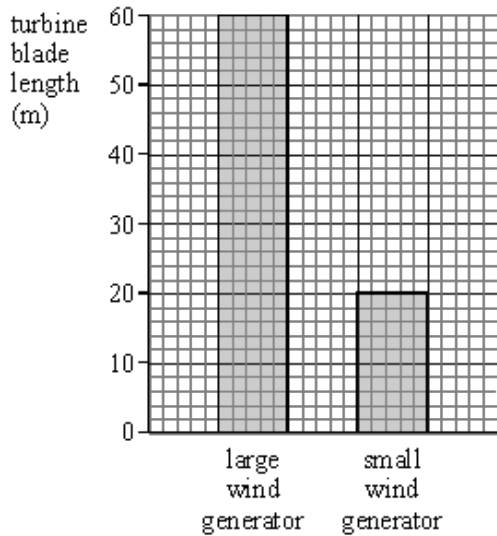


(3)
(Total 5 marks)

Q3. 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.

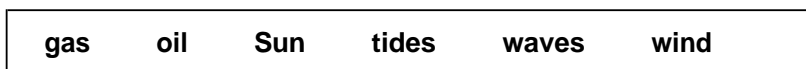
	LENGTH OF TURBINE BLADE (m)	ELECTRICAL OUTPUT (MW)
Large wind generator	60	
Small wind generator		

(Total 3 marks)

Q4. (a) Different energy sources are used to generate electricity.

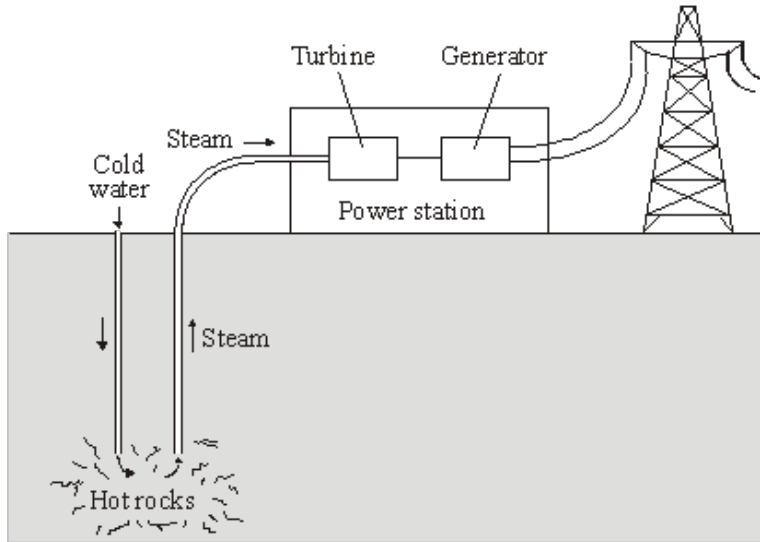
Which **two** of the energy sources in the box are likely to be used up first?

Draw a ring around each of your answers.



(2)

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

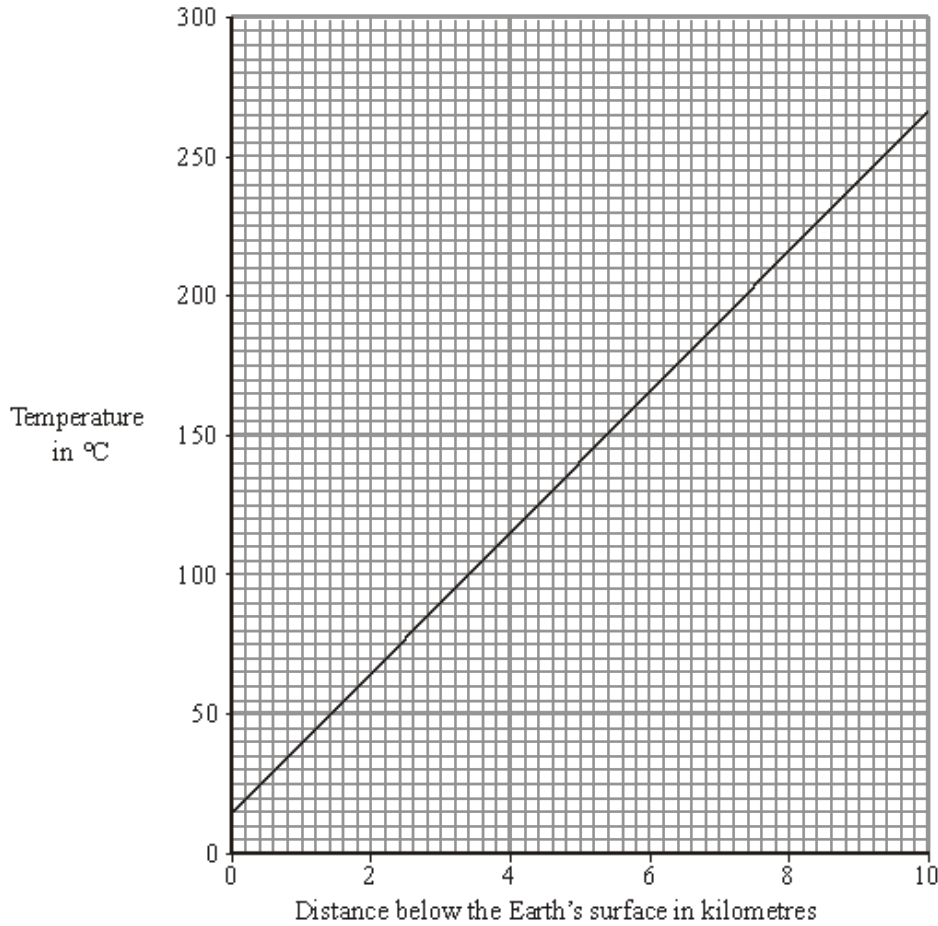


How is the way in which a geothermal power station generates electricity the same as the way in which a coal burning power station generates electricity?

.....
.....

(1)

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



Estimate the temperature of the rocks 5 kilometres below the Earth's surface.

Show clearly how you have used the graph to get your answer.

.....

Temperature = °C

(2)

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

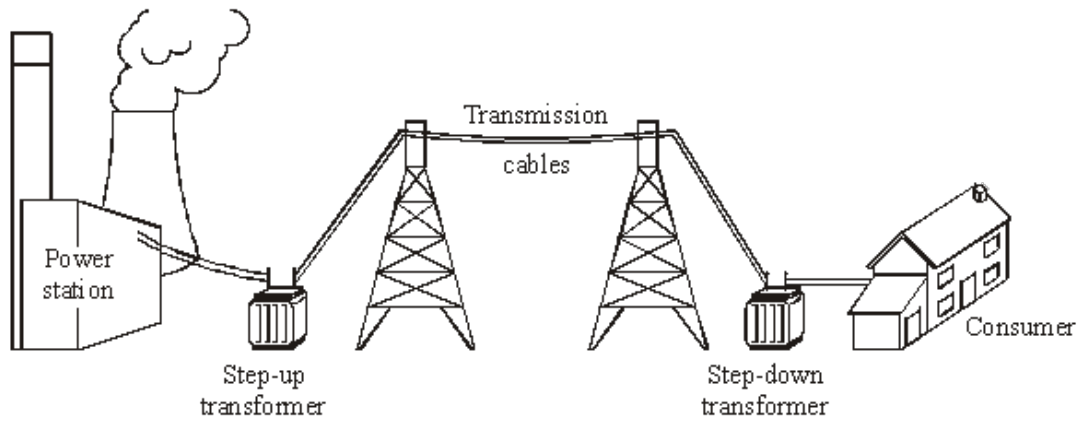
Give **one** reason that scientists might use to persuade a government to spend large amounts of money building geothermal power stations.

.....

(1)

(Total 6 marks)

Q5. The diagram shows how electricity gets from power stations to consumers.



(a) Complete the following sentences by drawing a ring around the correct line in each box.

(i) The network of cables and transformers linking power stations to consumers is

called the national

grid
line
network

(1)

(ii)

A step-up transformer

decreases voltage
increases current
increases voltage

(1)

(iii)

Electricity is supplied to consumers' homes at

230 V
25 000 V
400 000 V

(1)

(iv)

Making the current in the cables smaller will

increase
make no difference to
reduce

the

energy lost in the cables.

(1)

(b) Transformers always waste some energy.

- (i) What effect does the waste energy from a transformer have on the air around the transformer?

.....

(1)

- (ii) Which **one** of the following describes the efficiency of a transformer?

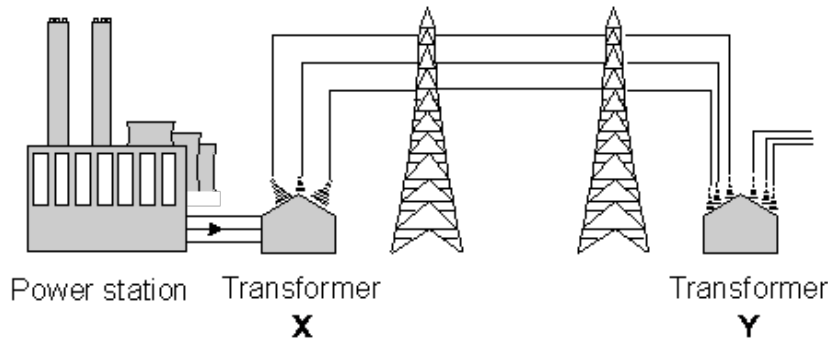
Draw a ring around your answer.

always 100 % less than 100 % more than 100%

(1)

(Total 6 marks)

- Q6.** 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)

- Q7.** (a) A swimming pool has a wave making machine. The diagram shows the water wave pattern for 3 seconds.



- (i) How many water waves are shown in the diagram?

.....

(1)

- (ii) What is the frequency of the water waves?

.....

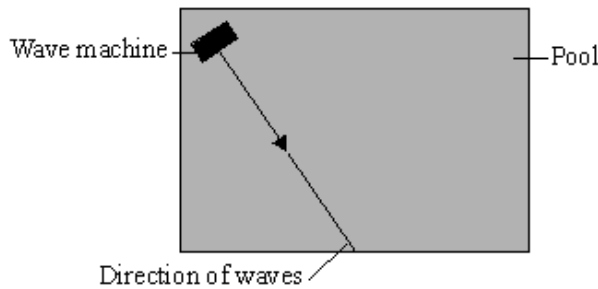
(1)

- (iii) Which **one** of the units below is used to measure frequency? Underline your answer.

hertz joule watt

(1)

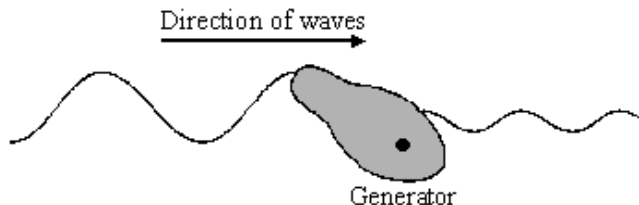
- (b) The diagram shows the direction of the waves across the pool. The waves reflect off the side of the pool.



Draw a line on the diagram to show the direction of the waves after they hit the side of the pool.

(1)

- (c) The swimming pool is used to test a model of an electricity generator. The waves make the floating generator move up and down. This energy is transferred to electricity.



- (i) In the following sentence, cross out the **two** lines that are wrong in the box.

The diagram shows that the amplitude of the waves

gets larger
stays the same
gets smaller

 as the waves pass the generator.

(1)

(ii) What type of energy does the generator transfer to electricity?

.....

(1)

(iii) Energy from ocean waves could be used to generate electricity. Would this be a renewable or non-renewable energy resource?

.....

(1)

(Total 7 marks)

Q8. (a) (i) A student wrote "Coal traps energy from the Sun". Explain what the student means.

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(2)

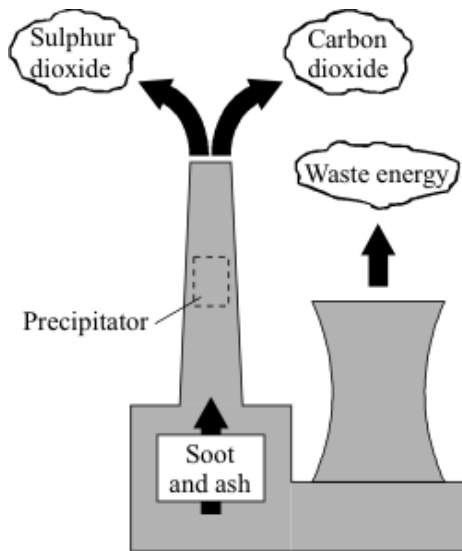
(ii) How is energy released from coal?

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(1)

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



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

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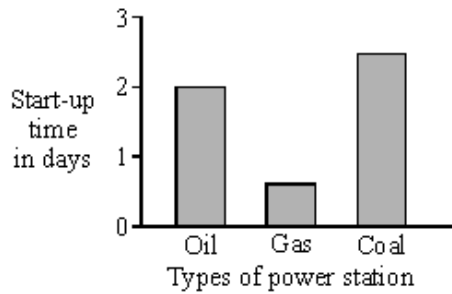
(1)

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

.....
.....

(1)
(Total 5 marks)

- Q9.** (a) The bar chart shows the start-up time for different types of fuel-burning power stations.



Which type of power station would be the quickest to start producing electricity?

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(1)

- (b) A fuel-burning power station is more reliable than a wind generator at producing electricity. Explain why.

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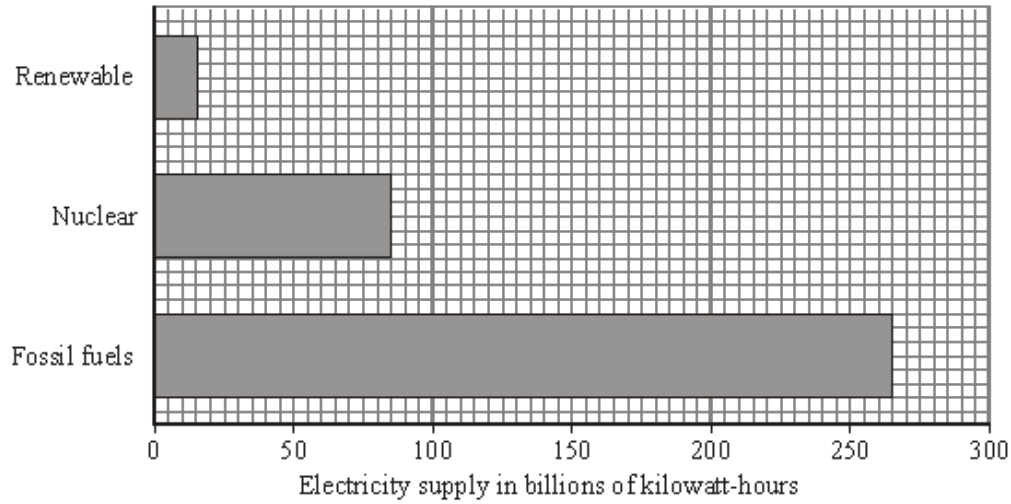
(2)

- (c) Fuel-burning power stations may produce air pollution. Why does a wind generator not produce any air pollution?

.....
.....

(1)
(Total 4 marks)

Q10. The bar chart shows the different energy sources used to generate the UK's electricity in 2007.



(a) (i) The wind is a renewable energy source.

Name **one** more renewable energy source used to generate electricity.

.....

(1)

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

Using less fossil fuels to generate electricity will

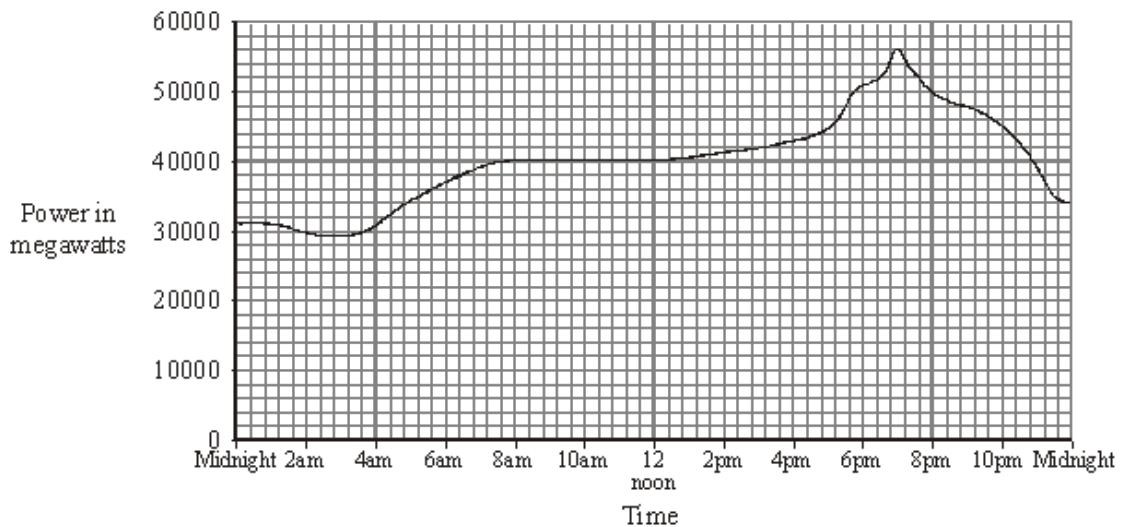
decrease	
not change	
increase	

the

amount of carbon dioxide emitted into the atmosphere.

(1)

(b) The graph shows how the demand for electricity in the UK varied over one day in the winter.



(i) Describe how the demand for electricity varied between 4.00 am and 10.00 am.

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.....
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.....

(2)

(ii) Which type of power station has the fastest start-up time?

Draw a ring around your answer.

coal natural gas nuclear oil

(1)

(Total 5 marks)

Q11. Wind and tides are renewable 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 predictable energy source.

a constant energy source.

an unreliable energy source.

(1)

(ii) The tides are:

a predictable energy source.

a constant energy source.

an unreliable energy source.

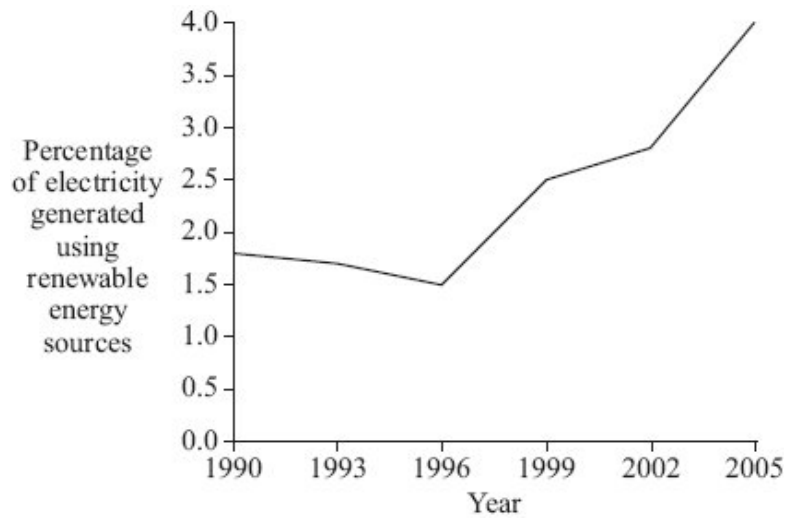
(1)

(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 line in the box.

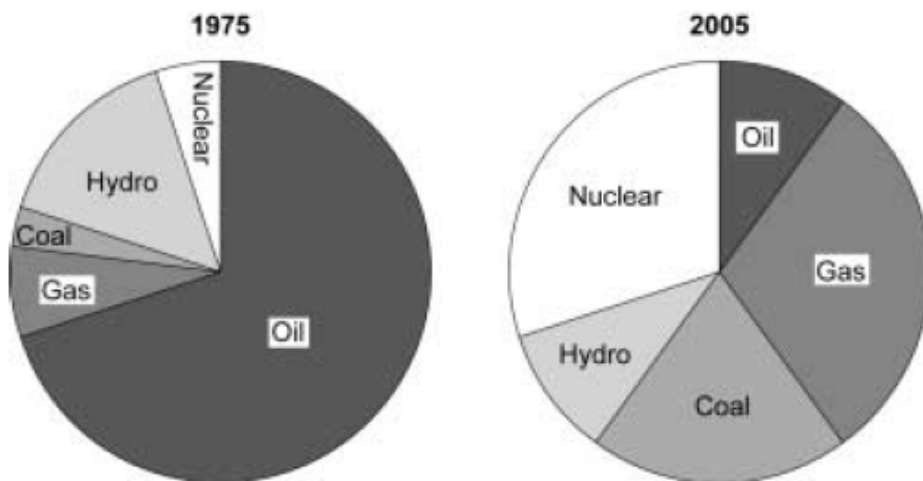
In 2015, the percentage of electricity generated using renewable energy sources is most

likely to be

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

(1)
(Total 4 marks)

- Q12.** The pie charts show the relative proportions of electricity generated in Japan from different energy sources in 1975 and 2005.



- (a) Describe and suggest a reason for **two** differences in the energy sources used in 2005 compared with 1975.

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.....
.....

(2)

- (b) Mining for coal often releases large amounts of methane gas. Methane is both explosive and a greenhouse gas. At the Sihe coal mine in China the methane is diverted to a gas burning power station where it is used to generate electricity.

- (i) A newspaper reported a scientist as saying:

If the concentration of greenhouse gases in the atmosphere doubles, the average temperature of the Earth will increase by up to 5 °C over the next 100 years.

What has been stated in the newspaper?

Draw a ring a round your answer.

a fact

a guess

a prediction

Give a reason for your answer.

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(2)

- (ii) Explain an environmental advantage of taking the methane gas from coal mines and using it to generate electricity.

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(2)

- (c) The average person in Britain uses 1930 kWh of electricity each year. Many people in the world's poorest countries do not have access to electricity.

Giving examples, explain why electricity is essential for both improving public health and for modern communications.

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(3)
(Total 9 marks)

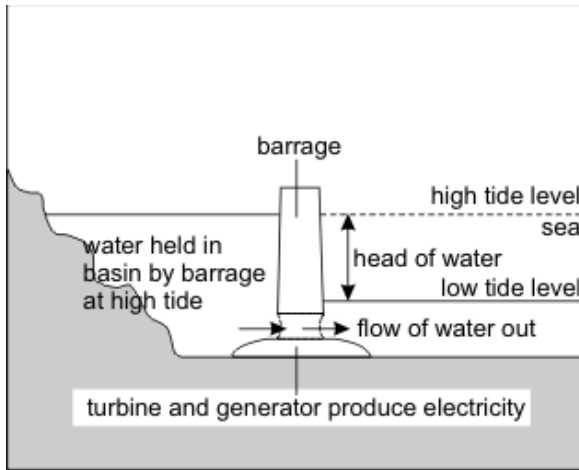
- Q13.** Three energy sources used to generate electricity are given in **List A**. Statements about the energy sources used to generate electricity are given in **List B**.

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
Geothermal	Uses energy from falling water
Hydroelectric	Uses energy from inside the Earth
Nuclear	Is unpredictable
	Produces dangerous waste

(Total 3 marks)

Q14. The outline diagram below shows a tidal power generating system.



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

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

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

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

.....

(2)

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

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

1.

 2.

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

1.

 2.

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

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.....

(6)
(Total 8 marks)

Q15. 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.

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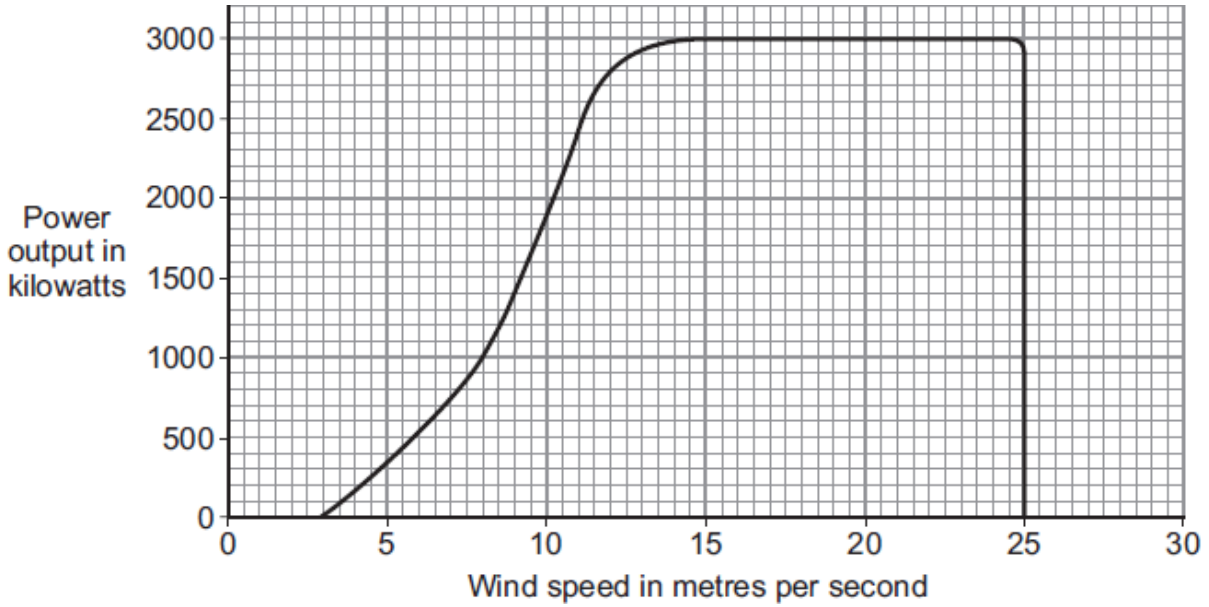
(1)

(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.

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(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.

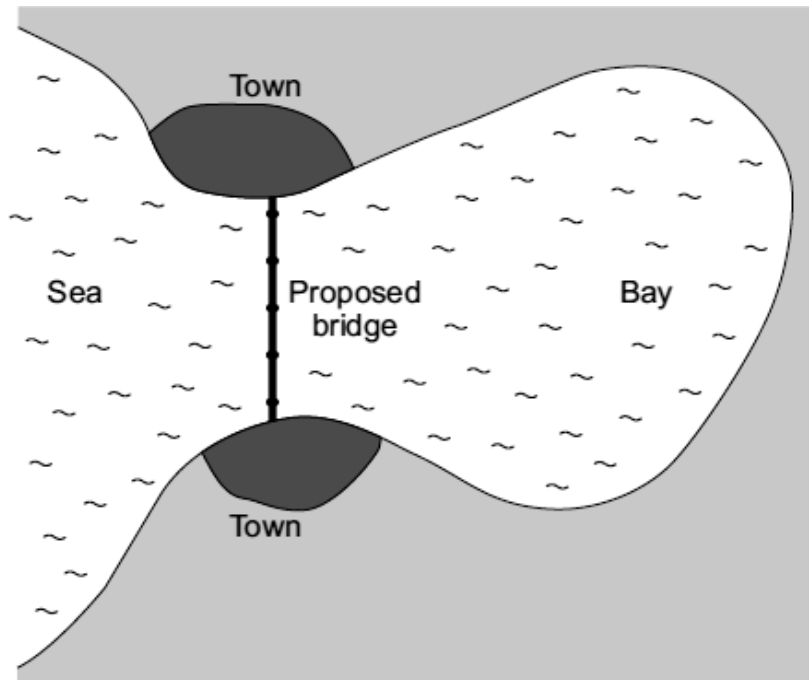
A small amount of nuclear fuel generates a large amount of electricity.

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)

Q16. The map shows the positions of two towns on either side of a very large coastal bay in England. The map also shows where a bridge may be built to link the towns. The road journey from one town to the other is about 60 kilometres at present.



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

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

.....

(1)

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

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

Reason 1

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Reason 2

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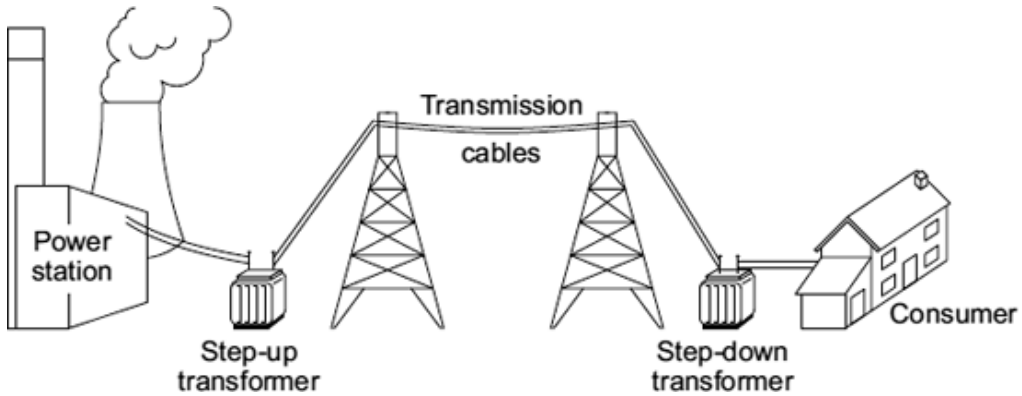
Reason 3

.....

(3)

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

The diagram shows part of the National Grid.



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

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(1)

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

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(2)

(Total 7 marks)

Q17. (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.

.....
.....

(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.

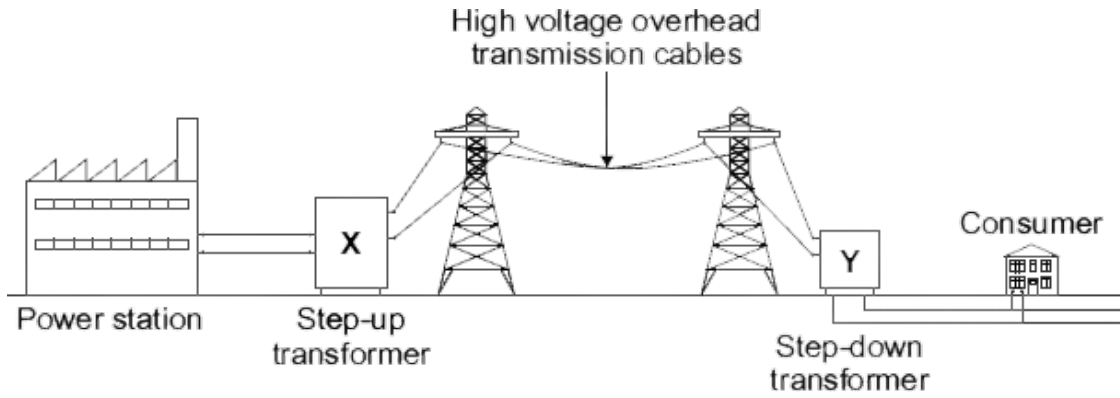
economic issues

ethical issues

social issues

(1)
(Total 7 marks)

Q18. 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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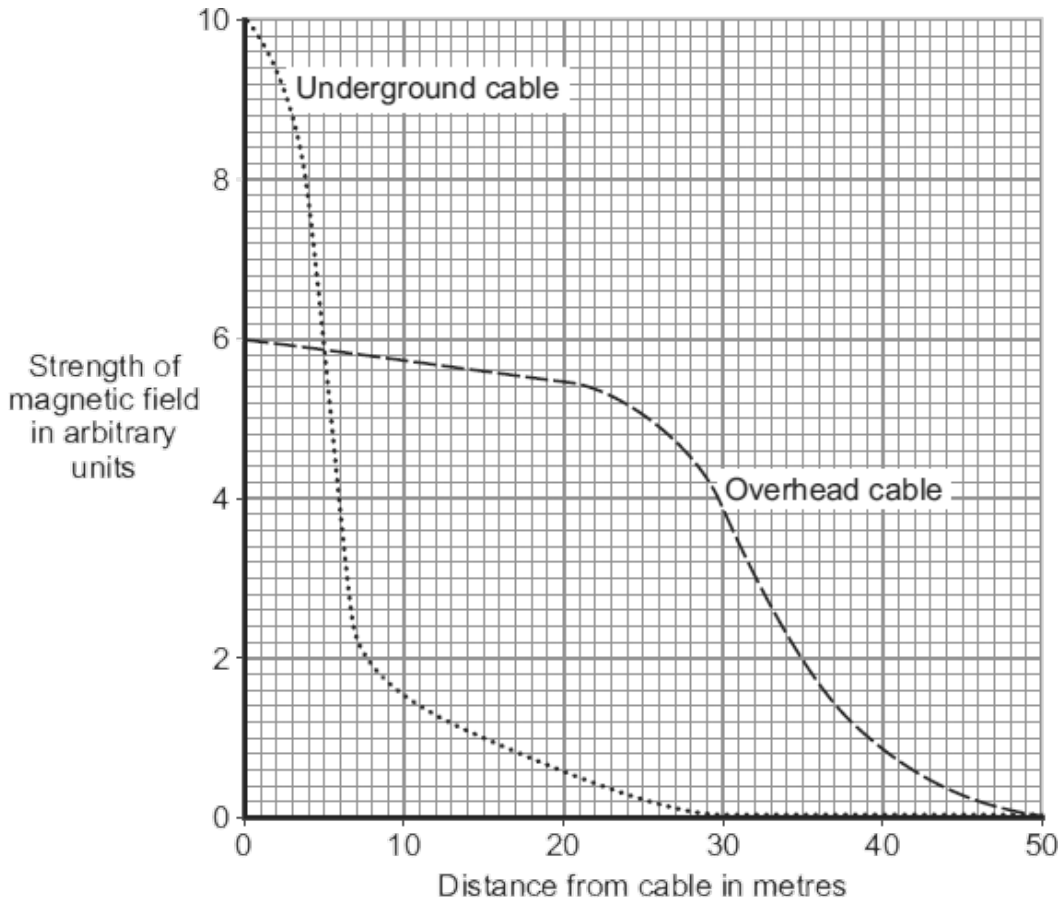
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(6)

(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)

Q19. Electricity is generated in power stations. It is then sent to all parts of the country through a network of cables.

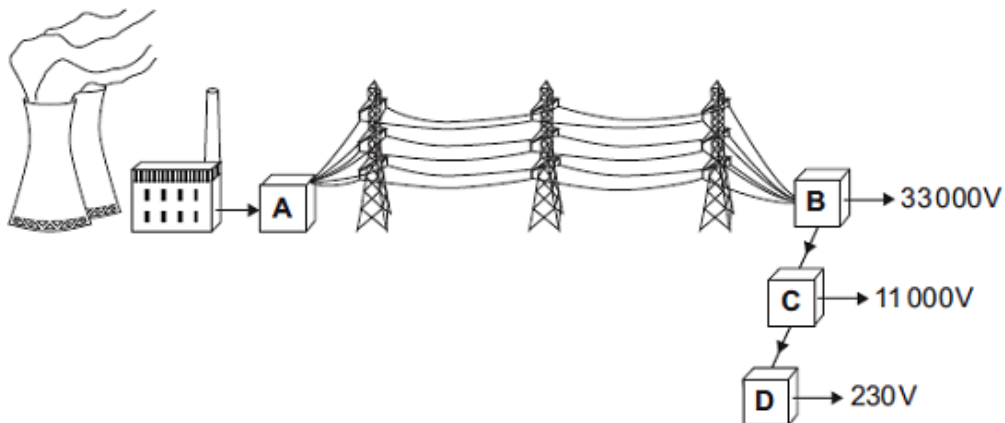
- (a) Complete the following sentence by using **one** of the words in the box.

Grid	Power	Supply
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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)

Q20. There is an increasing demand for electricity and the reserve of fossil fuels is decreasing. A way to meet increasing demand for electricity is to build new nuclear power stations. Some people feel that no new nuclear power stations should be built because of the risks associated with nuclear fuels.

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

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(3)

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

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

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.....

(1)

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

Look at this information from a newspaper report.

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

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

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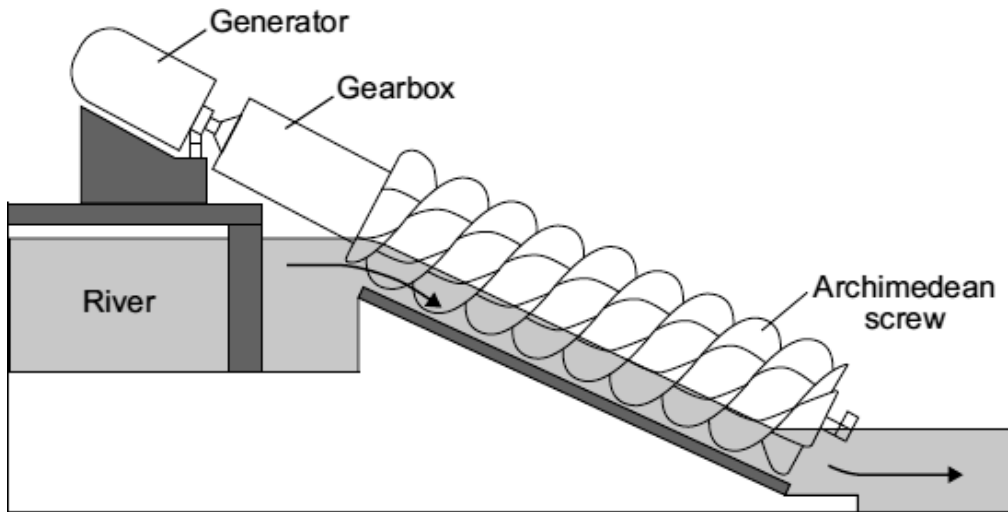
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(3)
(Total 7 marks)

- Q21.** The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate. The Archimedean screw is linked to the generator by a gearbox.



- (a) Complete the following sentence by drawing a ring around the correct word in the box.
The gravitational potential energy of the falling water is transformed

into the

chemical
electrical
kinetic

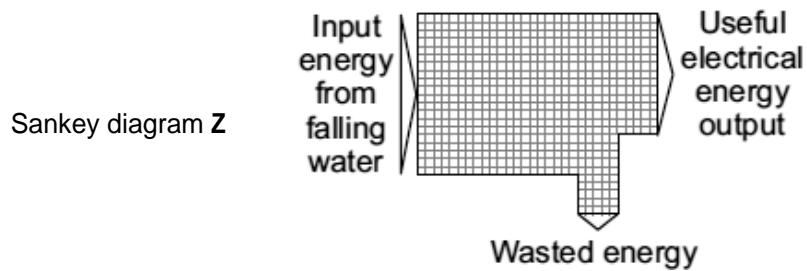
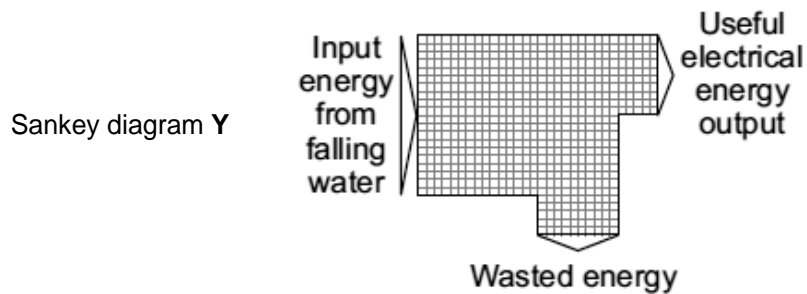
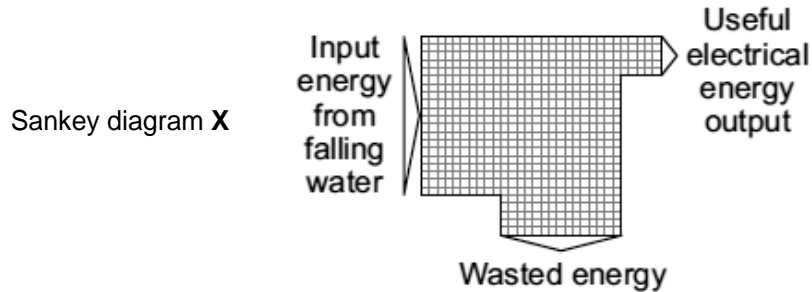
 energy of the Archimedean screw.

(1)

- (b) A micro-hydroelectric generator is very efficient. Most of the input energy from the falling water is transformed into useful electrical energy.

Which **one** of the following Sankey diagrams, **X**, **Y** or **Z**, shows the energy transformations produced by this generator?

Write your answer, **X**, **Y**, or **Z**, in the box.



Sankey diagram

(1)

- (c) A micro-hydroelectric system generates about 60 kW of electricity, enough for 50 homes. A conventional large-scale hydroelectric power station may generate more than 5 000 000 kW of electricity.

- (i) Give **one** advantage of a conventional large-scale hydroelectric power station compared to a micro-hydroelectric system.

.....

(1)

- (ii) Which **one** of the following statements gives a **disadvantage** of a conventional large-scale hydroelectric power station compared to a micro-hydroelectric system?

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

Energy is wasted as heat and sound.

Large areas of land are flooded.

A constant flow of water is needed.

(1)

- (d) The electricity generated by the micro-hydroelectric system is transferred directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to homes anywhere in the country through a system of cables and transformers.

- (i) What name is given to the system of cables and transformers used to transfer electricity to homes anywhere in the country?

.....

(1)

- (ii) Using short cables to transfer electricity to local homes is much more efficient than using very long cables to transfer electricity to homes anywhere in the country.

Why?

.....

.....

(1)

- (e) Nepal is a mountainous country with over 6000 rivers. In Nepal, 9000 kW of electricity are generated using micro-hydroelectric generators.

Suggest **one** reason why in the UK much less electricity is generated using micro-hydroelectric generators, than in Nepal.

.....

.....

(1)

(Total 7 marks)

Q22. 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)

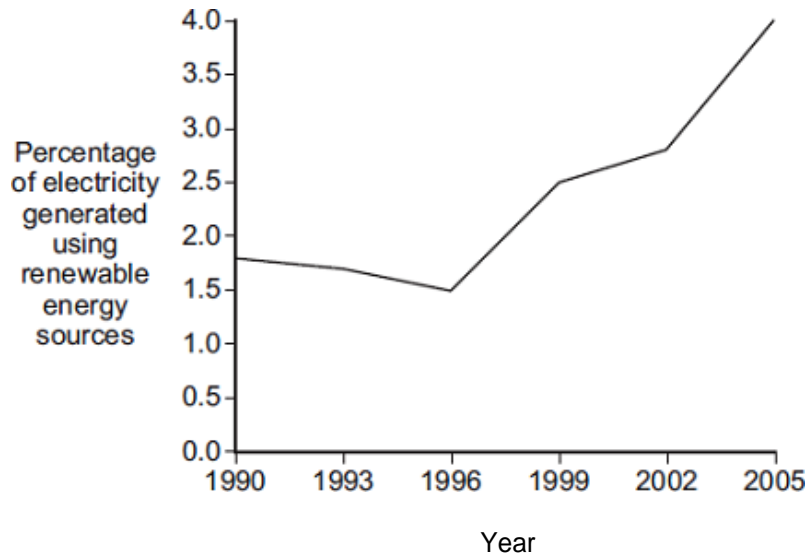
(b) If wood is to be used as a renewable energy source, what must be done each time a tree is chopped down?

.....

.....

(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)

Q23. 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)

Q24. 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.

.....

.....

.....

.....

.....

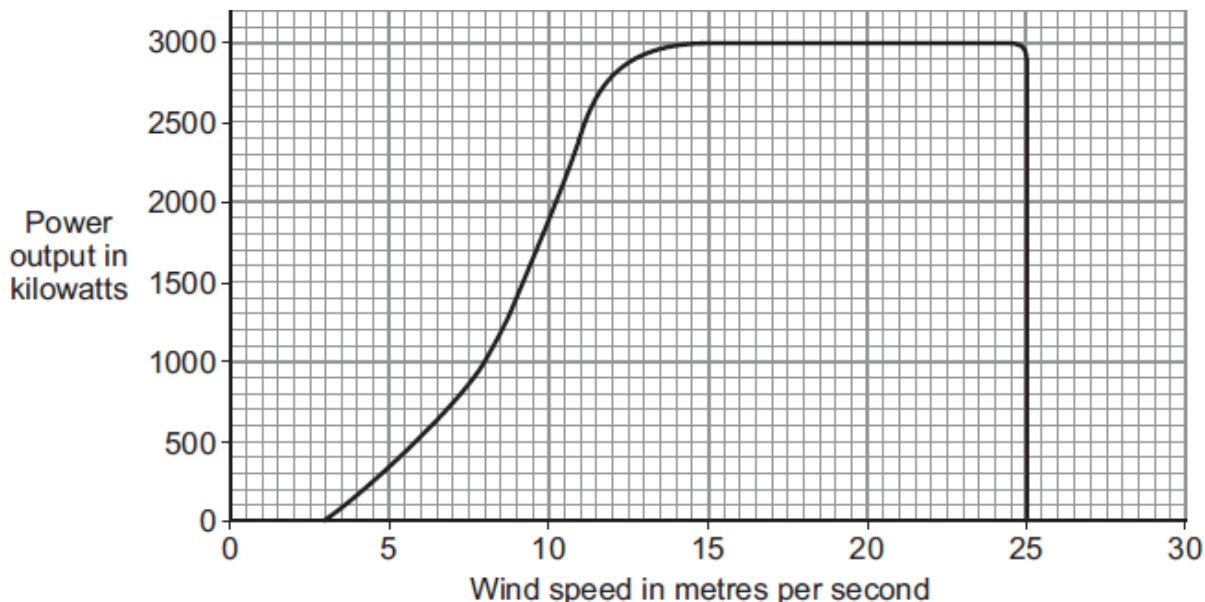
.....

(3)

(Total 7 marks)

Q25. 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 equation in the box and the data in the graph to calculate the average wind speed during this 4-hour period.

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

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)

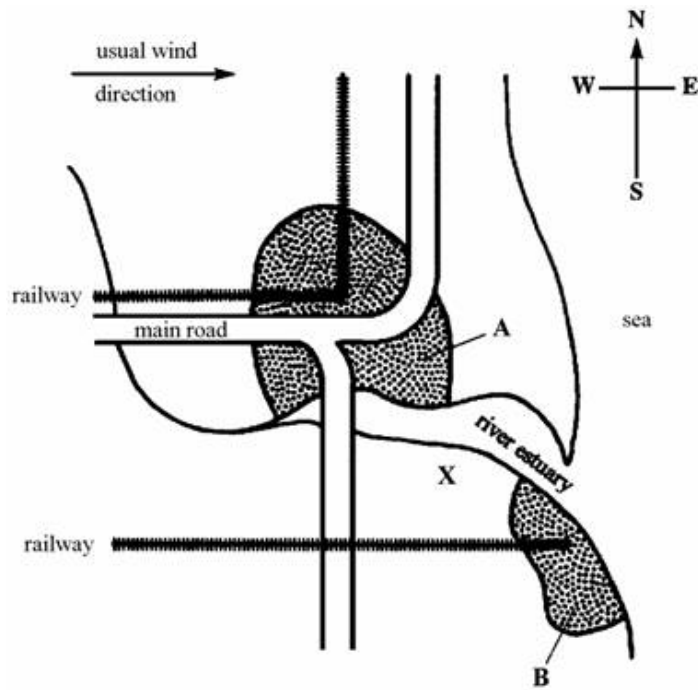
Q26. The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

A is an important fishing and ferry port.

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

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

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



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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

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

.....

Explain the reason for your choice.

.....

.....

.....

.....

.....

.....

(3)
(Total 9 marks)

M1. do **not** give any credit for renewable **or** non-renewable **or** installation **or** decommissioning costs

fossil fuel advantage

1

a reliable source of energy

fossil fuel disadvantage

pollution by carbon dioxide /

accept causes acid rain

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

1

nuclear advantage

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

accept nuclear is cheaper than fossil

1

nuclear disadvantage

accidents / waste can release very dangerous radioactive material radiation

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

1

renewable advantage

there are no fuel costs

almost pollution free (apart from noise and visual)

accept cheaper than fossil

1

renewable disadvantage

not a reliable source of energy except for hydroelectric

accept (most) require large areas of land

accept visual / noise pollution

1

[6]

- M2.** (a) any **two** from:
- (burning) fossil fuels produces greenhouse gases / pollutant gases / acid rain / leads to global warming
accept a named fossil fuel
accept a named pollutant gas
 - nuclear fuels produce dangerous waste
accept radioactive for dangerous
accept reference to dangers of nuclear fuels
 - fossil fuels are non-renewable
accept running out of fuels
 - renewable energy resources produce no pollutant gases
 - large amounts of energy are available
accept renewable won't run out
 - running costs are low
accept any reasonable benefit of renewables
accept any reasonable drawback of non-renewables
*do **not** accept better for the environment on its own*

2

(b) **R U S T**

all in correct order
allow 2 marks for 2 correct
allow 1 mark for one correct

3

[5]

M3. 20 0.3 3

each for 1 mark

[3]

M4. (a) gas

1

oil

1

(b) (both) use steam to drive a turbine

accept (both) use turbines to drive generators

*do **not** accept both have a turbine /generator / use steam*

must describe a step in the process

accept heat / thermal energy transformed to kinetic / electrical energy

1

(c) 140 (°C)

correct answer only

allow 1 mark for method clearly shown on graph

accept a cross or other indication at correct position on the line

accept correct description

accept even if numerical answer is incorrect

2

(d) any **one** from:

*do **not** accept answers purely in terms of disadvantages of other methods except for fossil fuels are running out*

- very large energy source / reserves
- no polluting / harmful gases produced
 - accept named gas CO₂ SO₂ NO_x*
 - accept reduces harmful carbon emissions*
- reduces carbon emissions
 - accept does not contribute to global warming*
- no fuel needed
- energy is free
- can generate energy for a long time
 - accept energy available for a long time*
- renewable (energy source)
- fossil fuels are running out
 - accept it saves fossil fuels / non-renewable*
 - accept reduces the amount of fossil fuels being burnt*
 - accept a named fossil fuel*
 - Better for the environment / environmentally friendly insufficient*
 - it is cheaper is insufficient*

1

[6]

- M5.** (a) (i) grid
accept any way of indicating correct answer 1
- (ii) increases voltage
accept any way of indicating correct answer 1
- (iii) 230 V
accept any way of indicating correct answer 1
- (iv) reduce
accept any way of indicating correct answer 1
- (b) (i) increases the temperature
accept make it hotter / heat goes into the air
accept convection currents
accept sensible comment eg sound energy / it buzzes
ignore pollutes the air 1
- (ii) less than 100% 1
- [6]**

- M6.** (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]**

- M7.** (a) (i) 3 1
- (ii) 1
accept a definition of frequency ignore units 1
- (iii) hertz 1

(b) straight line in correct direction
judge by eye (from 'a' of waves to 's' of across) ignore arrow
accept equal angles shown on waves 1

(c) (i) gets smaller 1

(ii) kinetic
accept movement 1

(iii) renewable 1

[7]

M8. (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]

M9. (a) gas 1

(b) fuel burning stations produce electricity at any time / all the time
accept fuel available all the time 1

wind generator can only produce when the wind is strong enough
accept it's not always windy

1

- (c) no fuel is burnt **or** no fuel is used **or** uses only energy from wind **or**
does not emit harmful gases / soot / smoke

*do **not** accept wind is natural / environmentally friendly / renewable
answer must be in terms of wind, **not** negative of fuel burning*

specific examples of gases CO₂, SO₂,

*acid rain and greenhouse gases can be accepted
ozone negates credit*

1

[4]

M10. (a) (i) any **one** from:

- waves
*do **not** accept water*
- tides
- falling water
accept hydroelectric
- biofuel / biomass
- solar
*accept sun / sunlight
do **not** accept light
accept solar cells / panels*
- geothermal
*do **not** accept heat*

1

(ii) decrease

1

- (b) (i) increases from 4am (to 8am) remains constant from 8am (to 10am)

accept increases from 30 000

accept stays constant from 40 000

allow 1 mark for goes up then stays the same

for full credit must be some indication of time or power

2

(ii) natural gas

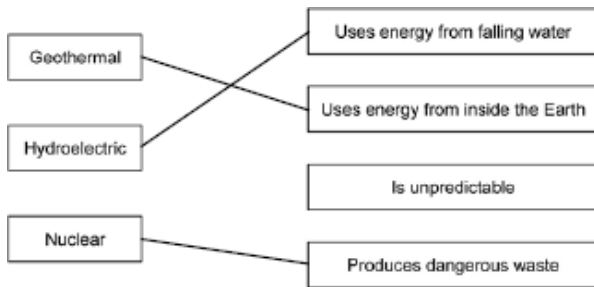
1

[5]

- M11.** (a) (i) an unreliable energy source 1
- (ii) a predictable energy source 1
- (b) plant / grow (at least) one new tree 1
- (c) greater than 4 % 1
- [4]**

- M12.** (a) decrease in (proportion of) oil as reserves are decreasing 1
- increase in (proportion of) coal / nuclear / gas / as new reserves / more nuclear power stations built 1
- no marks are awarded for simply describing the differences*
- (b) (i) a prediction 1
- forecast based on scientific evidence 1
- (ii) less methane goes into the atmosphere
accept air for atmosphere 1
- therefore making global warming less rapid 1
- (c) idea that many devices transform electricity into other useful forms of energy 1
- example related to public health eg refrigeration / production of vaccines / X-ray machines 1
- example related to modern communications eg internet / telephones 1
- [9]**

M13.



*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]

M14. (a) 90% of 2.1011
2.16.1011

2

- (b) (i) Can be located anywhere
Continuous output
Sustain coal industry
any 2 for 1 mark each
- (ii) Low running cost
No atmospheric pollution
Gives calm coastal waters
any 2 for 1 mark each
- (iii) High installation costs – built in sea
Coast environmental damage – wildlife disturbance
Time dependence – need dropping tide
*any 2 for 1 mark each
(1 for a valid disadvantage, 1 for reason)*

6

[8]

M15. (a) (i) any **one** from:

- produces no (air / atmospheric) pollution
accept named pollutant eg CO₂
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]

M16. (a) (i) tidal / tides
*do **not** accept water / waves*

1

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

3

- (b) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)
accept in case turbines / generators fail
or
can sell (excess) electricity (to the National Grid)

1

- (ii) decreases the current
accept increases the voltage

1

reducing energy loss (along cables)
accept less heat / thermal energy lost / produced

1

[7]

- M17.** (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]

M18. (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]

M19. (a) grid

accept any unambiguous indication

1

(b) (i) A (only)

1

(ii) D (only)

1

(c) less than

1

[4]

- M20.** (a) only accept answers in terms of the argument of the nuclear power scientist any **three** from:
- produces a lot of energy for a small mass of fuel **or** is a concentrated energy source
accept amount for mass
 - it is reliable **or** it can generate all of the time
 - produces no pollutant gases
*accept named gas or greenhouse gases do **not** accept no pollution*
 - produces only a small volume of (solid) waste
accept amount for volume
 - advances in technology will make fuel reserves last much longer
accept an argument in terms of supply and demand

3

(b) any **one** from:

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

1

(c) any **three** from:

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

3

[7]

M21. (a) kinetic

1

- (b) **Z** 1
- (c) (i) generates a lot more energy / electricity / power
need fewer conventional large-scale hydroelectric power stations is neutral
- or**
- can supply (energy / electricity / power) to more homes 1
- (ii) Large areas of land are flooded. 1
- (d) (i) National Grid
this answer only 1
- (ii) less energy / heat loss (from the cables)
accept wasted for loss
accept answers in terms of fewer transformers needed
*do **not** accept less electricity lost / wasted*
*do **not** accept no energy lost* 1
- (e) any **one** from:
- fewer rivers (suitable for generators)
 - less mountainous (so rivers fall smaller distances)
accept answers in terms of difficulty linking villages and towns to grid (in Nepal)
accept answers in terms of more isolated communities
accept answers in terms of UK having more resources for large-scale power stations 1
- [7]

- M22.** (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]

M23. (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]

M24. (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]

M25. (a) 9

allow 2 marks for power = 1400 (kW)
if a subsequent calculation is shown award 1 mark only

or

allow 1 mark for correct substitution and transformation

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

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

3

(b) (i) system of cables and transformers

both required for the mark

ignore reference to pylons

inclusion of power stations / consumers negates the mark

wire(s) is insufficient

1

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

accept (transfers energy / electricity at) high voltage

or

(uses step-up transformer to) reduce current

accept (transfers energy / electricity at) low current

ignore correct references to step-down transformers

1

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

accept a named fuel

eg coal or wood

or

buy (lots of) petrol / diesel generators

1

stockpile supplies of the fuel

accept fuel does not rely on the weather

or

fuel provides a reliable source of energy

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

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

or

when other methods fail

or

when it is needed

answers in terms of using other forms of renewables is insufficient

1

[7]

M26. (a) *must give one advantage and one disadvantage of each to get 4 marks and 2 further scoring points*

Advantages and disadvantages relevant to:

(1) health risk

(5) cost

(6) environmental factors

(7) transport/ storage

e.g. common coal / nuclear – high cost of building both

anti-nuclear examples

nuclear fuel transported on roads/rail in region

possible effects on public health in surrounding area

high cost of de-commissioning

long life very active waste materials produced

how waste materials stored safely for a long time

anti-coal examples

unsightly

pollution

supplies of fuel limited

acid rain

non-renewable

pro-nuclear examples

fuel cheap

no foreseeable fuel shortage

pro-coal examples

safe

reliable

large coal reserves

disposal of solid waste is easier

to max 6

6

(b) choice 0 marks

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

But

at least two of which must be relevant to this site

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[9]

