PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



EXAM QUESTION PACK

SECTION 4: ENERGY RESOURCES AND ENERGY TRANSFERS (PACK 2)

SCORE	PERCENTAGE
/180	%

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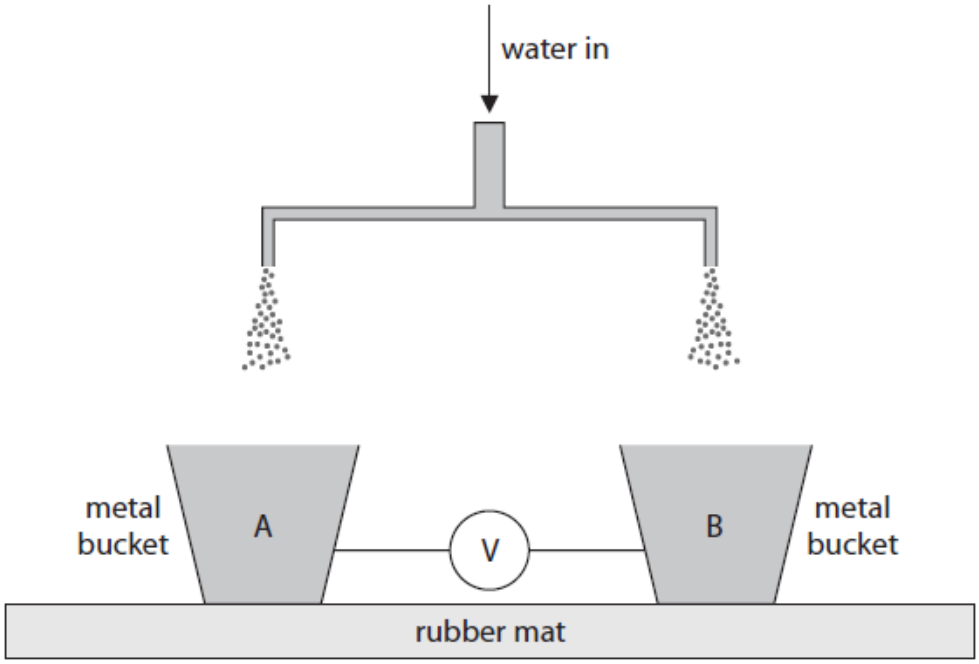
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Q1.

The diagram shows part of a device used to demonstrate electrostatic charge.



(a) Negatively charged water droplets fall into bucket A.

Describe how bucket A becomes negatively charged.

(2)

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(b) Explain why the negatively charged droplets spread out as they fall.

(2)

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(c) (i) A droplet hits bucket A with a speed of 3.8 m/s.

Calculate the kinetic energy of the droplet when it hits bucket A.

[mass of droplet = 6.2×10^{-9} kg]

(3)

kinetic energy = ... J

(ii) The total charge stored in bucket A is -1.1×10^{-10} C.

This charge passes through the air between the buckets in 9.2×10^{-3} s, causing a spark between bucket A and bucket B.

Calculate the mean current between the buckets.

(3)

mean current = ... A

(iii) The spark transfers a charge of -1.1×10^{-10} C.

The mean voltage between the buckets is 1.7 kV.

Calculate the energy transferred by the spark.

(3)

energy transferred = ... J

(Total for question = 13 marks)

Q2.

A racing car uses an engine and an electric motor to power its wheels.



(Source: Jens Mommens/Shutterstock)

(a) The electric motor can only operate at maximum power for part of each lap of the race.

The electric motor has a maximum power output of 1.2×10^5 W.

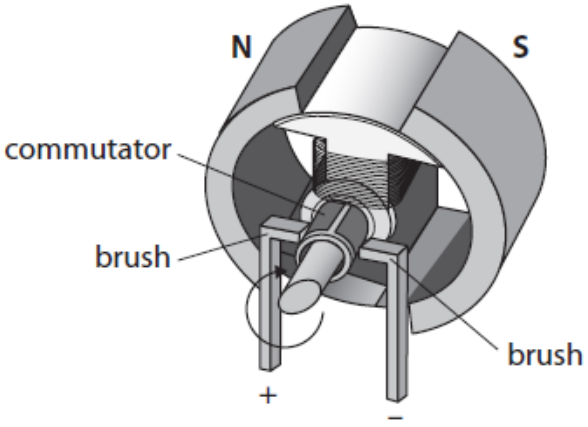
The electric motor transfers 4.0×10^6 J of energy when it operates at maximum power.

Calculate the amount of time the electric motor can operate at maximum power.

(3)

time = ... s

(b) The diagram shows a simplified view of a direct current (d.c.) electric motor.



(i) State what is meant by the term **direct current**.

(1)

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(ii) Explain the purpose of the brushes and the commutator in the d.c. motor.

(3)

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(c) The electric motor in the racing car can also be used as a generator to charge a battery pack. It is known as a motor generator unit (MGU).

The rotating wheels of the car cause the magnets in the MGU to spin near a coil of wire.

This induces a current in the coil when the coil is connected to the battery pack.

(i) Name the energy store of the battery pack that increases when the battery pack is being charged.

(1)

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(ii) Explain why the kinetic energy store of the car must decrease when the MGU charges the battery pack.

(3)

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(Total for question = 11 marks)

Q3.

(a) The table lists four methods of generating electricity and four energy stores.

	Energy store			
Method of generating electricity	**Thermal**	**Gravitational potential**	**Kinetic**	**Chemical**
geothermal power station				
hydroelectric power station				
petrol generator				
wind turbine				

The energy store of the initial energy resource decreases when electricity is being generated.

(i) Complete the table by placing one tick (✓) in each row to show which energy store decreases.

(4)

(ii) State which method of generating electricity in the table does **not** use a renewable energy resource.

(1)

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(b) State two disadvantages of using wind turbines to generate electricity.

(2)

1 .....

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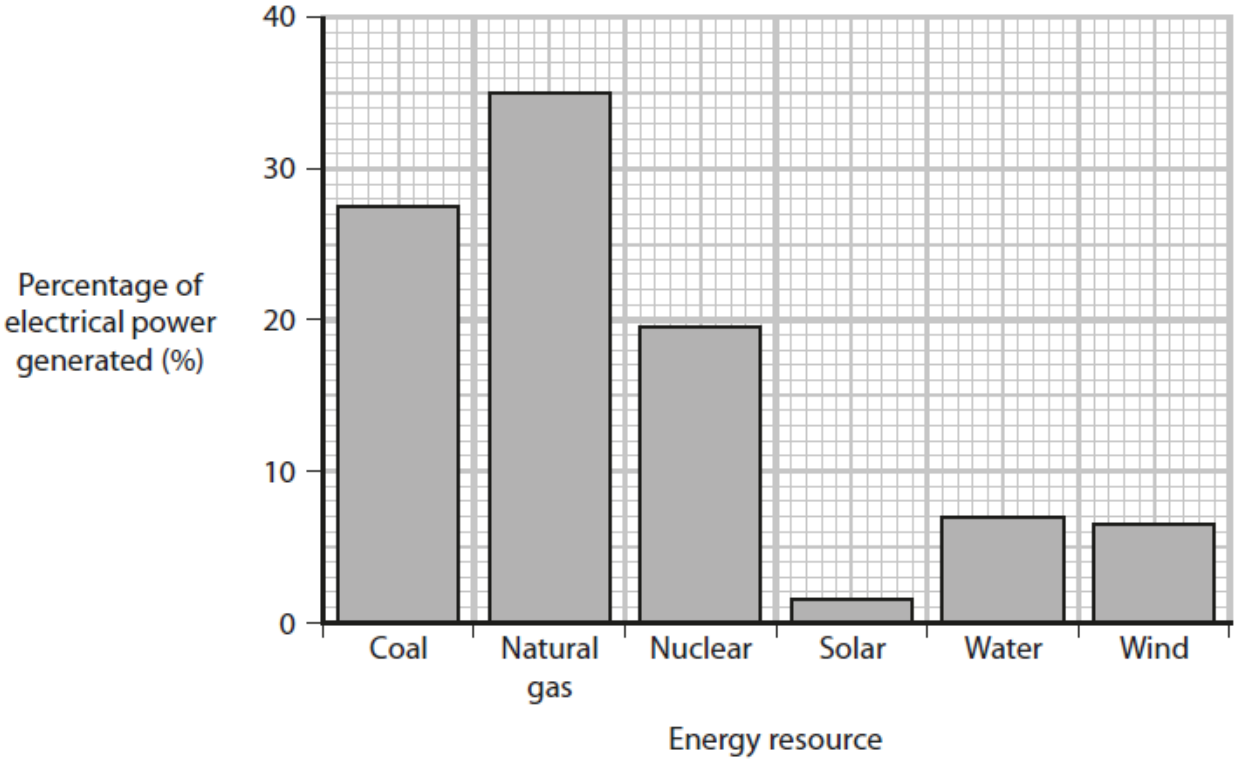
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(Total for question = 7 marks)

Q4.

The bar chart gives information about how some of the electrical power in the United States of America (USA) was generated in the year 2018.



(a) Most of the electricity generated in the USA uses non-renewable energy resources.

(i) State what is meant by the term **non-renewable**.

(1)

.....

.....

(ii) Determine the percentage of electrical power generated using the non-renewable energy resources shown on the bar chart.

(2)

percentage = ... %

(b) In 2018, the USA generated more than half of its electrical power by burning fossil fuels.

Explain one way that burning fossil fuels can be harmful to the environment.

(2)

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(c) The mean total electrical power output of the USA in 2018 was 4.76×10^{11} W.

(i) Calculate the mean electrical power output from solar energy resources.

(2)

mean electrical power output = ... W

(ii) The mean total electrical power output of the USA in 2018 was 4.76×10^{11} W.

A typical solar farm generates 250 W of electrical power for every 1.0 m^2 of land area used.

Calculate the amount of land area needed if the USA were to generate all of its electrical power using solar energy resources.

(2)

land area = ... m^2

(iii) The total land area of the USA is 9.83×10^{12} m^2.

Discuss whether the USA could generate all of its electrical power using solar energy resources.

(3)

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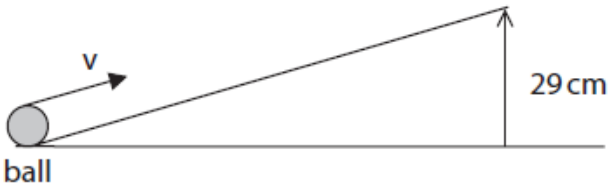
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(Total for question = 12 marks)

Q5.

The diagram shows a ball at the bottom of a ramp. The ball moves up the ramp with an initial

speed v.



(a) State the formula linking gravitational potential energy (GPE), mass, gravitational field strength (g) and height.

(1)

(b) The ball has a mass of 14 g.

Show that when the ball reaches a height of 29 cm above the bottom of the ramp, the GPE gained by the ball is about 4×10^{-2} J.

(3)

(c) At the bottom of the ramp, the 14 g ball has a kinetic energy (KE) of 5.1×10^{-2} J.

Calculate the speed of the ball at the bottom of the ramp.

(3)

speed = ... m / s

(d) The ball is stationary when it reaches the top of the ramp. There is a difference between the KE of the ball at the bottom of the ramp and the GPE of the ball at a height of 29 cm above the bottom of the ramp.

Explain why the work done by friction between the ball and the ramp is equal to this difference.

(2)

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(Total for question = 9 marks)

Q6.

The photograph shows the Three Gorges Dam in China, one of the largest hydroelectric power stations on Earth.



© PRILL/Shutterstock

(a) State two advantages of generating electricity using hydroelectric power stations.

(2)

1 .....

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2 .....

.....

(b) Water is held in a reservoir on one side of the dam.

The water flows through turbines to a river on the other side of the dam.

The water level of the river is lower than the water level of the reservoir.

(i) State which energy store of the water decreases as the water flows from the reservoir to the river.

(1)

.....

(ii) How is energy transferred from the dam to homes and factories in China?

(1)

☒ **A** by heating

☒ **B** by radiation

☒ **C** electrically

☒ **D** mechanically

(c) The Three Gorges Dam has a larger maximum output power than any other hydroelectric

power station on Earth.

(i) State what is meant by the term **power**.

(1)

.....

.....

(ii) The mean energy transferred by the dam each day is 9.7×10^{14} J.

Calculate the mean output power of the dam.

(3)

mean output power = ... W

(iii) The maximum output power is 22 500 MW.

Which of these is the same as 22 500 MW?

(1)

☒ **A** 22 500 000 J

☒ **B** 22 500 000 J/s

☒ **C** 22 500 000 000 J

☒ **D** 22 500 000 000 J/s

(iv) Suggest why the Three Gorges Dam does not always operate at its maximum output power.

(1)

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(Total for question = 10 marks)

Q7.

The photographs show two large-scale electrical production methods

- a hydroelectric power (HEP) station
- a wind farm



(Source: © Bryan Busovicki/Shutterstock)

Hydroelectric power station



(Source: © Tom Buysse/Shutterstock)

Wind farm

(a) Discuss the advantages and disadvantages of using hydroelectric power stations compared with wind farms for large-scale electricity production.

(4)

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(b) Describe the energy transfers that are involved in generating electricity in a hydroelectric power station.

(3)

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(Total for question = 7 marks)

Q8.

A dog sits on a water-filled bag to keep cool.



(a) The table shows some data about the dog and the water in the bag.

mass of water in kg	8.7
power output of dog by heating in W	75
specific heat capacity of water in J/kg °C	4200
initial temperature of water in °C	16

The dog sits on the bag for 22 minutes.

(i) Calculate the energy transferred from the dog to the water by heating in 22 minutes.

(3)

energy = ... J

(ii) State an assumption you have made when calculating the energy transferred.

(1)

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.....

(iii) Calculate the temperature of the water after 22 minutes.

(4)

temperature = ... °C

(b) Discuss why conduction is the main way that thermal energy is transferred from the dog to the water.

(3)

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(Total for question = 11 marks)

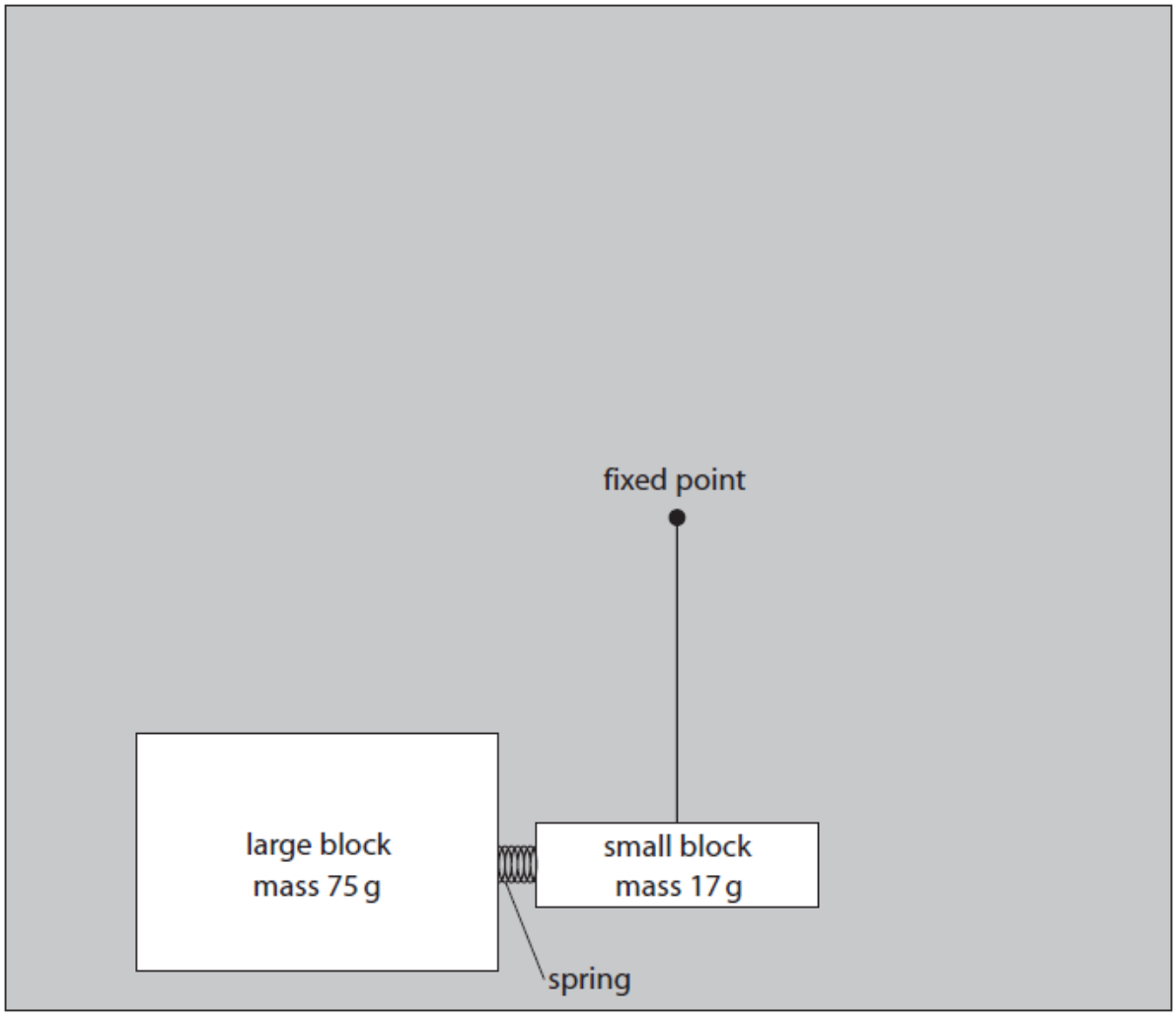
Q9.

The diagram shows two blocks at rest on a table, viewed from above.

A spring is attached to the large block.

The small block is attached by a piece of string to a fixed point on the table.

A student pushes the two blocks together so that the spring is compressed.



(a) The student releases the blocks.

The kinetic energy (KE) store of the small block is 0.29 J when the blocks are no longer in contact.

Show that the speed of the small block is about 6 m/s.

(3)

(b) Using ideas about momentum, show that the speed of the large block is about 1 m/s after the blocks are no longer in contact.

(4)

(c) The small block takes 0.11 s to reach 6 m/s.

Calculate the mean force exerted on the small block by the spring.

(3)

mean force = ... N

(d) The small block then moves around the fixed point on the table.

The block moves in a circular orbit of radius 17.6 cm at a constant orbital speed of 6 m/s.

The time period of the orbit can be found using the formula

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}}$$

Calculate the time period of the orbit.

(3)

time period = ... s

(Total for question = 13 marks)

Q10.

This question is about energy resources.

(a) The table lists some methods of generating electricity using energy resources.

Place ticks (✓) in the table to show if each method uses a renewable energy resource. One has been done for you.

(3)

Method of generating electricity	Uses a renewable energy resource
coal power station	
diesel generator	
geothermal power station	
hydroelectric power station	
natural gas turbine	
nuclear power station	
solar cell	✓
wind turbine	

(b) Solar cells can be used to generate electricity.

(i) How is energy transferred from the Sun to a solar cell?

(1)

☒ **A** by heating

☒ **B** by radiation

☒ **C** electrically

☒ **D** mechanically

(ii) State one disadvantage of using solar cells to generate electricity.

(1)

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(Total for question = 5 marks)

Q11.

This is a question about a nuclear fusion power station.

(a) Explain what happens during nuclear fusion.

(3)

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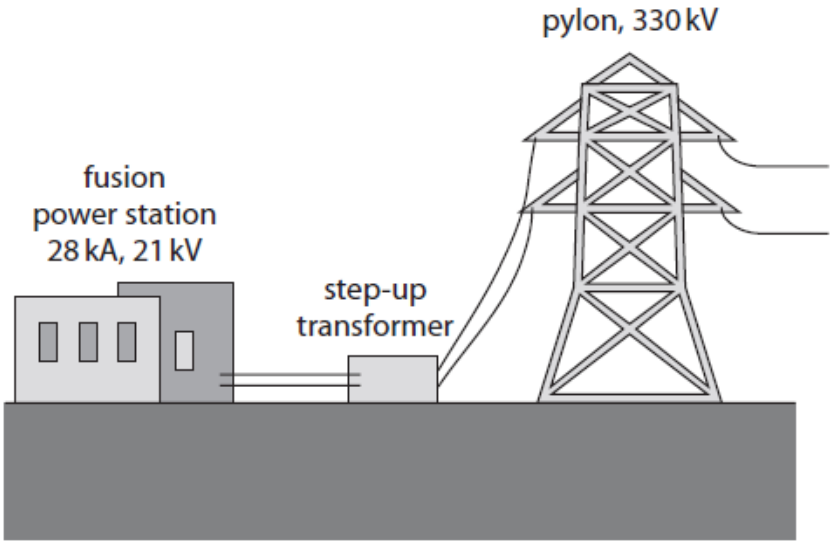
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(b) The diagram shows how a fusion power station could supply the National Grid in the future.



(i) State the main method of energy transfer from the fusion power station generator to the primary coil of the
step-up transformer.

(1)

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(ii) The fusion power station could supply the input coil of the step-up transformer with a current of 28 kA at a
voltage of 21 kV.

The output coil of the transformer has a voltage of 330 kV.

Assume the transformer is 100% efficient.

Calculate the current in the output coil of the transformer.

(3)

current = ... kA

(Total for question = 7 marks)

Q12.

Energy is transferred from the Sun to the Earth.

(a) Nuclear fusion happens in the Sun.

(i) Which energy store of the Sun decreases during nuclear fusion?

(1)

☒ **A** chemical

☒ **B** kinetic

☒ **C** nuclear

☒ **D** thermal

(ii) How is energy transferred through space from the Sun to the Earth?

(1)

☒ **A** by heating

☒ **B** by radiation

☒ **C** electrically

☒ **D** mechanically

(b) Solar panels use energy from the Sun to heat water.



© John_T/Shutterstock

(i) The total area of the solar panels is 15 m^2.

Each 1.0 m^2 of the solar panels receives 1000 J of energy per second from the Sun.

Show that the total energy transferred to the solar panels in 2 hours is about 100 MJ.

(3)

(ii) A mass of 1100 kg of cold water is in the solar panels at an initial temperature of 20 °C.

Calculate the final temperature of this water after it has been heated by the Sun for 2 hours.

[specific heat capacity of water = 4200 J/kg °C]

(4)

final temperature = ... °C

(iii) Give a reason why the actual final temperature of the water will be lower than the calculated value.

(1)

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.....

(Total for question = 10 marks)

Q13.

This question is about heating water.

(a) Liquid water boils and becomes a gas at 100 °C.

Describe the differences between the arrangement and motion of particles in a liquid and in a gas.

You may include a diagram in your answer.

(3)

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(b) A teacher uses a 2200 W kettle to heat water.

The kettle is switched on for 2 minutes.

(i) Calculate the energy transferred by the kettle.

(3)

energy transferred = ... J

(ii) State the equation relating change in thermal energy, mass, specific heat capacity and change in temperature.

(1)

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(iii) The mass of water in the kettle is 1.1 kg and its initial temperature is 20 °C.

Calculate the final temperature of the water after it has been heated for 2.0 minutes.

[the specific heat capacity of water is 4200 J/kg °C]

(4)

final temperature = ... °C

(c) The teacher measures the final temperature of the water after heating it for 2 minutes.

(i) Name a piece of equipment the teacher could use to measure the temperature of the water.

(1)

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(ii) Explain why the measured final temperature is different from your calculated value.

(2)

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(Total for question = 14 marks)

Q14.

A student uses a watt-meter to measure the power of electrically-operated appliances.



(a) State what is meant by the term **power**.

(1)

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.....

(b) The student measures the mean power output (in watts) for six different appliances.

Diagram 1 shows their results.

Toaster = 1068 W

Kettle = 2025 W

Laptop = 47 W

Electric drill = 713 W

Television = 59 W

Hair dryer = 1511 W

Diagram 1

Draw a results table for the student's results.

(2)

(c) The student measures the power output for a different appliance.

Diagram 2 shows their raw data.

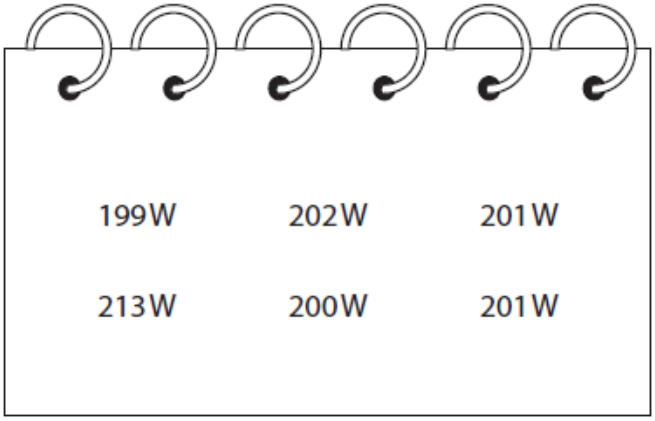


Diagram 2

(i) The student identifies an anomalous result in their data.

Draw a circle around the anomalous result.

(1)

(ii) Calculate the mean power output for this appliance.

Give your answer to three significant figures.

(3)

mean power output = ... W

(Total for question = 7 marks)

Q15.

The photograph shows a solar power farm.



© Alessandro Pierpaoli/Shutterstock

(a) Discuss the advantages and disadvantages of using solar power rather than fossil fuels to generate electricity.

(4)

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(b) Solar panels produce direct current (d.c.).

The National Grid in many countries operates on alternating current (a.c.).

Describe the difference between direct current (d.c.) and alternating current (a.c.).

(2)

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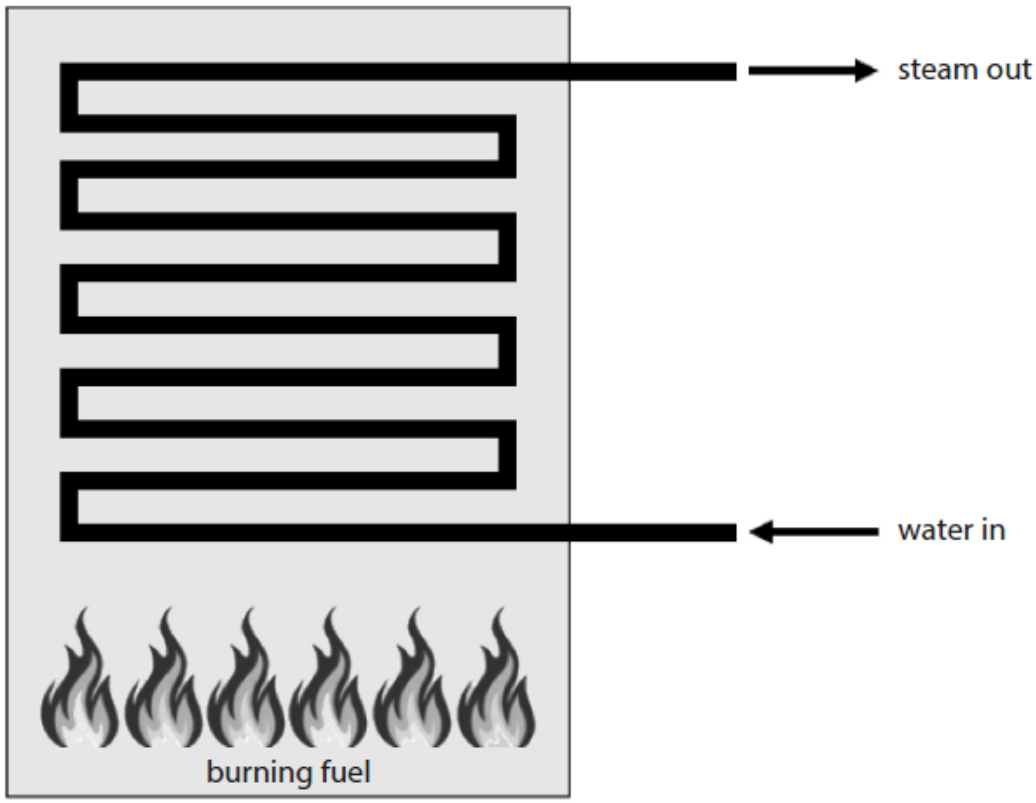
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(Total for question = 6 marks)

Q16.

Conventional power stations burn fuel in a furnace.



(a) The fuel can be a solid, a liquid or a gas.

Describe the motion of particles in a solid, a liquid and a gas.

(3)

solid

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liquid

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gas

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(b) When the fuel is burned, energy is transferred from the fuel to the water.

The water boils and turns into steam.

(i) Describe how energy stored in the fuel is transferred to the water.

Refer to energy stores and transfers in your answer.

(3)

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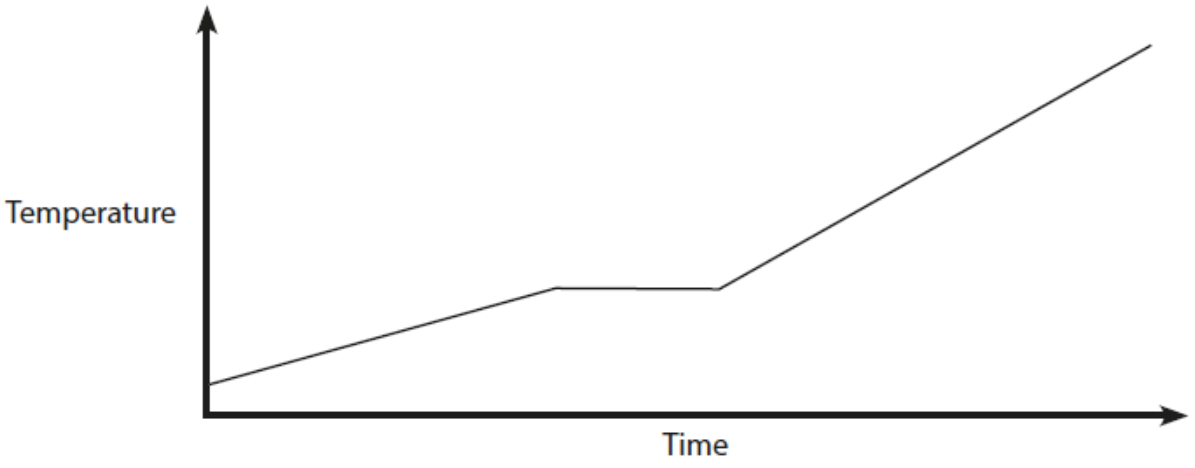
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(ii) The temperature-time graph shows how the temperature of the water changes as it is heated in the furnace at a constant rate.



Explain how the graph shows that the water changes state as it is heated.

(2)

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(Total for question = 8 marks)

Q17.

A student heats a sample of water.

The student measures the temperature of the sample of water during heating.

(a) The sample of water has a mass of 0.45 kg.

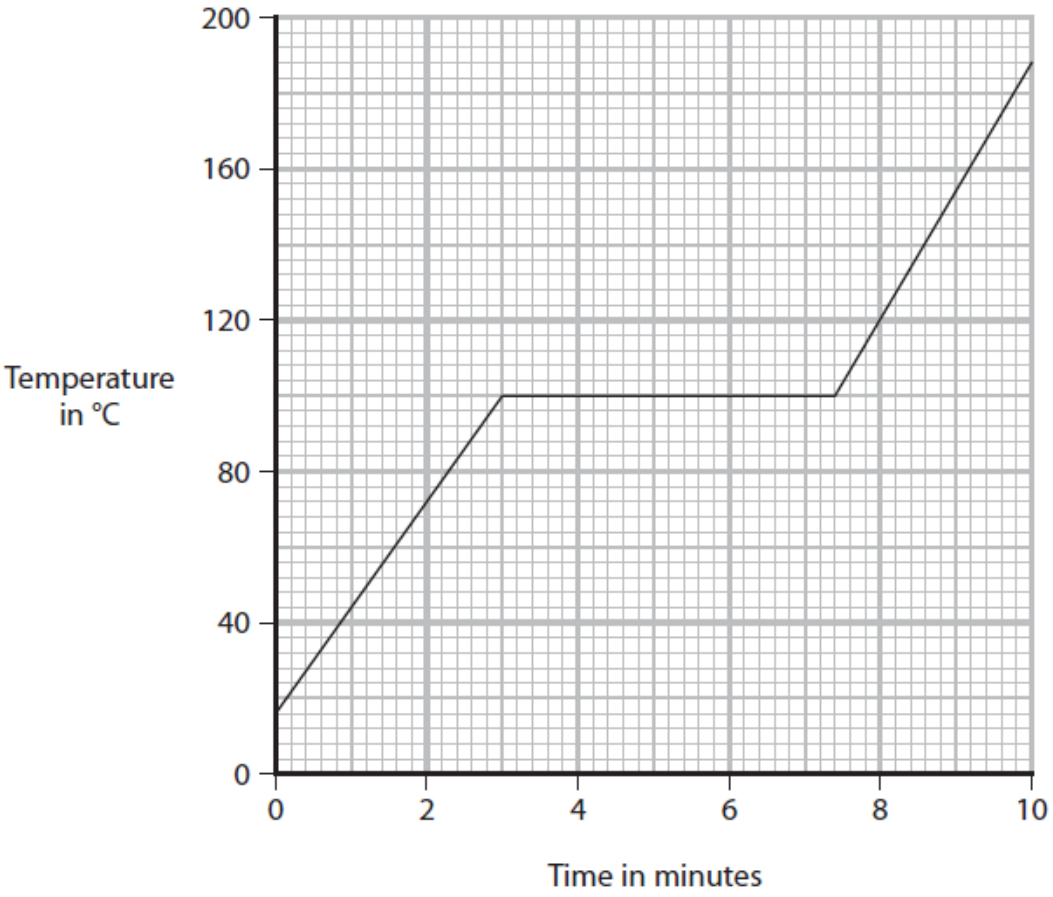
Calculate the energy required to increase the temperature of the water from 16 °C to 100 °C.

[specific heat capacity of water = 4200 J / kg °C]

(3)

energy = ... J

(b) The diagram shows the temperature-time graph for the sample of water.



(i) Use the graph to determine the time taken from when the water started to boil to when the water stopped boiling.

(1)

time taken = ... minutes

(ii) The heater used to heat the water has a power rating of 2200 W.

Calculate the energy required to boil all of the water.

(3)

energy = ... J

(c) Give a reason why the liquid water should be stirred during the heating.

(1)

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(d) When water boils, the liquid water becomes a gas called steam.

Describe the changes in arrangement and motion of the molecules in liquid water and the molecules in steam.

(4)

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(Total for question = 12 marks)

Q18.

The Parker Solar Probe is a spacecraft that was launched in 2018 on a mission to explore the Sun.

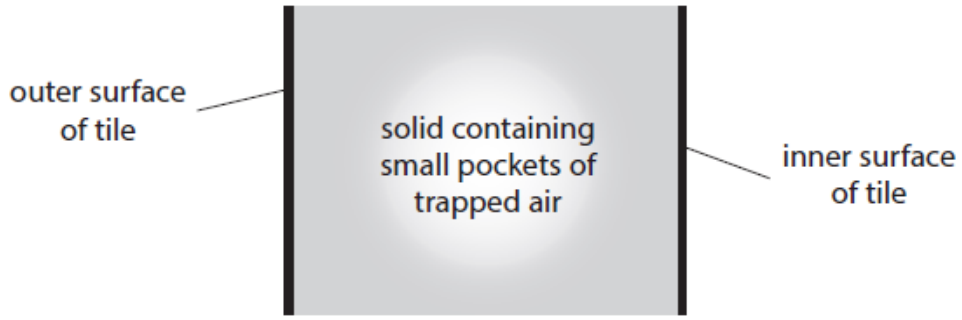
The spacecraft is partly covered in tiles.

These tiles are filled with a solid containing small pockets of trapped air.

The outer surface of the tiles is painted white.

These tiles protect the electric circuits in the spacecraft from extreme temperatures.

(a) The diagram shows one of these tiles in cross-section.



(i) Explain why the outer surface of the tile is painted white.

(2)

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(ii) Explain how the small pockets of trapped air help to reduce thermal energy transfer from the outer surface to the inner surface of the tile.

(2)

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(b) The electric circuits inside the spacecraft are cooled by 4.5 kg of water.

The initial temperature of the water is 35 °C.

The thermal store of the water increases by 210 kJ.

Calculate the final temperature of the water.

[specific heat capacity of water = 4200 J/kg °C]

(4)

final temperature = ... °C

(Total for question = 8 marks)

Q19.

Wind is a renewable resource used to generate electricity.

(a) (i) State **one** advantage and **one** disadvantage of producing electricity using wind turbines.

(2)

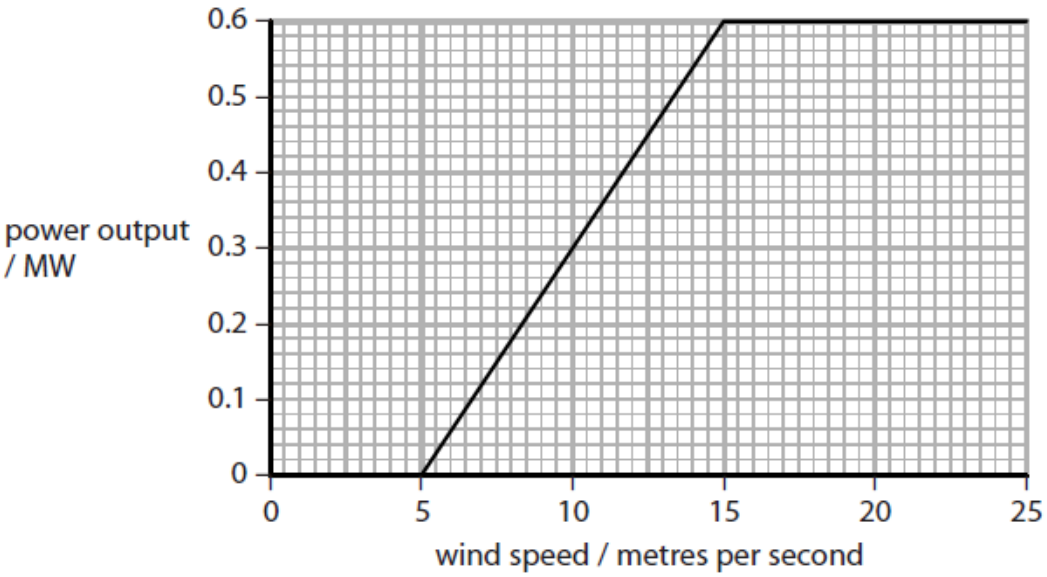
Advantage .....

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Disadvantage .....

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(ii) The graph shows how the power output of a wind turbine varies with wind speed.



Describe how the power output of a wind turbine varies with wind speed.

You should use data points from the graph in your answer.

(3)

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(b) A wind turbine produces an alternating voltage of 600 V.

The voltage needs to be increased to 132 kV before transmission to a nearby town.

The size of the voltage is changed using a transformer.

Describe the structure and operation of a suitable transformer.

You may use a diagram in your answer.

(5)

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(Total for question = 10 marks)