1 The International Space Station (ISS) has several solar panels called wings.



The wings convert energy from the Sun into a form useful in the ISS.

(a) The energy reaching the ISS from the Sun is carried by waves which are

(1)

- ☒ **A** transverse and electromagnetic
- ☒ **B** electromagnetic but not transverse
- ☒ **C** transverse but not electromagnetic
- ☒ **D** neither transverse nor electromagnetic

(b) In one second, the useful energy available from one wing is 34.3 kJ.
The energy incident on the wing from the Sun is five times this amount.

What is the percentage efficiency of the wing?

(3)

efficiency = ... %

(c) A wing is in direct sunlight.
The ISS is not receiving energy from the wing.
The temperature of the wing remains constant.

Explain why the temperature of the wing remains constant in these conditions.

(2)

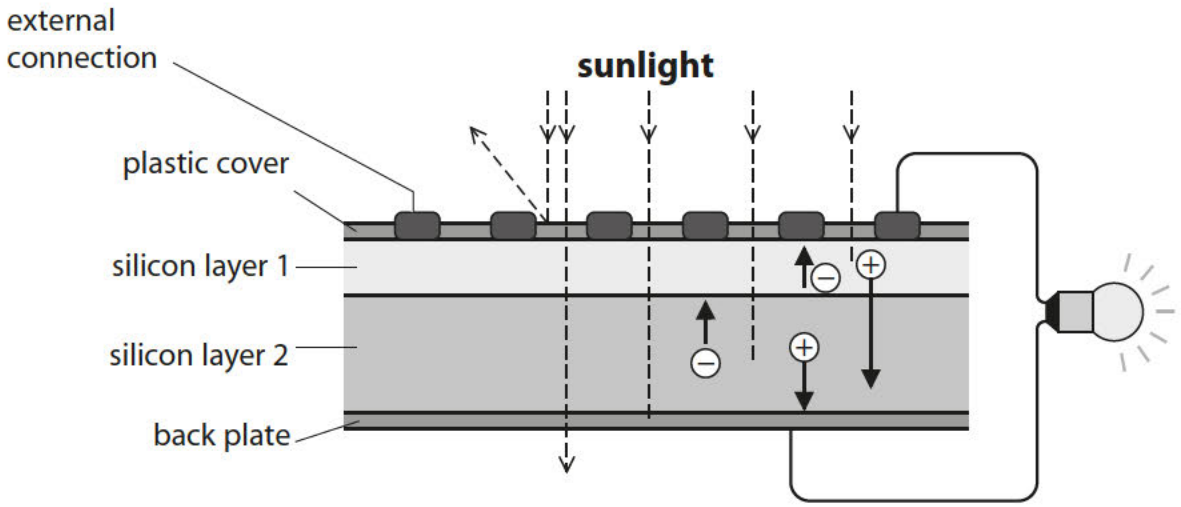
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(d) The diagram shows how a solar cell produces electricity when receiving energy from the Sun.
When energy from the Sun is absorbed in a silicon layer, it makes charges move.
This movement of charges produces a current.



Suggest **two** reasons why the efficiency of this solar cell at producing electricity from sunlight is less than 100%.

(2)

1 .....

.....

2 .....

.....

(Total for Question 1 = 8 marks)

Power from the wind

2 A windfarm generates electrical power from the wind.

(a) State **one** disadvantage of using the wind to generate electrical power.

(1)

.....

.....

(b) A windfarm generates 322 MW of electrical power.

The windfarm is connected to a transmission line at a potential difference of 132 kV.

(i) Calculate the current from the windfarm.

(3)

current = ... A

(ii) The windfarm produces 322 MW of power.
The windfarm is to be extended by adding 75 improved turbines.
The extended windfarm will then produce a total of 539 MW.

Calculate the power produced by each improved turbine.

(2)

power = ... MW

*(c) There is a plan to replace the existing transmission line from the windfarm with one at the higher potential difference of 400 kV.

The new transmission line will cross more than 200 km of mountains.
The cables will hang 50 m above the ground from 600 new, taller pylons.
Eventually, about 1000 of the old, shorter pylons will be removed.

Discuss the advantages and disadvantages of this plan.

(6)

(Total for Question 5 = 12 marks)

Generating electrical energy

3 (a) Complete the sentence by putting a cross (☒) in the box next to your answer.

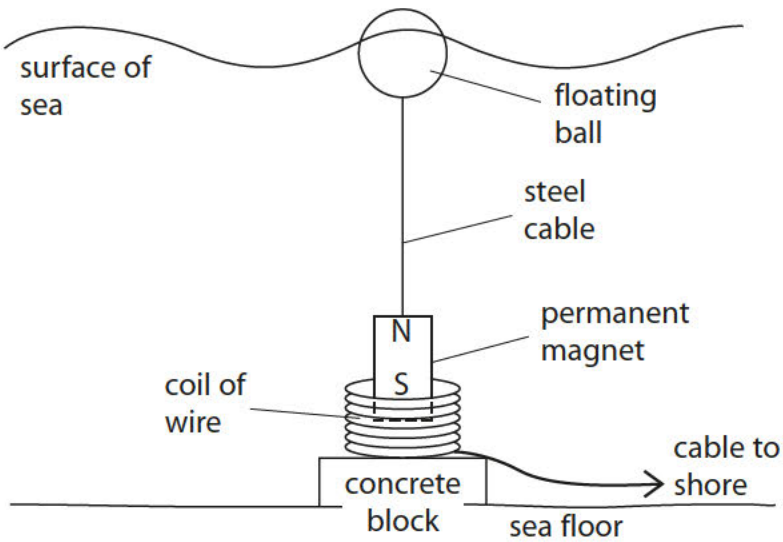
Electrical energy can be measured in

(1)

- ☒ **A** amps
- ☒ **B** kilowatt-hours
- ☒ **C** volts
- ☒ **D** watts

(b) Scientists are looking for new ways to produce electricity from renewable resources.

The diagram shows a model of a device to generate electricity from waves.
The coil is fixed to the concrete block.
The magnet can move freely inside the coil.



(i) Explain how this device produces an electric current.

(3)

(ii) Describe how the device can be altered to increase the electric current.

(2)

*(c) Another way of producing electricity from a renewable source is tidal power.
A dam is built across the mouth of a river.
Tidal water gets trapped behind the dam.



The trapped water is used to generate electricity.

Discuss the advantages and disadvantages of using tidal power rather than other methods of generating electricity.

(6)

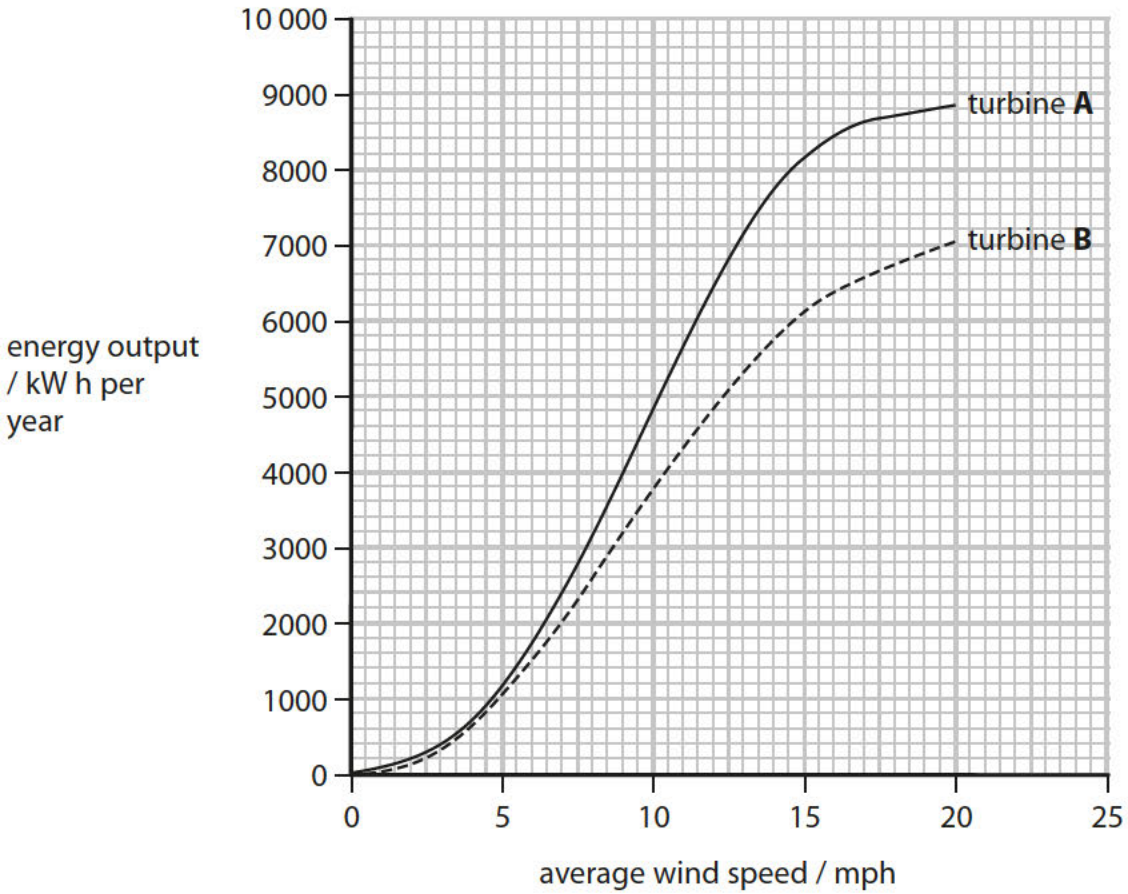
(Total for Question 6 = 12 marks)

Generating electrical energy

4 (a) Eric owns a small farm where chicks are hatched from eggs.

He is considering generating his own electricity to heat and light a barn rather than using electricity from the National Grid.

This graph shows how the energy output varies with wind speed for two different wind turbines, **A** and **B**.



The average wind speed at Eric's farm is 13 mph.
The total heating and lighting in the barn requires 6000 kW h of electrical energy each year.

(i) Use the data in the graph to recommend the best turbine for Eric's barn.

(1)

The best turbine is ..... because.....

.....

.....

(ii) Eric pays 14p per kW h for electrical energy supplied by the National Grid.
Calculate how much he could expect to save each year by using the energy from this wind turbine to heat and light the barn.

(2)

annual saving = £.....

(iii) Eric looks at the cost of installing the turbine.

State how he should work out the payback time.

(1)

.....

.....

(iv) The chicks need to be kept warm at all times.
Eric uses halogen lamps to provide heat and light for most of the day.
Eric thinks about changing his halogen lamps for energy saving lamps.
Suggest why this might not actually be a benefit.

(2)

.....

.....

.....

.....

*(b) There are several large-scale energy resources which are suitable alternatives to fossil fuels in some situations.
Two of these alternatives are hydro-electric power and solar power.

Compare hydro-electric power with solar power as energy resources for the large-scale generation of electricity.

(6)

(Total for Question 6 = 12 marks)