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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P7: Energy (F)

GCSE Physics A Foundation Tier (J249) · Topic P7

47 questions · 252 marks · Mark schemes included

OCR GCSE (9–1) Physics A (Gateway Science) J249, June 2018 – June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

47 questions · 252 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P7.1

WORK DONE

22 questions in this sub-topic · 86 marks · lowest tariff first



- 9** An object moved 20 cm with a force of 20 N.

Use the equation: work done = force $\times$ distance

Which is the correct calculation of work done?

- A** 0.4 J
- B** 4.0 J
- C** 40 J
- D** 400 J

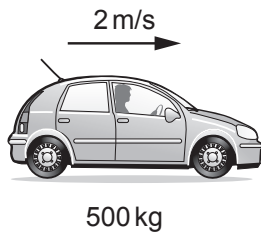
Your answer

[1]

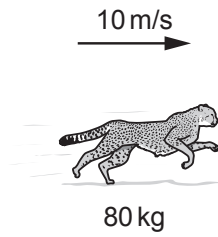


13 Which of the following has the **most** kinetic energy?

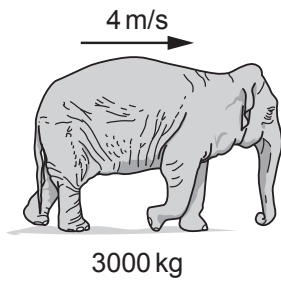
A



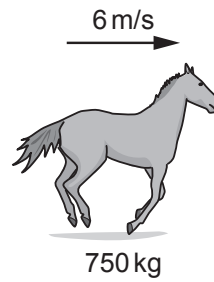
B



C



D



Your answer

[1]

15 A lorry has a mass of 3500 kg. It travels at a speed of 30 m/s.

Use the equation: Kinetic Energy = $0.5 \times \text{Mass} \times \text{Speed}^2$

Calculate the kinetic energy of this lorry.

- A** 10 500 J
- B** 52 500 J
- C** 1 575 000 J
- D** 3 150 000 J

Your answer

[1]



- 9** A runner has a mass of 80 kg and moves at a speed of 5 m/s.

Calculate the kinetic energy of the runner.

Use the equation: kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

- A** 200 J
- B** 1000 J
- C** 2000 J
- D** 40 000 J

Your answer

[1]



12 A boy of mass 65 kg climbs a ladder of height 3.0 m.

Calculate the gain in potential energy of the boy.

Use the equation: potential energy = mass $\times$ height $\times$ gravitational field strength

Gravitational field strength = 10 N/kg.

- A** 30 J
- B** 195 J
- C** 650 J
- D** 1950 J

Your answer

[1]



13 The kinetic energy of motorbike **X** is 10 kJ.

Motorbike **Y** has the same speed but double the mass.

What is the kinetic energy of motorbike **Y**?

Use the equation: kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

- A** 5 kJ
- B** 10 kJ
- C** 20 kJ
- D** 40 kJ

Your answer

[1]



12 A book of mass 3 kg is lifted vertically onto a shelf 1.5 m high.

Calculate the gain in potential energy of the book.

Assume gravitational field strength = 10 N/kg.

Use the equation: potential energy = mass × height × gravitational field strength

A 0.45 J

B 5.0 J

C 20 J

D 45 J

Your answer

[1]



8 A force of 6 N moves through a distance of 3 m in the direction of the force.

Calculate the work done.

A 0.5 J

B 2 J

C 9 J

D 18 J

Your answer

[1]



15 A dog has a mass of 10 kg and runs at a speed of 14 m/s.

What is the kinetic energy of the dog?

Use the equation: kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

- A** 70 J
- B** 196 J
- C** 980 J
- D** 1960 J

Your answer

[1]



- 1 A motor transfers 4.3 kJ of energy.

What is 4.3 kJ converted into joules?

- A 0.0043 J
- B 0.43 J
- C 430 J
- D 4300 J

Your answer

[1]



10 In which of these situations is the **most** work done?

- A** 5 kg cat climbing 5 m vertically upwards
- B** 10 kg dog climbing 10 m vertically upwards
- C** 50 kg boy climbing 10 m vertically upwards
- D** 75 kg man climbing 5 m vertically upwards

Your answer

[1]



15 What is 15 J converted into newton-metres?

A 0.15 Nm

B 1.5 Nm

C 15 Nm

D 150 Nm

Your answer

[1]



12 A book is lifted a vertical distance, x , from the floor to a table.

The gravitational potential energy store of the book increases by 10 J.

The book is then lifted a further vertical distance, x , from the table onto a shelf.

What is the **total** increase in the gravitational potential energy store of the book when it is lifted from the floor to the shelf?

A 5 J

B 10 J

C 20 J

D 40 J

Your answer

[1]



14 A force of 1200 N moves an object a distance of 16 m.

What is the work done on the object?

Use the equation: work done = force $\times$ distance

A 75 J

B 9600 J

C 19200 J

D 153600 J

Your answer

[1]

- 4 A ball is lifted vertically from a height of 1.6 m to a height of 2.0 m.

The force used to lift the ball is 3.0 N.

What is the **work done** on the ball?

Use the equation: work done = force $\times$ distance

A 1.2 J

B 3.2 J

C 4.8 J

D 6.0 J

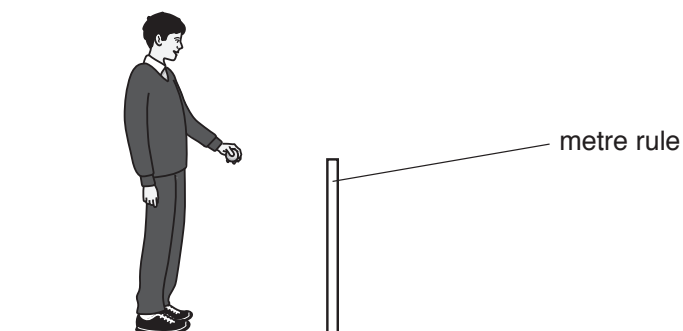
Your answer

[1]



17 A student wants to investigate how a ball bounces.

He drops the ball from different heights and measures the bounce height each time.



He calculates the ratio bounce height / drop height.

The table shows his results.

Drop height (cm)	Bounce height (cm)	Bounce height / drop height
100	70	0.70
80	64	0.80
60	54	0.90
40	40	1.00
20		

(a) The student predicts the ratio bounce height / drop height to be 1:1 when the drop height is 20 cm.

(i) Suggest why he has made this prediction.

.....
 [1]

(ii) Use ideas about energy to explain why this prediction cannot be correct.

.....
 [1]

(b) Suggest **two** improvements to his experiment.

1

.....

.....

2

.....

.....

[2]

(c) The mass of the ball is 60 grams.

(i) Calculate the mass of the ball in kg.

Mass = ... kg [1]

(ii) Calculate the potential energy of the ball when it is 0.80 m above the ground.

Use your answer to (c)(i) and the equation:

potential energy = mass $\times$ height $\times$ gravitational field strength

Gravitational field strength = 10 N/kg

Potential energy = ... J [2]



20 This question is about energy transfers.

A car with a mass of 800 kg rolls down a hill with its engine switched off.

(a) The hill is 12 m high.

The gravitational field strength is 10 N/kg.

Calculate the potential energy of the car at the top of the hill.

Use the equation: potential energy = mass × height × gravitational field strength

Potential energy = ... J **[2]**

(b) The speed of the car at the bottom of the hill is 10 m/s.

Calculate the kinetic energy of the car at the bottom of the hill.

Use the equation: kinetic energy = $\frac{1}{2} \times \text{mass} \times (\text{speed})^2$

Kinetic energy = ... J **[2]**

(c) The kinetic energy at the bottom of the hill is **less** than the potential energy at the top of the hill.

Explain why.

Write about energy stores.

.....

.....

.....

..... **[2]**

(d) The test is repeated with a different car.

The potential energy of this car at the top of the hill is 120 000 J.

The kinetic energy of this car at the bottom of the hill is 48 000 J.

Calculate the efficiency of the transfer of energy from the potential store to the kinetic store.

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

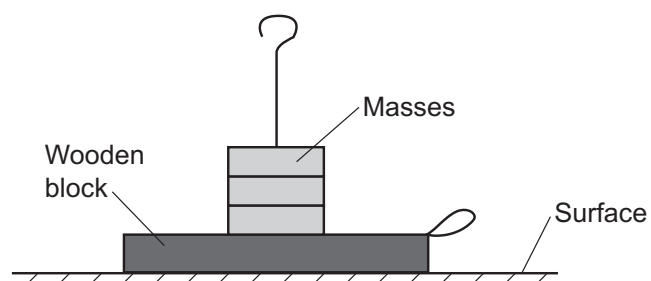
Efficiency = ... [2]



21 Fig. 21.1 shows a teacher's experiment.

The teacher pulls a wooden block through a fixed distance and calculates the work done from their measurements.

Fig. 21.1



The table shows the teacher's results.

Mass (kg)	Work done (J)
0.1	1.9
0.2	2.3
0.3	2.8
0.4	3.3
0.5	3.7
0.6	4.3

- (a) Describe how the teacher can do this experiment, including any equipment used. Use the Data Sheet.

.....

.....

.....

.....

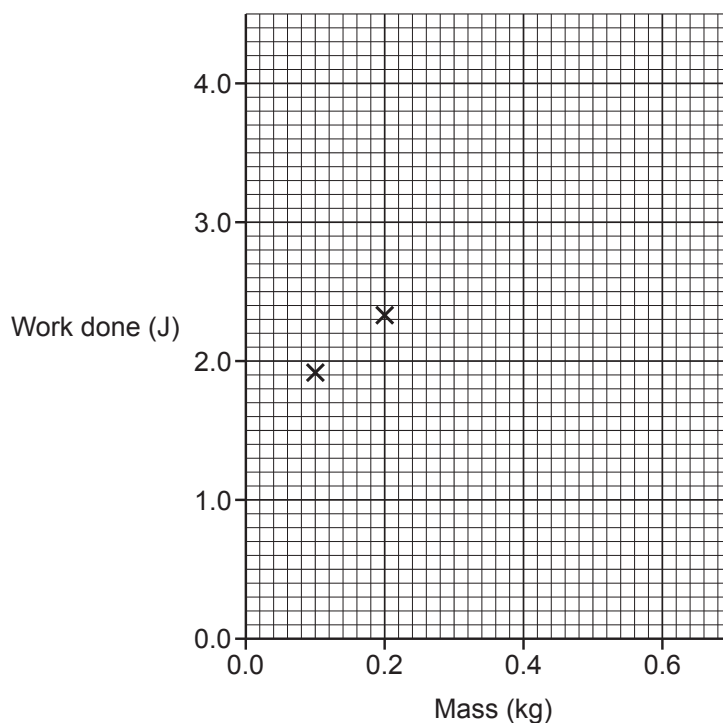
.....

..... [3]

- (b) (i) Plot a graph of the data in the table and draw a line of best fit on **Fig. 21.2**.

Two of the points have already been completed for you.

Fig. 21.2



[3]

- (ii) Describe the relationship between work done and mass.

.....

..... [1]

- (c) The teacher adds a lubricant between the surface and the block.

They keep the mass of the block and distance travelled the same as before.

- (i) Sketch a line on the graph to show how work done varies with mass in this new experiment.
Label this line with the letter **L**.

[1]

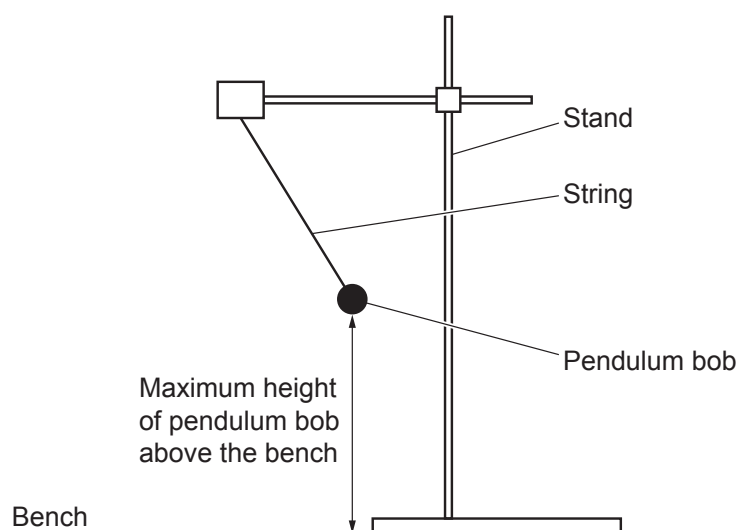
- (ii) Explain your reason for how you have drawn the line labelled **L** in (c)(i).

.....

..... [1]



23 The diagram shows a pendulum bob attached to a stand using string.



A student lifts the pendulum bob to the position shown on the diagram.

The student then releases the pendulum bob so that it swings freely.

- (a) The student notices that the maximum height of the pendulum bob above the bench decreases after each swing.

Explain why the maximum height of the pendulum bob decreases after each swing.

.....

 [2]

- (b) The student holds a metre ruler behind the swinging pendulum bob and measures the maximum height of the pendulum bob above the bench.

- (i) Give **two** reasons why the student's method might **not** give an **accurate** value for the maximum height of the pendulum bob.

1

 2
 [2]

- (ii) Describe **two** ways to improve the student's method to obtain a more accurate value of the maximum height of the pendulum bob at the end of each swing.

1

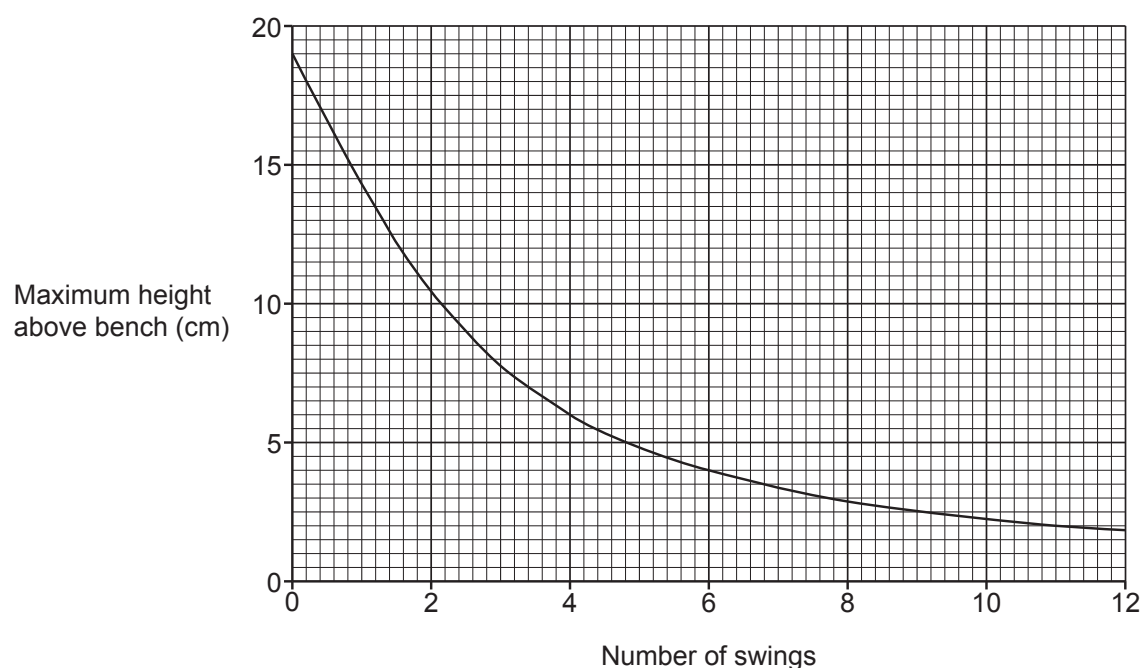
.....

2

.....

[2]

- (c) The graph shows how the maximum height of the pendulum bob above the bench changes as the pendulum bob swings.



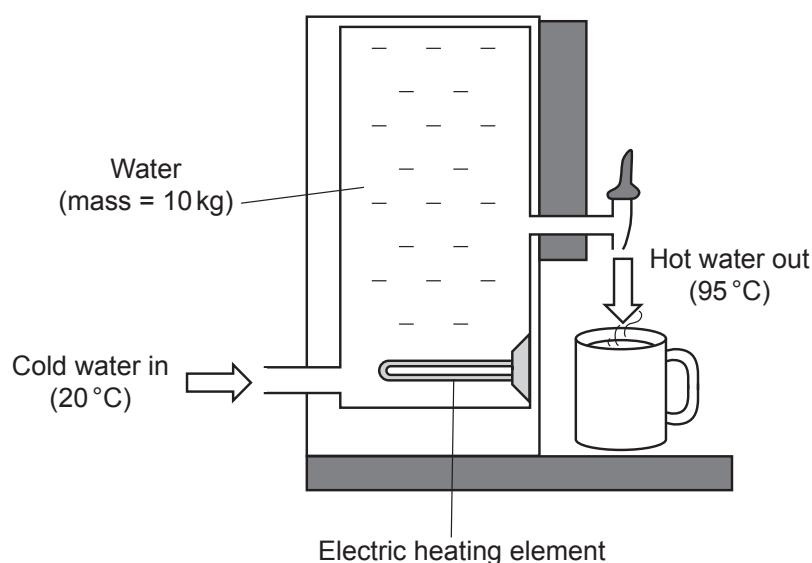
The initial release height of the pendulum bob above the bench is 19 cm.

Determine the maximum height after 6 swings as a percentage of the initial release height.

Percentage of the initial release height = ... % [3]



- 19 An electric water heater is used to make hot water for drinks.



- (a) The water heater is plugged into the mains supply and turned on.

Explain why the temperature of the water increases.
Write about energy stores in your answer.

.....

.....

.....

..... [2]

- (b) The temperature of the water increases from 20 °C to 95 °C.
The mass of water is 10 kg.
The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy required to increase the temperature of the water.

Use the equation:

change in thermal energy = mass × specific heat capacity × change in temperature

Energy = ... J [3]

- (c) (i) The power of the water heater is 1840 W.
The p.d. of the mains supply is 230 V.

Calculate the current in the heating element.

Use the equation: power = potential difference $\times$ current

Current = ... A [3]

- (ii) An engineer says, 'You should use a water heater with a higher current.'

Suggest **two** reasons why this is a good idea.

- 1
.....
2
..... [2]

- (d) The water heater is plugged into the mains supply.
The water heater has a metal case.

Which wire(s) should be connected in the electric plug of the water heater?

Tick (✓) one, two **or** three boxes.

Earth wire

☐

Live wire

☐

Neutral wire

☐

[1]



23 In 1986, there was an accident when a nuclear reactor in a power station exploded.

In the explosion, radioactive materials from inside the reactor were spread over the power station.

(a) Explain why workers at the power station were both contaminated **and** irradiated in the accident.

Contaminated because

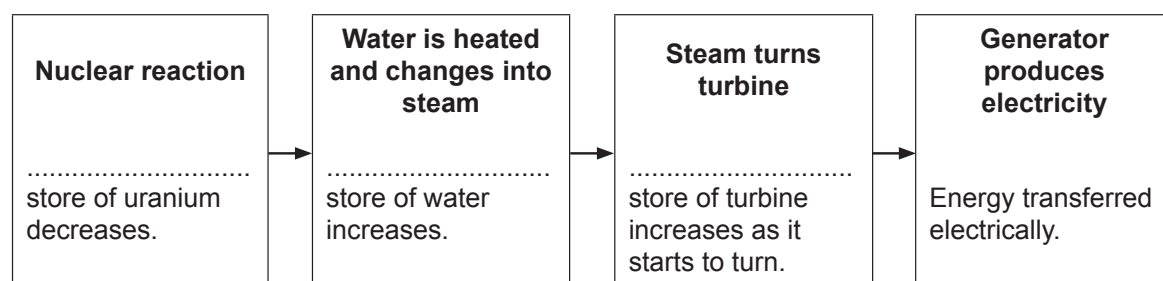
.....

Irradiated because

.....

[2]

(b) The flow diagram shows energy transfers when electricity is generated in a nuclear power station.



Complete the flow diagram to show the changes in energy stores.

[3]



- (c) One of the elements released in the accident when the nuclear reactor exploded was caesium-137.

Caesium-137 has a half-life of 30 years.

- (i) Explain what is meant by the phrase 'a half-life of 30 years'.

.....
 [1]

- (ii) Which sentence explains why we use the idea of half-life in radioactive decay?

Tick (✓) **one** box.

Radioactive decay is a random process.

☐

When a nucleus decays, it splits in half.

☐

With large numbers, it is easier to count half of the nuclei.

☐

[1]

- (iii) In the accident, 28 kg of caesium-137 was released into the atmosphere.

What mass of caesium-137 remains undecayed after 90 years?

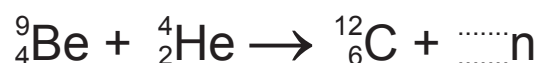
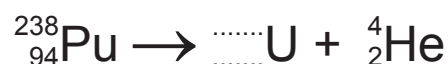
Mass = ... kg [2]

- (d) A nuclear reactor needs neutrons to start a nuclear fission reaction.

A plutonium nucleus (Pu) decays into a uranium nucleus (U) and an alpha particle (${}^4_2\text{He}$).

The alpha particle then joins with a beryllium nucleus (Be) to produce a carbon nucleus (C) and a neutron (n).

Complete the equations.

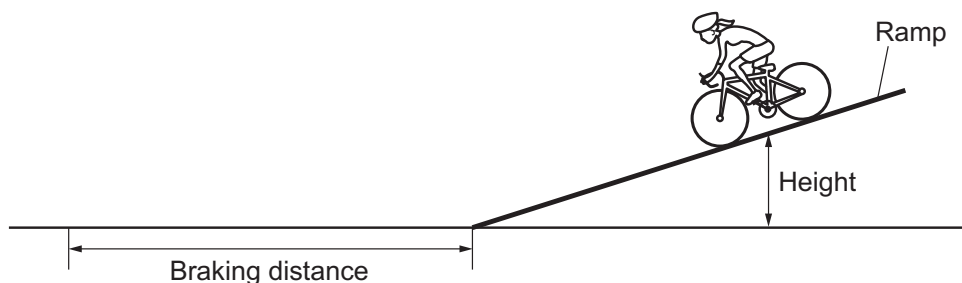


[3]



17 Student **A** is investigating braking distance using a bicycle. This is their method:

- Freewheel down a ramp **without** pedalling.
- At the bottom of the ramp, press the brakes until the bicycle comes to a stop.
- Measure the braking distance of the bicycle from the bottom of the ramp.



(a) Student **A** repeats the investigation three times. Each time they start at the same height. Their results are shown in the table.

Measurement number	Braking distance (m)
1	4.4
2	8.0
3	5.6

(i) Suggest what equipment student **A** can use to measure the braking distance.

..... [1]

(ii) Use the results from the table to calculate the **mean** braking distance.

Mean braking distance = ... m [2]

(iii) Suggest why the values of the braking distance are **not** the same.

.....
 [1]

(b) Student **B** repeats the investigation using the same method.

The mass of student **B** and the bicycle is 80 kg.

The height of student **B** and the bicycle at the top of the ramp is 2.0 m.

Gravitational field strength = 10 N/kg.

Calculate the gravitational potential energy of student **B** and the bicycle at the top of the ramp.

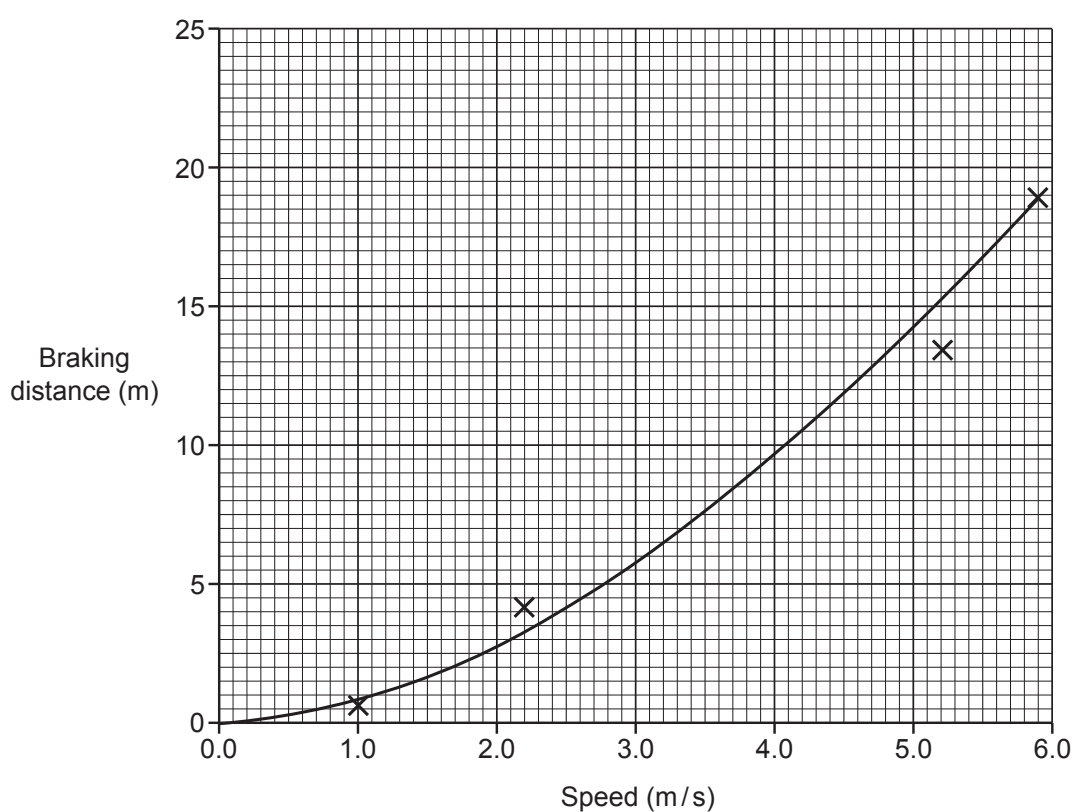
Use the Data Sheet.

Gravitational potential energy = ... J [3]



(c) Student **C** measures the braking distance for different speeds at the bottom of the ramp.

The graph shows student **C**'s results.



(i) Use the graph to find the braking distance when the speed is 4.3 m/s.

Braking distance = ... m [1]

(ii) It can be more dangerous to cycle quickly.

Use data from the graph to explain why.

.....

.....

.....

..... [2]



(iii) Suggest how student **C**'s investigation could be improved.

.....
 [1]

(d) The students increase the mass of the bicycle.

What happens to the braking distance?

Tick (✓) **one** box.

Decreases

☐

Increases

☐

Stays the same

☐

[1]

(e) Student **D** pedals the bicycle on a level surface.

They start from rest and reach a velocity of 6 m/s.

Estimate the acceleration of student **D** on the bicycle.

Use the equation: acceleration = $\frac{\text{change in velocity}}{\text{time}}$

Acceleration = ... m/s² [3]



SUB-TOPIC P7.2

POWER AND EFFICIENCY

25 questions in this sub-topic · 166 marks · lowest tariff first



- 8** A vehicle has an input power from fuel of 20 kW and a useful output power of 6 kW.

Calculate the power it wastes.

- A** 3 kW
- B** 6 kW
- C** 14 kW
- D** 20 kW

Your answer

[1]

5 A boiler has an input energy of 720 kJ from the gas it burns.

It transfers 540 kJ of useful energy to the home.

What is the efficiency of the boiler?

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$

A 0.12

B 0.75

C 0.90

D 1.33

Your answer

[1]

- 1 A motor has an input energy of 800 J. The useful output energy is 500 J.

What is the wasted energy?

- A 300 J
- B 500 J
- C 800 J
- D 1300 J

Your answer

[1]

- 3** A radiator has a power of 2 kilowatts (2 kW).

Convert 2 kW into watts.

- A** 0.002 W
- B** 200 W
- C** 2000 W
- D** 2000000 W

Your answer

[1]



10 A 3.0 kW oven is switched on for 1.5 hours.

Calculate the energy transferred by the oven.

Use the equation: energy transferred = power $\times$ time

A 2.0 J

B 2.0 kWh

C 4.5 J

D 4.5 kWh

Your answer

[1]

11 A lamp has an input energy of 200 J.

The useful output energy is 80 J.

What is the efficiency of the lamp?
Use the Data Sheet.

A 0.4

B 2.5

C 40

D 250

Your answer

[1]

14 Which row describes the walls of a building with the **lowest** rate of cooling?

	Thickness of walls	Thermal conductivity of walls
A	thick	high
B	thick	low
C	thin	high
D	thin	low

Your answer

[1]

9 Energy use in the home can be measured in kWh.

How do you calculate energy use in kWh?

- A** Divide power in kilowatts by time in hours.
- B** Divide power in watts by time in seconds.
- C** Multiply power in kilowatts by time in hours.
- D** Multiply power in watts by time in seconds.

Your answer

[1]



8 Person **Q** has a mass of 50 kg and climbs a vertical distance of 6 m in 6 s.

Person **R** has a mass of 60 kg and climbs a vertical distance of 6 m in 5 s.

Who has the most power and why?

- A** Person **Q** because they have a smaller mass.
- B** Person **Q** because they transfer more energy in a longer time.
- C** Person **R** because a greater mass always means a greater power.
- D** Person **R** because they transfer more energy in a shorter time.

Your answer

[1]



2 A hot drink is poured into a mug.

Which method would **not** help to keep the drink hot?

- A** Use a lid on the mug.
- B** Use a mug with a larger surface area.
- C** Use a mug with thicker sides.
- D** Wrap the mug with an insulating material.

Your answer

[1]

24 (a) A TV has a power rating of 0.2 kW.

Calculate the energy transferred, in kWh, if the TV is switched on for 4 hours.

Energy transferred = ... kWh [3]

(b) A different TV works with a 12.0 V battery. It has a current of 3.19 A.

Calculate the power rating of the TV.

Power = ... W [3]



23 A TV has the label below on it.

OCR TV

Voltage: 230 V

Power: 65 W

Frequency: 50 Hz

(a) Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference $\times$ current

Give your answer to **2** significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

Energy used = ... J [4]



16 A student investigates how the thickness of insulation affects the cooling of a cup of tea.

Fig. 16.1 is a diagram of her apparatus.

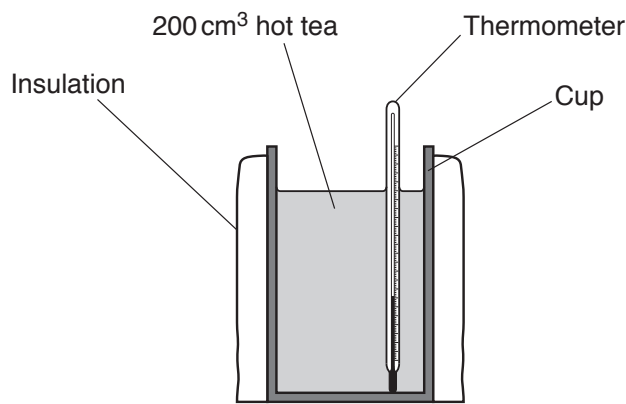


Fig. 16.1

The student wraps a layer of insulation around a cup containing 200 cm³ of hot tea. She measures the temperature of the tea at the start of the experiment and after 10 minutes. She repeats the experiment with different thicknesses of the insulation.

Table 16.1 shows her results.

Thickness of the insulation (mm)	Temperature of tea (°C)		
	Start	End	Difference
2	90	65	25
4	88	66	22
6	91	72	19
8	89	73	16
10	98	84	14
12	100	60	

Table 16.1

(a) (i) Calculate the temperature **difference** when the thickness of insulation is 12 mm.

Temperature difference = ...°C [1]

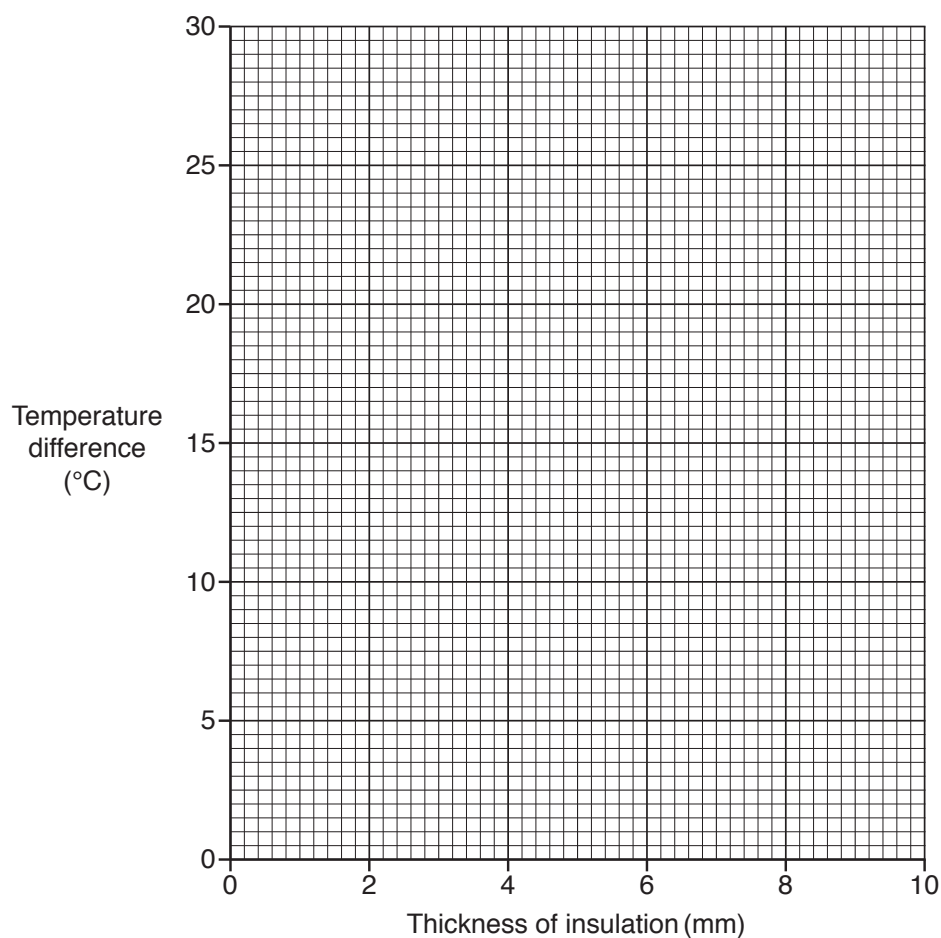
- (ii) The result when the thickness of the insulation is 12 mm is anomalous.

Suggest a reason why this result appears to be anomalous.

.....
 [1]

- (b) Plot a graph of the results in **Table 16.1** and draw a line of best fit.

Ignore the anomalous result for 12 mm.



[2]

- (c) Describe how the temperature difference is affected as the thickness of the insulation increases.

.....
 [1]

- (d) Suggest how the thickness of the insulation affects the rate of cooling of the tea.

.....
 [1]



(e) This experiment could be improved.

Describe two **different** ways of improving the experiment.

1

.....

2

.....

[2]



18 Look at the information about different electric motors.

Electric motor	Energy input per hour (J)	Useful energy output per hour (J)	Energy 'wasted' per hour (J)
A	72 000	60 000	
B	54 000	36 000	
C	18 000		3 000
D		48 000	12 000
E	54 000	48 000	

(a) (i) Calculate the energy input per hour in J for electric motor D.

Answer = ... J [2]

(ii) Which electric motor has the **lowest** 'wasted' energy in one hour?

..... [1]

(iii) Which electric motor has the **highest** 'wasted' energy in one hour?

..... [1]

(iv) Describe how energy is 'wasted' in an electric motor.

.....
 [1]

(v) Suggest how this 'wasted' energy can be reduced in an electric motor.

.....
 [1]

(b) Calculate the % efficiency of electric motor E.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Give your answer to 2 significant figures.

Answer = ...% [3]



20 A group of students compare the power of three kettles **A**, **B** and **C** using this method:

- They pour water in each kettle.
- They plug the kettles in and switch the kettles on.
- They measure the temperature of the water every 20 s.
- They calculate the change in thermal energy of the water every 20 s.

(a) Each kettle has the **same** efficiency and is used for the **same** time.

Describe **one other** factor the students should control in their method.

.....
 [1]

(b)* The students test the kettles using a valid method.

Fig. 20.1 shows how the change in thermal energy varies with time:

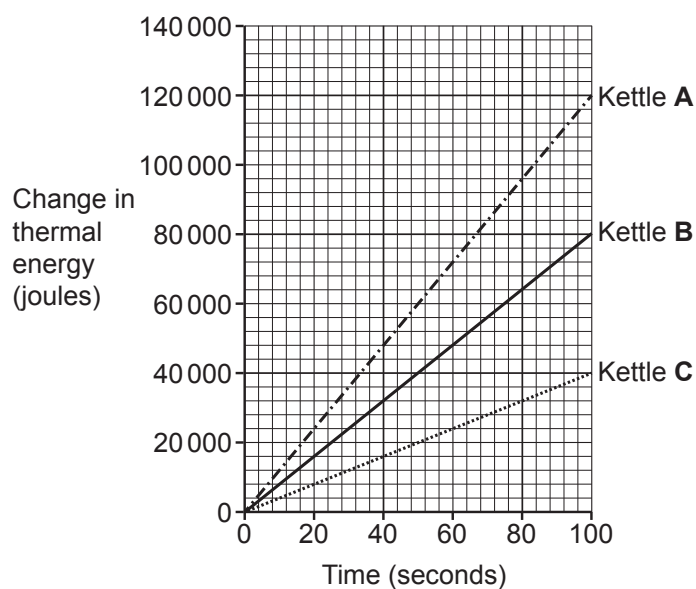


Fig. 20.1

19 A toy car travels around a race track. After one lap it is back at the start position.

(a) Explain why the velocity of the toy car is different from its speed as it travels around the track.

.....

 [2]

(b) The mass of the toy car is 5 kg and it has an acceleration of 4 m/s^2 .

(i) Calculate the force needed to accelerate the toy car.

Use the equation: force = mass $\times$ acceleration

Force = ... N [2]

(ii) Suggest why the **actual** force needed would be more than in part **(b)(i)**.

..... [1]

(c) (i) Another toy car requires a constant force of 30 N to move it along a surface.

Calculate the work done on the car when it moves a distance of 50 m.

Use the equation: work done = force $\times$ distance

Work done = ... J [2]

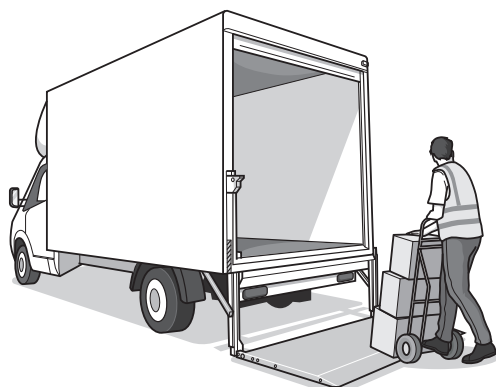
(ii) Calculate the power output of this toy car if the work is done over 75 seconds.

Use your answer from **(c)(i)**.

Power = ... W [3]



- 22 (a)** A delivery driver is loading boxes onto a lorry. The boxes are moved from the ground to the lorry using an electric lift.



- (i)** Calculate the work done when boxes with a weight of 0.6 kN are lifted a vertical distance of 0.8 m from the ground to the lorry.

Use the equation: work done = force $\times$ distance

Work done = ... J [3]

- (ii)** The power of the lift is 50 W .

Calculate the time taken for the lift to move these boxes from ground to lorry level.

Use the equation: power = work done / time taken

Time taken = ... s [3]

- (iii)** The lorry uses a 24 V battery to power the 50 W lift.

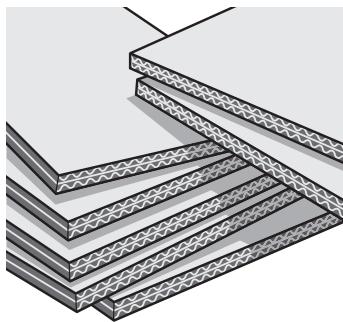
Calculate the current which flows while the lift is in use.

Use the equation: power = potential difference $\times$ current

Give your answer to **2** significant figures.

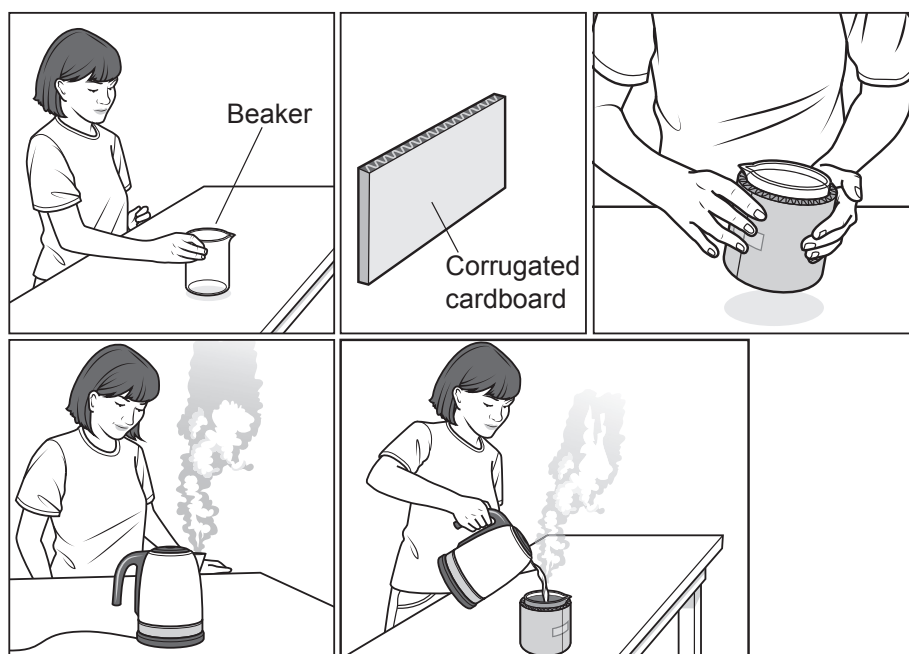
Current = ... A [4]

- 17 Corrugated cardboard can be used as an insulator around a beaker.



Student **A** does an experiment to investigate how the thickness of corrugated cardboard wrapped around a beaker affects the time it takes for hot water in the beaker to cool down.

The diagrams show how student **A** starts the experiment.



- (b) Student **B** does the same experiment using the same method as student **A**.

The table shows the students' results when there is **no** insulation around the beaker.

Time (min)	Temperature ($^{\circ}\text{C}$)	
	Student A	Student B
0	80	80
1	75	76
2	71	71
3	67	68
4	65	65
5	63	63

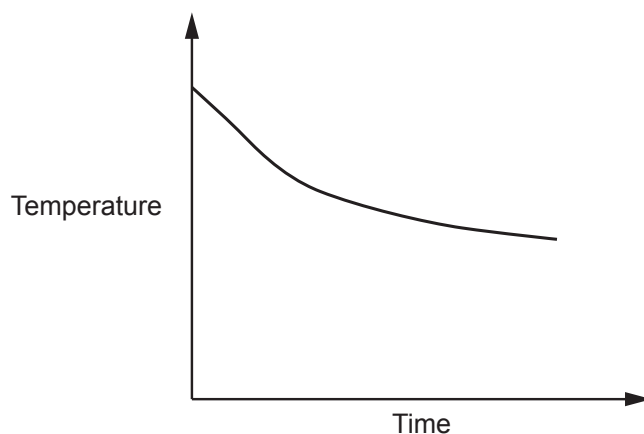
- (i) Describe the trend shown by the students' results.

.....
 [1]

- (ii) Describe how the table shows the students' results are reproducible.

.....
 [1]

- (iii) The student plots a graph of temperature against time.



State **two** reasons why the graph does **not** show that the temperature is directly proportional to time.

- 1
 2

[2]

22 A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

(a) Describe a method she can use to do this investigation.

.....

.....

.....

.....

.....

..... **[3]**

(b) Here are the results of one of her experiments.

Time (minutes)	Temperature of water (°C)
0	90
2	75
4	63
6	54
8	47
10	41
12	37

(i) Plot the results on the grid in **Fig. 22.1**.

Two of the points have been plotted for you.

[2]

(ii) Draw a line of best fit on your graph.

[1]



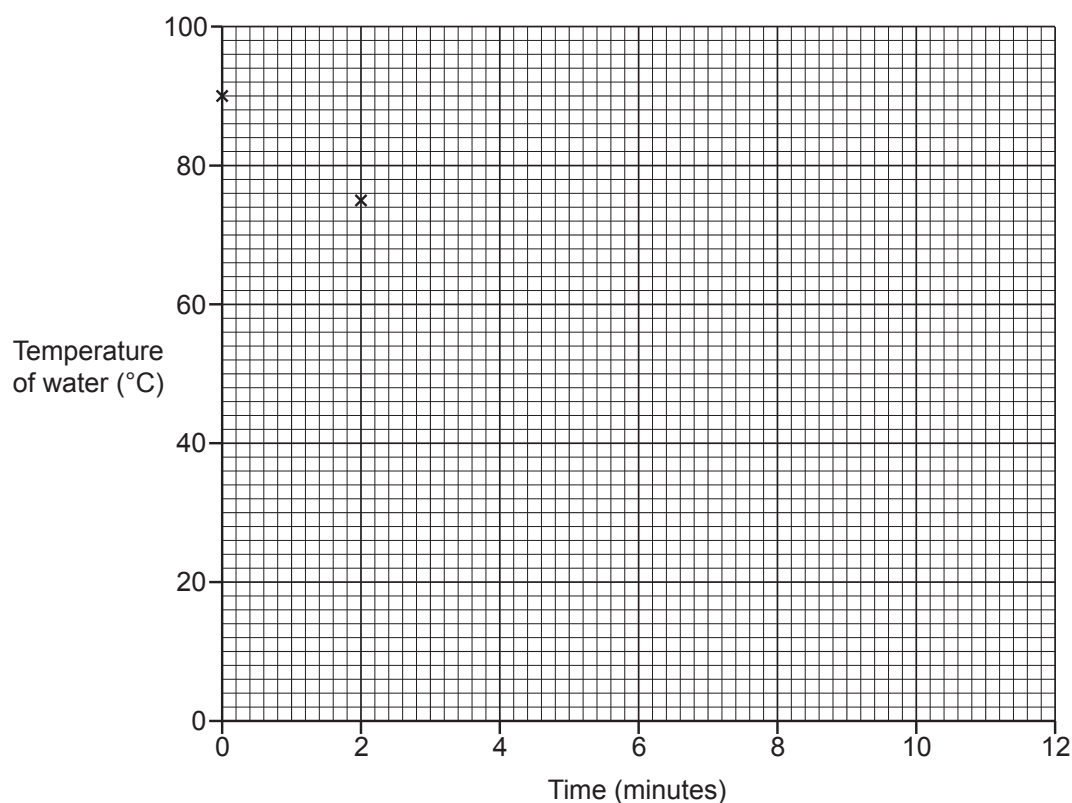


Fig. 22.1

- (iii) Describe how the temperature of the water changes with time.
Use data from the graph in **Fig. 22.1** in your answer.

.....

 [2]

- (iv) The thickness of the cardboard box is doubled. Everything else stays the same.

Sketch a line on the graph in **Fig. 22.1** to suggest what these new results may look like.
Label your line **Z**. [1]

- (v) Suggest **one** way to improve the investigation.

.....
 [1]

- (c) Explain why the rate of cooling of a metal box is different to a cardboard box.
Assume the thickness of the walls is the same in both boxes.

.....
 [1]



17 A 20 kg concrete block is lifted by a crane. The mass of **one** block is 20 kg.

(a) (i) Calculate the kinetic energy of the 20 kg block when it moves at 0.3 m/s.

Use the equation: kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

Kinetic energy = ... J [2]

(ii) The 20 kg block is lifted through a height of 16 m.

Calculate the gravitational potential energy gained by the 20 kg block.

Gravitational field strength is 10 N/kg.

Gravitational potential energy = ... J [3]



(b) The crane lifts blocks through a different height using an electric motor:

- The gravitational potential energy gained by the blocks is 0.6 MJ.
- The input energy of the motor is 1.5 MJ.

(i) Calculate the efficiency of the motor.

Use the equation: $\text{efficiency} = \text{useful output energy transfer} / \text{input energy transfer}$

Efficiency = ... [2]

(ii) Explain why the efficiency of the motor is **not** 100%.

.....
.....
.....
..... [2]

(iii) The crane's lifting equipment contains moving parts. A workman suggests adding oil to these moving parts.

Explain how this will affect the efficiency.

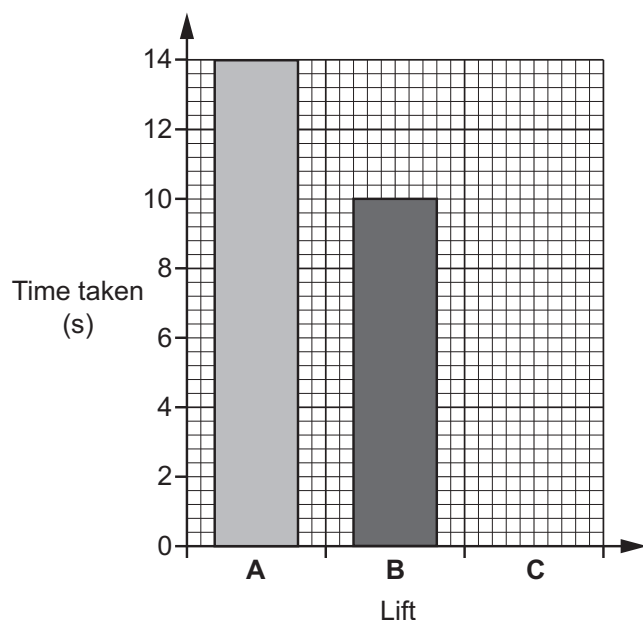
.....
.....
.....
..... [2]

19 A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(a) (i) Lift **C** takes 12 s to move between the two floors.

Draw a bar for lift **C** on the bar chart.

[1]

(ii) Calculate the **mean** time of the three lift journeys.

Mean = ... s [2]

(iii) Explain which lift uses the most power.

.....

 [2]

- (b) (i) One lift uses 50 000 J for a 12 s journey.

Calculate the power of the lift.

Give your answer to 1 decimal place.

Power = ... W [4]

- (ii) When the lift is broken the stairs are used.

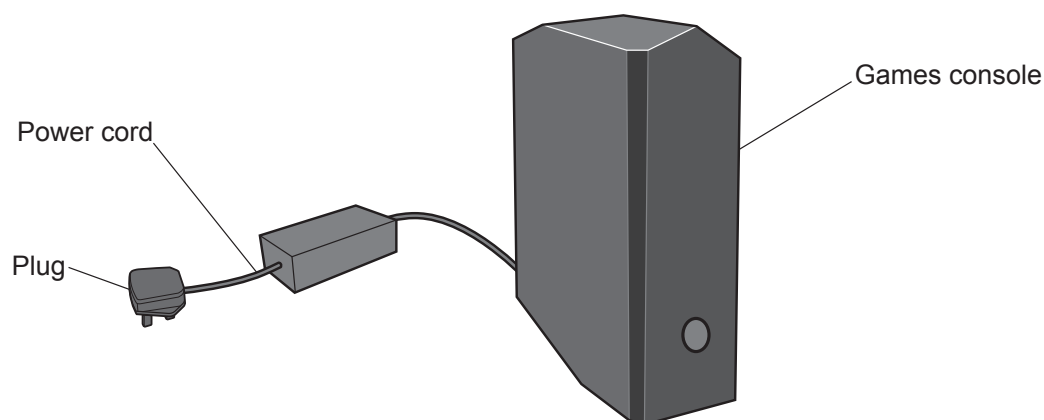
Calculate the work done when a 750 N person climbs a distance of 4 m.

Work done = ... J [3]



20 The diagram shows a games console.

A games console is an electrical device used to play computer games.



(a) The games console is connected to the mains supply and switched on.

Describe how energy is **transferred** through the power cord to the games console.

..... [1]

(b)

(i) The games console uses $4.2 \times 10^5 \text{ J}$ of energy per hour when a student is playing on it.

The actual energy input to the games console in one hour is $5.2 \times 10^5 \text{ J}$.

Calculate the energy **wasted** by the games console in one hour of playing.

Energy wasted = ... J [2]

(ii) Explain why some energy is wasted when the student is playing on the games console.

.....

 [2]

(iii) Calculate the efficiency of the game console.

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

Give your answer to **2** significant figures.

Efficiency = ... [3]

(c) The games console has a transformer built into the power cord.

The transformer needs to decrease the potential difference of the mains supply from 230 V to 12.1 V.

(i) State the type of transformer used in the games console.

..... [1]

(ii) The current in the primary coil of the transformer is 0.51 A.

Calculate the current in the secondary coil of the transformer.

Assume the transformer is 100% efficient.

Use the Equation Sheet.

Current in secondary coil = ... A [3]



- 17 Since 2009, filament lamps in the home have often been replaced by other lamps, called LED lamps.

The table compares a filament lamp and an LED lamp which produce the **same** intensity of light.

	Filament lamp	LED lamp
Power	60W	0.01 kW
Lifetime	2000 hours	26 000 hours
Cost to buy	£1.00	£5.00
Cost to run over 1 year	£22.00	£3.65
Dimmable	Yes	No
Structure	Glass	Plastic

- (a) State the power of the filament lamp in kW.

..... kW [1]

- (b) Calculate the energy transferred by the LED lamp during its lifetime.

Use the equation: energy transferred = power × time

Give your answer in kWh.

Energy transferred = ... kWh [2]

- (c) In 1 year, the filament lamp transfers 110 kWh of energy.

This costs £22.00.

What is the cost of 1 kWh of electricity?

Cost = £ [1]



- (d) Calculate the number of filament lamps a person must buy during the lifetime of **one** LED lamp.

Number of filament lamps = ... [1]

- (e) Suggest **one** reason **for** and **one** reason **against** using LED lamps.

Use the data in the table.

For

.....

Against

.....

[2]

- (f) One LED lamp has an efficiency of 0.4.

In one second, the input energy transferred by the lamp is 10 J.

Calculate the energy **wasted** by the lamp in one second.

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

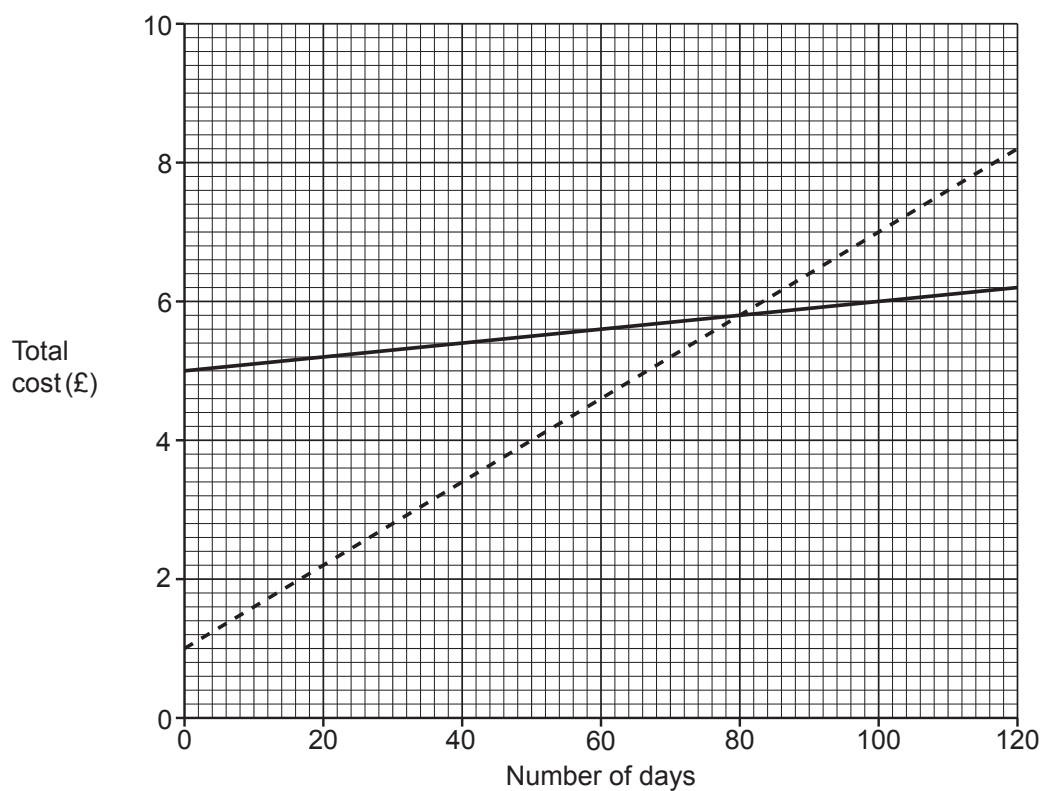
Energy wasted = ... J [3]



- (g) The graph shows how the total cost of buying and using each lamp varies with the number of days each lamp is used.

Key:

— LED lamp
 - - - Filament lamp



- (i) A person buys an LED lamp.

After how many days is the total cost of the LED lamp the same as the total cost of the filament lamp?

Use the graph.

Number of days = ... days [1]

(ii) The person uses the LED lamp for 100 days.

How much money does the person save by buying and using the LED lamp instead of the filament lamp?

Use the graph.

Money saved = £ [2]



21

- (a)** In a shop, a lift moves customers a vertical distance of 12 m from the ground floor to the top floor.

The maximum weight of passengers allowed in the lift is 4500 N.

- (i)** Calculate the maximum mass of passengers allowed in the lift.

Use the equation: gravitational force = mass $\times$ gravitational field strength

Mass = ... kg [4]

- (ii)** Calculate the work done in moving the maximum weight of passengers between the ground floor and the top floor.

Use the equation: work done = force $\times$ distance

Work done = ... J [2]

- (iii)** The lift takes 1.2 minutes to move the passengers from the ground floor to the top floor.

Calculate the power needed to move the maximum weight of passengers in the lift.

Use your answer from part **(a)(ii)** and the equation: power = $\frac{\text{work done}}{\text{time}}$

Power = ... W [3]



(b) The power of the motor of another lift is 920 W.

The potential difference across the motor of this lift is 230 V.

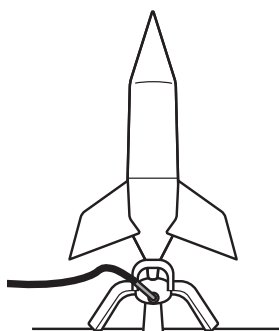
Calculate the current in the motor.

Use the Equation Sheet.

Current = ... A [4]



19 The diagram shows a water rocket on the ground.



(a)

(i) The rocket is stationary on the ground.

What are the names of the upwards force and the downwards force on the rocket?

Use words from the list.

normal contact force

tension

thrust

weight

Upwards force:

Downwards force:

[2]

(ii) The rocket lifts off the ground when water is pushed out of the bottom of the rocket.

Explain how Newton's third law applies to the rocket as it lifts off the ground.

Use ideas about the force of the water and the force of the rocket.

.....

 [2]

(iii) Describe the conditions needed for the rocket to accelerate upwards.

Use ideas about the upwards force and the downwards force.

.....
 [1]

(b)

(i) The rocket has a mass of 5.0 kg and rises a vertical distance of 45 m.

Calculate the gravitational potential energy gained by the rocket.

Use the equation: gravitational potential energy = mass $\times$ gravitational field strength $\times$ height

Gravitational field strength = 10 N/kg

Gravitational potential energy = ... J [2]

(ii) A different water rocket does 12 500 J of work in 5 seconds when it rises upwards.

Calculate the power of this water rocket.

Use the equation: power = $\frac{\text{work done}}{\text{time}}$

Include the correct unit.

Power = ... Unit [3]

(c) A student writes a summary about gravitational fields.

The student has made **two** mistakes in their summary.Gravitational Fields

All matter has a gravitational field.

Gravitational fields cause repulsion.

More massive objects have a smaller gravitational field strength.

Identify the **two** mistakes and write down the correct word for each mistake.

Mistake 1:

Correct word 1:

Mistake 2:

Correct word 2:

[4]



MARK SCHEMES

official Pearson Edexcel mark schemes



Question				Answer		Marks	AO element	Guidance	
9				B ✓		1	2.1		



Question				Answer	Marks	AO element	Guidance
13				C ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
15			C ✓	1	2.2	

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.



Question	Answer	Marks	AO element	Guidance
9	B✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
12			D ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
13			C ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
12				D ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
8			D ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
15	C ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
1			D ✓	1	1.2	



Question	Answer	Marks	AO element	Guidance
10	C	1	2.1	



Question	Answer	Marks	AO element	Guidance
15	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
12	C	1	2.1	



Question	Answer	Marks	AO element	Guidance
14	C	1	2.1	



4	A	1	2.1	A: $3.0 \times (2.0 - 1.6)$ B: 1.6×2.0 C: 3.0×1.6 D: 3.0×2.0
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17	(a)	(i)	Any one from: Ratio of 1:1 at a height of 40 cm ✓ ratio (seems to) increase by 0.1 when height decreases by 20 cm (until ratio is 1:1) / AW ✓	1	3.2a	ALLOW when drop height was 40 cm, bounce height was the same / bounce ratio coming closer to 1:1 each time / bounce height cannot be higher than drop height
		(ii)	Some of the energy from the KE store is transferred to other energy stores as ball hits the ground AW ✓	1	2.1	ALLOW ball will lose energy (when it hits the ground)
	(b)		Any two from: Lower head to read bounce height / take bounce height readings at eye level / AW ✓ Take multiple readings and <u>average</u> them ✓ Take readings at other intervals (eg. 90, 70, 50) ✓	2	2×3.3b	ALLOW second person to read bounce height / idea of video camera and play back ALLOW drop from greater heights
	(c)	(i)	(Mass = $60 \div 1000$ =) 0.06 (kg) ✓	1	1.2	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.48 (J) award 2 marks Energy = $0.06 \times 0.8 \times 10$ ✓ Energy = 0.48 (J) ✓	2	2×2.1	ALLOW ECF from (c)(i) $E = (c)(i) \times 10 \times 0.8$ ✓ $E = \text{answer to (c)(i)} \times 8$ ✓ ALLOW $E = 60 \times 10 \times 0.8 = 480$ (J) for one mark

20	(a)	First check the answer on answer line If answer = 96 000 (J) award 2 marks (Potential energy $\Rightarrow$ $800 \times 10 \times 12$ ✓) (Potential energy $\Rightarrow$ 96 000 (J) ✓)	2	2 × 2.1	
	(b)	First check the answer on answer line If answer = 40 000 (J) award 2 marks (Kinetic energy $\Rightarrow$ $\frac{1}{2} \times 800 \times 10^2$ ✓) (Kinetic energy $\Rightarrow$ 40 000 (J) ✓)	2	2 × 2.1	
	(c)	Energy is transferred to the thermal energy (store) ✓ And any one from: (Work is done against) friction / drag / resistive forces ✓ Energy is transferred in the surroundings / brakes ✓	2	2 × 2.1	ALLOW heat for thermal energy ALLOW energy transferred to the surroundings by heating scores two marks
	(d)	First check the answer on answer line If answer = 0.4 award 2 marks (efficiency $\Rightarrow$ $48\,000 \div 120\,000$ ✓) (efficiency $\Rightarrow$ 0.4 ✓)	2	2 × 2.1	ALLOW for one mark 0.4% ALLOW for two marks 40%

21	(a)	Any three from: Use a force meter/newton meter to measure (pulling) force ✓ Measure distance (moved) using a ruler/metre rule/measuring tape ✓ Repeat experiment with different masses (on the wooden block) ✓ Use work done = force × distance ✓	3	3 × 3.3a	ALLOW metre stick / metre tape ALLOW different weights (on the wooden block) ALLOW balance/scales to measure mass (on the wooden block) IGNORE ideas about masses on pulleys IGNORE idea of repeating the same experiment (with same mass)
	(b) (i)	4 points correctly plotted to within ½ small square ✓✓ Thin, straight line of best fit drawn ✓	3	3 × 2.2	ALLOW 1 mark for 2 points correctly plotted. DO NOT ALLOW points more than half a square in diameter DO NOT ALLOW all points above or below the line IGNORE line before first plot DO NOT ALLOW first plot joined to last plot ALLOW ECF for lbf drawn for candidate's points
	(ii)	Work done increases as mass increases / ORA ✓	1	3.1a	ALLOW linear relationship IGNORE it is proportional IGNORE positive correlation

Question	Answer	Marks	AO element	Guidance
(c) (i)	Line with positive gradient drawn below the first line of best fit (for all points) ✓	1	3.2b	IGNORE horizontal line / line starting at origin ALLOW curve / missing label L DO NOT ALLOW if the line cuts the x axis from 0.1 kg or more
(ii)	Any one from: (The lubricant) reduces friction ✓ reduces transfer to thermal energy (store) ✓	1	2.1	ALLOW less friction / prevents friction / less resistance (to motion) ALLOW heat for thermal energy ALLOW less energy transferred to other stores / less energy dissipated / more efficient IGNORE less work done / less energy (needed) / less force

23	(a)	friction / air resistance / drag ✓ (friction) does work on pendulum / energy transferred to thermal (store of surroundings) ✓	2	2 × 2.2	ALLOW force of air ALLOW energy lost to surroundings / energy dissipated (to surroundings/thermal store) IGNORE pendulum loses energy IGNORE KE decreases
	(b) (i)	Any two from: difficult to read the ruler at the right time / while bob is moving/swinging ✓ ruler might not be vertical ✓ reading might not be taken perpendicularly/at eye level to the ruler/scale ✓	2	2 × 3.1b	IGNORE human error unqualified ALLOW difficult to see where the bottom of the bob is / bob is moving too fast / hard to tell exactly when bob is at its highest point ALLOW ruler held at an angle ALLOW there is parallax error when reading scale ALLOW if the ruler is behind the pendulum it is hard to see the values
	(ii)	Any two from: Record the motion on a video and playback in slow motion ✓ (Idea of) mark a point (on piece of card) behind the bob (at end of swing) or use a grid/graph paper behind bob ✓ Clamp the metre ruler/card/graph paper in place ✓ (Idea of) Use a set square/plumb line/spirit level to ensure metre ruler is vertical ✓	2	2 × 3.3b	IGNORE repeat and average ALLOW record/video it (and playback) / take photo(s) at end of swing

19	(a)	Any two from: Energy transferred electrically from the supply to the heating element or energy transferred by heating from element to the water. ✓ (So) thermal energy store of the element increases. ✓ (So) thermal energy store of water increases. ✓	2	2 × 2.1	IGNORE conduction and convection (as question refers to energy stores).
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3 150 000 (J) award 3 marks Temperature change = $95 - 20 = 75^{\circ}\text{C}$ ✓ Change in thermal energy = $10 \times 4200 \times 75$ ✓ (Change in thermal energy =) 3 150 000 (J) ✓	3	2.2 2 × 2.1	ALLOW ECF from their temperature change.
	(c) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (A) award 3 marks Current = power ÷ p.d ✓ (Current =) $1840 \div 230$ ✓ (Current =) 8 (A) ✓	3	1.2 2 × 2.1	Rearrangement of the given equation

Question		Answer	Marks	AO element	Guidance
	(c) (ii)	Any two from: The power would be higher ✓ The water would heat up quicker ✓ (So) more water could be heated (in the same time) ✓	2	3.2a	IGNORE Higher currents are more dangerous IGNORE it would get hotter
	(d)	All three boxes ticked ✓	1	1.2	



23	(a)	Contaminated because radioactive material touched the workers / was breathed in ✓ Irradiated because workers were exposed to radiation (from outside of the body) ✓	2	2 × 1.1	ALLOW it is in contact with (workers) / went on/inside them DO NOT ALLOW answers which also include ideas about irradiation e.g. radiation touches the workers/is inhaled ALLOW in presence of radiation/radiation passes into body DO NOT ALLOW answers which also include ideas about contamination
	(b)	Nuclear ✓ → Thermal ✓ → Kinetic ✓	3	3 × 2.1	IGNORE heat
	(c) (i)	(It takes) 30 years / (average) time taken for number of (un-decayed or unstable) nuclei to halve / for activity to halve / for count rate to halve / for mass of undecayed nuclei to halve ✓	1	1.1	ALLOW atoms for nuclei ALLOW mass (of it/caesium) to halve / half of it/substance to decay IGNORE reactivity / time taken for a nucleus to halve
	(ii)	Radioactive decay is a random process. ☒ When a nucleus decays, it splits in half. ☐ With large numbers, it is easier to count half of the nuclei. ☐ ✓	1	1.1	
	(iii)	First check the answer on the answer line If answer = 3.5 (kg) award 2 marks (idea that 90 years ⇒ 3 (half-lives) ✓ (mass = $28 \times (\frac{1}{2})^3 = 3.5$ (kg) ✓	2	2 × 2.2	ALLOW evidence of 3 half-lives e.g. 28 → 14 → 7 → 3.5
23	(d)	$\begin{array}{c} {}^{238}_{94}\text{Pu} \rightarrow {}^{234}_{92}\text{U} + {}^4_2\text{He} \\ {}^9_4\text{Be} + {}^4_2\text{He} \rightarrow {}^{12}_6\text{C} + {}^1_0\text{n} \end{array}$ Correct mass for U ✓ Correct atomic number for U ✓ Correct mass and atomic number for n ✓	3	3 × 2.2	

17	(a)	(i)	Use a tape-measure / trundle wheel ✓	1	1.2	IGNORE ruler ALLOW metre rule / stick
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.0 (m) award 2 marks Mean = $(4.4 + 8.0 + 5.6) \div 3$ ✓ (Mean =) 6.0 (m) ✓	2	2 × 1.2	ALLOW 8(.0) is an anomaly so Mean = $(4.4 + 5.6) \div 2$ ✓ (Mean =) 5(.0) (m) ✓ working must be seen ALLOW 6 (m)
		(iii)	Any one from: They did not use the same force when braking / AW ✓ They did not measure height to the same part of the bike each time ✓ They did not start at the same place on the ramp ✓ They did not apply the brakes at the same place / time ✓	1	3.2a	ALLOW wind may affect braking IGNORE They did not measure distance correctly. IGNORE They used the pedals (instead of freewheeling) IGNORE reaction time / human error
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1600 (J) award 3 marks potential energy = mass × gravitational field strength × height ✓ (potential energy =) $80 \times 10 \times 2.0$ ✓ (potential energy =) 1600 (J) ✓	3	1.2 2 × 2.1	

Question	Answer	Marks	AO element	Guidance
(c) (i)	11(m) ✓	1	2.2	
(ii)	Use of data to show as speed increases, braking distance increases ✓ OR (As speed increases,) (braking) distance increases ✓ At higher speeds more likely to hit an obstacle (in front) as you travel further before stopping / cause more damage / AW ✓	2	3.1a 3.1b	<u>Example</u> at 1m/s, bd = 1m but at 2m/s, bd = 4m. ALLOW stopping for braking ALLOW longer time to stop
(iii)	Any one from: Repeat for more speeds / heights ✓ Make sure constant force when braking / press brakes by same amount each time / AW ✓	1	3.3b	IGNORE repeats experiment / averages results
(d)	Increases ✓	1	1.1	
(e)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 – 3.0 (m / s²) award 3 marks Estimate for time = 2 – 12 seconds ✓ Acceleration = $6 \div$ their estimate of time ✓ (Acceleration =) 0.5 – 3(.0) m / s ² ✓	3	3 × 2.1	

Question				Answer	Marks	AO element	Guidance
8				C ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
5	B ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
1			A ✓	1	1.2	



Question			Answer	Marks	AO element	Guidance
3			C ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
10			D ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
11				A ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
14			B ✓	1	2.2	



Question	Answer	Marks	AO element	Guidance
9	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
8	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
2	B	1	2.1	



24	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (kWh) award 3 marks Recall (Energy transferred =) power $\times$ time ✓ 0.2×4 ✓ (Energy =) 0.8 (kWh) ✓	3	1.2 ALLOW correct equation in any form ALLOW 200×4 or $200 \times 4 \times 60 \times 60$ or 200×14400 or $200 \times 4 \times 60$ or $0.2 \times 4 \times 60 \times 60$ or 0.2×14400 or $0.2 \times 4 \times 60$ for one mark 2.1 ALLOW 800 or 2 880 000 or 2880 or 48 000 or 48 for two marks 2.1
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.28 (W) award 3 marks Recall (Power =) potential difference $\times$ current ✓ 12×3.19 ✓ (P =) 38.28 (W) ✓	3	1.2 ALLOW correct equation in any form 2.1 2.1 ALLOW 38.3 (W) or 38 (W)

23	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28$ (A) ✓	4	1.2 2.1 2.1 1.2	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000$ (J) ✓	4	1.2 1.2 2.1 2.1	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000$ (J) ✓

16	(a)	(i)	40 (°C) ✓	1	2.2	
		(ii)	Any one from: Difference is much too high / difference should be lower than the previous result AW ✓ End temperature is too low ✓	1	3.2a	ALLOW does not follow the trend/pattern IGNORE not stirring/thermometer touching the bottom / start temperature / boiling temperature
	(b)		All points plotted correctly ✓ Appropriate straight line of best fit ✓	2	2×2.2	ALLOW tolerance of $\pm$ half a square DO NOT ALLOW straight line from top to bottom ALLOW ECF for mis-plotted data points
	(c)		(As thickness of the insulation increases) temperature difference falls / ORA ✓	1	3.1a	
	(d)		As thickness increases rate decreases / AW / ORA ✓	1	3.2b	ALLOW as thickness increases tea cools slower / takes longer to cool ORA
	(e)		Any two from: Keep starting temperatures the same ✓ Keep room temperature the same ✓ Stir tea before taking measurements ✓ Use a lid / add (same) insulation underneath the cup / cover whole cup in (same) thickness insulation ✓ Repeat <u>and</u> average	2	2×3.3b	

18	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 60 000 (J) award 2 marks 48 000 + 12 000 ✓ = 60 000 (J) ✓	2	2.2 2.2	Check table
		ii	C ✓	1	3.2b	
		iii	B ✓	1	3.2b	
		iv	Heat / sound / KE of particles passed to other particles / AW ✓	1	1.1	ALLOW (energy) transferred to surroundings / by friction
		v	Lubrication / oil ✓	1	2.1	ALLOW reduce friction
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 89 (%) award 3 marks 48 000 ÷ 54 000 (x 100) ✓ = 88.88888....etc ✓ = 89(%) (2 sig figs) ✓	3	2.1 2.1 1.2	ALLOW two marks for 0.89 or 88(%) ALLOW one mark for 0.88

20	(a)	Any one from: (Ensure the same) volume / mass of water (in each kettle) ✓ Ensure the water (in the kettles) has the same starting temperature ✓	1	3.3a	DO NOT ALLOW amount / quantity DO NOT ALLOW Use the same kettle/power of kettle/efficiency/time
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Question	Answer	Marks	AO element	Guidance
20 (b)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Uses data to describe detailed relationship between energy and time AND calculates power AND draws a conclusion <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Describes relationship between energy and time AND calculates power OR draws a conclusion in terms of power <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Describes simple relationship between energy and time described OR calculates a power OR draws a conclusion <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	2 × 2.1 2 × 3.1a 2 × 3.2b	AO3 – Analyses graph to describe how the change in thermal energy varies with time • (Thermal) energy (store) increases (with time) • Increase is proportional / As one doubles the other doubles / AW • Straight line graph through origin • Some data used to show this relationship E.g. for Kettle A, Energy at 50 s = 60000J. Energy at 100s = 120000 J • Rate for each kettle is constant • Energy of A (is always) > B > C / ORA • Rate of increase of Energy of A > B > C / ORA AO3 – Analyses information to draw conclusions about power of kettles • Power of A > B > C / ORA • Higher power means more energy transferred in the same time / ORA AO2.1 – Applies knowledge of power as rate of energy transfer • $P = E \div t$ • Attempt at calculating power of kettles • E.g. Power of A = $120\,000 / 100 = 1200\text{ W}$ • Power of B = $80000/100 = 800\text{ W}$ • Power of C = $40000/100 = 400\text{ W}$

Question	Answer	Marks	AO element	Guidance
20 (c)	Energy is transferred from the mains / via National grid / via transformers / via power lines ✓ Using a.c. / AW ✓	2	2 × 1.2	



19	(a)	Any two from: Speed is a scalar ✓ Velocity is a vector ✓ Speed does not take direction into account / AW ✓ Velocity does take direction into account / AW ✓ Speed is calculated using distance ✓ Velocity is calculated using displacement ✓ Displacement depends on direction from start point / displacement takes into account direction ✓ Distance does not depend on direction from start point / distance does not take into account direction ✓	2	1.1 x 2	
	(b) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (N) award 2 marks 5×4 ✓ $= 20$ (N) ✓	2	2.1 2.1	
	(ii)	Any one from: Not all energy is transferred to motion ✓ (Air) resistance ✓ Drag ✓ Friction ✓	1	3.2a	ALLOW Energy losses

Question			Answer	Marks	AO element	Guidance
19	(c) (i)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1500 (J) award 2 marks 30×50 ✓ $= 1500$ (J) ✓	2	2.1 2.1	
	(ii)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (W) award 3 marks work done ÷ time ✓ $1500 \div 75$ ✓ $= 20$ (W) ✓	3	1.2 2.1 2.1	ALLOW ecf from (c)(i) ALLOW $P = WD \div t$

22	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 480 (J) award 3 marks (0.6 kN $\Rightarrow$) 600 N ✓ 600 $\times$ 0.8 ✓ 480 (J) ✓	3	1.2 2.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 9.6 (s) award 3 marks (Rearrangement) Time taken = work done / power ✓ 480 $\div$ 50 ✓ 9.6 (s) ✓	3	1.2 2.1 2.1	ALLOW ECF from (a)(i)
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.1 (A) award 4 marks (Rearrangement) Current = power / potential difference or $I = P / V$ ✓ 50 / 24 ✓ 2.08(3) (A) ✓ 2.1 (A) (2 sig.fig) ✓	4	1.2 2.1 2.1 1.2	ALLOW voltage for potential difference

17	(a)	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of extra equipment and what it measures AND a detailed method AND a control variable identified <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Detailed method AND either control variable identified or some relevant extra equipment chosen OR Basic method outlined AND a control variable identified AND some relevant equipment chosen <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic method outlined AND either a control variable identified or some relevant equipment chosen OR Some relevant equipment chosen AND a control variable <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	2 × 1.2 2 × 2.2 2 × 3.3a	AO1.2 – Demonstrates knowledge and understanding of scientific techniques to choose equipment for the experiment - measure time with stopwatch - measure the temperature of water with a thermometer - measure the volume of water with a measuring cylinder or the mass of water with a balance - measure thickness of insulation with a ruler AO2.2 – Applies knowledge and understanding of scientific enquiry to develop a valid experiment by controlling variables - the starting temperature - the time / end temperature / change in temperature - volume / mass of water - room temperature AO3.3a – Analyses information and ideas to develop the method for the practical - measure temperature of water at the start - measure temperature at regular time intervals or at a fixed time - change the thickness of cardboard and repeat experiment - repeat each measurement for each thickness - calculates a mean temperature change - use at least 5 thicknesses of cardboard - safety consideration for hot water
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Question	Answer	Marks	AO element	Guidance
(b) (i)	(As time increases) temperature decreases / ORA ✓	1	3.1a	ALLOW it cools / gets colder
(ii)	Values / repeats / results (at each time) are close together / almost the same / similar ✓	1	3.1b	ALLOW the same results
(iii)	Any two from: The line is curved / not a straight line / not linear ✓ The line does not pass through origin / zero ✓ The line has a negative gradient ✓	2	2 x 3.2a	ALLOW gradient changes ALLOW there is an intercept / non-zero starting temperature ALLOW (as time increases,) temperature decreases / line 'goes down' / negative correlation

22	(a)	Change the thickness of the cardboard (and repeat) ✓ Any 2 from: (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer / time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	3	3 × 3.3a	ALLOW use different boxes with different thicknesses / line the box with an insulator ALLOW same beaker / both beakers (don't) have a lid / same room temperature ALLOW a specified amount of water in the beaker / a specified starting temperature
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Question			Answer	Marks	AO element	Guidance
22	(b)	(i)	5 or 4 points correctly plotted to within ½ small square ✓✓	2	2 × 2.2	3 or 2 correctly plotted points gains 1 mark IGNORE 'blobs' more than ½ square diameter
		(ii)	Smooth curved line of best fit through most points ✓	1	1.2	DO NOT ALLOW a straight line of best fit
		(iii)	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2	2 × 3.1a	IGNORE non-linear relationship / positive/negative correlation ALLOW inverse proportion for this mark only ALLOW gradient decreases / temperature decreases more quickly at the start (than at the end) ALLOW use of data from the graph to show decreasing rate
		(iv)	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	1	3.2b	IGNORE shape of the line but no mark for a horizontal line ALLOW 90 +/- 2 °C
		(v)	Any one from: Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	1	3.3b	ALLOW any sensible suggestion IGNORE a longer time / use more thicknesses ALLOW use equipment with higher resolution / data logger IGNORE better equipment unless qualified
	(c)		Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1	3.2a	ALLOW metal is a (better thermal) conductor / ORA

17	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 0.9 (J) award 2 marks (Kinetic energy =) $0.5 \times 20 \times 0.3^2$ ✓ (Kinetic energy =) 0.9 (J) ✓	2	2 × 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 3200 (J) award 3 marks Gravitational potential energy = $m \times g \times h$ ✓ (Gravitational potential energy =) $20 \times 10 \times 16$ ✓ (Gravitational potential energy =) 3200 (J) ✓	3	1 × 1.2 2 × 2.1	
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 0.4 award 2 marks (Efficiency =) $0.6 \div 1.5$ ✓ (Efficiency =) 0.4 / 40 % ✓	2	2 × 2.1	ALLOW 2 marks for 40 % ALLOW 1 mark for 40 (without % sign) ALLOW 1 mark for 0.4% IGNORE attempt of conversion of energy to joules
		(ii)	Any two from: Friction occurs / Resistance in wires / coil ✓ Energy transferred to <u>thermal energy</u> (store) ✓ of cable / winch / coil / motor / wires / surroundings ✓	2	2 × 2.1	ALLOW heat for thermal energy

Question			Answer	Marks	AO element	Guidance
		(iii)	Any two from: (Oil) provides <u>lubrication</u> / is a <u>lubricant</u> ✓ This reduces friction ✓ Reduces transfer to thermal store / Less energy is wasted / less energy transferred to surroundings ✓ So efficiency is increased ✓	2	2 × 2.1	ALLOW heat for thermal energy

19	(a)	(i)	Bar C drawn to the correct height of 12s ✓	1	1.2	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (s) award 2 marks $14 + 10 + 12 = 36 / (14 + 10 + 12)/3$ without the 36 ✓ $36 \div 3 = 12$ (s) ✓	2	3.1a 1.2	ECF from (a)(i) ECF from mp1 above
		(iii)	Lift B ✓ Takes the least time (power is work done ÷ time taken)/AW ✓	2	3.1b 1.2	If A chosen and correct explanation (for B) given, award mp2 but not mp1
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4166.7 (W) award 4 marks $P = E \div t$ / power = work done ÷ time taken ✓ $P = 50000 \div 12$ ✓ $P = 4166.666667$ (W) ✓ $P = 4166.7$ (W) (1dp)✓	4	1.2 2.1 2.1 1.2	ALLOW energy (transferred) ÷ time taken ALLOW 4166.7 for 2 marks if more dp not given ECF own calculated power to 1 dp
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3000 (J) award 3 marks Work done = force × distance ✓ $W = 750 \times 4$ ✓ $W = 3000$ (J) ✓	3	1.2 2.1 2.1	

20	(a)		(transferred by) electric current ✓	1	2.1	ALLOW transferred by electrical working / electrically IGNORE electricity / voltage
	(b)	(i)	First check the answer on the answer line If answer = 1.0×10^5 award 2 marks $5.2 \times 10^5 - 4.2 \times 10^5$ ✓ (energy wasted) = 1.0×10^5 (J) ✓	2	2×2.1	ALLOW 1×10^5 or 100 000 ALLOW $5.2 - 4.2$ (expression needed)
		(ii)	(it is transferred to) thermal / heat (store) ✓ BUT (it is transferred to) thermal / heat (store) (of) power cord / air / console / transformer ✓✓	2	1.1 2.1	IGNORE not 100% efficient ALLOW surroundings
		(iii)	First check the answer on the answer line If answer = 0.81 award 3 marks substitution: (efficiency =) $4.2(\times 10^5) \div 5.2(\times 10^5)$ ✓ (efficiency =) 0.8(0769)... ✓ (efficiency to 2sf =) 0.81 ✓	3	 2.1 2.1 1.2	ALLOW 81% for three marks ALLOW 80(.769)% for two marks ALLOW any answer given to 2sf for this mark if processing attempted
	(c)	(i)	step-down ✓	1	1.1	
		(ii)	First check the answer on the answer line If answer = 9.7 award 3 marks Select and substitute: $230 \times 0.51 = 12.1 \times \text{current}$ ✓ Rearrangement: current = $(230 \times 0.51) \div 12.1$ ✓ evaluation: 9.7 (A) ✓	3	3×2.1	ALLOW substitution and rearrangement in any order ALLOW 9.69421.....

17	(a)	0.06(0) (kW) ✓	1	1.2	
	(b)	First check the answer on the answer line If answer = 260 (kW h) award 2 marks (E =) $0.01 \times 26\,000$ ✓ (E =) 260 (kW h) ✓	2	2 × 2.1	
	(c)	(£) 0.20 ✓	1	2.2	ALLOW 20 p with unit or (£) 0.2 or (£) 0.20 p
	(d)	13 ✓	1	2.2	
	(e)	For: Cheap(er) to run / saves energy / uses less power / more efficient / lasts longer / needs replacing less often ✓ Against: (More) expensive to buy / not dimmable / plastic is non-recyclable ✓	2	2 × 3.2b	IGNORE save money without qualification IGNORE colour (not in table) IGNORE expensive without qualification IGNORE environment without qualification ALLOW £5.00 as a reference to cost to buy
	(f)	First check the answer on the answer line If answer = 6 (J) award 3 marks (useful energy =) efficiency × input energy or 0.4×10 ✓ (useful energy =) 4 (J) ✓ (wasted energy = $10 - 4$ =) 6 (J) ✓	3	1.2 2.1 2.1	ALLOW 4 (J) for 2 marks (wasted proportion of energy = $1 - 0.4$ =) 0.6 ✓ (wasted energy =) 0.6×10 ✓ (wasted energy =) 6 (J) ✓
	(g)	80 (days) ✓	1	3.1a	
	(ii)	First check the answer on the answer line If answer = (£) 1 award 2 marks Filament lamp cost = £7 OR LED cost = £6 ✓ (actual saving =) $7 - 6$ = (£) 1(.00) ✓	2	2 × 3.1a	Note needs to be explicitly stated in text ALLOW 100 p

21	(a)	(i)	First check the answer on the answer line If answer = 450 (kg) award 4 marks $(W = mg)$ $m = W / g \checkmark$ $g = 10 \text{ (N/kg)} \checkmark$ $m = 4500 / 10 \checkmark$ $m = 450 \text{ (kg)} \checkmark$	4	1.2 1.1 2.1 2.1	45000 kg scores 1 mark (incorrect use of g) ALLOW mass = gravitational force / gravitational field strength ALLOW 9.8 or 9.81 ALLOW 4500 = mass x 10/9.8/9.81 for 2 marks ALLOW answers between 458.7 and 460 for 4 marks
		(ii)	First check the answer on the answer line If answer = 54000 (J) award 2 marks $(W = Fd)$ $W = 4500 \times 12 \checkmark$ $W = 54000 \text{ (J)} \checkmark$	2	2.1 2.1	

Question			Answer	Marks	AO element	Guidance
		(iii)	First check the answer on the answer line If answer = 750(W) award 3 marks $(P = W/t)$ 1.2 minutes = 72 seconds $\checkmark$ $P = 54000 / 72 \checkmark$ $P = 750 \text{ (W)} \checkmark$	3	1.2 2.1 2.1	ALLOW "answer from 21aii $\div$ 72" ECF ALLOW "answer from 21aii $\div$ 1.2" ECF ALLOW correct result of above ECF ALLOW 54 000 $\div$ 1.2/incorrect conversion seen for 1 mark ECF ALLOW 45 000 for 2 marks ECF
	(b)		First check the answer on the answer line If answer = 4(.0) (A) award 3 marks $P = IV \checkmark$ $I = P / V \checkmark$ $I = 920 / 230 \checkmark$ $I = 4(.0) \text{ (A)} \checkmark$	4	1.2 1.2 2.1 2.1	Substitution and rearrangement can be in any order ALLOW equation in any form ALLOW values substituted correctly into equation in any form e.g. $920=230 \times I \text{ (MP3)}$

19	(a)	(i)	Upwards force = normal contact force ✓ Downwards force = weight ✓	2	1.1 x2	
		(ii)	Any two from: The water pushes on the rocket and the rocket pushes on the water ✓ The forces act in opposite directions ✓ The forces are the same size (and type) ✓ Each force acts on a different object ✓	2	2.1 x2	ALLOW 2 marks for Forces are equal and opposite ALLOW Upwards and downwards forces ALLOW Forces are equal ALLOW 1 mark for stating 'For every action there is an equal and opposite reaction' if no other mark has been awarded
		(iii)	The upwards force needs to be greater/stronger than the downwards force / AW / ORA ✓	1	2.1	ALLOW the thrust needs to be greater/stronger than the weight/force due to gravity IGNORE pressure
	(b)	(i)	First check the answer on the answer line If answer = 2250 (J) award 2 marks E = 5x10x45 ✓ E = 2250 (J) ✓	2	2.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 2500 W award 3 marks (P = E / t) P = 12500 / 5 ✓ P = 2500 ✓ W or watts ✓	3	2.1 2.1 1.2	Unit mark is an independent mark ALLOW J/s

Question	Answer	Marks	AO element	Guidance
(c)	Mistake 1: (gravitational fields cause) repulsion ✓ Correct word 1: (gravitational fields cause) attraction ✓ Mistake 2: (More massive objects have a) smaller (gravitational field strength) ✓ Correct word 2: (More massive objects have a) greater (gravitational field strength) / AW ✓ OR Mistake 2: More (massive objects have a) smaller gravitational field strength) ✓ Correct word 2: Less (massive objects have a) smaller gravitational field strength) ✓	4	3.2a 1.1 3.2a 1.1	Mistakes can be listed in any order ALLOW smaller = less massive