National and global energy resources

Questions

Name: _____

Class: _____

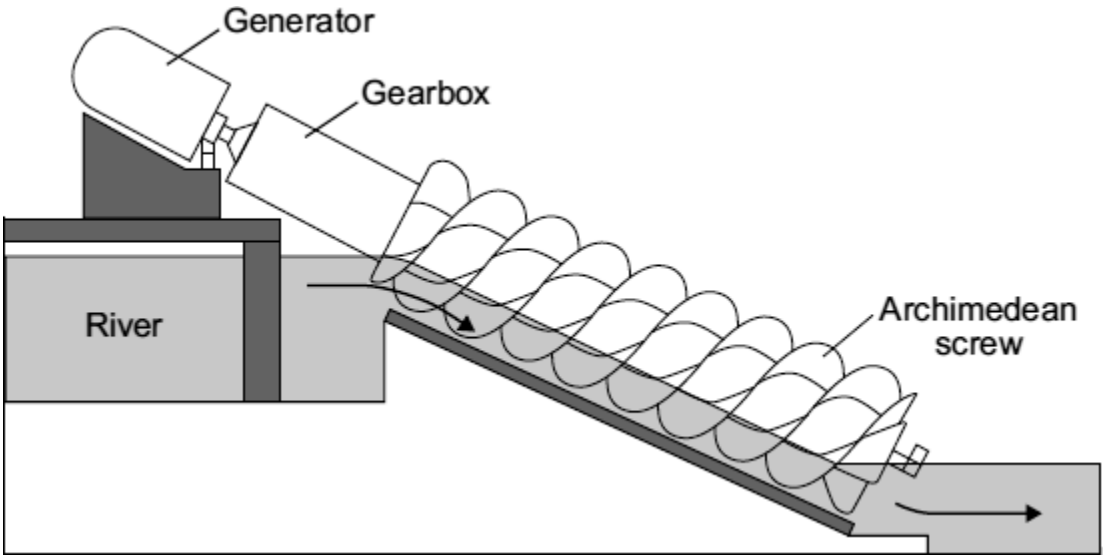
Date: _____

Time: **97 minutes**

Marks: **97 marks**

Comments:

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



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

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

Gravitational potential energy of the falling water	→	_____ energy of the Archimedean screw	→	Electrical energy generated

(1)

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

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

Show clearly how you work out your answer.

_____

_____

Efficiency = _____

(2)

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

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

_____

_____

(1)

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

(i) What is the National Grid?

_____

_____

(1)

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

_____

_____

_____

_____

(2)

(Total 7 marks)

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

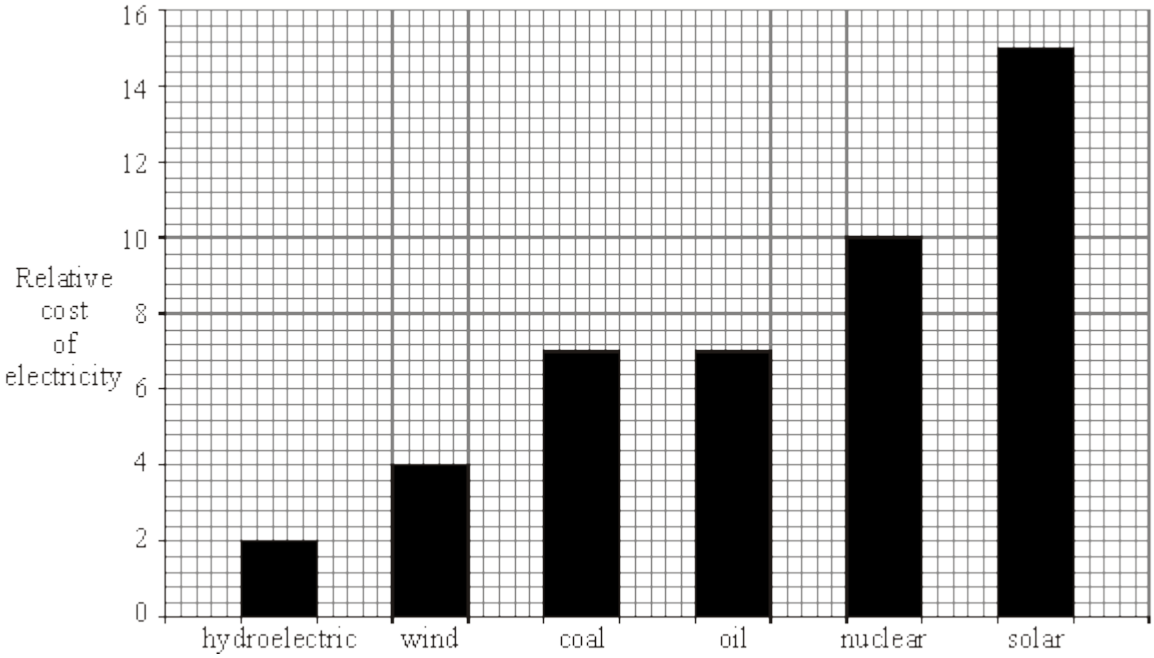
Types of energy sources used in the UK	Cost of producing 1 kWh of electrical energy	
Fossil fuels(non-renewable)	Coal	1.0 p
	Gas	1.4 p
	Oil	1.5 p
Nuclearfuels (non-renewable)	Nuclear	0.9 p
Renewable	Hydroelectric	0.2 p
	Wind	0.9 p
Installation and decommissioning costs are notincluded		

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

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

(Total 6 marks)

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



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

1. _____

_____

2. _____

_____

(2)

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

Advantage _____

_____

Disadvantage _____

_____

(2)

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

_____

_____

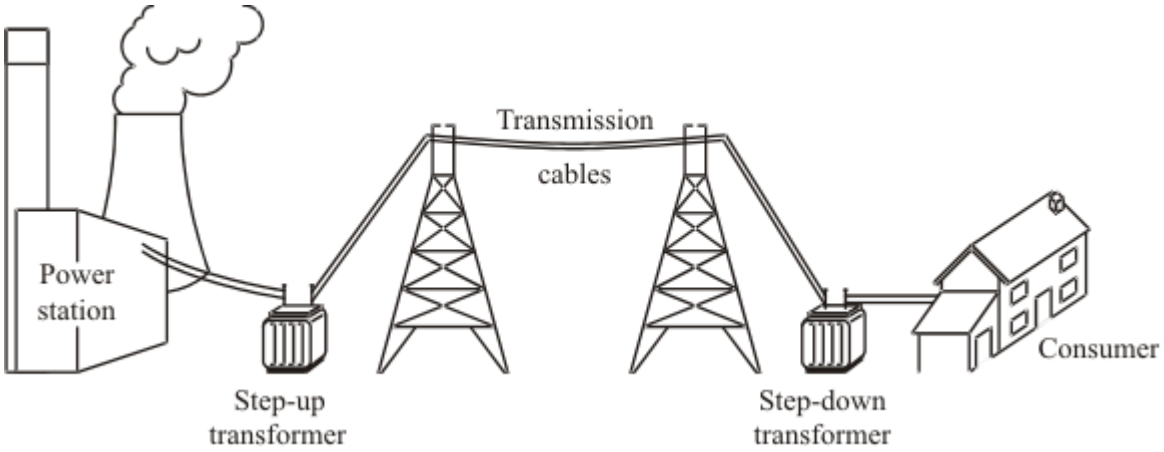
_____

_____

(2)

(Total 6 marks)

4 The diagram shows how electricity is distributed from power stations to consumers.



(a) (i) What name is given to the network of cables and transformers that links power stations to consumers?

_____

(1)

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

_____

(1)

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

_____

_____

_____

_____

(2)

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

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

_____

_____

(1)

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

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

_____

_____

_____

_____

(2)

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

_____

_____

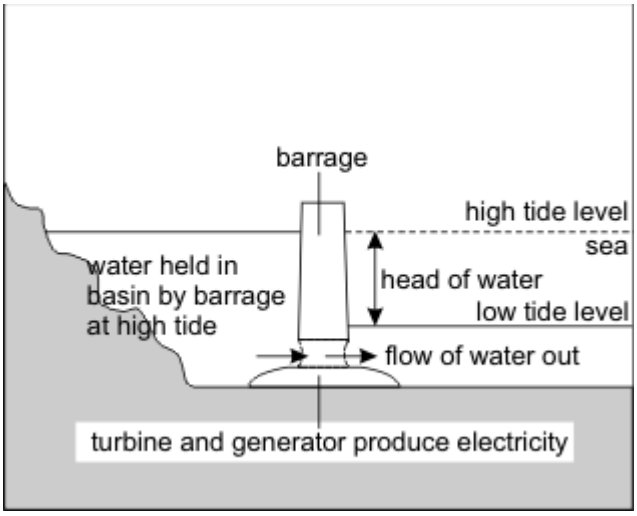
_____

_____

(2)

(Total 9 marks)

5 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.

_____

_____

_____

_____

(6)

(Total 8 marks)

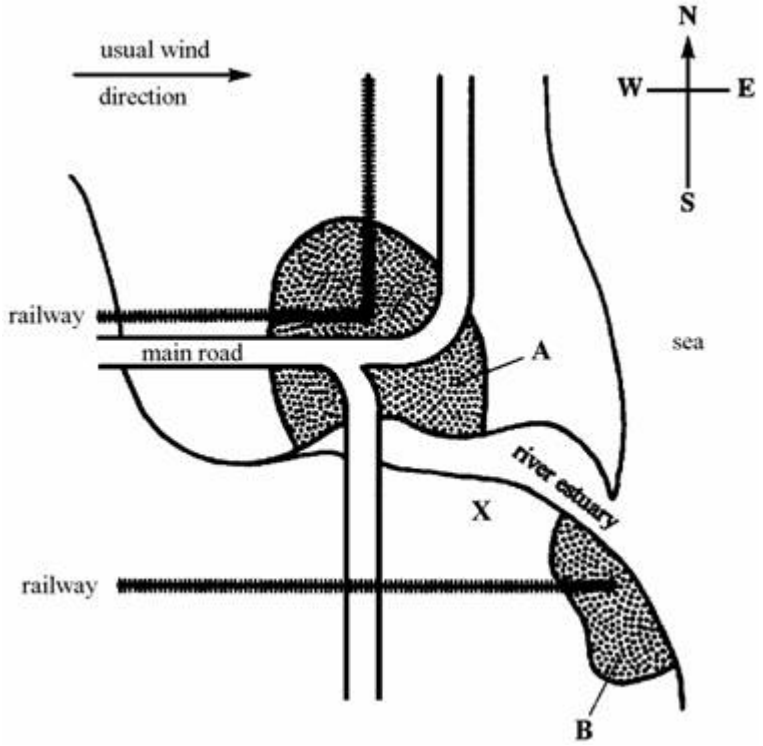
6 The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

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)

7 Solar panels are often seen on the roofs of houses.

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

_____

_____

_____

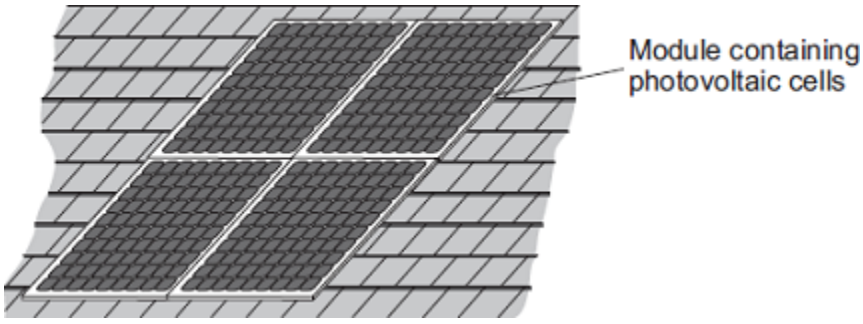
_____

(2)

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

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

Four modules are shown in the diagram.



The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is 1.4×10^3 W.

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

_____

_____

_____

_____

_____

_____ Time = _____ minutes

(3)

(c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.

(i) The diagram shows two readings of this electricity meter taken three months apart. The readings are in kilowatt-hours (kWh).

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

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

_____

Energy transferred = _____ kWh

(1)

(ii) The electricity company pays 40p for each kWh of energy transferred.

Calculate the money the electricity company would pay the householder.

_____

_____

Money paid = _____

(2)

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

Calculate the payback time in years for the modules.

_____

_____

Payback time = _____ years

(3)

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

_____

_____

(1)

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

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

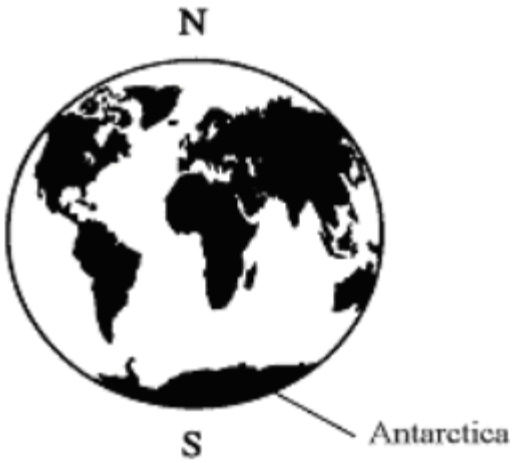
_____

_____

(1)

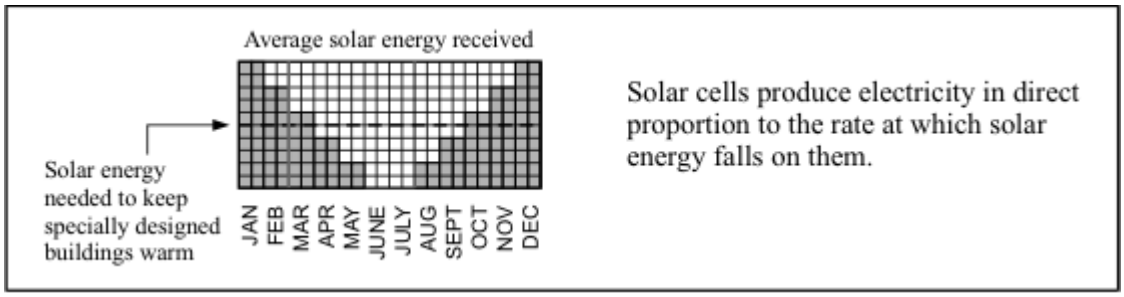
(Total 13 marks)

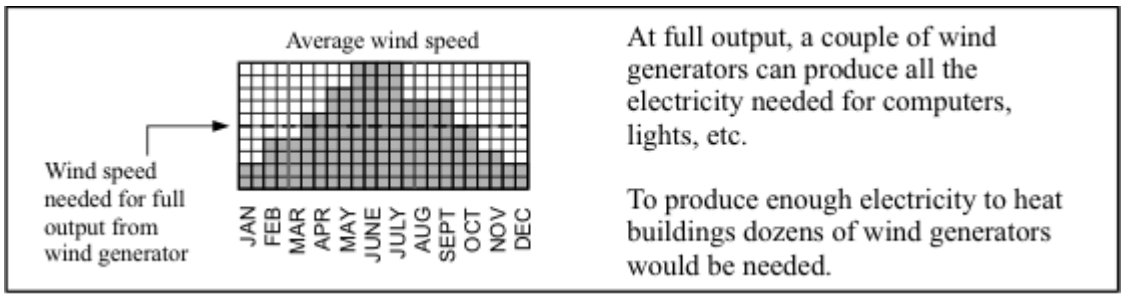
8 Antarctica is a huge land mass surrounding the Earth's south pole. It is covered in a very thick layer of ice and is the only remaining large area of the Earth's surface that has not been affected very much by humans.



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

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





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

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

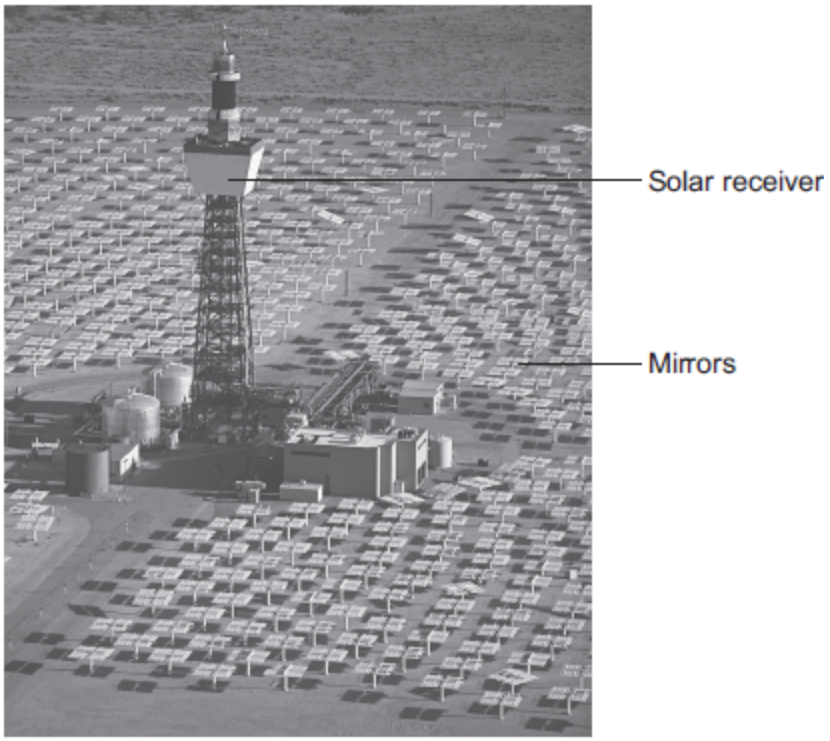
- solar energy
- energy from the wind
- natural gas (present in large quantities deep down in the Antarctic land mass)
- diesel oil (which would have to be imported)

(Total 10 marks)

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

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

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



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

_____

(1)

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

_____

_____

_____

_____

_____

_____

(3)

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

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

_____

_____

(1)

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

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

Give your answer to 2 significant figures.

_____

_____

_____

Time = _____ hours

(3)

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

Table 1

Season	**Mean number of daylight hours**	**Mean power received from the Sun per square metre in kW**
Spring	11.5	0.90
Summer	13.5	1.10
Autumn	12.0	0.95
Winter	10.5	0.71

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

Suggest why.

_____

_____

_____

_____

(2)

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

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

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

Table 2

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

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

_____

_____

_____

_____

_____

_____

(3)

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

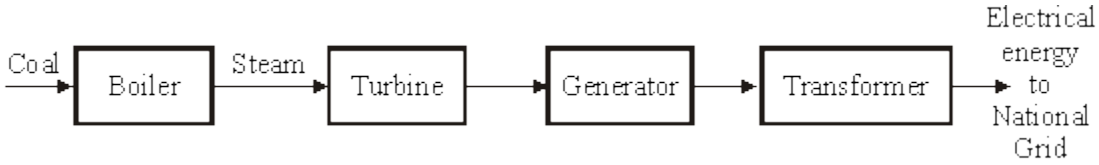
_____

_____

(1)

(Total 14 marks)

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



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

1. _____

_____

_____

2. _____

_____

_____

(ii) How may these environmental problems be reduced?

1. _____

_____

_____

2. _____

_____

_____

(4)

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

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

Use the given data to calculate:

(i) the total electrical energy output each day.

_____

_____

_____

Answer _____J/day

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

_____

_____

_____

Answer _____J/day

(iii) the efficiency of the power station.

_____

_____

_____

Answer _____ %

(8)

(c) Energy is conserved.

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

_____

_____

_____

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

_____

_____

_____

(3)

(Total 15 marks)