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H

Friday 13 November 2020 – Morning

GCSE (9–1) Physics A (Gateway Science)

J249/03 Paper 3 (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Physics A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for a correct method, even if the answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*****).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

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SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box provided.

1 Which of the pairs are contact forces?

A Air resistance and gravity

B Friction and gravity

C Magnetism and normal contact force

D Normal contact force and air resistance

Your answer ☐ **[1]**

2 A student uses 2250 J of energy climbing up steps. It takes the student 15 seconds to climb the steps.

Calculate the power of the student.

Use the equation: power = work done ÷ time taken

A 15 W

B 150 W

C 9000 W

D 33750 W

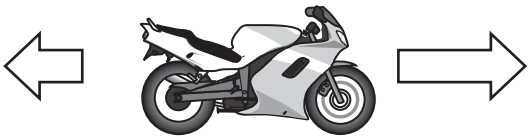
Your answer ☐ **[1]**

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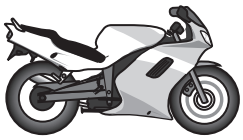
3 A motorbike travels along a straight flat road.

The arrows represent the horizontal forces acting on the motorbike.

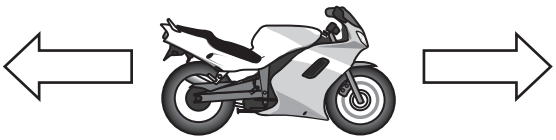
A



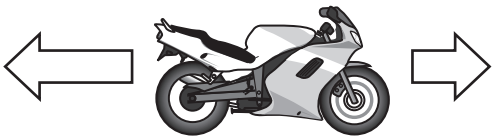
B



C



D



Which motorbike is travelling at a uniform velocity?

Your answer ☐ **[1]**

4 An elephant has a weight of 60 kN. Its four feet have a total area of 0.75 m^2 in contact with the ground.

Calculate the total pressure the elephant exerts on the ground.

Use the equation: pressure = force normal to a surface / area of that surface

A 45 Pa

B 80 Pa

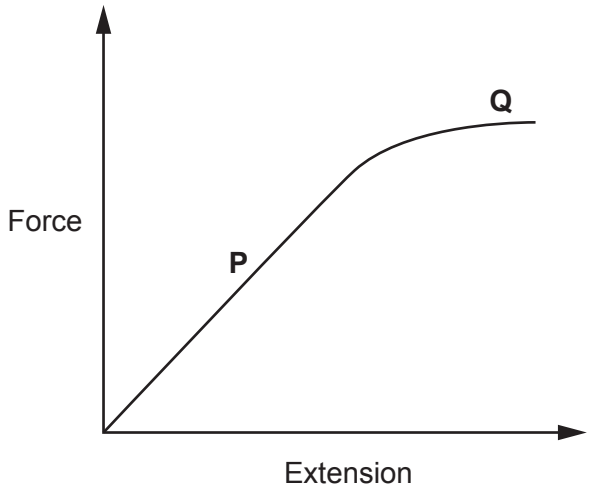
C 45 000 Pa

D 80 000 Pa

Your answer ☐ **[1]**

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5 A student plots a force-extension graph for a material.



Which row in the table correctly identifies part **P** and part **Q** of the graph?

	Part P	**Part Q**
A	Elastic	Elastic
B	Elastic	Plastic
C	Plastic	Elastic
D	Plastic	Plastic

Your answer ☐ **[1]**

6 Which statement explains why atmospheric pressure changes as you climb up a mountain?

A Number of air molecules above you decrease the further you move from the centre of the Earth.

B Density of air increases the further you move from the centre of the Earth.

C Gravity increases the further you move from the centre of the Earth.

D Temperature decreases the further you move from the centre of the Earth.

Your answer ☐ **[1]**

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7 Which statement is an example of Newton's third law?

A Doubling the engine force on a car doubles its acceleration.

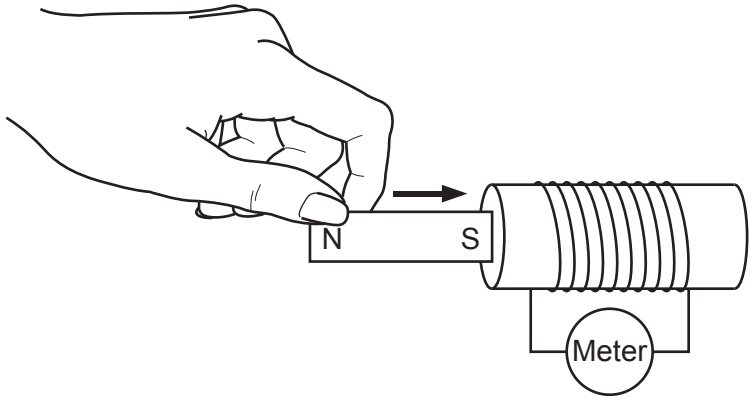
B Doubling the engine force on a car halves its acceleration.

C When a ball is rolling on a table it continues rolling at a steady speed.

D When you clap your hands each hand experiences a force from the other hand.

Your answer ☐ **[1]**

8 A student inserts a magnet into a coil of wire.



What is induced across the ends of the coil of wire?

A Charge

B Magnetism

C Potential difference

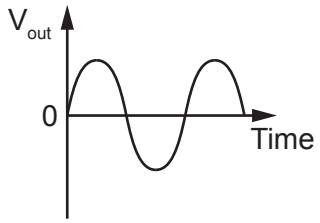
D Resistance

Your answer ☐ **[1]**

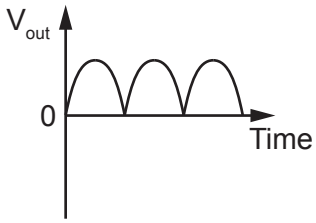
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9 Which of the following graphs shows the typical output potential difference, V_{out}, for a dynamo?

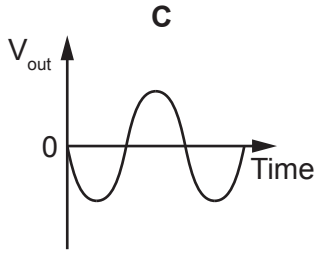
A



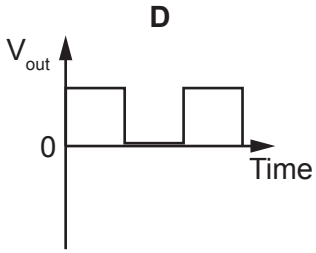
B



C



D



Your answer ☐ **[1]**

10 A student investigates what happens when she heats a beaker of water.

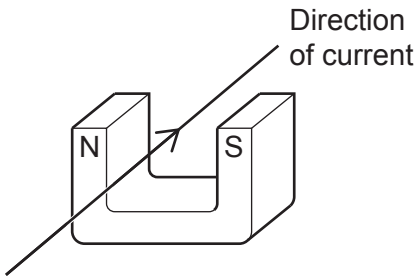
	The temperature increases	The state changes	The energy stored in the water changes
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✗	✓

Which row in the table describes what **could** happen when the water is heated?

Your answer ☐ **[1]**

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11 A wire is placed between the poles of a magnet, perpendicular to the magnetic field lines.



Which direction will the wire move when a current flows?

A Down

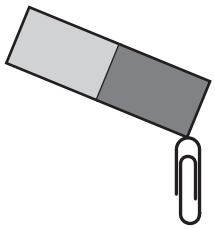
B Left

C Right

D Up

Your answer ☐ **[1]**

12 A magnet is used to pick up a paperclip.



Which statement explains why the paperclip is picked up?

A The magnet is a permanent magnet and the opposite pole has been induced at the top of the paperclip.

B The magnet is a permanent magnet and the same pole has been induced at the top of the paperclip.

C The magnet is a temporary magnet and the opposite pole has been induced at the top of the paperclip.

D The magnet is a temporary magnet and the same pole has been induced at the top of the paperclip.

Your answer ☐ **[1]**

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13 A student is measuring power of different machines. Which two measurements show the **same** power measured?

A 10 GW and 1.0×10^{10} W

B 4.0 kW and 40×10^{3} W

C 10 mW and 10×10^{3} W

D 10 MW and 1.0×10^{6} W

Your answer ☐ **[1]**

14 What is the change in pressure when a diver moves from a depth of 3.0 m to a depth of 8.0 m?

Assume gravitational field strength on Earth = 10 N / kg and water density = 1000 kg / m^3.

Use an equation from the data sheet to help you.

A 30 000 Pa

B 50 000 Pa

C 80 000 Pa

D 110 000 Pa

Your answer ☐ **[1]**

15 An astronaut on the Moon lifts a 5.5 kg object a vertical distance of 50 cm.

Calculate the potential energy gained by the object.

Gravitational field strength on the Moon = 1.6 N / kg.

A 4.4 J

B 8.8 J

C 17.6 J

D 440 J

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 A student investigates static electricity using a plastic ruler.

(a) (i) Explain in terms of electrons why the plastic ruler is not normally charged.

.....

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

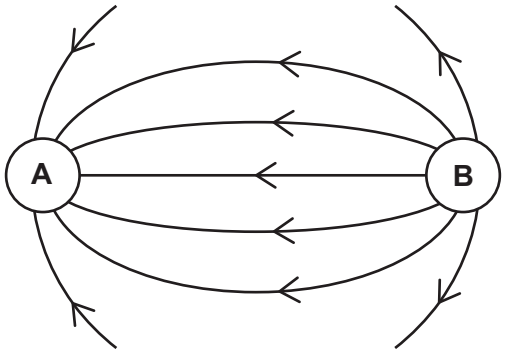
(ii) Explain in terms of electrons why the ruler becomes charged when the student rubs it with a cloth.

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

(b) The diagram shows the electric field between two charges, **A** and **B**.



(i) State the charges of **A** and **B**.

Use the diagram to explain your answer.

.....

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

(ii) Describe **one** similarity between the electric field line diagram and a magnetic field line diagram.

.....

..... **[1]**

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(c) Calculate the charge when 200 J of energy is transferred with a potential difference of 40 V.

Use the equation: energy transferred = charge × potential difference

Charge = ... C **[3]**

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17 A student drops a paper ball from a balcony 4.00 m high. Her friend measures the time taken for the paper ball to reach the ground.

(a) Suggest the equipment used to measure the height of the balcony and the time taken for the paper ball to reach the ground.

Height .....

Time taken .....

[1]

(b) They record their results in a table.

Attempt	**1**	**2**	**3**	**4**	**5**
Time taken (s)	1.84	2.08	2.02	2.08	1.98

(i) Use the data in the table to calculate the mean, median and mode of their results.

Mean = ...

Median = ...

Mode = ...

[3]

(ii) The results are not very precise. Explain how you can tell from the data in the table.

.....

..... **[1]**

(iii) Suggest a possible source of error in the experimental method **and** how it could be improved.

Source of error .....

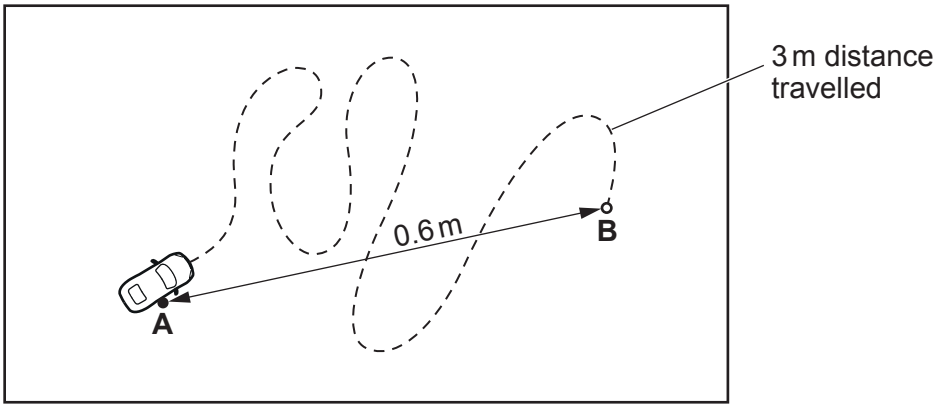
Improvement .....

.....

[2]

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18* A toy car moves randomly on a table.



It moves from position **A** to position **B** in 0.5 minutes, covering a distance of 3.0 m. The start and finish positions are 0.6 m apart.

Explain why the average speed and average velocity of the moving toy car are different from one another.

You should include calculations in your answer.

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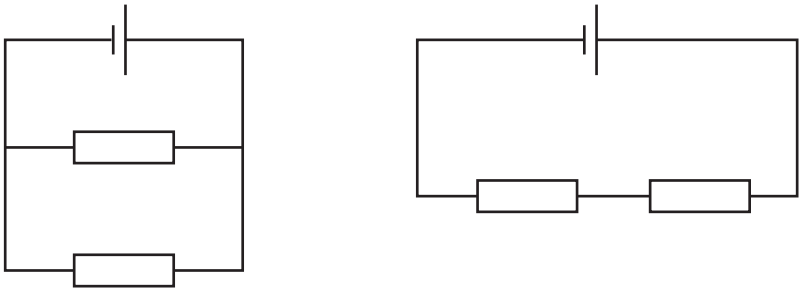
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..... **[6]**

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19 A student builds two electrical circuits. Each circuit uses identical cells and identical fixed resistors.



A **B**

(a) Explain why circuit **A** has a lower total resistance than circuit **B**.

.....

.....

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

(b) Another student investigates the resistance of a filament lamp.

(i) Explain why the resistance of a filament lamp increases when current increases.

.....

.....

.....

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

(ii) Design a circuit diagram which could be used to investigate how the resistance of a filament lamp changes with current.

Use the circuit symbols below. Each symbol can be used once, more than once, or not at all.



[2]

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(iii) Describe how the student would use the circuit you have drawn in **19(b)(ii)** to investigate how the resistance of a filament lamp changes with current.

.....

.....

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

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20 **(a)** A student uses a ruler to determine the volume of a cube, **A**. The length of one side of the cube is 0.100 m.

(i) Calculate the volume of cube **A**.

Volume of cube **A** = ... m^3 **[2]**

(ii) Cube **B** has the same volume as cube **A**.

The mass of cube **B** is ten times greater than the mass of cube **A**.

Compare the density of cube **B** with cube **A**.

Use the equation for density to help your explanation.

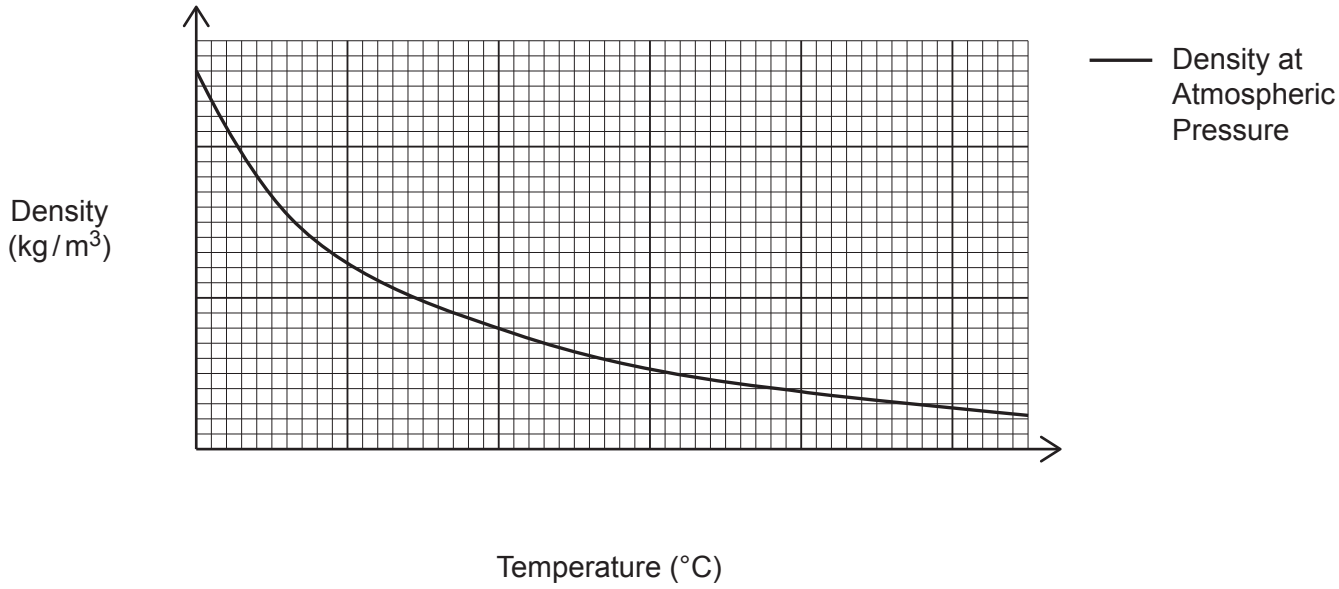
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..... **[2]**

(b) A student researches how the density of air varies with the temperature of the air. Look at the graph of her findings.



Describe the relationship between the temperature and density of air shown in the graph.

..... **[1]**

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(c) Give **one** reason why a solid is more dense than a gas.

.....

..... **[1]**

(d) A boat can be made out of concrete.

Explain why a concrete boat floats but a lump of concrete sinks.

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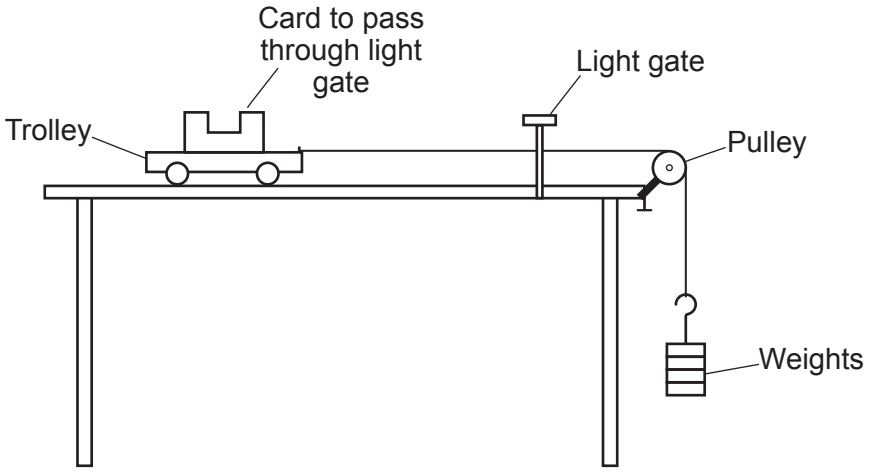
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..... **[3]**

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21 A student investigates the acceleration of a trolley.



The trolley is released from a fixed position and accelerates.

The accelerating force is provided by the weights attached to the trolley with string.

Acceleration is measured using a light gate and data logging equipment.

Look at the results from the experiment.

Force (N)	Acceleration
1.0	1.3
2.0	2.9
3.0	4
4.0	5.7
5.0	6.9

(a) The student has made **two** mistakes in their results table. Identify the two mistakes and suggest corrections to them.

Mistake 1: .....

Correction 1: .....

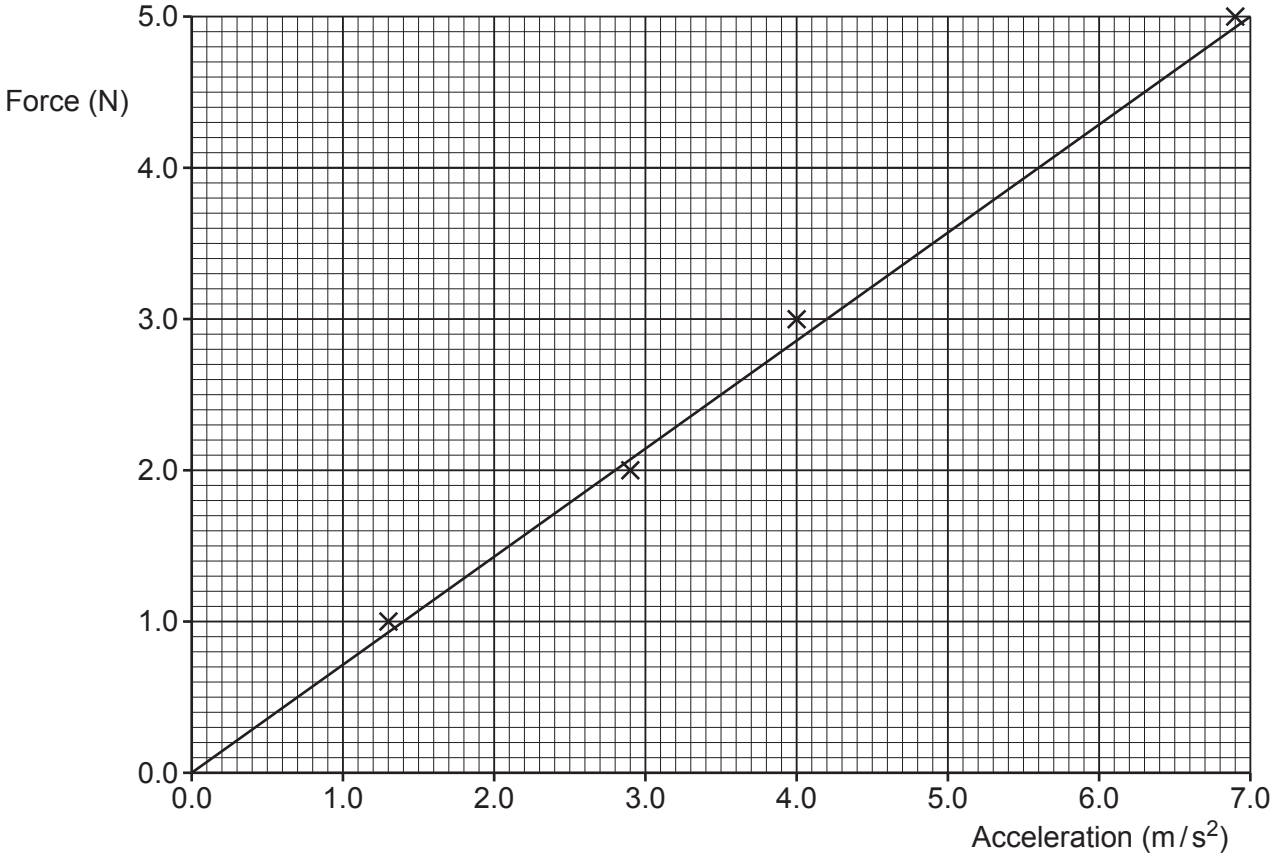
Mistake 2: .....

Correction 2: .....

[4]

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(b) The student plots the results on a graph.



(i) One point has not been plotted on the graph. Plot the missing point on the graph. **[1]**

(ii) Describe the relationship between the two variables on the graph.

.....

.....

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

(iii) Calculate the gradient of the graph and use this to determine the mass of the trolley.

Mass = ... kg **[2]**

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(iv) The actual mass of the trolley is lower than that found in the experiment. Suggest **two** reasons why.

Use ideas about forces and energy in your answer.

1 .....

.....

2 .....

.....

[2]

(v) Suggest **two** ways the experiment could be improved.

1 .....

.....

2 .....

.....

[2]

(c) (i) Describe the energy transfer as the trolley accelerates on the desk.

.....

..... **[1]**

(ii) The trolley moves a distance of 86 cm along the desk.

Calculate the work done when a force of 3.0 N is applied.

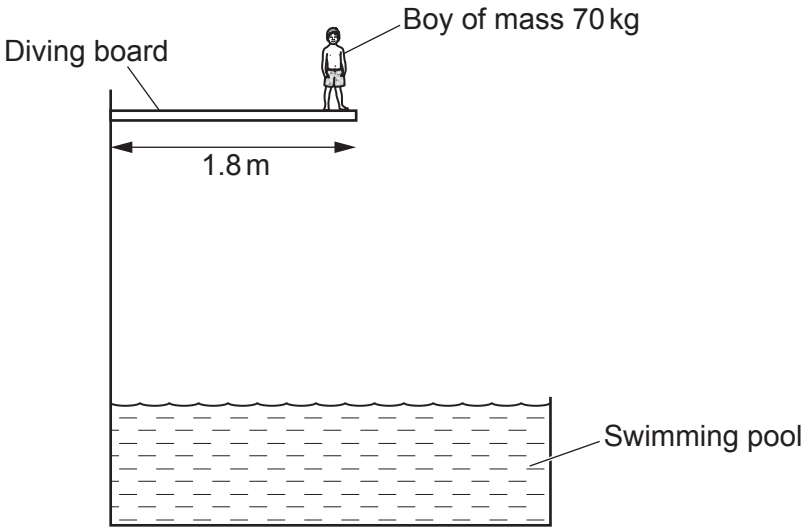
Use the equation: work done = force × distance

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

Work done = ... J **[4]**

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22 A boy of mass 70 kg stands on the end of a diving board at a distance of 1.8 m from the wall.



(a) Calculate the moment of the boy standing on the diving board.
Gravitational field strength on Earth = 10 N / kg.

Moment = ... N m **[4]**

(b) The boy dives vertically into the swimming pool. The water in the pool is 3.2 m below the diving board.

Calculate the velocity of the boy when he enters the water.

Use an equation from the data sheet to help you.

Gravitational field strength on Earth = 10 N / kg.

Velocity = ... m / s **[4]**

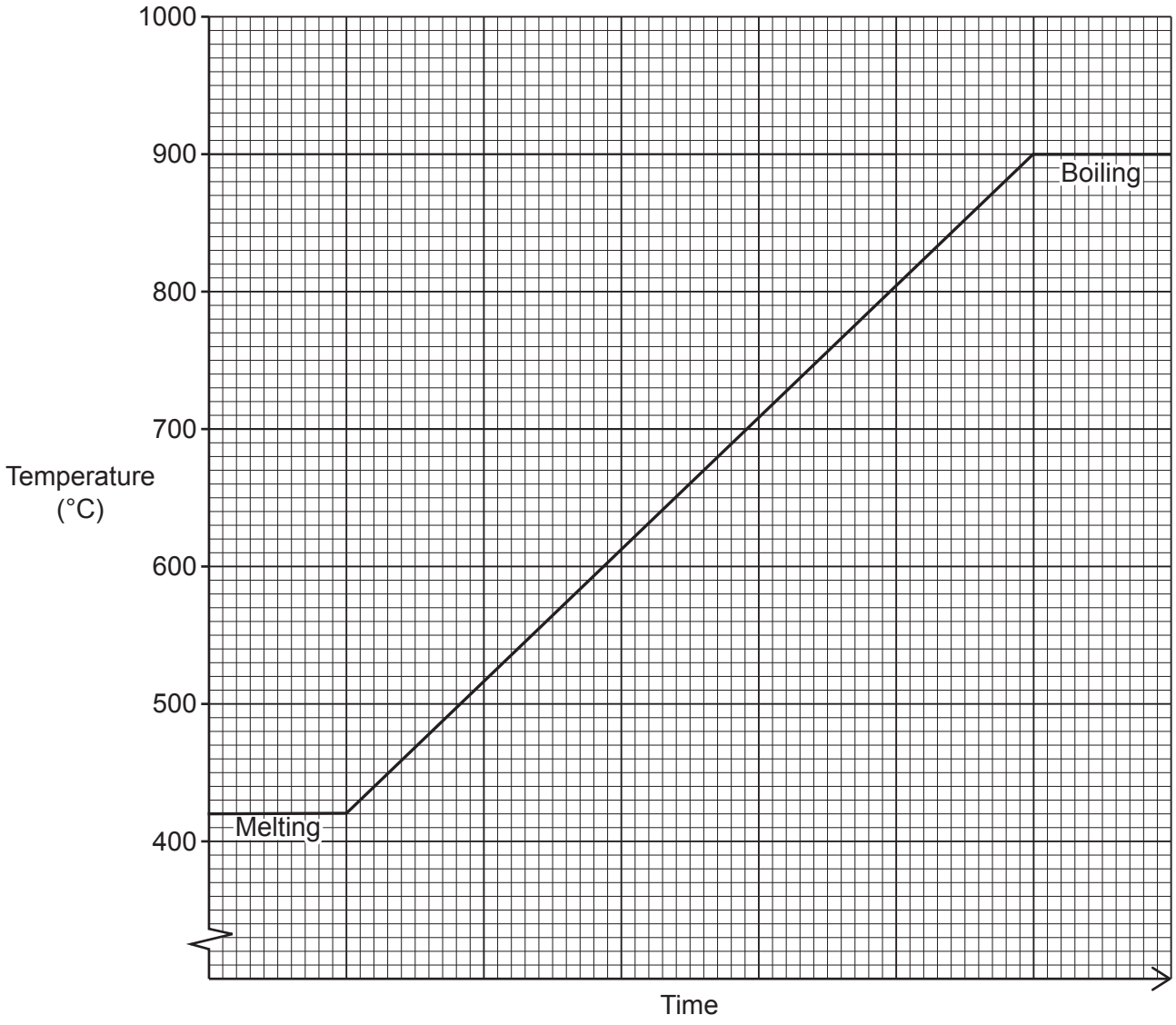
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23 The table shows the specific heat capacities of different materials.

Material	Specific heat capacity (J / kg °C)
Copper	330
Brass	380
Zinc	385
Nickel	440
Concrete	880
Aluminium	913

A scientist heats an unknown substance from a solid to a liquid.

The graph shows how the temperature of the substance varies with time.



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The scientist has 2.5 kg of the substance and records that it takes 462 kJ of energy to increase it from the lowest to the highest temperature in the liquid state.

(a) Use the graph to calculate the specific heat capacity of the substance.

Suggest what material it could be from the table.

Specific heat capacity = ... J / kg °C

Material = ...

[5]

(b) Suggest **two** reasons why the scientist cannot be certain that the substance has been identified correctly.

1 .....

.....

.....

2 .....

.....

.....

[2]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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