

PHYSICS



EXAM QUESTION PACK

4.1.1.4 POWER

SCORE

/98

PERCENTAGE

%

STEMUP

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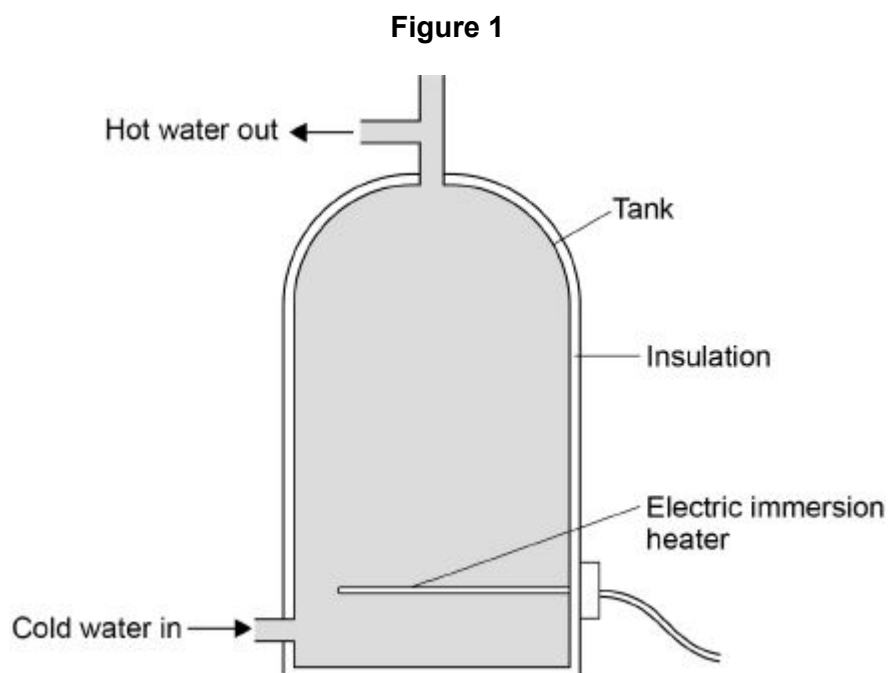
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Q1.

Figure 1 shows a hot water tank made of copper.



- (a) Copper has a higher thermal conductivity than most metals.

How does the rate of energy transfer through copper compare with the rate of energy transfer through most metals?

Tick **one** box.

Higher

☐

Lower

☐

The same

☐

(1)

- (b) The tank is insulated. When the water is hot, the immersion heater switches off.

Complete the sentences.

Compared to a tank with no insulation, the rate of energy transfer from the water in an insulated tank is _____.

This means that the water in the insulated tank stays _____ for longer.

(2)

Figure 2 shows how temperature varies with time for water in a tank heated with an immersion heater.

Figure 3 shows how temperature varies with time for water in a tank heated with a solar panel.

Figure 2

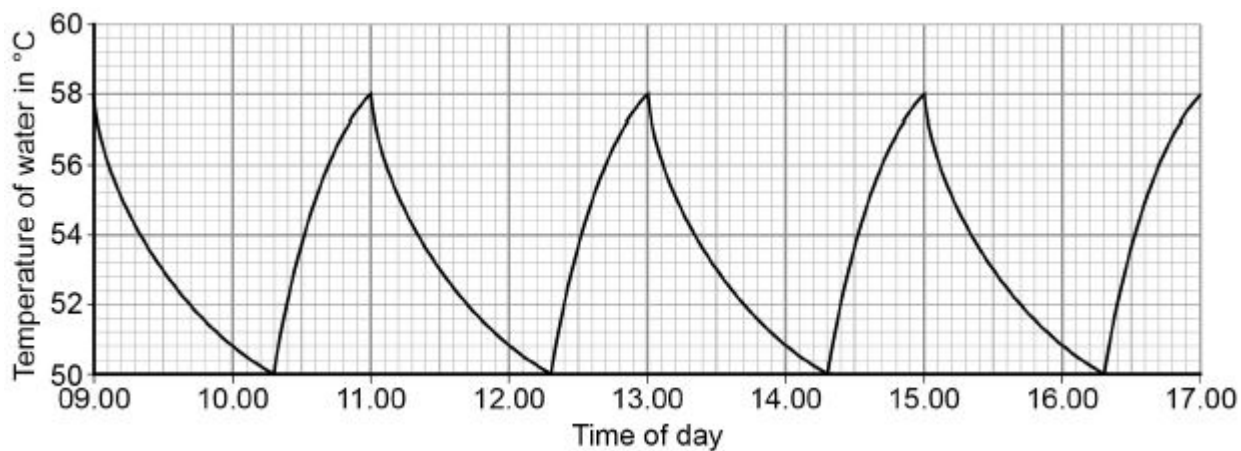
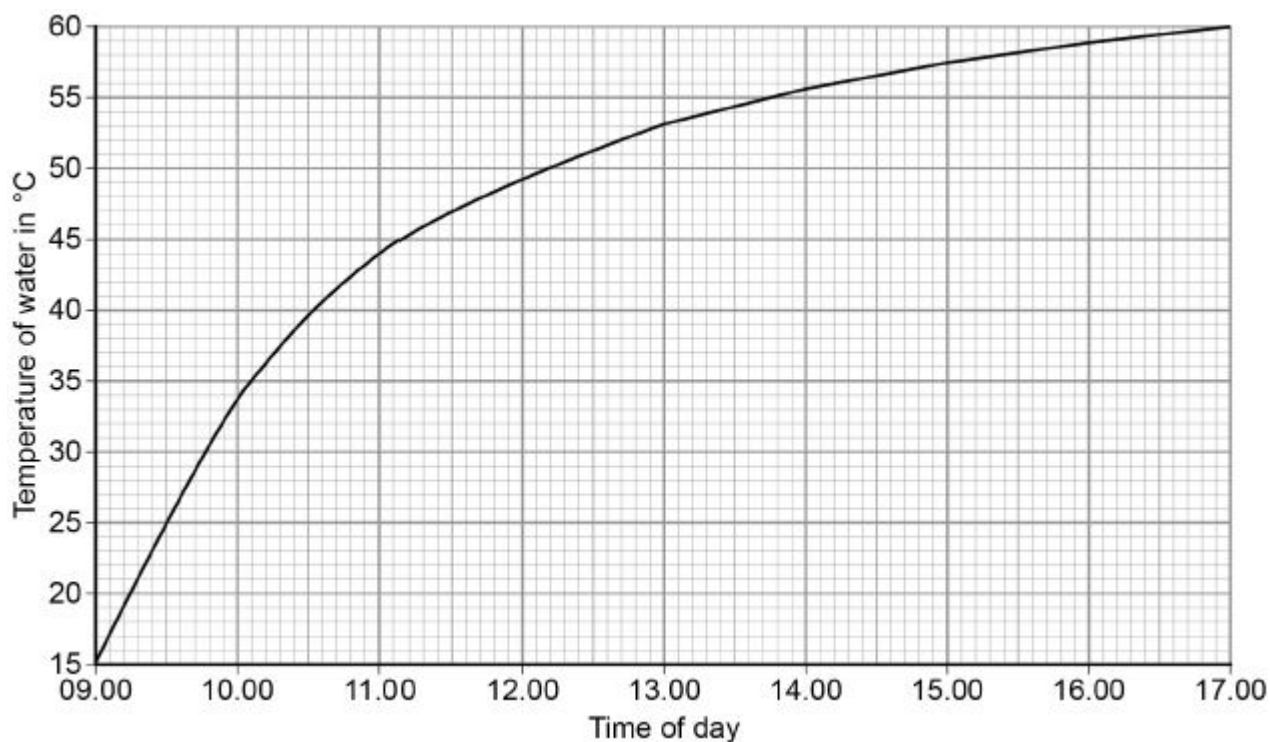


Figure 3



- (c) Give **one** advantage and **one** disadvantage of heating the water using solar panels rather than an immersion heater.

Use only information from **Figure 2** and **Figure 3**.

Advantage of solar panels _____

Disadvantage of solar panels _____

(2)

- (d) During one morning, a total of 4 070 000 J of energy is transferred from the electric immersion heater.

4 030 000 J of energy are transferred to the water.

Calculate the proportion of the total energy transferred to the water.

Proportion of total energy = _____

(2)

- (e) Write down the equation that links energy transferred, power and time.

(1)

- (f) The power output of the immersion heater is 5000 W.

Calculate the time taken for the immersion heater to transfer 4 070 000 J of energy.

Give the unit.

Time = _____ Unit _____

(4)

(Total 12 marks)

Q2.

Figure 1 shows a lift inside a building.

Figure 1



- (a) The motor in the lift does 120 000 J of work in 8.0 seconds.

Calculate the power output of the motor in the lift.

Use the equation:

$$\text{Power output} = \frac{\text{work done}}{\text{time}}$$

Power output = _____ W

(2)

- (b) The power input to the motor is greater than the power output.

Tick **two** reasons why.

Energy is transferred in heating the surroundings.

☐

Friction causes energy to be transferred in non-useful ways.

☐

The motor is connected to the mains electricity supply.

☐

The motor is more than 100% efficient.

☐

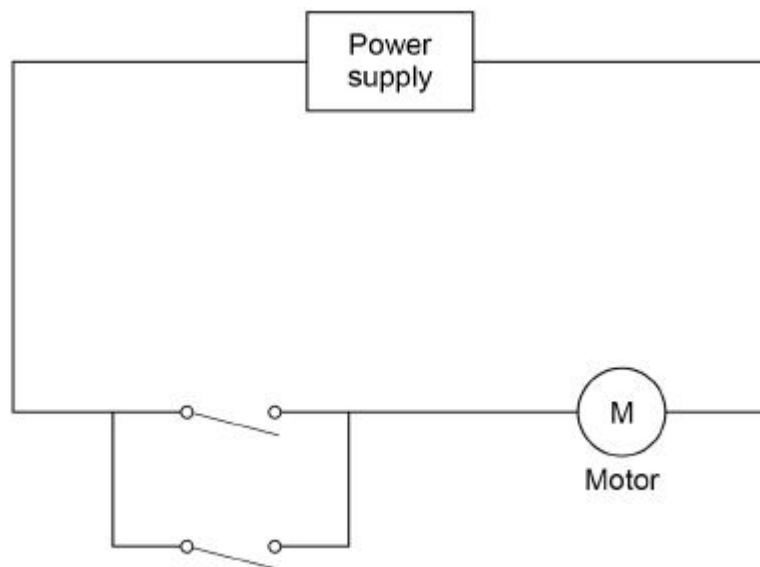
There are only four people in the lift.

☐

(2)

- (c) **Figure 2** shows part of the circuit that operates the lift motor.

Figure 2



The lift can be operated using either of the two switches.

Explain why.

(2)

- (d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

(1)

- (e) The lift goes up 14 m. The total mass of the people in the lift is 280 kg.

gravitational field strength = 9.8 N/kg

Calculate the increase in gravitational potential energy of the people in the lift.

Give your answer to 2 significant figures.

Increase in gravitational potential energy = _____ J

(3)

(Total 10 marks)

Q3.

Figure 1 shows a cyclist riding along a straight, level road at a constant speed.

Figure 1



- (a) Complete the sentences.

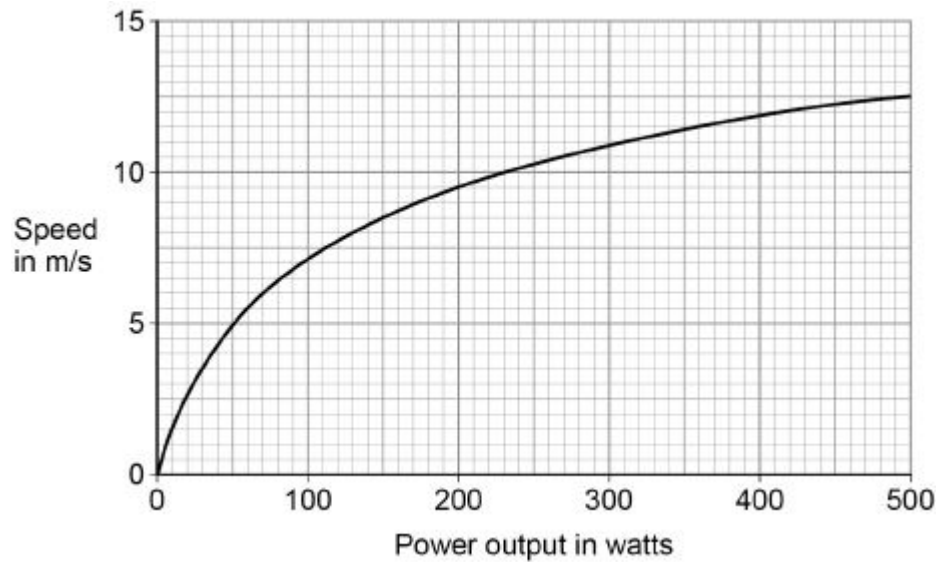
As the cyclist rides along the road, the _____ energy store in the cyclist's body decreases.

The speed of the cyclist is constant when the work done by the cyclist is _____ the work done against air resistance.

(2)

Figure 2 shows how the speed changes as the power output of the cyclist changes.

Figure 2



- (b) Write down the equation that links power, time and work done.

_____ (1)

- (c) Calculate the work done by the cyclist when his power output is 200 W for 1800 seconds.

Work done = _____ J

(3)

- (d) Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 300 W.

Percentage increase in speed = _____

(2)

- (e) The maximum speed this cyclist can travel on a level road is 14 m/s.

How does cycling uphill affect the maximum speed of this cyclist?

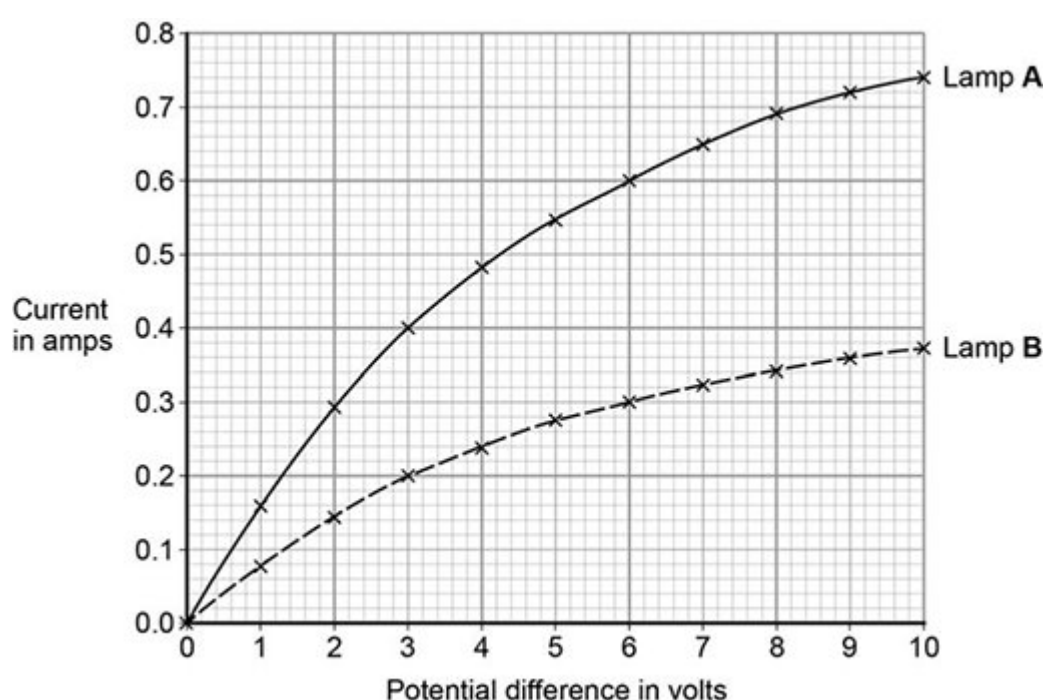
Explain your answer.

(3)
(Total 11 marks)

Q4.

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

(2)

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

Explain how the figure above shows this.

(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.

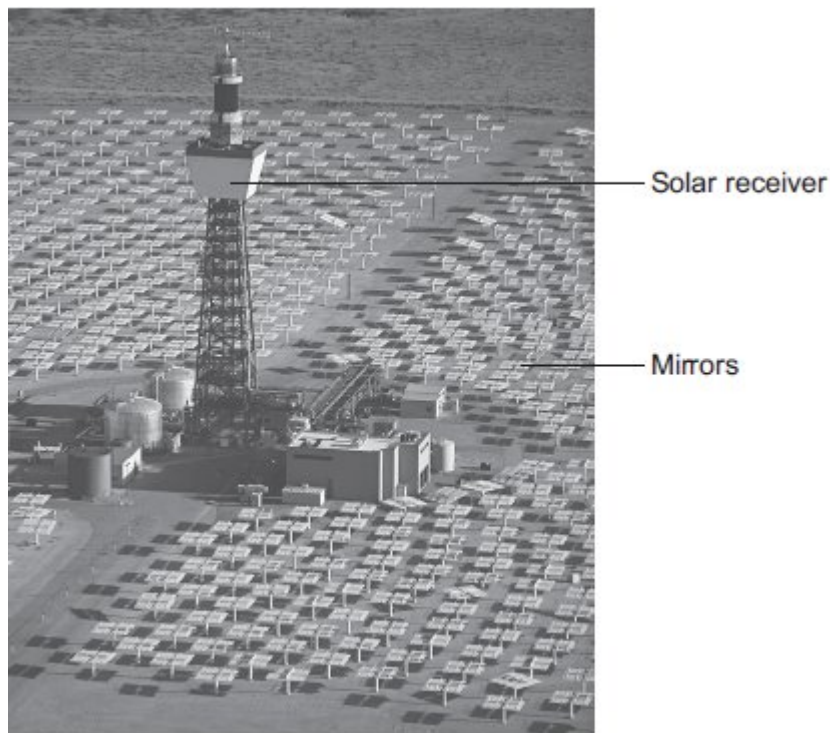
Explain your answer.

(3)

(Total 10 marks)

Q5.

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)

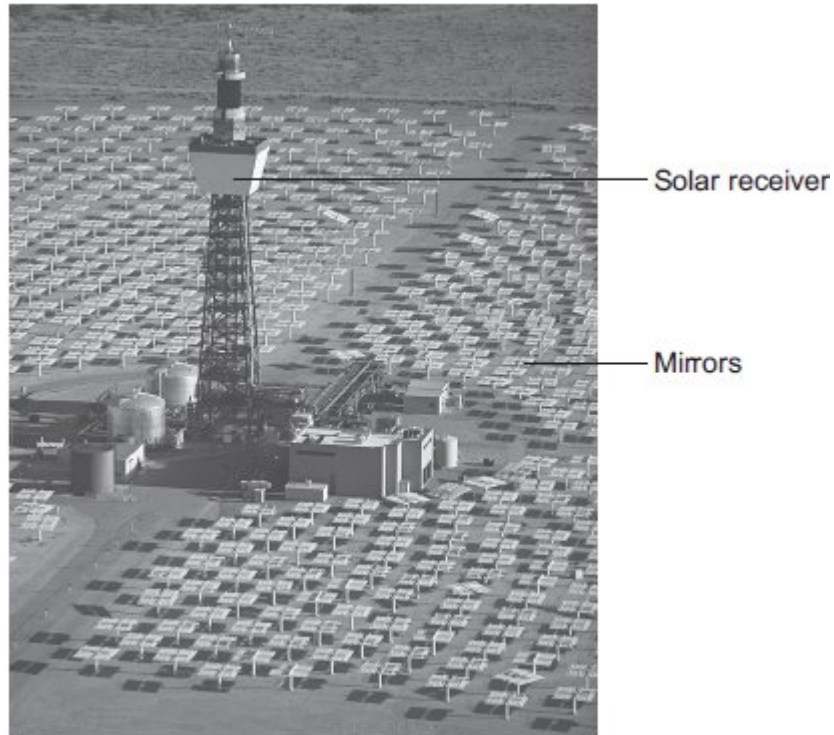
(Total 11 marks)

Q6.

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.



© Kim Steele/Photodisc/Thinkstock

- (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)

Q7.

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.

(2)

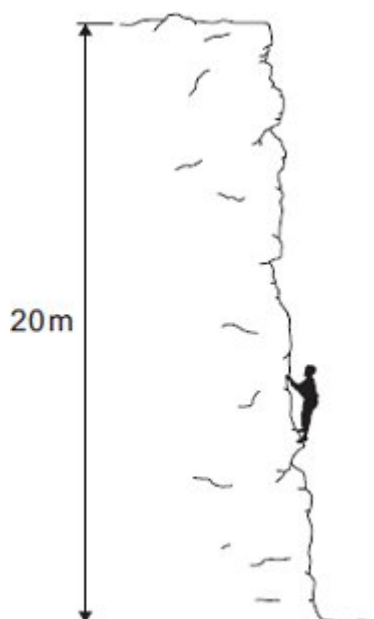
- (iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

(1)

(Total 10 marks)

Q8.

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.

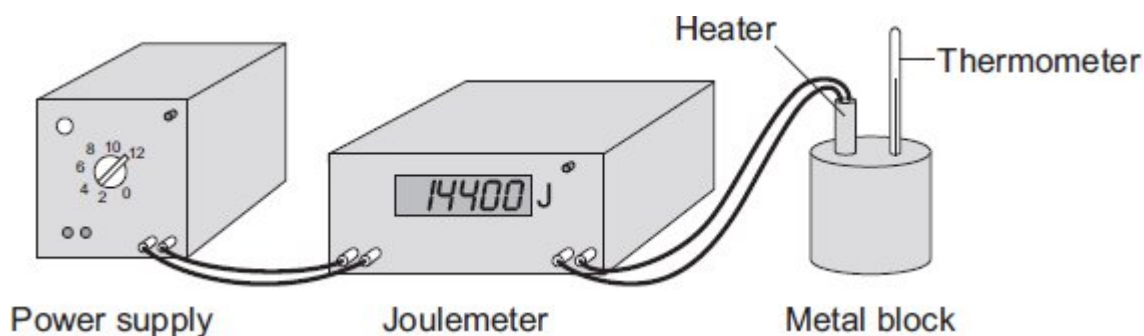
Power = _____ W

(2)

(Total 5 marks)

Q9.

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.

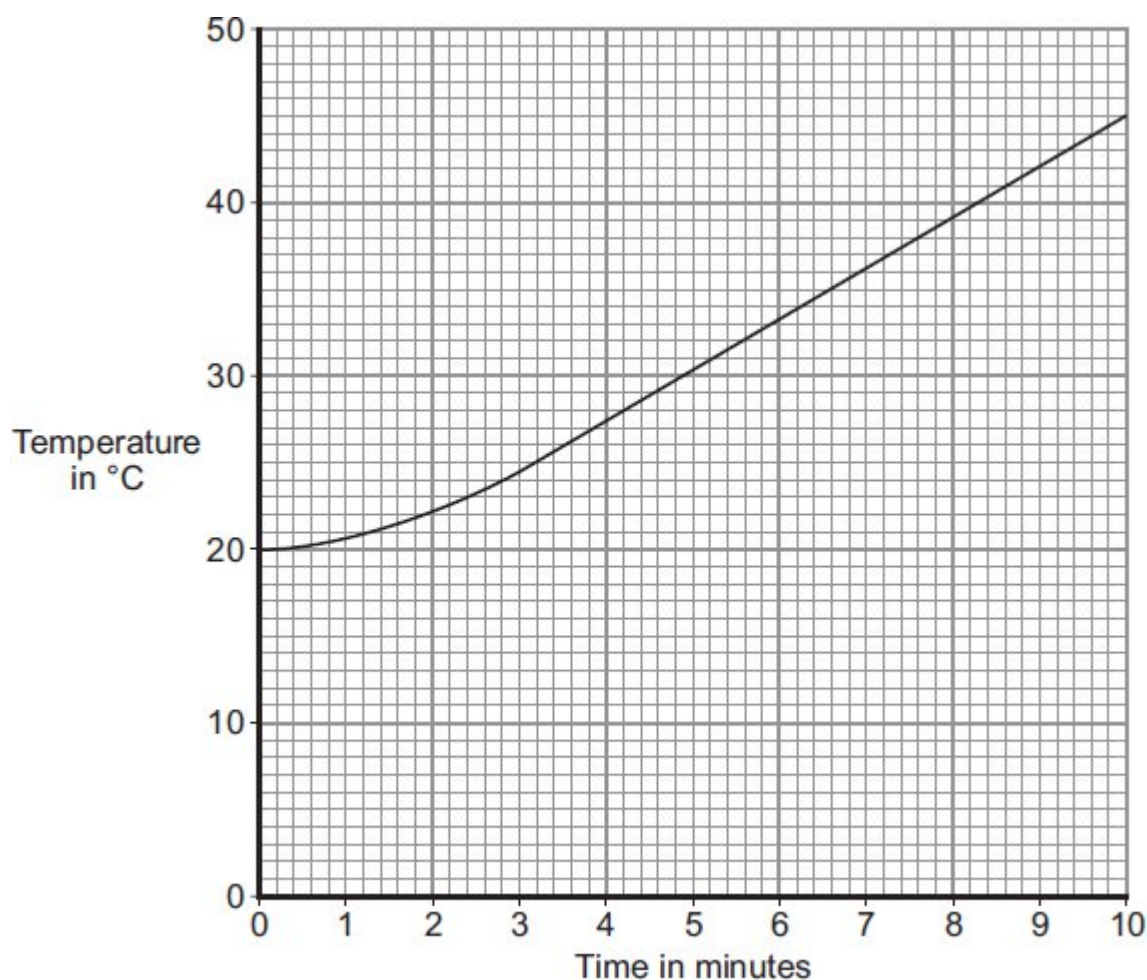
Energy transferred each second = _____ J/s

(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.

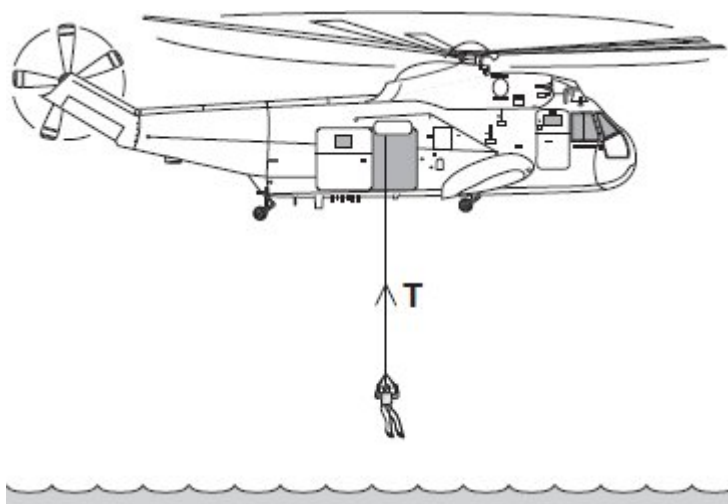


(1)

(Total 5 marks)

Q10.

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.

$\text{weight} = \text{mass} \times \text{gravitational field strength}$
--

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)

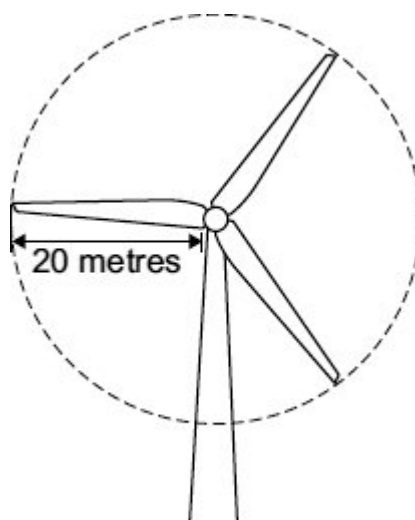
Power = _____

(3)

(Total 7 marks)

Q11.

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.

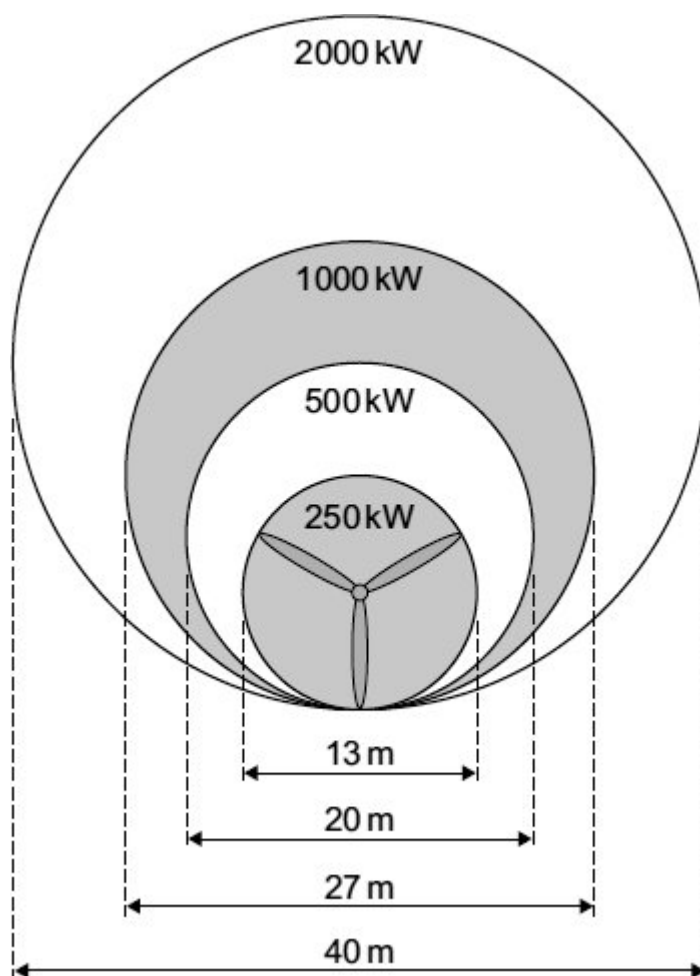
Calculate the kinetic energy of the air hitting the blades every second.

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.

(1)

(Total 3 marks)

Mark schemes

Q1.

- (a) higher 1
- (b) low(er) 1
- hot(ter)
allow warm(er) 1
- (c) advantage:
 • water heated continuously (by the Sun) 1
 one disadvantage from:
 • temperature of water is lower (for most of the time than water heated by immersion heater)
 • water may not be hot enough
allow less control over water temperature
 • it takes longer to heat the water 1
- (d)
$$\frac{4\,030\,000}{4\,070\,000}$$
 1
- 0.99
an answer of 99% scores 2 marks
an answer of 99 or 0.99% scores 1 mark 1
an answer of 0.99 scores 2 marks
allow an answer that rounds to 0.99 for 2 marks
- (e) power = energy transferred / time
allow $P = E / t$ 1
- (f)
$$5000 = \frac{4\,070\,000}{t}$$
 1
- $$t = \frac{4\,070\,000}{5000}$$
 1
- $$t = 814$$
 1
- seconds

other units of time must be consistent with numerical value

1

an answer of 814 seconds scores 4 marks

an answer of 13.57 minutes scores 4 marks

[12]

Q2.

(a) $P = \frac{120\,000}{8.0}$

1

$P = 15\,000 \text{ (W)}$

1

an answer of 15 000 (W) scores 2 marks

(b) energy is transferred in heating the surroundings

1

friction causes energy to be transferred in non-useful ways

1

(c) the switches are in parallel

1

(so) closing either switch completes the circuit

1

(d) gravitational potential energy = mass $\times$ gravitational field strength $\times$ height

allow $E_p = m g h$

1

(e) $E_p = 280 \times 9.8 \times 14$

1

$E_p = 38\,416 \text{ (J)}$

1

$E_p = 38\,000 \text{ (J)}$

an answer that rounds to 38 000 scores 2 marks

1

an answer of 38 000 scores 3 marks

[10]

Q3.

(a) chemical

1

equal to

allow the same as

1

in this order only

(b) $\text{power} = \frac{\text{work done}}{\text{time}}$
allow $P = \frac{W}{t}$ 1

(c) $200 = \frac{W}{1800}$ 1

$W = 200 \times 1800$ 1

$W = 360\,000 \text{ (J)}$ 1

an answer of 360 000 (J) scores 3 marks

(d) $11 - 9.5 = 1.5 \text{ (m/s)}$
allow a change in speed between 1.2 and 1.5 (m/s) 1

$\left(\frac{1.5}{9.5}\right) \times 100 = 15.8 \text{ (\%)}$

allow an answer consistent with their change in speed

an answer of 16 (%) scores 2 marks

an answer that rounds to 15.8 (%) scores 2 marks

(e) maximum speed is lower 1

because maximum power output of cyclist is constant

allow maximum force on pedals is constant

(but) additional work is done (against gravity)

*do **not** accept additional work done against friction or air resistance*

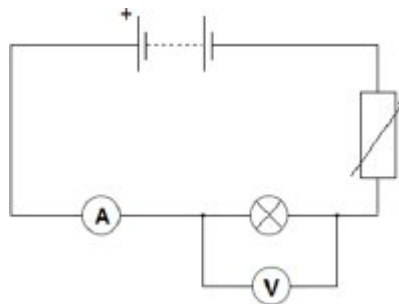
or

gravitational potential energy (of cyclist) is increased

[11]

Q4.

(a)



battery in series with bulb and ammeter

1

voltmeter in parallel with bulb

1

variable resistor

or

variable power pack

or

potentiometer

1

- (b) A is brighter because it has a higher current (than lamp B at any p.d.)

1

(therefore A has a) higher power output (than bulb B)

accept higher energy output per second

1

- (c) lower current (than lamp A) for the same potential difference

accept answer in terms of $R = V / I$

1

lower gradient (than lamp A)

1

- (d) 0 – 2 Volts

allow a range from 0 V up to any value between 1 and 2 V.

1

(for an ohmic conductor) current is directly proportional to potential difference

allow lines (of best fit) are straight and pass through the origin

1

(so) resistance is constant

1

[10]

Q5.

- (a) (i) high levels of infrared radiation (from the Sun)

allow lots of (solar) energy (available)

*do **not** accept 'heat' for infrared*

'it is hot' is insufficient

'lots of sunlight' is insufficient

1

(ii)	reflected	1
(iii)	boiler	
	<i>correct order only</i>	1
	turbine	1
	transformer	1
(b)	2 100 000 (kWh)	
	<i>allow 1 mark for correct substitution i.e. $140\,000 \times 15$ provided no subsequent step</i>	2
(c)	(i) only 1 wind turbine was considered	
	<i>accept only one location is considered</i>	1
	or other wind turbines may have generated more electricity	
	<i>accept insufficient sample size</i>	
	only 1 week's weather was reported on	
	or wind speed varies from one week to another	
	<i>'wind speed varies' is insufficient</i>	1
(ii)	any one from:	
	• wind speed is too high / low	
	<i>allow no wind</i>	
	<i>allow too windy</i>	
	• wind is unreliable.	
	<i>allow wind is variable</i>	1
(iii)	any one from:	
	• wind is a renewable energy source	
	• do not use fuel	
	• energy source is free	
	• do not release carbon dioxide	
	• do not release greenhouse gases	
	• do not release sulfur dioxide	
	• do not cause acid rain	
	• do not cause climate change	
	• do not cause global warming	
	• do not cause global dimming.	
	<i>answer must be an advantage of wind, converse answers in terms of fossil fuels are insufficient</i>	
	<i>accept do not release pollutant gases</i>	
	<i>'no pollution' is insufficient</i>	1

Q6.

- (a) (i) infrared (radiation)
accept IR (radiation) 1
- (ii) (heated) water turns to steam
ignore reference to fossil fuels
*do **not** accept water evaporates to steam* 1
- steam turns a turbine 1
- turbine turns a generator
accept turbine connected to a generator 1
- (b) (i) (so the molten salts) can store large amounts of energy
accept there is a small temperature change for a large energy transfer
accept heat for energy 1
- (ii) 16 (hours)
an answer that rounds to 16 gains 2 marks eg 15.71
allow 1 mark for a correct substitution ie $2\,200\,000 = 140\,000 \times t$ 3
- (iii) the number of daylight hours varies
less sunlight is insufficient 1
- the (mean) power (received from the Sun per square metre) varies
accept an answer in terms of maximum possible electrical output only possible during Summer for 1 mark 1
- (c) (i) non-renewable power stations have higher Capacity Factors than renewable power stations 1
- fuel (for non-renewable power stations) is always available
reference to non-renewable power stations operating all the time is insufficient
non-renewable energy sources are reliable is insufficient 1
- (most) renewable energy sources are unpredictable / unreliable
accept (most) renewable energy sources depend on the weather 1
- (ii) the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources) 1

Q7.

- (a) (i) 150 1
- (ii) transferred to the surroundings by heating
reference to sound negates mark 1
- (iii) 0.75
450 / 600 gains 1 mark
accept 75% for 2 marks
maximum of 1 mark awarded if a unit is given 2
- (iv) 20 (s)
correct answer with or without working gains 2 marks
correct substitution of 600 / 30 gains 1 mark 2
- (b) (i) to avoid bias 1
- (ii) use less power and last longer 1
- 1 LED costs £16, 40 filament bulbs cost £80
or
filament costs (5 times) more in energy consumption 1
- (iii) any **one** from:
 - availability of bulbs
 - colour output
 - temperature of bulb surface
1

[10]

Q8.

- (a) potential 1
- (b) (i) 13 200
allow 1 mark for correct substitution, ie 660×20 provided no subsequent step shown 2
- (ii) 16.5
allow 1 mark for correct
or

$\frac{\text{their (b)(i)}}{800}$ correctly calculated
 substitution, ie $\frac{13\,200}{800}$ or $\frac{\text{their (b)(i)}}{800}$
 provided no subsequent step shown

2

[5]

Q9.

(a) (i) 24

allow **1** mark for converting time to 600 seconds
 or showing method ie $14400/10$

$$\frac{14400}{10 \times 60}$$

provided no further steps shown

2

(ii) 24

ignore any unit

or
 their (a)(i)

1

(b) (i) 20 45

both required – either order

1

(ii) the block transfers energy to the surroundings

1

[5]

Q10.

(a) (i) 720

allow **1** mark for correct substitution,
 ie 72×10 provided no subsequent step shown

2

(ii) 720

or
 their (a)(i)

1

(b) (i) gravitational potential
 allow gravitational
 allow potential

1

(ii) 432

allow **1** mark for correct substitution, ie $\frac{21600}{50}$ provided no
 subsequent step shown

2

watt / W

1

[7]

Q11.

(a) 1 080 000

allow 1 mark for correct substitution

ie $\frac{1}{2} \times 15\,000 \times 12 \times 12$

2

(b) any **one** from:

- KE (of wind) more than doubles
- mass of air (hitting blades) more than doubles
- area swept out by blades more than doubles
*do **not** accept blades are larger / have a bigger area*
- area swept out by blades increases $\times 4$

1

[3]