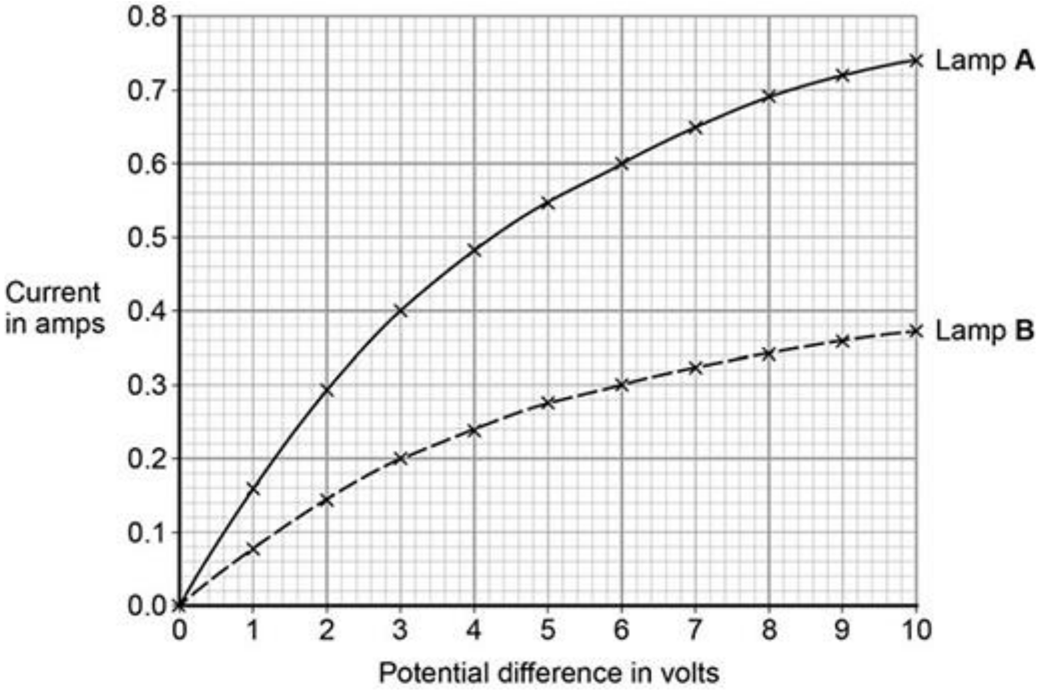
POWER

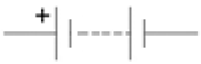
Q1.

A student investigated how current varies with potential difference for two different lamps.

Her results are shown in the figure below.



(a) Complete the circuit diagram for the circuit that the student could have used to obtain the results shown in the figure above.



(3)

(b) Which lamp will be brighter at any potential difference?

Explain your answer.

Use the figure above to aid your explanation

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(2)

(c) Lamp **B** has the higher resistance at any potential difference.

Explain how the figure above shows this.

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(2)

(d) Both lamps behave like ohmic conductors through a range of values of potential difference.

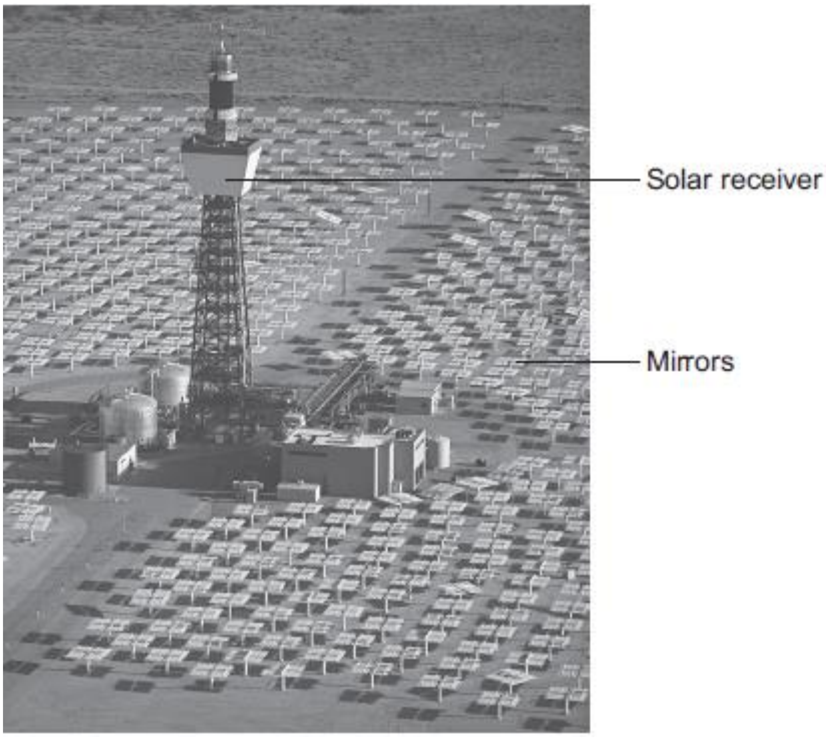
Use the figure above to determine the range for these lamps.

Explain your answer.

(3)
(Total 10 marks)

Q2.

The image shows a solar thermal power station.



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

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

____

____

(1)

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

Energy from the Sun is __________________________ by the mirrors

towards the solar receiver.

(1)

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

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

At the solar receiver, water is heated in a ____________________

which turns the water into steam. The steam turns a

__________________which is connected to a water into steam. The

steam turns a __________________ which is connected to a generator.

The generator produces electricity. A ____________________ is used

to change the voltage for transmission along power lines.

(3)

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

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

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

____

____

____

Energy = ________________________________ kWh

(2)

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

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

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

1. ____

____

2. ____

____

(2)

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

____

____

(1)

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

____

____

(1)

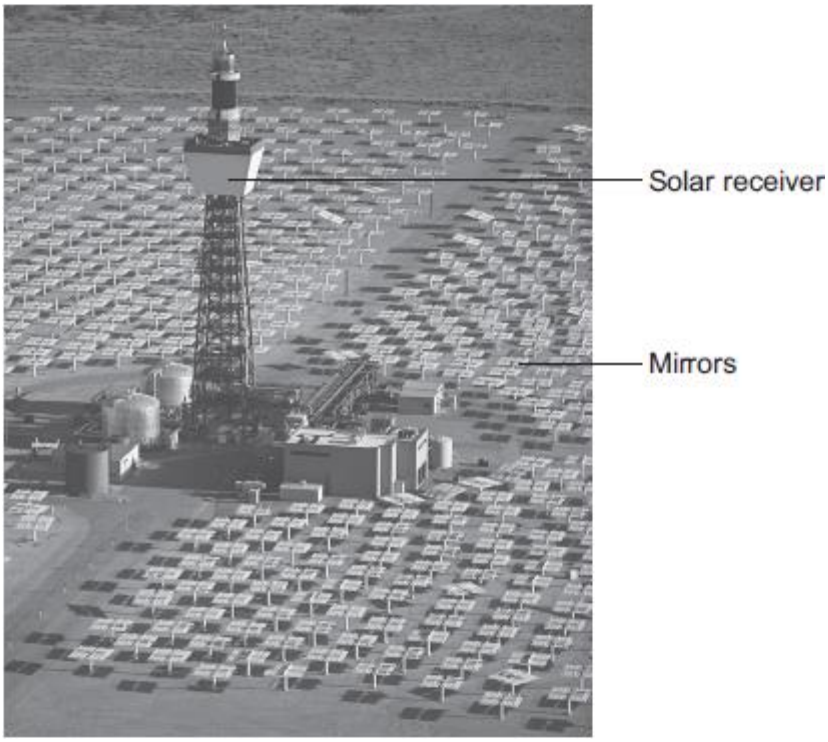
(Total 11 marks)

Q3.

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?

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(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.

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(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.

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____

(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.

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(3)

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

____

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(1)
(Total 14 marks)

Q4.

A student finds some information about energy-saving light bulbs.

(a) A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i) Calculate the energy wasted by the light bulb in this period of time.

____

Wasted energy = ____________________ J

(1)

(ii) What happens to the energy wasted by the light bulb?

____

____

(1)

(iii) Calculate the efficiency of this light bulb.

____

____

Efficiency = ____________________________________

(2)

(iv) Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

____

____

Time = _______________ s

(2)

(b) A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

	Power in watts	**Lifetime in hours**	**Cost of bulb in £**
Filament bulb	60	1250	2.00
LED bulb	12	50 000	16.00

(i) Suggest why it is important to confirm this information independently.

___

(1)

(ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

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___

___

(2)

(iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

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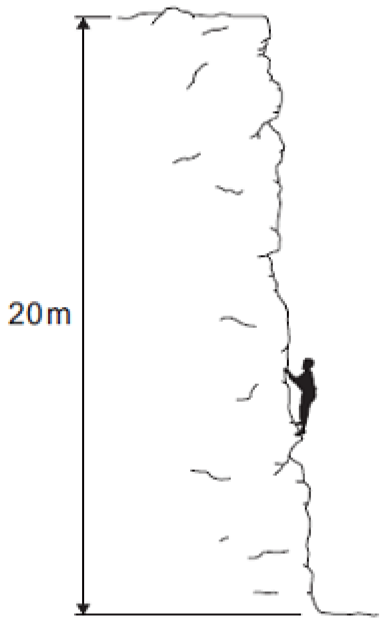
(1)

(Total 10 marks)

Q5.

The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational ______________________ energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

____

____

Work done = __________________________ J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff. During this time the energy transferred to the climber equals the work done by the climber.

Calculate the power of the climber during the climb.

____

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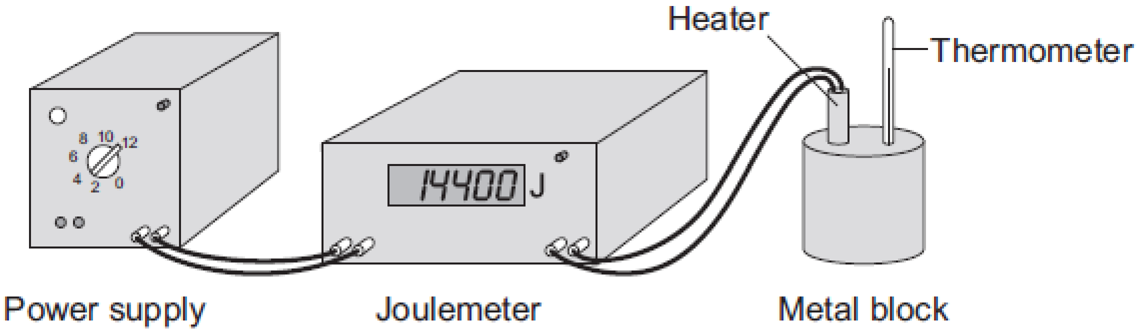
Power = __________________________ W

(2)

(Total 5 marks)

Q6.

A student used an electric heater to heat a metal block. The student measured the energy input to the heater with a joulemeter.



Before starting the experiment, the student reset the joulemeter to zero. The student switched the power supply on for exactly 10 minutes. During this time, the reading on the joulemeter increased to 14 400.

(a) (i) Calculate the energy transferred each second from the power supply to the heater.

Show clearly how you work out your answer.

____

____

Energy transferred each second = ____________ J/s

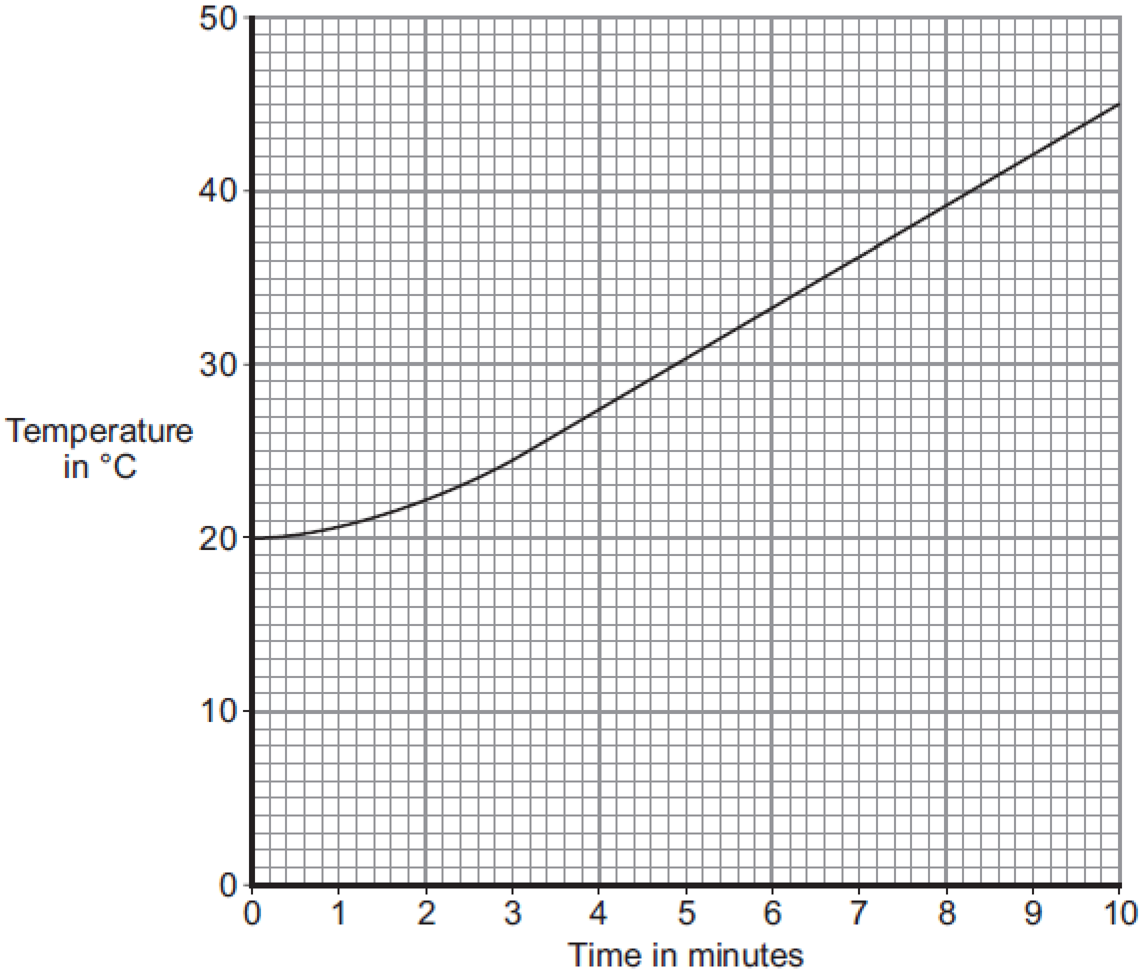
(2)

(ii) What is the power of the heater?

____

(1)

(b) The student measured the temperature of the metal block every minute. The data obtained by the student is displayed in the graph.



(i) What range of temperatures did the student measure?

From ________________________ °C to ________________________ °C

(1)

(ii) Before starting the experiment, the student had calculated that the temperature of the block would go up by 36 °C.

The student's data shows a smaller increase.

Which **one** of the following statements gives the most likely reason for this?

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

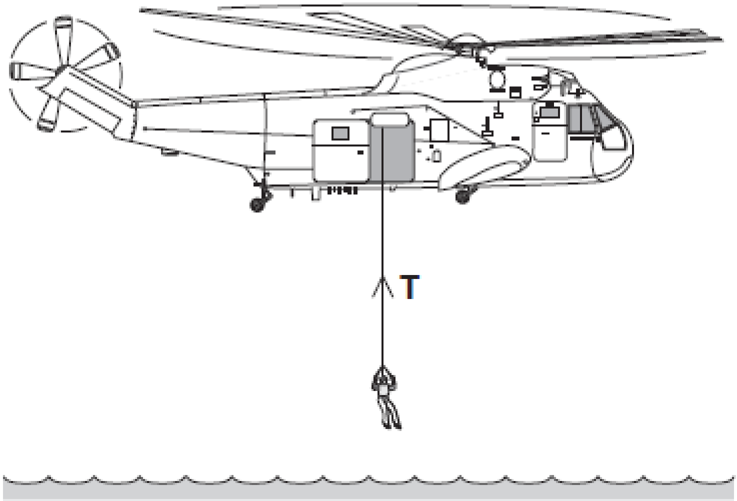
The student does not read the thermometer accurately.	☐
The block transfers energy to the surroundings.	☐
The power supply is not connected correctly to the joulemeter.	☐

(1)

(Total 5 marks)

Q7.

The diagram shows a helicopter being used to rescue a person from the sea.



(a) (i) The mass of the rescued person is 72 kg.

Use the equation in the box to calculate the weight of the rescued person.

weight = mass × gravitational field strength

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

____

____

Weight = ____________________________ N

(2)

(ii) An electric motor is used to lift the person up to the helicopter.
The motor lifts the person at a constant speed.

State the size of the force, **T**, in the cable.

Force **T** = ____________________________ N

(1)

(b) To lift the person up to the helicopter, the electric motor transformed 21 600 joules of energy usefully.

(i) Use a form of energy from the box to complete the following sentence.

gravitational potential	heat	sound

The electric motor transforms electrical energy to kinetic energy. The kinetic energy

is then transformed into useful ______________________________ energy.

(1)

(ii) It takes 50 seconds for the electric motor to lift the person up to the helicopter.

Use the equation in the box to calculate the power of the electric motor.

$$\text{power} = \frac{\text{energy transformed}}{\text{time}}$$

Show clearly how you work out your answer and give the unit.

Choose the unit from the list below.

coulomb (C) **hertz (Hz)** **watt (W)**

____

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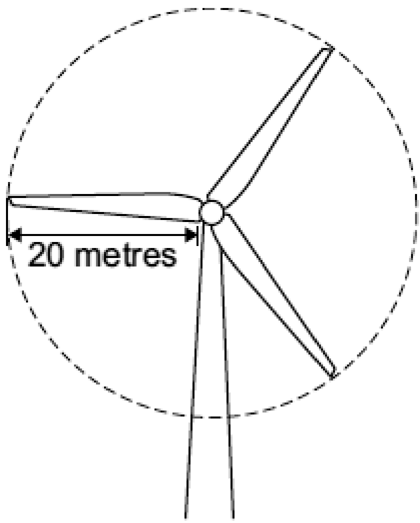
Power = ___________________________

(3)

(Total 7 marks)

Q8.

The diagram shows a wind turbine.



(a) The blades of the turbine are 20 metres long. On average, 15 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

Calculate the kinetic energy of the air hitting the blades every second.

Show clearly how you work out your answer.

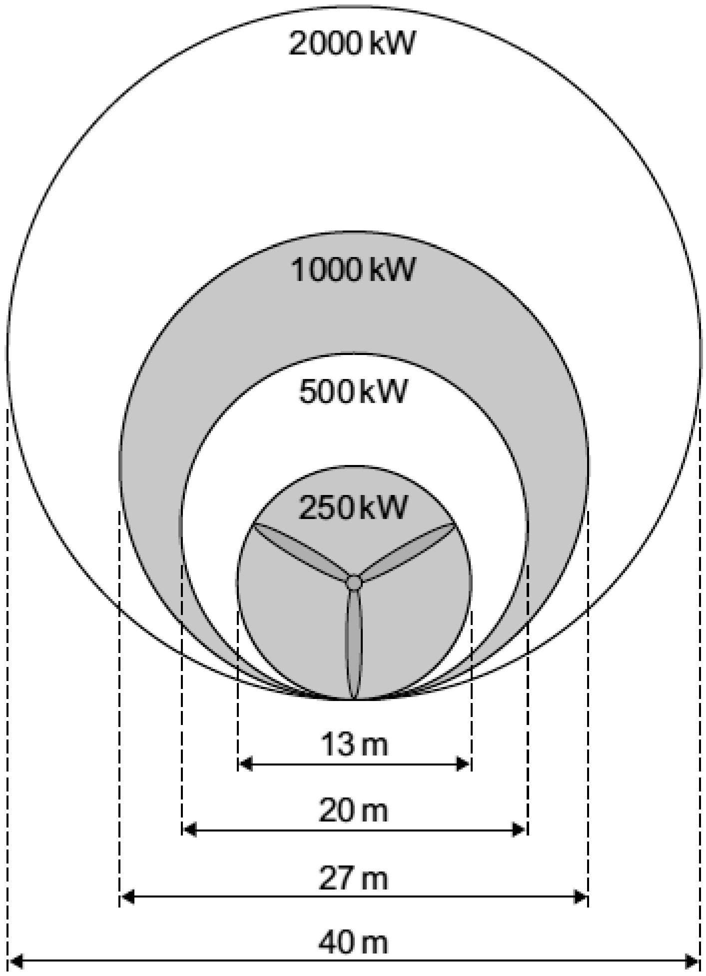
____

____

Kinetic energy = ___________________________ J

(2)

(b) Part of the kinetic energy of the wind is transformed into electrical energy. The diagram shows that, for the same wind speed, the power output of a turbine, in kilowatts, depends on the length of the turbine blades.



Give a reason why doubling the diameter of the blades more than doubles the power output of a turbine.

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(1)

(Total 3 marks)