Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________
I declare this is my own work.

# GCSE
# COMBINED SCIENCE: SYNERGY

**F**

## Foundation Tier Paper 4 Physical Sciences

Wednesday 10 June 2020 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. Pencil should only be used for drawing.
- 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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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.

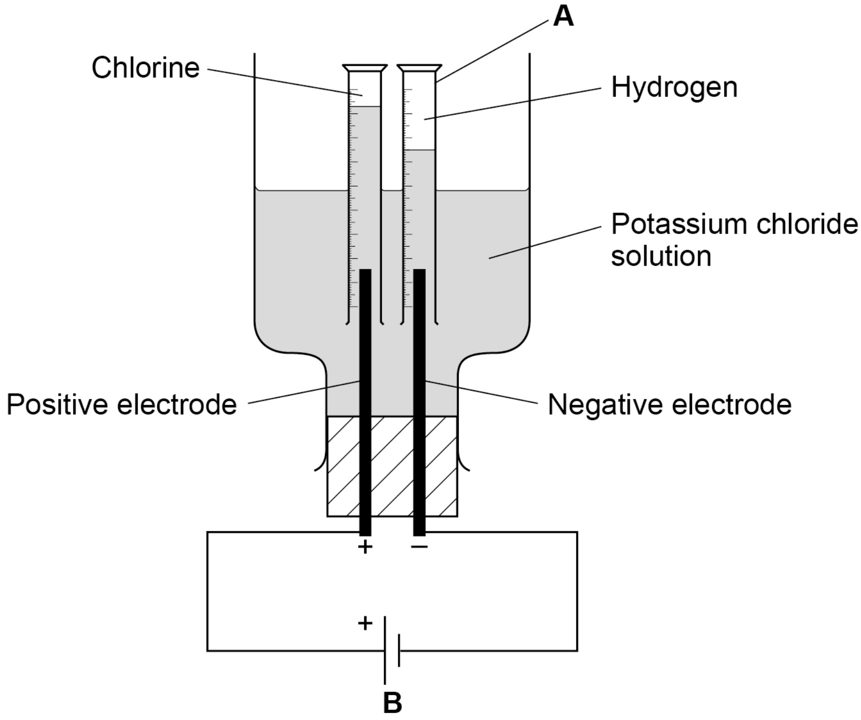
| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| **TOTAL** | |

Do not write outside the box

**0 1** A student investigated the electrolysis of potassium chloride solution.

**Figure 1** shows the apparatus used.

**Figure 1**




**0 1 . 1** The student used the piece of equipment labelled **A** to measure the volume of gas collected.

What is the piece of equipment labelled **A**?

**[1 mark]**

Tick (✓) **one** box.

Balance ☐

Conical flask ☐

Measuring cylinder ☐

Thermometer ☐

*Do not write outside the box*

**0 1 . 2** What does the circuit symbol **B** represent?

**[1 mark]**

______________________________________________

**0 1 . 3** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | | |
|---|---|---|---|
| **anode** | **cathode** | **electrolyte** | **product** |

In this process potassium chloride solution is the ______________________.

**0 1 . 4** Direct current (dc) is supplied to the circuit.

What is direct current?

**[1 mark]**

Tick (✓) **one** box.

Current that always passes in the same direction. ☐

Current that changes direction 100 times each second. ☐

Current that does not have a direction. ☐

**0 1 . 5** Potassium chloride solution contains potassium ($K^+$) ions and chloride ($Cl^-$) ions.

Why are chloride ions attracted to the positive electrode?

**[1 mark]**

______________________________________________

______________________________________________

**Question 1 continues on the next page**

*Do not write outside the box*

**0 1 . 6** Hydrogen gas is produced at the negative electrode.

Which test should the student use to identify hydrogen gas?

**[1 mark]**

Tick (✓) **one** box.

A burning splint ☐

A glowing splint ☐

Bubble through limewater ☐

Damp litmus paper ☐

**0 1 . 7** Hydrogen ions and potassium ions move to the negative electrode.

Hydrogen gas is produced at the negative electrode.

Why is hydrogen gas produced at the negative electrode?

**[1 mark]**

Tick (✓) **one** box.

Hydrogen is a non-metal. ☐

Hydrogen is less reactive than potassium. ☐

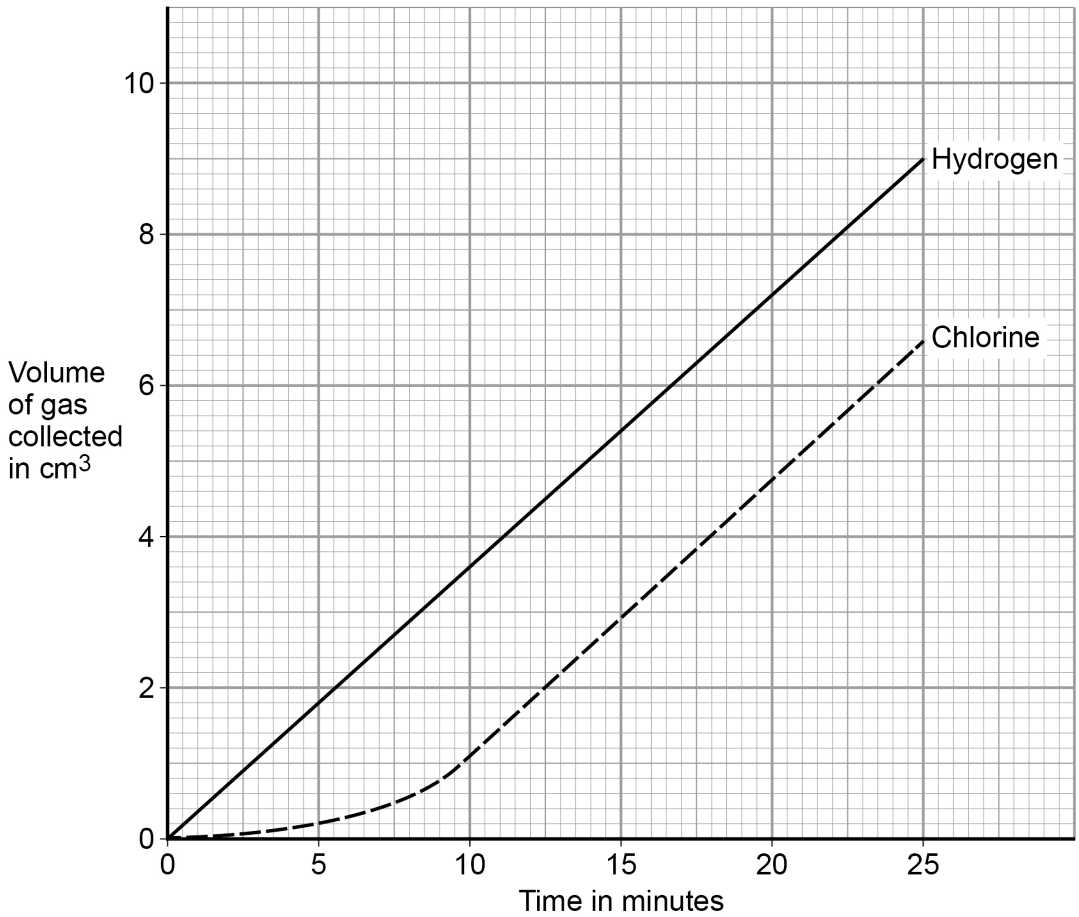
Too few potassium ions move to the electrode. ☐

Do not write outside the box

**0 1 . 8** The student measured the volume of gas collected at each electrode every minute for 25 minutes.

**Figure 2** shows the results.

**Figure 2**




Describe **one** similarity and **one** difference in the volume of hydrogen and the volume of chlorine collected during the 25 minutes.

Use **Figure 2**.

**[2 marks]**

Similarity ______________________________________________

______________________________________________

Difference ______________________________________________

______________________________________________

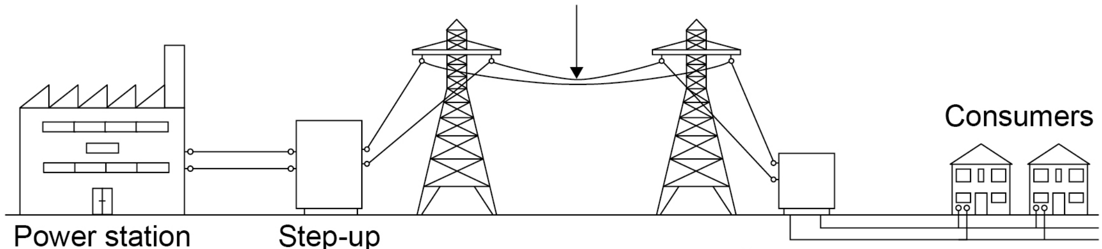
9

**Turn over ►**

Do not write outside the box

**0 2** **Figure 3** shows how a power station supplies electricity to consumers.

**Figure 3**




**0 2 . 1** The National Grid is a system of cables and transformers linking power stations to consumers.

Complete the sentences.

Choose answers from the box.

Each answer may be used once, more than once or not at all.

**[3 marks]**

| | | |
|---|---|---|
| **decrease** | **increase** | **remain the same** |

The step-up transformer causes the potential difference to increase and

the current to ____________________________.

The use of the step-up transformer causes the energy transferred by heating

of the cables to ____________________________.

The step-down transformer causes the potential difference to decrease and

the current to ____________________________.

Do not write outside the box

**0 2 . 2** A nuclear power station has a power output of 350 000 000 W

Calculate the energy transferred by the power station in 60 seconds.

Use the equation:

energy transferred = power × time

**[2 marks]**

_______________________________________________

_______________________________________________

_______________________________________________

Energy transferred = ____________________ J

**Question 2 continues on the next page**

**Turn over ►**

*Do not write outside the box*

**Table 1** shows some of the waste products produced by three different types of power station.

**Table 1**

| **Type of power station** | **Carbon dioxide produced in kg/MJ** | **Other waste products** |
|---|---|---|
| Coal | 0.08 | sulfur dioxide |
| Geothermal | 0.03 | none |
| Nuclear | 0.00 | radioactive waste |

**0 2 . 3** Which type of power station contributes least to global warming?

Give a reason for your answer.

**[2 marks]**

Power station ____________________________________________

Reason ____________________________________________

____________________________________________

**0 2 . 4** Which type of power station produces waste products that cause acid rain?

Give a reason for your answer.

**[2 marks]**

Power station ____________________________________________

Reason ____________________________________________

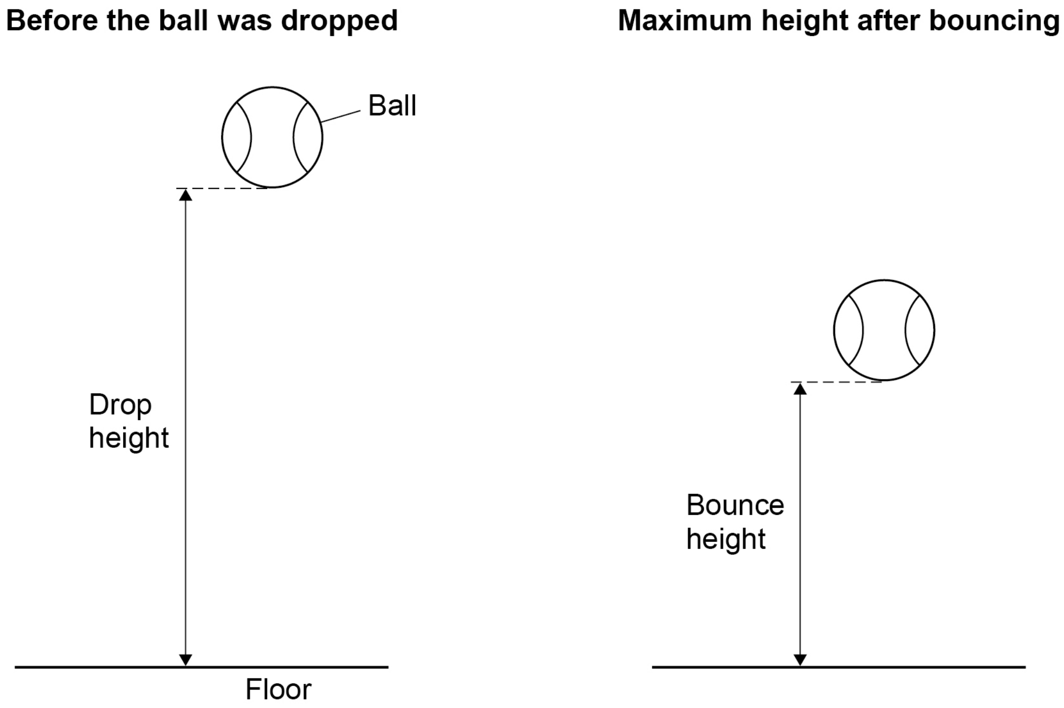
____________________________________________

**9**

**0 3** A student investigated how the bounce height of a ball varied with drop height.

**Figure 4** shows the ball before and after bouncing.

**Figure 4**

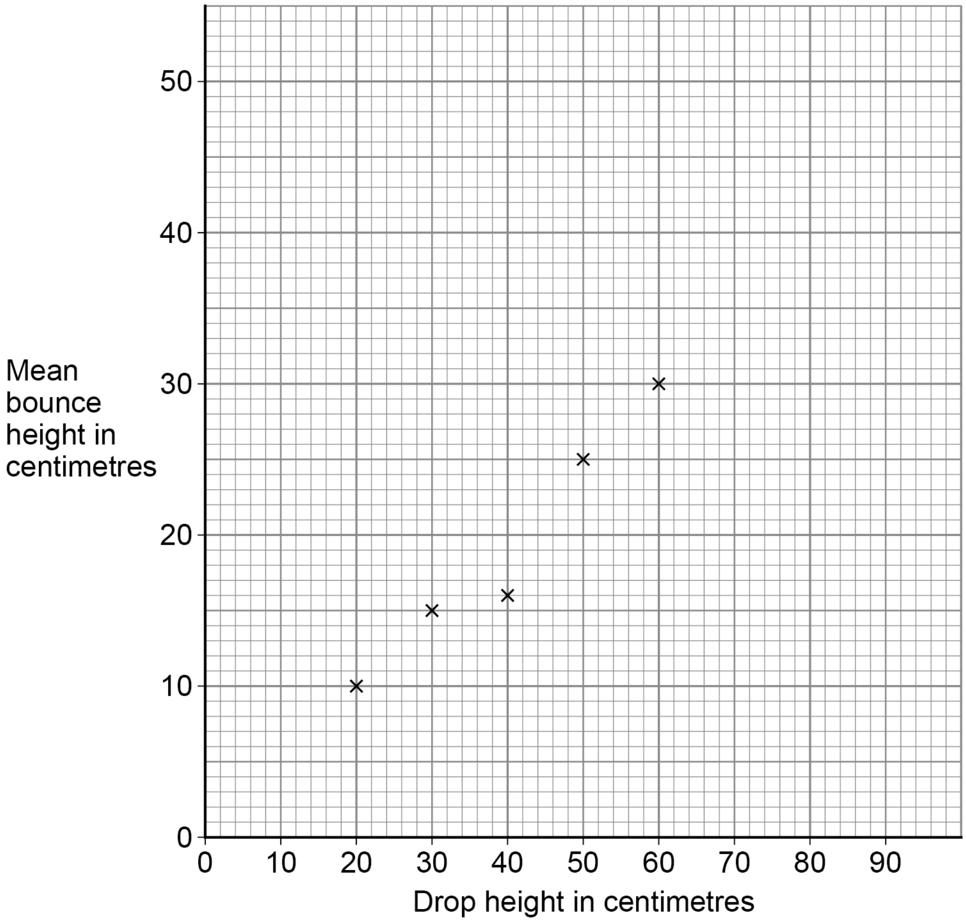



**Question 3 continues on the next page**

*Do not write outside the box*

**Figure 5** shows some of the student's results.

**Figure 5**




**0 3 . 1** Describe a method the student could use to obtain the data shown in **Figure 5**.

**[4 marks]**

*Do not write outside the box*

**0 3 . 2** Draw a ring around the anomalous result on **Figure 5**.

Give **one** reason why you chose this result.

**[2 marks]**

____________________________________________________________

____________________________________________________________

**0 3 . 3** **Table 2** shows some of the student's results.

**Table 2**

| Drop height in centimetres | Mean bounce height in centimetres |
|---|---|
| 70 | 35 |
| 80 | 40 |

Plot the data in **Table 2** on **Figure 5**.

Draw a line of best fit.

**[2 marks]**

**0 3 . 4** What conclusion can be made from **Figure 5**?

**[1 mark]**

Tick (✓) **one** box.

As drop height increases, the mean bounce height decreases. ☐

Mean bounce height is always higher than drop height. ☐

Drop height and mean bounce height show a linear relationship. ☐

**Question 3 continues on the next page**

Do not write outside the box

**0 3 . 5** **Table 3** shows some of the student's results.

**Table 3**

| **Drop height in centimetres** | **Bounce height in centimetres** | | | |
|---|---|---|---|---|
| | **Test 1** | **Test 2** | **Test 3** | **Mean** |
| 60 | 31 | 30 | 29 | 30 |

What was the uncertainty in the student's results when the drop height was 60 cm?

**[1 mark]**

Tick (✓) **one** box.

Uncertainty = ±1 cm ☐

Uncertainty = ±2 cm ☐

Uncertainty = ±4 cm ☐

**0 3 . 6** What is the reason for the uncertainty in the values of bounce height?

**[1 mark]**

Tick (✓) **one** box.

It is difficult to judge when the ball is at maximum height. ☐

The bounce height is too small to measure. ☐

When the ball bounces, energy is transferred to the surroundings. ☐

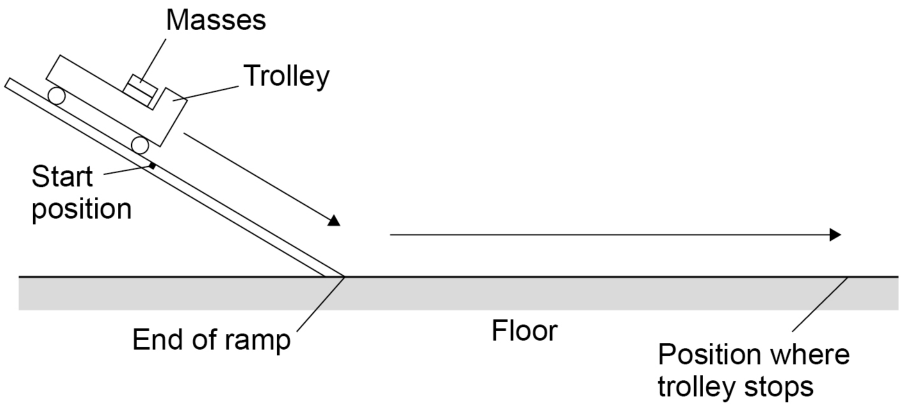
11

Do not write outside the box

**0 4** A student investigated how the distance travelled by a trolley from the end of a ramp varied with the total mass of the trolley.

**Figure 6** shows the equipment the student used.

**Figure 6**




This is the method used.

1. Put the trolley on the ramp at the start position.
2. Let the trolley roll down the ramp.
3. Measure the distance from the end of the ramp to the position where the trolley stops.
4. Repeat steps **1** to **3** with different masses on the trolley.

**0 4 . 1** Give **one** variable the student should have kept the same in the investigation.

**[1 mark]**

**Question 4 continues on the next page**

**Table 4** shows the results.

**Table 4**

| **Total mass of trolley and masses in kilograms** | **Distance travelled by trolley until it stopped in metres** |
|---|---|
| 0.50 | 1.60 |
| 1.00 | 3.50 |
| 1.50 | **X** |
| 2.00 | 6.40 |

**0 4 . 2** Predict a value for **X** in **Table 4**.

**[1 mark]**

**X** = ____________________ m

**0 4 . 3** What conclusion can be made from these results?

**[1 mark]**

____________________

____________________

____________________

____________________

Do not write outside the box

**0 4 . 4** When the trolley was in the start position, the vertical height between the centre of mass of the trolley and the floor was 0.600 m

gravitational field strength = 9.8 N/kg

Calculate the gravitational potential energy of the trolley when the total mass of the trolley and masses was 2.50 kg

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

**[2 marks]**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

Gravitational potential energy = ______________________ J

**0 4 . 5** When the trolley is released from the start position, energy is transferred in different ways.

Complete the sentences.

Choose answers from the box.

**[3 marks]**

| | | |
|---|---|---|
| **chemical** | **elastic potential** | **gravitational potential** |
| **kinetic** | **thermal** | |

As the trolley moves down the ramp the trolley accelerates.

There is a **decrease** in the trolley's ______________________ energy.

There is an **increase** in the trolley's ______________________ energy.

After leaving the ramp the trolley slows down.

There is an **increase** in the ______________________ energy of the surroundings.

8

Do not write outside the box

**0 5** This question is about hydrogen peroxide.

The formula of hydrogen peroxide is $H_2O_2$

**0 5 . 1** Name the elements in a molecule of hydrogen peroxide.

**[1 mark]**

____________________ and ____________________

**0 5 . 2** How many atoms are in a molecule of hydrogen peroxide?

**[1 mark]**

____________________________________________

**0 5 . 3** Hydrogen peroxide decomposes to produce oxygen and water.

Write the word equation for the reaction.

**[1 mark]**

______________ → ______________ + ______________

*Do not write outside the box*

A student investigated the decomposition of hydrogen peroxide.

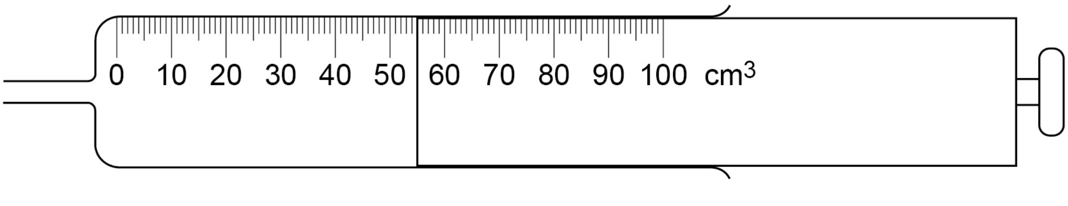
The student used manganese dioxide as a catalyst.

The student measured the volume of oxygen produced.

**0 5 . 4** The student collected the oxygen in a gas syringe.

**Figure 7** shows a gas syringe.

**Figure 7**




What is the volume of oxygen in the syringe?

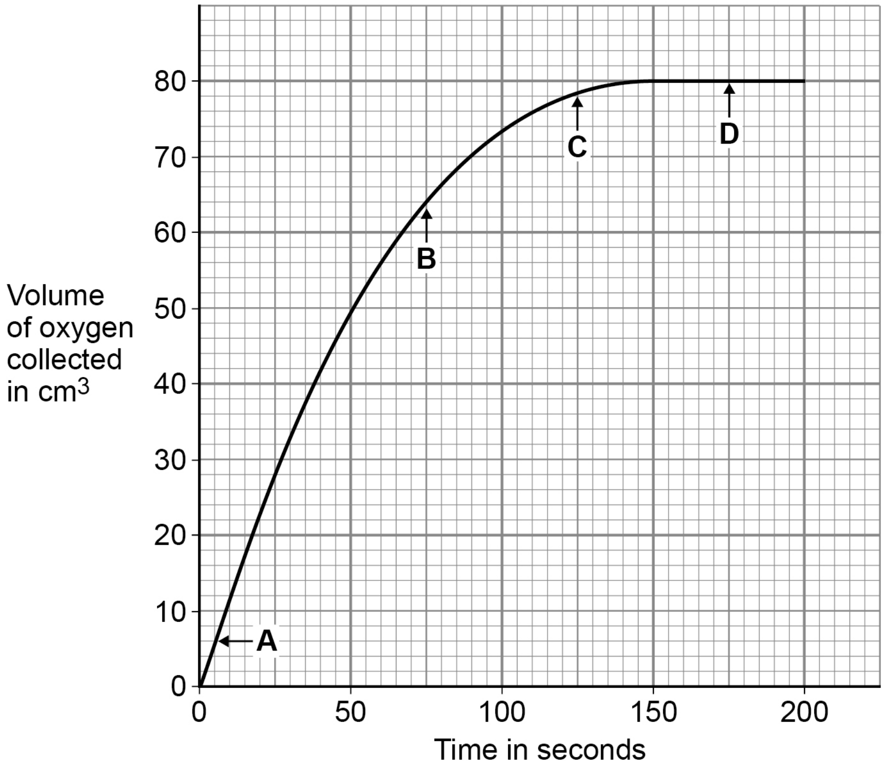
**[1 mark]**

Volume of oxygen = ______________________ $cm^3$

**Question 5 continues on the next page**

**Figure 8** shows how the volume of oxygen collected varied with time.

**Figure 8**




**0 5 . 5** Which point on **Figure 8** shows when the reaction is fastest?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 5 . 6** Which point on **Figure 8** shows when the reaction has stopped?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

Do not write outside the box

**0 5 . 7** The student repeated the investigation using raw potato instead of manganese dioxide.

An enzyme in the potato acts as the catalyst.

Draw **one** line from each catalyst to the type of substance the catalyst is.

**[2 marks]**

| **Catalyst** | **Type of substance** |
| --- | --- |
| | Buckminsterfullerene |
| Enzyme | Gaseous element |
| Manganese dioxide | Metal compound |
| | Protein molecule |

**0 5 . 8** The student repeated the investigation using boiled potato instead of raw potato.

The enzyme in the boiled potato did **not** catalyse the reaction.

How will the rate of decomposition of hydrogen peroxide using boiled potato compare with the rate using raw potato?

**[1 mark]**

Tick (✓) **one** box.

The hydrogen peroxide will decompose at a faster rate. ☐

The hydrogen peroxide will decompose at a slower rate. ☐

The hydrogen peroxide will decompose at the same rate. ☐

9

*Do not write outside the box*

**0 6** This question is about the reaction of metals with sulfuric acid.

**0 6 . 1** The word equation for the reaction of zinc with sulfuric acid is:

zinc + sulfuric acid → zinc sulfate + hydrogen

What type of substance is zinc sulfate?

**[1 mark]**

Tick (✓) **one** box.

Acid ☐

Alkali ☐

Base ☐

Salt ☐

**0 6 . 2** Calculate the relative formula mass ($M_r$) of zinc sulfate ($ZnSO_4$).

Relative atomic masses ($A_r$): Zn = 65 S = 32 O = 16

**[2 marks]**

______________________________

______________________________

______________________________

Relative formula mass ($M_r$) = ______________

*Do not write outside the box*

A student investigated the temperature increase when the same mass of different metals were added to 0.1 M sulphuric acid.

The student used four different metals.

The student did the experiment three times for each metal and calculated the mean temperature increase for each metal.

**0 6 . 3** **Table 5** shows the results for nickel.

**Table 5**

| **Temperature increase in °C** | | | |
|---|---|---|---|
| **Test 1** | **Test 2** | **Test 3** | **Mean** |
| 3.5 | **X** | 3.5 | 4.0 |

Calculate value **X**.

**[2 marks]**

______________________________

______________________________

______________________________

______________________________

**X** = ____________ °C

**Question 6 continues on the next page**

**Table 6** shows the mean values for the four metals.

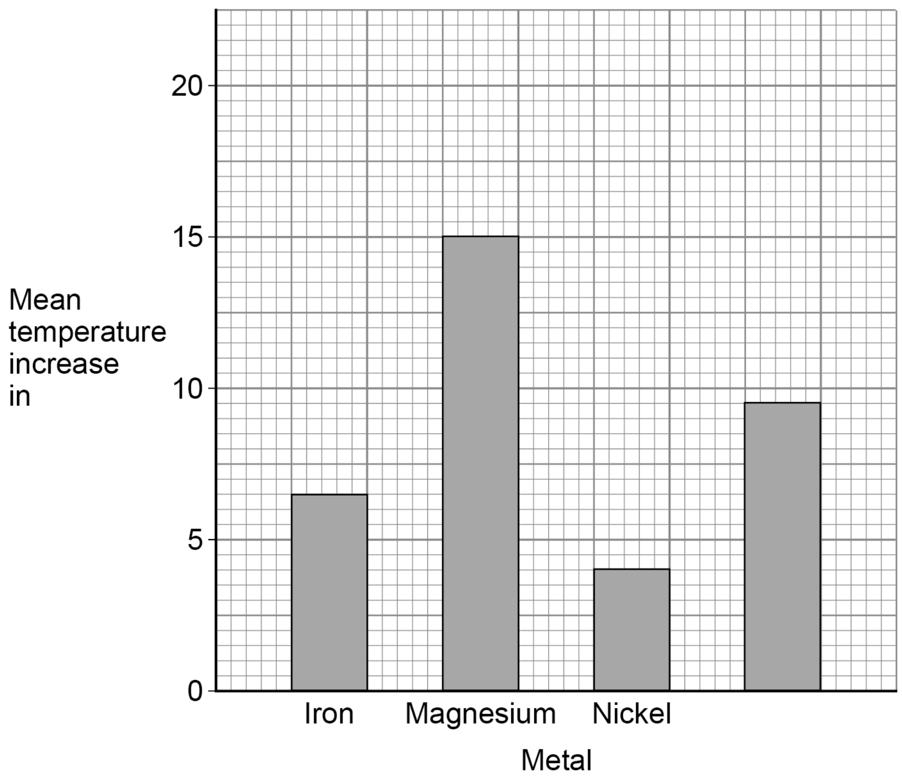
**Table 6**

| **Metal** | **Mean temperature increase in °C** |
|---|---|
| Iron | 6.5 |
| Magnesium | 18.0 |
| Nickel | 4.0 |
| Zinc | 9.5 |

The student plotted the results on a bar chart.

**Figure 9** shows the bar chart.

**Figure 9**



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**0 6 . 4** The student made some errors when plotting the bar chart.

Give **three** errors the student made.

**[3 marks]**

1 ____________________________________________

____________________________________________

2 ____________________________________________

____________________________________________

3 ____________________________________________

____________________________________________

**0 6 . 5** Use **Table 6** to place the metals in order of reactivity.

**[1 mark]**

Most reactive ____________________

____________________

____________________

Least reactive ____________________

9

**Turn over for the next question**

*Do not write outside the box*

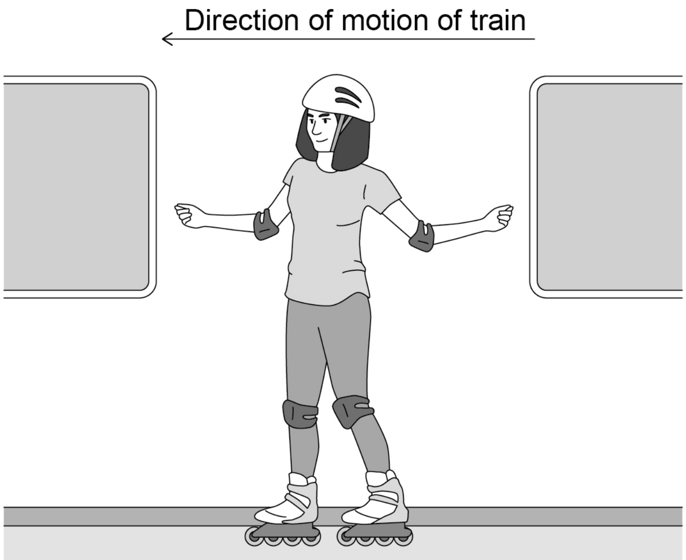
**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

**0 7** **Figure 10** shows a girl inside a train which is moving to the left at a speed of 20 m/s

The girl is wearing inline skates.

**Figure 10**




**0 7 . 1** The train is moving at a constant speed of 20 m/s

The train suddenly decelerates.

The girl continues to move with a speed of 20 m/s

Which of Newton's laws is a correct explanation of this situation?

**[1 mark]**

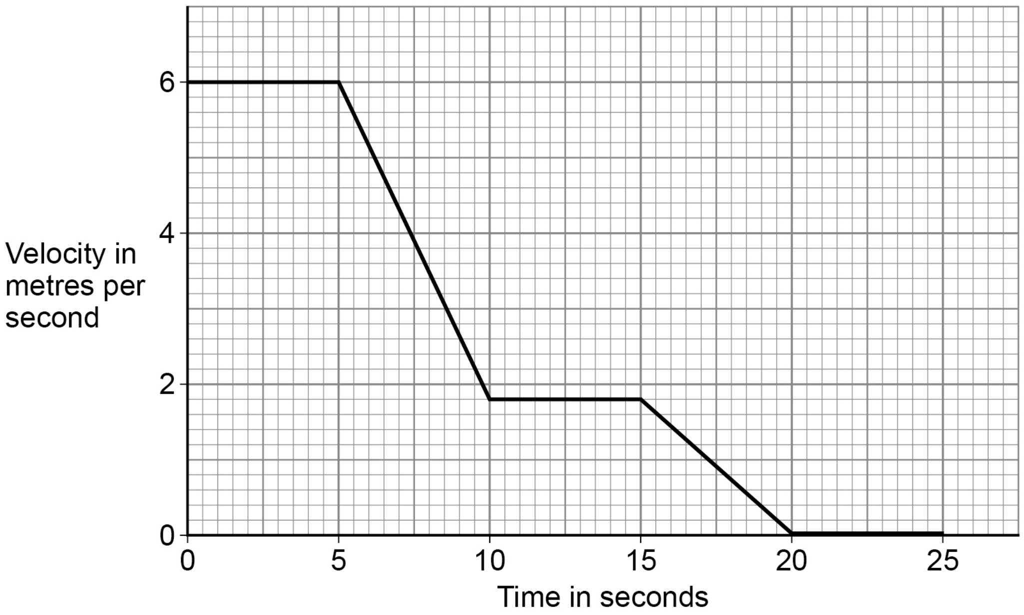
Tick (✓) **one** box.

| | |
|---|---|
| Newton's First Law | ☐ |
| Newton's Gravitational Law | ☐ |
| Newton's Third Law | ☐ |

**Question 7 continues on the next page**

**Figure 11** shows a velocity-time graph for the train as it arrives at a station and stops.

**Figure 11**




**0 7 . 2** Between which two times on **Figure 11** is the train stationary?

**[1 mark]**

Tick (✓) **one** box.

Between 0 and 5 seconds ☐

Between 10 and 15 seconds ☐

Between 20 and 25 seconds ☐

Do not write outside the box

**0 7 . 3** The train travels at a constant speed between 0 seconds and 5 seconds.

Determine the distance the train travels between 0 seconds and 5 seconds.

Use the equation:

distance travelled = speed × time

**[2 marks]**

Distance = ______________________ m

**0 7 . 4** Between which two times on **Figure 11** is the deceleration of the train the greatest?

**[1 mark]**

Between ______________ seconds and ______________ seconds.

**0 7 . 5** Write down the equation which links acceleration ($a$), change in velocity ($\Delta v$) and time taken ($t$).

**[1 mark]**

**0 7 . 6** Determine the acceleration of the train between 15 seconds and 20 seconds.

**[2 marks]**

Acceleration = ______________________ $m/s^2$

**Question 7 continues on the next page**

*Do not write outside the box*

**0 7 . 7** Write down the equation which links kinetic energy ($E_k$), mass ($m$) and speed ($v$).

**[1 mark]**

___________________________________________________________________________

**0 7 . 8** At one point in the train's journey the train's speed was 6.0 m/s

At this point the kinetic energy of the train was 1 080 000 J

Calculate the mass of the train.

**[3 marks]**

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

Mass = ________________________________ kg

12

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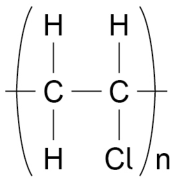
**Turn over for the next question**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

**0 8** This question is about polymers and plastics.

**Figure 12** shows the displayed formula for poly(chloroethene).

**Figure 12**



**0 8 . 1** What does 'n' represent in the displayed formula for poly(chloroethene)?

**[1 mark]**

**0 8 . 2** The representation of poly(chloroethene) in **Figure 12** does **not** show the actual structure of the molecule.

Give **one** reason why.

**[1 mark]**

Poly(chloroethene) is commonly known as PVC.

PVC does not decompose in the ground.

Many polymer plastics like PVC become pollutant waste in the oceans.

In the oceans, PVC can break into smaller pieces.

The smaller pieces are called PVC nanoplastic.

Do not write outside the box

**0 8 . 3** A piece of PVC nanoplastic has a thickness of 50 nm

Calculate the thickness of the PVC nanoplastic in metres.

Give your answer in standard form.

1 nm = 0.000 000 001 m

**[2 marks]**

Thickness (in standard form) = ______________________ m

**0 8 . 4** Suggest **two** reasons why PVC nanoplastic can be harmful to marine life.

**[2 marks]**

1 ______________________

2 ______________________

**0 8 . 5** Suggest **two** ways to reduce plastic waste.

**[2 marks]**

1 ______________________

2 ______________________

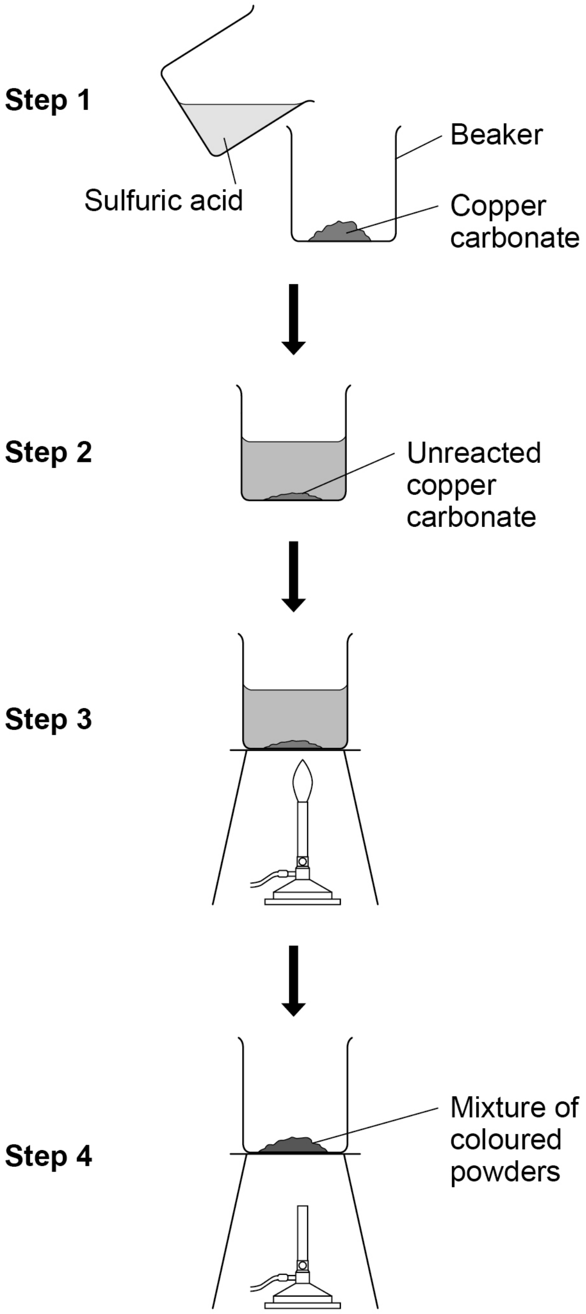
8

*Do not write outside the box*

**0 9** A student wanted to make blue copper sulfate crystals from green copper carbonate powder and sulfuric acid.

**Figure 13** shows the method the student used.

**Figure 13**



*Do not write outside the box*

The student obtained a mixture of coloured powders **not** blue crystals.

Describe how the method could be improved so that blue copper sulfate crystals are produced.

**[6 marks]**

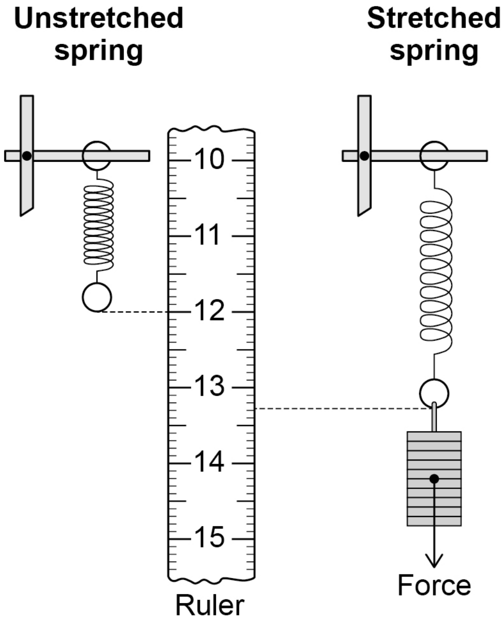
6

**Turn over for the next question**

**1 0** A student investigated how the extension of a spring varied with the force acting on the spring.

**Figure 14** shows the equipment the student used and a ruler scale between 10 cm and 15 cm

**Figure 14**




**1 0 . 1** Describe how the student should determine the extension of the spring.

**[2 marks]**

Do not write outside the box

**1 0 . 2** Write down the equation which links extension ($e$), force ($F$) and spring constant ($k$).

**[1 mark]**

**1 0 . 3** The extension of the spring was 0.12 m when the force was 3.0 N

Calculate the spring constant of the spring.

**[3 marks]**

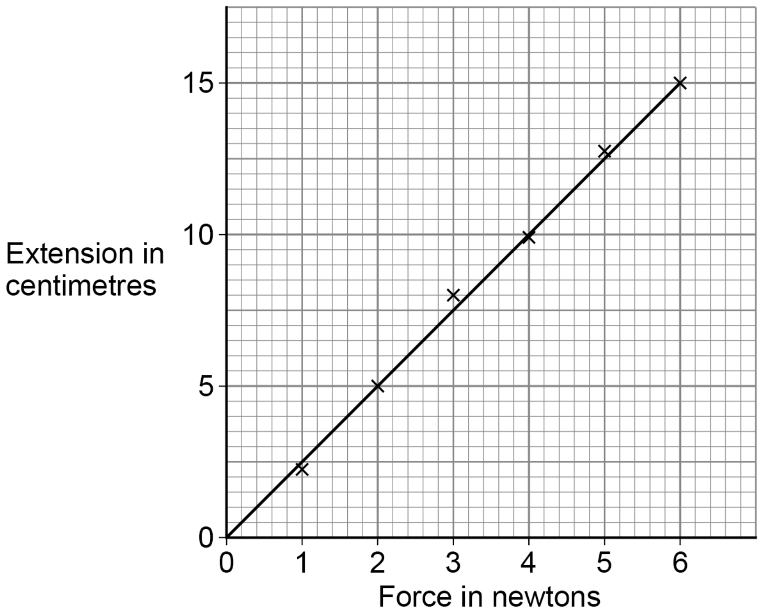
Spring constant = ____________________ N/m

**Question 10 continues on the next page**

*Do not write outside the box*

**1 0 . 4** **Figure 15** shows the results of the same investigation using a different spring.

**Figure 15**




The spring constant of the spring was 40 N/m

Determine the energy stored by the spring when the force was 3.6 N

Use the Physics Equations Sheet.

**[4 marks]**

Energy stored = ____________________ J

**10**

*Do not write outside the box*

**Turn over for the next question**

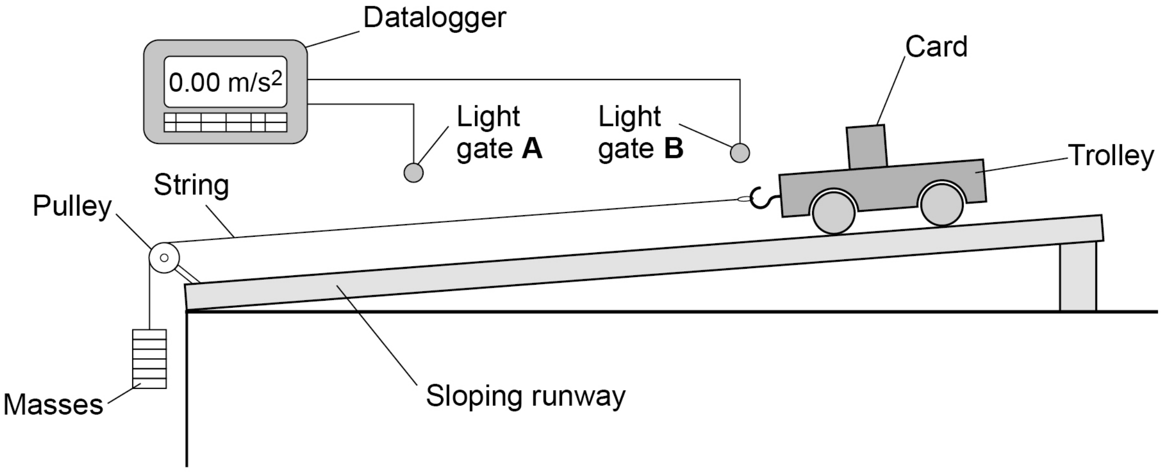
**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

**1 1** A student investigated how the acceleration of a trolley varied with the resultant force on the trolley.

The force on the trolley was provided by the masses on the string.

**Figure 16** shows how the student set up the equipment.

**Figure 16**




This is the method used.

1. Release the trolley from the top of the runway.
2. As the card passes each light gate a timer turns on and off.
3. The datalogger calculates the velocity of the trolley at light gate **A** and at light gate **B**.
4. The datalogger calculates the acceleration using the two velocities.
5. Repeat steps **1** to **4** using different masses.

*Do not write outside the box*

**1 1 . 1** Which **two** measurements are needed to determine the velocity of the trolley at each light gate?

**[2 marks]**

Tick (✓) **two** boxes.

Angle of sloping runway ☐

Distance between light gates ☐

Length of card ☐

Resultant force causing the acceleration ☐

Time that light gates are blocked by the card ☐

**1 1 . 2** Why was a sloping runway used instead of a flat runway?

**[1 mark]**

Tick (✓) **one** box.

To compensate for the effect of friction ☐

To increase the effect of air resistance on the trolley ☐

To make the trolley accelerate ☐

**Question 11 continues on the next page**

Do not write outside the box

**11.3** What are **two** advantages of using a datalogger and light gates instead of a stopclock in this investigation?

**[2 marks]**

Tick (✓) **two** boxes.

| | |
|---|---|
| Ensures readings are repeatable | ☐ |
| Ensures readings are reproducible | ☐ |
| No reaction time error | ☐ |
| No systematic errors | ☐ |
| Performs calculations automatically | ☐ |

**11.4** Write down the equation which links acceleration ($a$), mass ($m$) and resultant force ($F$).

**[1 mark]**

______________________________________________

**11.5** The acceleration of the trolley was 2.4 m/s$^2$

The resultant force on the trolley was 1.2 N

Calculate the mass of the trolley.

**[3 marks]**

______________________________________________

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______________________________________________

Mass = ______________________ kg

9

**END OF QUESTIONS**

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**ANSWER IN THE SPACES PROVIDED**

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