

Please write clearly in block capitals.

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Candidate number

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Surname

Forename(s)

Candidate signature

GCSE COMBINED SCIENCE: SYNERGY

F

Foundation Tier Paper 4 Physical sciences

Wednesday 12 June 2019

Morning

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- the Physics Equations Sheet (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
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TOTAL	



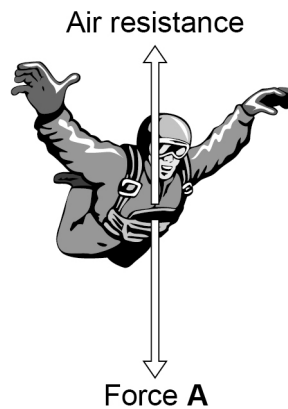
Answer **all** questions in the spaces provided.

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0 1

Figure 1 shows the forces acting on a skydiver falling through the air at a constant velocity.

Figure 1



0 1 . 1

What is the name of force **A**?

[1 mark]

Tick (✓) **one** box.

Electrostatic force

☐

Friction

☐

Magnetic force

☐

Weight

☐

0 1 . 2 The skydiver is falling at a constant velocity.

What name is given to this velocity?

[1 mark]

Tick (✓) **one** box.

Braking velocity

☐

Minimum velocity

☐

Resultant velocity

☐

Terminal velocity

☐

0 1 . 3 The skydiver travels downwards at a speed of 56 m/s for 40 s

Calculate the distance travelled during this time.

Use the equation:

distance travelled = speed $\times$ time

[2 marks]

Distance travelled = _____ m

Question 1 continues on the next page

Turn over ►



0 1 . 4

The total mass of the skydiver and equipment is 85 kg

Calculate the weight of the skydiver and equipment.

Use the equation:

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

gravitational field strength = 9.8 N/kg

[2 marks]

Weight = _____ N

0 1 . 5

The skydiver opens her parachute.

The velocity of the skydiver decreases.

Why does the velocity decrease when the parachute opens?

[1 mark]Tick (✓) **one** box.

Air resistance decreases

☐

Air resistance increases

☐

Air resistance stays the same

☐

7


Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

Turn over ►



0 2

The National Grid supplies electricity to consumers in the UK.

0 2 . 1

Complete the sentences.

Choose answers from the box.

[3 marks]

current	efficiency	energy	force	frequency
---------	------------	--------	-------	-----------

Step-up transformers are used to increase the potential difference, which causes a decrease in the _____.

This means that the temperature of the cables is lower, so there is less wasted _____.

This increases the _____ of the power transmission process.

0 2 . 2

What is the frequency of the UK mains electricity supply?

[1 mark]

Tick (✓) **one** box.

20 Hz

☐

50 Hz

☐

230 Hz

☐

20 000 Hz

☐


Electricity supplied to the National Grid is generated in different ways.

Table 1 shows the percentage of UK electricity generated from different energy resources in 2017.

Table 1

Energy resource	Percentage of UK electricity generated
Coal	7
Natural gas	41
Nuclear	X
Wind	12
Other resources	17

0 2 . 3 Calculate value **X** in **Table 1**.

[1 mark]

X = _____ %

0 2 . 4 Explain why generating electricity using natural gas causes environmental problems.

[2 marks]

Question 2 continues on the next page

Turn over ►



0 2 . 5

Give **one** advantage and **one** disadvantage of using wind turbines to generate electricity.

[2 marks]

Advantage _____

Disadvantage _____

A student investigated how the output potential difference of a model wind turbine was affected by the length of the turbine blades.

Figure 2 shows the equipment the student used.

Figure 2

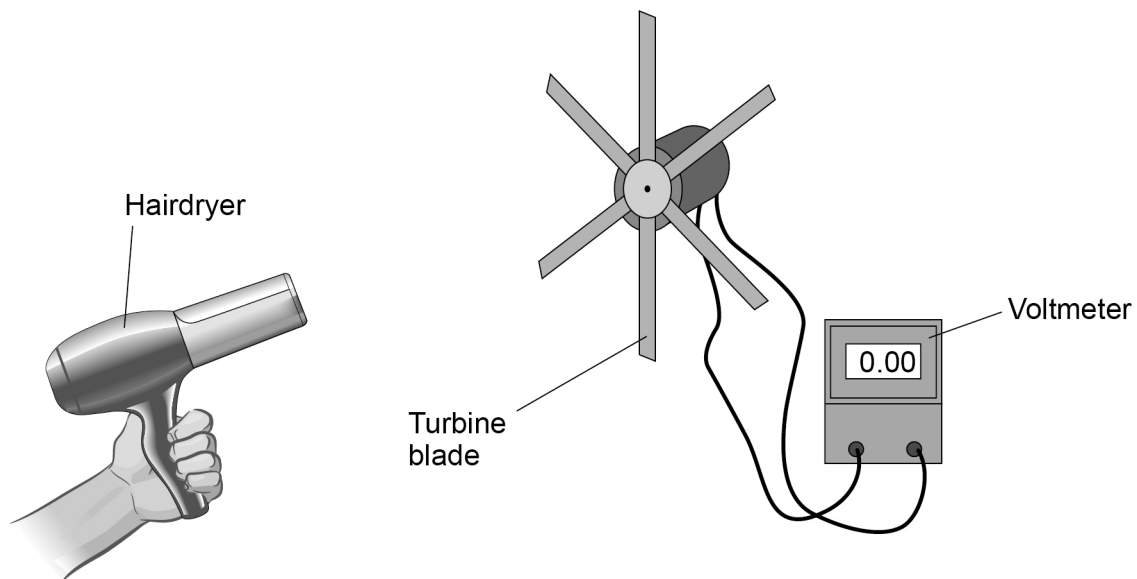


Table 2 shows the student's results.

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Table 2

Length of turbine blades in cm	Output potential difference in volts			
	Test 1	Test 2	Test 3	Mean
8	0.13	0.12	0.11	0.12
6	0.15	0.14	0.16	0.15
4	0.27	0.25	0.23	0.25
2	0.26	0.30	0.12	X

0 2 . 6 Calculate value **X** in **Table 2**.

Do **not** include the anomalous result.

[2 marks]

X = _____ volts

0 2 . 7 What type of error caused the variation in this student's repeat readings?

[1 mark]

Tick (✓) **one** box.

Random error

☐

Systematic error

☐

Zero error

☐

Question 2 continues on the next page

Turn over ►



0	2	.	8
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Another student did the same investigation but used a clamp stand to hold the hairdryer.

Explain how this would improve the results.

[2 marks]

14



Turn over for the next question

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0 3**Table 3** shows the mass of each ingredient in an indigestion tablet.**Table 3**

Ingredient	Mass in milligrams
Calcium carbonate	522
Magnesium carbonate	68
Sodium hydrogencarbonate	64
Other substances	146

0 3 . 1

Calculate the mass of the indigestion tablet in grams.

[2 marks]

Mass of tablet in milligrams = _____

Mass of tablet in grams = _____

0 3 . 2

Calcium carbonate in the indigestion tablet reacts with hydrochloric acid in the stomach.

Which gas is produced?

[1 mark]Tick (✓) **one** box.

Carbon dioxide

☐

Chlorine

☐

Hydrogen

☐

Oxygen

☐

03.3

Sodium hydrogencarbonate has the chemical formula NaHCO_3

How many different elements are in sodium hydrogencarbonate?

[1 mark]Tick (✓) **one** box.

3

☐

4

☐

5

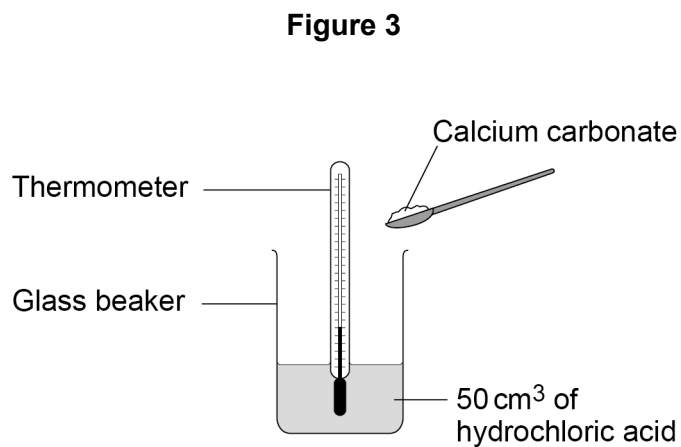
☐

6

☐**Question 3 continues on the next page****Turn over ►**

A student investigated the temperature change when different masses of calcium carbonate were reacted with 50 cm³ of hydrochloric acid.

Figure 3 shows the apparatus used.



This is the method used.

1. Add 50 cm³ of hydrochloric acid to a glass beaker.
2. Record the temperature of the hydrochloric acid.
3. Add 1 g of calcium carbonate to the hydrochloric acid.
4. Stir the mixture.
5. Record the highest temperature of the mixture.
6. Repeat steps 1–5 with different masses of calcium carbonate.

0 3 . 4 Which **two** changes would increase the accuracy of the results?

[2 marks]

Tick (✓) **two** boxes.

Add a lid to the top of the glass beaker

☐

Add indicator to the hydrochloric acid

☐

Use 100 cm³ of hydrochloric acid

☐

Use a polystyrene cup instead of the glass beaker

☐

Use a thermometer with intervals of 5 °C instead of 1 °C

☐

0 3 . 5 The student added different masses of calcium carbonate to the hydrochloric acid.

Which **two** terms describe the mass of calcium carbonate in this investigation?

[2 marks]

Tick (✓) **two** boxes.

Categoric variable

☐

Continuous variable

☐

Control variable

☐

Dependent variable

☐

Independent variable

☐


0 4

The country Iceland is a major producer of aluminium.

Aluminium is extracted from aluminium oxide using electrolysis.

Electrolysis requires a large amount of electricity.

Iceland generates all of its electricity from renewable resources.

0 4 . 1

Which of the following is a renewable resource?

[1 mark]

Tick (✓) **one** box.

Coal

☐

Crude oil

☐

Hydroelectricity

☐

Nuclear fuel

☐**0 4 . 2**

Why is aluminium produced in Iceland?

[1 mark]

Tick (✓) **one** box.

Conserves aluminium ore

☐

Plentiful supply of cheap electricity

☐

Uses up non-renewable resources

☐**0 4 . 3**

Aluminium is extracted from aluminium oxide.

Complete the balanced equation for the reaction.

[2 marks]

0 4 . 4 What type of reaction takes place when oxygen is removed from aluminium oxide?

[1 mark]

Tick (✓) **one** box.

Combustion

☐

Neutralisation

☐

Reduction

☐

0 4 . 5 During electrolysis, aluminium ions (Al^{3+}) move towards the negative electrode.

Explain why aluminium ions move towards the negative electrode.

[2 marks]

0 4 . 6 At the negative electrode, an aluminium ion (Al^{3+}) gains electrons to become an aluminium atom.

How many electrons does each aluminium ion gain?

[1 mark]

Number of electrons = _____

0 4 . 7 The positive electrode is made of carbon.

Oxygen is produced at the positive electrode.

The oxygen reacts with the carbon.

Complete the word equation for the reaction.

[1 mark]

carbon + oxygen $\longrightarrow$ _____

Turn over ►



0 4 . 8

Why do the positive electrodes need to be replaced regularly?

[1 mark]

0 4 . 9

A ceramic material can be used as the positive electrode in the electrolysis of aluminium oxide.

The ceramic material has the following properties:

- high melting point
- unreactive.

Explain why each property is important when the ceramic material is used in the electrolysis of aluminium oxide.

[4 marks]High melting point

Unreactive

14

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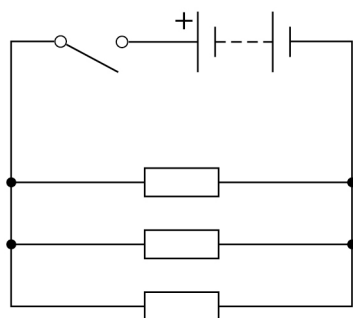
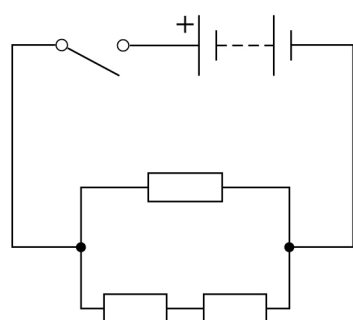
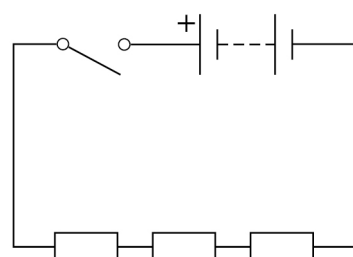
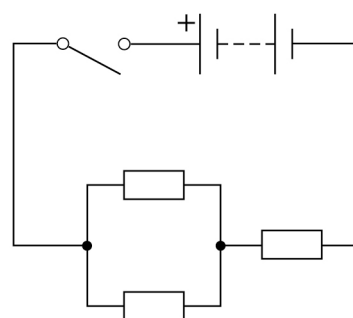
0 5

A student investigated electrical circuits.

The student built a circuit with three resistors in series.

0 5 . 1

Which circuit diagram shows a circuit containing three resistors in series?

[1 mark]Tick (✓) **one** box.☐☐☐☐

0 5 . 2

The student determined the total resistance of the circuit.

To determine the resistance, the student needed extra components in the circuit.

Which **two** components did the student need?

[2 marks]

Tick (✓) **two** boxes.

Ammeter

☐

Diode

☐

Fuse

☐

Variable resistor

☐

Voltmeter

☐

Question 5 continues on the next page

Turn over ►

The student built circuits with different numbers of resistors in series.

All the resistors used were identical.

0 5 . 3

The student switched the circuits off between readings.

Why did the student need to switch the circuits off?

[1 mark]

Tick (✓) **one** box.

So the battery could recharge

☐

So the current would increase

☐

So the potential difference would increase

☐

So the temperature of the resistors would remain constant

☐

Table 4 shows the student's results.

Table 4

Number of resistors	Total resistance in ohms
1	2.2
2	4.4
3	6.6
4	8.8
5	11.0
6	13.2

0 5 . 4

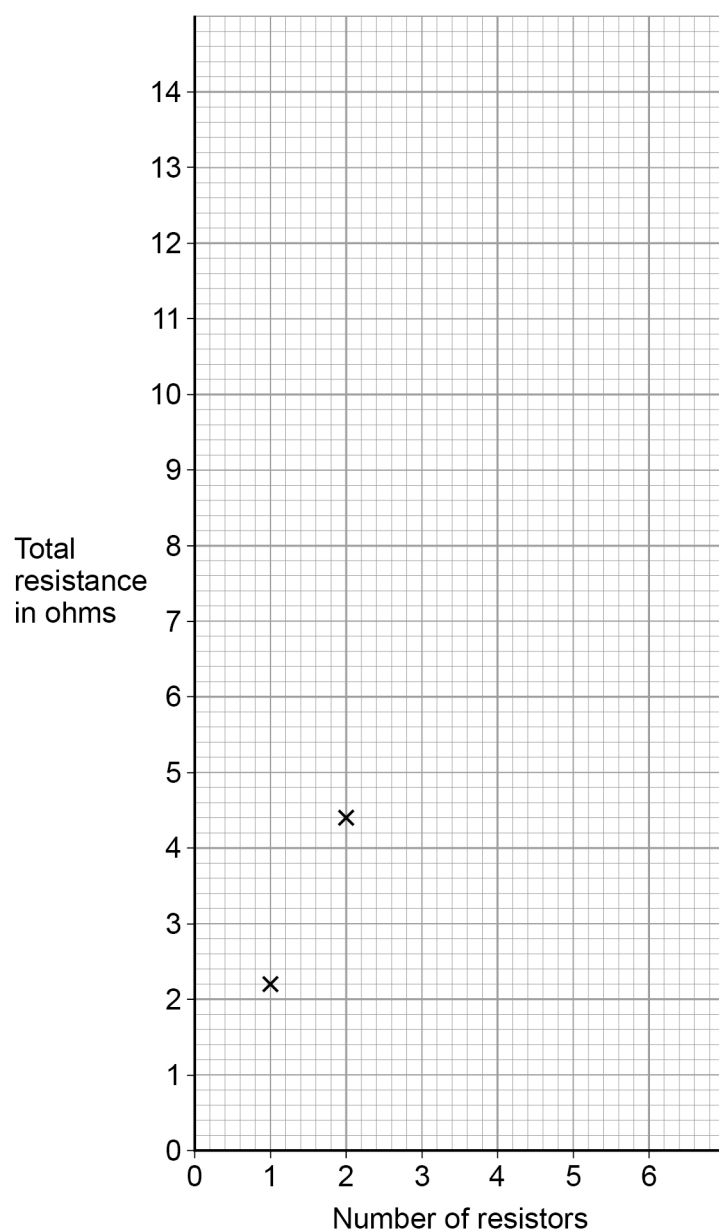
Complete **Figure 4** using data from **Table 4**.

You should:

- plot the rest of the results
- draw a line of best fit.

[3 marks]



Figure 4

0 5 . 5

The student concluded that there was a linear relationship between resistance and the number of resistors.

How do the results support this conclusion?

[1 mark]

Question 5 continues on the next page

Turn over ►



0 5 . 6

The student could have connected the resistors in parallel instead of in series.

How would the total resistance of three resistors in parallel compare with the total resistance of three resistors in series?

[1 mark]

Tick (✓) **one** box.

Higher

☐

Lower

☐

The same

☐

9



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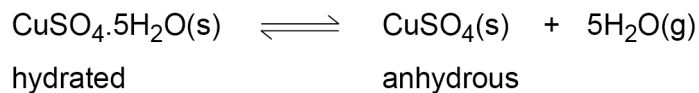


0 6

This question is about reversible reactions.

When blue hydrated copper sulfate is heated, white anhydrous copper sulfate and water are produced.

The equation for the reaction is:

**0 6 . 1**

How does the equation show that this is a reversible reaction?

[1 mark]

A student investigated the forward reaction.

This is the method used.

1. Place an empty test tube on a balance.
2. Zero the balance with the test tube on it.
3. Add 1.26 g of hydrated copper sulfate to the test tube.
4. Heat the test tube and contents for 5 minutes.
5. Measure the mass of the solid left in the test tube.
6. Repeat steps 4–5 until the mass of the solid is constant.



0 6 . 2 Figure 5 shows the test tube on the balance at the end of the investigation.

Figure 5

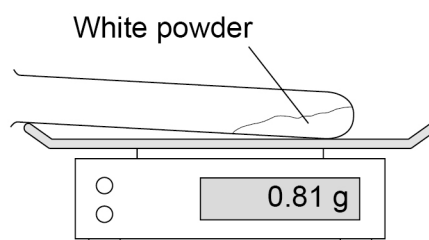


Table 5 shows some of the student's results.

Table 5

Substance	Mass of substance in g
Hydrated copper sulfate	1.26
Anhydrous copper sulfate	X
Water	Y

Determine the values **X** and **Y**.

Use **Figure 5** and **Table 5**.

[2 marks]

X = _____ g

Y = _____ g

Question 6 continues on the next page

Turn over ►



0 6 . 3

Why did the student keep heating the test tube and its contents until the mass was constant?

[1 mark]

Tick (✓) **one** box.

To make more hydrated copper sulfate

☐

To make sure all the water was removed

☐

To melt the anhydrous copper sulfate

☐

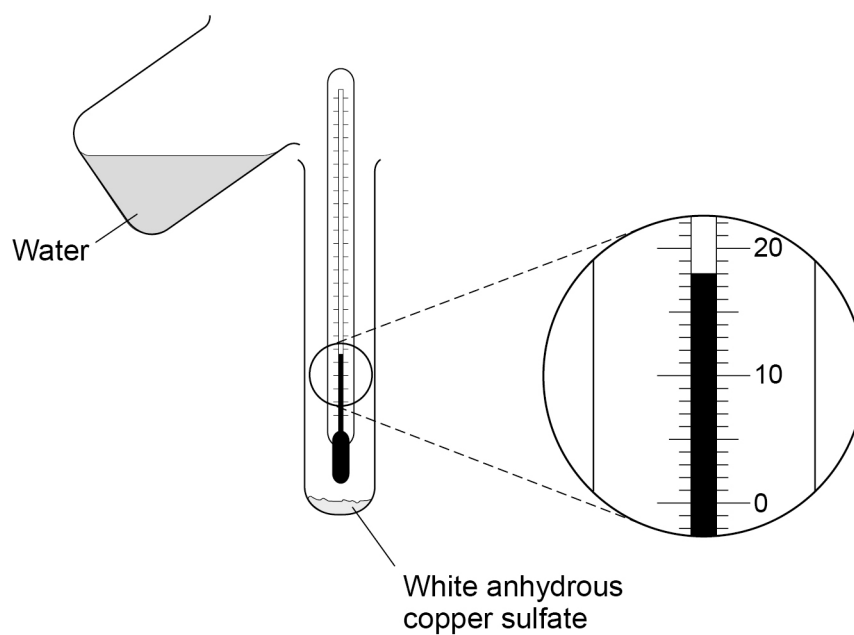
The student then investigated the reverse reaction.

The student added water to anhydrous copper sulfate.

This reaction is exothermic.

Figure 6 shows the apparatus used.

Figure 6



0 6 . 4 What is an exothermic reaction?

[1 mark]

Tick (✓) **one** box.

A reaction where there is no energy change

☐

A reaction that gives out energy to the surroundings

☐

A reaction that takes in energy from the surroundings

☐

0 6 . 5 What is the temperature shown on the thermometer in **Figure 6**?

[1 mark]

Temperature = _____ °C

0 6 . 6 The student measured the temperature during the reaction.

Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases

increases

stays the same

When water is added to anhydrous copper sulfate, the

temperature _____ .

7

Turn over ►



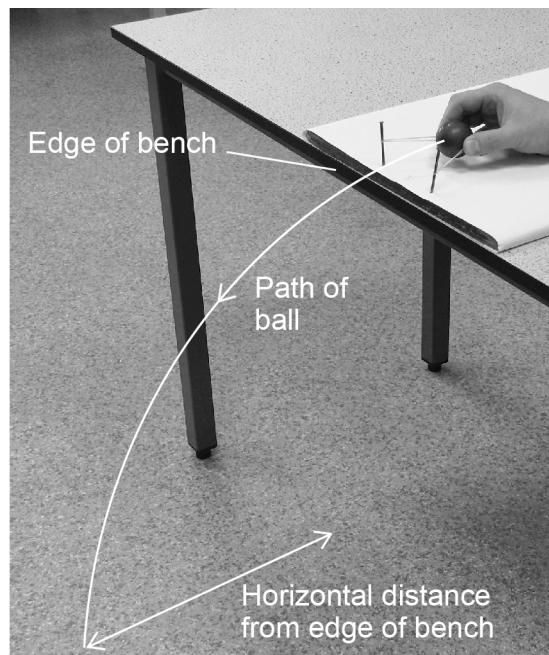
0 7

A student investigated how the horizontal distance travelled by a metal ball varied with launch speed.

The student used an elastic band to launch the ball at different speeds from a bench.

Figure 7 shows the equipment the student used.

Figure 7

**0 7 . 1**

What piece of apparatus could the student use to measure the horizontal distance travelled by the ball?

[1 mark]

0 7 . 2

Suggest how the student could use the elastic band to increase the launch speed.

[1 mark]



0 7 . 3 Suggest **one** variable which should be kept the same for this investigation.

[1 mark]

0 7 . 4 Suggest **one** hazard to the student and **one** precaution to avoid the hazard.

[2 marks]

Hazard _____

Precaution _____

Question 7 continues on the next page

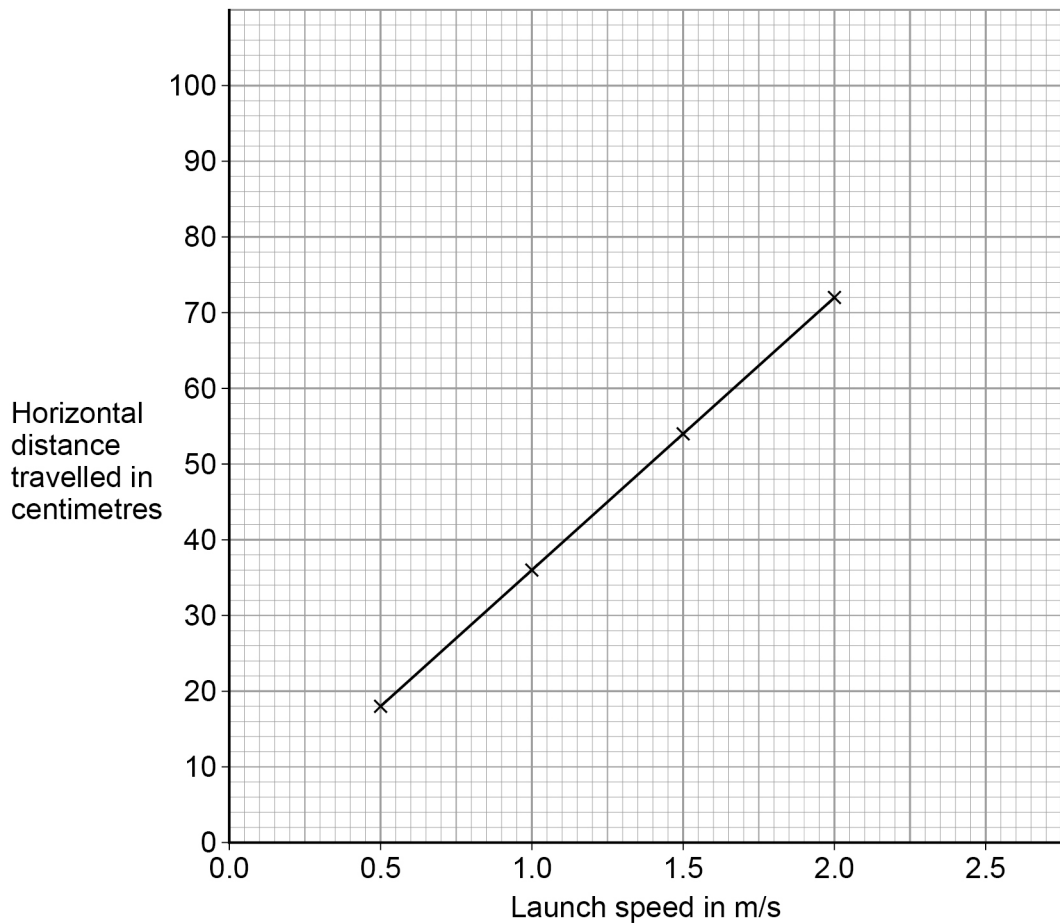
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The student measured the horizontal distance travelled for a range of launch speeds.

Figure 8 shows the results.

Figure 8



0 7 . 5

What range of launch speeds did the student use in the investigation?

[1 mark]

From _____ m/s to _____ m/s

0 7 . 6

Predict the horizontal distance travelled for a launch speed of 2.5 m/s

Use **Figure 8**.

[1 mark]

Horizontal distance travelled = _____ cm



0 7 . 7

Write the equation which links kinetic energy, mass and speed.

[1 mark]

0 7 . 8

The mass of the ball was 0.0044 kg

Calculate the kinetic energy of the ball when the speed was 1.6 m/s

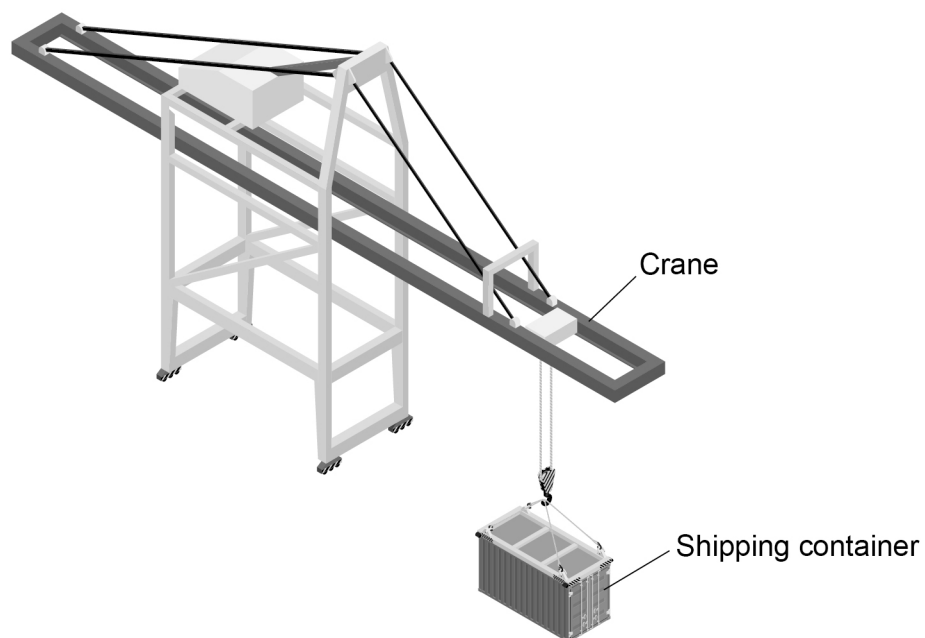
Give your answer to 2 significant figures.

[3 marks]

Kinetic energy = _____ J

11

Turn over for the next question**Turn over ►**

0 8**Figure 9** shows a crane being used to lift a shipping container.**Figure 9****0 8 . 1**

Write the equation which links distance, force and work done.

[1 mark]



0 8 . 2

The container was lifted a height of 14 m

The crane did 3 430 000 J of work on the container.

Calculate the force exerted by the crane on the container.

[3 marks]

Force = _____ N

0 8 . 3

Write the equation which links power, time and work done.

[1 mark]

0 8 . 4

The power of the crane was 68 600 W

Calculate the time taken for the crane to do 3 430 000 J of work.

Give the unit.

[4 marks]

Time taken = _____ Unit _____

Turn over ►

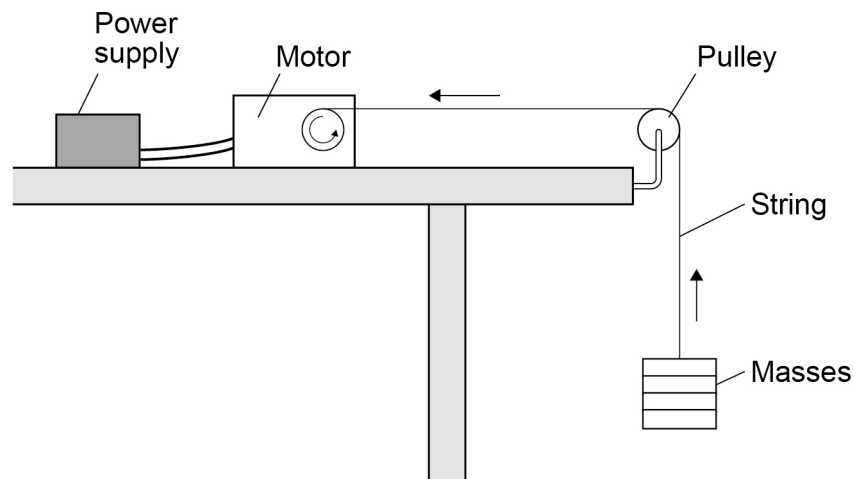
0 9

A student used an electric motor to lift a mass.

He investigated how the efficiency of the motor varied with the mass lifted.

Figure 10 shows the apparatus used.

Figure 10



0 9 . 1

Energy is transferred to the electric motor by the power supply.

Why is the energy transferred to the motor greater than the gravitational potential energy gained by the mass?

[2 marks]

Tick (✓) **two** boxes.

Energy is not conserved

☐

Friction in the motor causes energy transfer to the surroundings

☐

The temperature of the motor increases

☐

Thermal energy from the surroundings is transferred to the mass

☐

Wasted energy is destroyed

☐


0	9	.	2
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The student calculated the gravitational potential energy gained by different masses as they were lifted.

The student used the equation:

$$\text{gravitational potential energy} = \text{mass} \times 9.8 \times \text{height}$$

Describe how the student could make accurate measurements to use in the calculations.

[4 marks]

Question 9 continues on the next page

Turn over ►



0 9 . 3

Write the equation which links efficiency, total input energy transfer and useful output energy transfer.

[1 mark]

0 9 . 4

The efficiency of the motor was 15%.

The student calculated that the useful output energy transfer was 1.20 J

Calculate the total input energy transfer.

[4 marks]

Total input energy transfer = _____ J

11



1 0

Some drinks containers are made from aluminium. Other drinks containers are made from a polymer called PET.

Both aluminium and PET can be recycled.

1 0**. 1**

Figure 11 shows the recycling symbol for PET.

Figure 11



Suggest why this symbol is used on a PET bottle.

[1 mark]

1 0**. 2**

50 000 000 kg of aluminium are used each year to make drinks cans.

70% of these aluminium cans are recycled.

Calculate the mass of aluminium that is recycled each year from drinks cans.

Give your answer in standard form.

[3 marks]

Mass = _____ kg

Question 10 continues on the next page

Turn over ►



1	0	.	3
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Table 6 gives information about the Life Cycle Assessments (LCAs) of two types of drinks containers.

Table 6

The following table cannot be reproduced here due to third-party copyright restrictions.



Your answer should include supporting calculations.

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10

END OF QUESTIONS



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