Please write clearly in block capitals.

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

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher Tier Paper 3 Physical sciences

Monday 11 June 2018 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- 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	
3	
4	
5	
6	
7	
8	
TOTAL	

Do not write outside the box

0 1 This question is about hydrogen chloride.

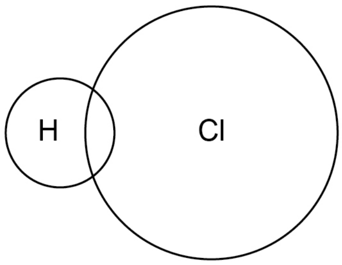
0 1 . 1 A hydrogen atom contains 1 electron and a chlorine atom contains 17 electrons.

Complete **Figure 1** to show a dot and cross diagram for a hydrogen chloride molecule.

Show the outer electrons only.

[2 marks]

Figure 1



Hydrogen gas (H_2) reacts with chlorine gas to produce hydrogen chloride.

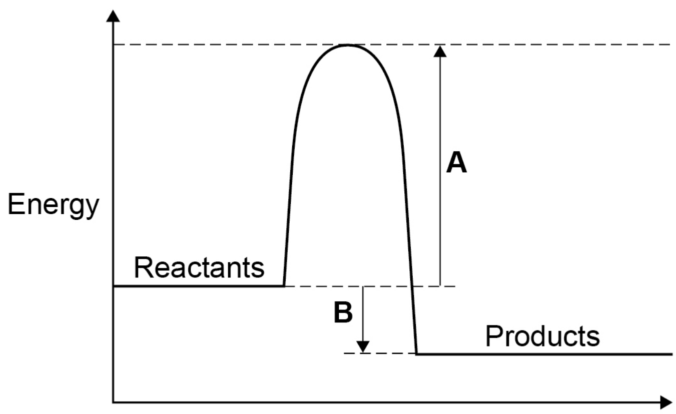
0 1 . 2 Complete the balanced chemical equation for the reaction between hydrogen and chlorine.

[2 marks]

$$H_2 + \_\_\_\_\_\_\_\_ \rightarrow \_\_\_\_\_\_\_\_$$

Figure 2 shows the reaction profile diagram for the reaction between hydrogen and chlorine.

Figure 2



Do not write outside the box

0 1 . 3 What do **A** and **B** represent on **Figure 2**?

[2 marks]

A ____________________

B ____________________

0 1 . 4 How does the reaction profile diagram show that the reaction is exothermic?

[1 mark]

____

____

0 1 . 5 Hydrogen chloride gas dissolves in water to form hydrochloric acid.

Hydrochloric acid contains hydrogen ions and chloride ions.

Explain why hydrogen chloride gas does **not** conduct electricity but hydrochloric acid is able to conduct electricity.

[3 marks]

____

____

____

____

____

____

10

Turn over for the next question

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 2 When a metal carbonate reacts with an acid, a salt, carbon dioxide and water are produced.

0 2 . 1 Describe how you would test for carbon dioxide gas.

Give the result of the test.

[2 marks]

Test ____

____

Result ____

____

0 2 . 2 Describe how to make pure dry crystals of magnesium chloride from magnesium carbonate and a dilute acid.

In your method you should name the apparatus and reagents you plan to use.

[6 marks]

____

____

____

____

____

____

____

____

____

____

____

____

____

____

8

Do not write outside the box

0 3 An energy input of 1.3×10^{18} J is supplied each year by power stations to the National Grid.

Not all of this energy is supplied to consumers. Some of the energy is wasted in the distribution process.

0 3 . 1 Write the equation which links efficiency, total input energy transfer and useful output energy transfer.

[1 mark]

____

____

0 3 . 2 The energy supplied each year to consumers is 1.2×10^{18} J

Calculate the efficiency of the distribution process.

[2 marks]

____

____

____

____

Efficiency = ____________________

0 3 . 3 How is electrical power transmitted across the National Grid to make the process as efficient as possible?

[1 mark]

Tick **one** box.

At a high potential difference and a high current ☐

At a high potential difference and a low current ☐

At a low potential difference and a high current ☐

At a low potential difference and a low current ☐

Do not write outside the box

0 3 . 4 Write the equation which links energy transferred, power and time.

[1 mark]

0 3 . 5 A wind turbine supplies a power output of 8000 kW for 1200 seconds.

Calculate the energy transferred by the wind turbine in kJ

[3 marks]

Energy transferred = ______________________ kJ

0 3 . 6 Describe the environmental advantages and disadvantages of using wind turbines to generate electricity in the UK.

[4 marks]

12

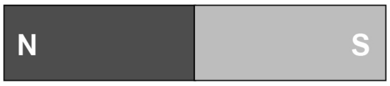
Do not write outside the box

0 4 **Figure 3** shows a bar magnet.

0 4 . 1 Complete the diagram to show the magnetic field lines around a bar magnet.

[2 marks]

Figure 3



0 4 . 2 Describe a method using a compass to plot the magnetic field lines around a bar magnet.

[4 marks]

Do not write outside the box

0 4 . 3 Explain why a compass needle moves when placed near the bar magnet.

[2 marks]

____

____

____

____

____

0 4 . 4 Iron is a magnetic element.

Which of the following is also a magnetic **element**?

[1 mark]

Tick **one** box.

Cobalt ☐

Copper ☐

Steel ☐

Zinc ☐

Question 4 continues on the next page

Do not write outside the box

0 4 . 5 Give **two** pieces of evidence that show the Earth's magnetic field is changing.

[2 marks]

1 ____

2 ____

0 4 . 6 Describe the most likely cause of the changes in the Earth's magnetic field.

[2 marks]

13

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 A teacher demonstrated the extraction of copper from copper oxide.

This is the method used.

1. Mix 1.30 g of zinc and 1.59 g of copper oxide.
2. Heat the mixture strongly.
3. When the mixture starts to glow, stop heating.
4. Let the glow spread through the mixture.
5. Leave the mixture to cool.
6. Add hydrochloric acid to the cooled mixture.
7. Filter the mixture obtained in step 6.

0 5 . 1 A student concluded that an exothermic reaction had taken place.

Explain how an observation made during the demonstration shows this.

[2 marks]

0 5 . 2 The equation for the reaction between zinc and copper oxide is:

$$Zn + CuO \longrightarrow ZnO + Cu$$

1.59 g of copper oxide reacted.

Calculate the mass of copper produced.

Relative atomic masses (A_r): Cu = 63.5 O = 16 Zn = 65

[3 marks]

Mass of copper produced = ____________________ g

Do not write outside the box

0 5 . 3 Explain why steps 6 and 7 result in only copper being obtained as the residue.

[4 marks]

____

____

____

____

____

____

____

____

0 5 . 4 The ionic equation for the reaction is:

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$

Which statement about the reaction between zinc and copper ions is correct?

[1 mark]

Tick **one** box.

Copper ions have been oxidised because the copper ions have gained electrons. ☐

Copper ions have been oxidised because the copper ions have lost electrons. ☐

Zinc has been oxidised because the zinc atoms have gained electrons. ☐

Zinc has been oxidised because the zinc atoms have lost electrons. ☐

10

Turn over for the next question

Do not write outside the box

0 6 Copper can be extracted using biological methods.

0 6 . 1 Name **two** biological methods used to extract copper from copper ores.

For each method, name the type of organism used in the process.

[4 marks]

Method 1 ______________________________

Type of organism ______________________________

Method 2 ______________________________

Type of organism ______________________________

0 6 . 2 Give **three** reasons why biological methods are being introduced to extract copper.

[3 marks]

1 ______________________________

____

2 ______________________________

____

3 ______________________________

____

Do not write outside the box

The biological methods produce copper compounds such as copper sulfate.

0 6 . 3 Copper can be extracted from copper sulfate solution by adding scrap iron.

Explain why.

[2 marks]

____

____

____

____

0 6 . 4 Complete the chemical equation for the reaction between iron and copper sulfate solution.

[2 marks]

Include state symbols.

$$\_\_\_\_\_(\_\_) + CuSO_4(\_\_) \rightarrow \_\_\_\_\_(\_\_) + \_\_\_\_\_(aq)$$

0 6 . 5 A solution of copper sulfate contains 3.175 g of copper ions.

Calculate the number of copper ions in the solution.

Give your answer in standard form.

Relative atomic mass (A_r): Cu = 63.5

The Avogadro constant is 6.02×10^{23} per mole.

[4 marks]

____

____

____

____

____

____

Number of copper ions = ______________

15

Do not write outside the box

0 7 A teacher demonstrated the temperature change when hydrochloric acid is added to sodium hydroxide solution.

This is the method used.

1. Measure 25 cm^3 of sodium hydroxide solution using a measuring cylinder.
2. Add the sodium hydroxide solution to a polystyrene cup.
3. Record the temperature of the sodium hydroxide solution.
4. Add 5 cm^3 of hydrochloric acid from a burette to the sodium hydroxide solution.
5. Stir the solution.
6. Record the temperature of the solution.
7. Repeat steps 4–6 until 50 cm^3 of hydrochloric acid in total is added.

Table 1 shows some of the teacher's results.

Table 1

Volume of hydrochloric acid added in cm^3	**Temperature in °C**
0	21.30
5	24.25
10	26.15
15	27.05
20	27.70

0 7 . 1 **Figure 4** shows the results when 30 cm^3 to 50 cm^3 of hydrochloric acid was added to sodium hydroxide solution.

A line of best fit has been drawn through these results.

Complete **Figure 4**.

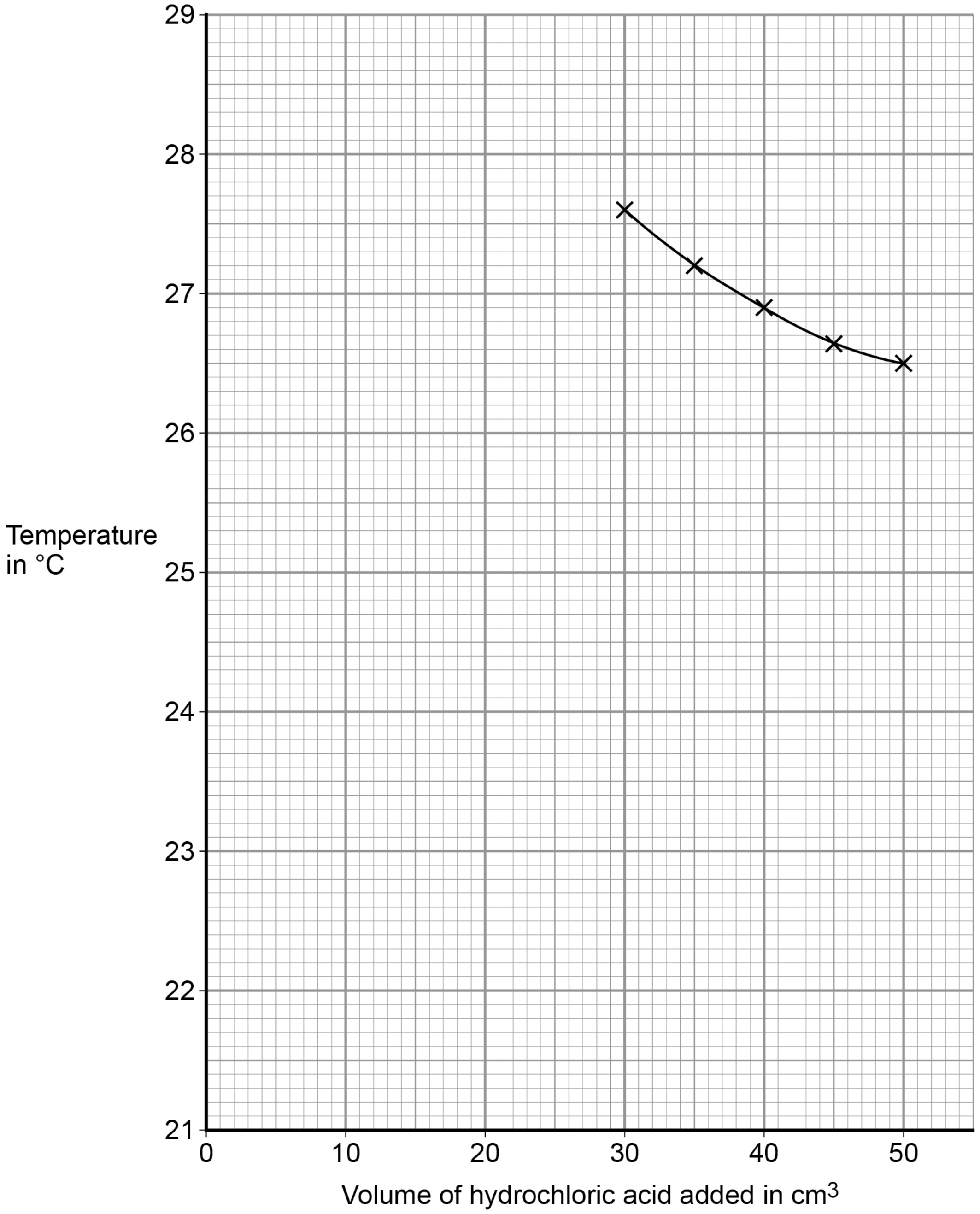
You should:

- plot the data from **Table 1** on **Figure 4**
- draw a line of best fit through these results
- continue both lines of best fit until the lines meet.

[4 marks]

Do not write outside the box

Figure 4



0 7 . 2 Estimate the maximum temperature reached in the reaction.

Use **Figure 4**.

[1 mark]

Maximum temperature = ____________________ °C

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 The teacher used a temperature sensor to measure the temperature of the reaction mixture.

What is the resolution of the temperature sensor?

[1 mark]

Tick **one** box.

1×10^{-1} °C ☐

1×10^{-2} °C ☐

1×10^{-3} °C ☐

1×10^{-4} °C ☐

0 7 . 4 Suggest **two** ways of improving the accuracy of the results.

[2 marks]

1 ____

____

2 ____

____

Do not write outside the box

0 7 . 5 The pH of the solution changes as hydrochloric acid is gradually added to sodium hydroxide solution, until hydrochloric acid is in excess.

Describe how the pH of the solution changes.

Give reasons for these changes.

You should refer to the pH value of the solution at different stages in the procedure.

[6 marks]

0 7 . 6 In a different demonstration the teacher used a 25 cm^3 solution containing 1.4 g of sodium hydroxide.

Calculate the concentration of the sodium hydroxide solution in g/dm^3

[2 marks]

Concentration of sodium hydroxide solution = ____________ g/dm^3

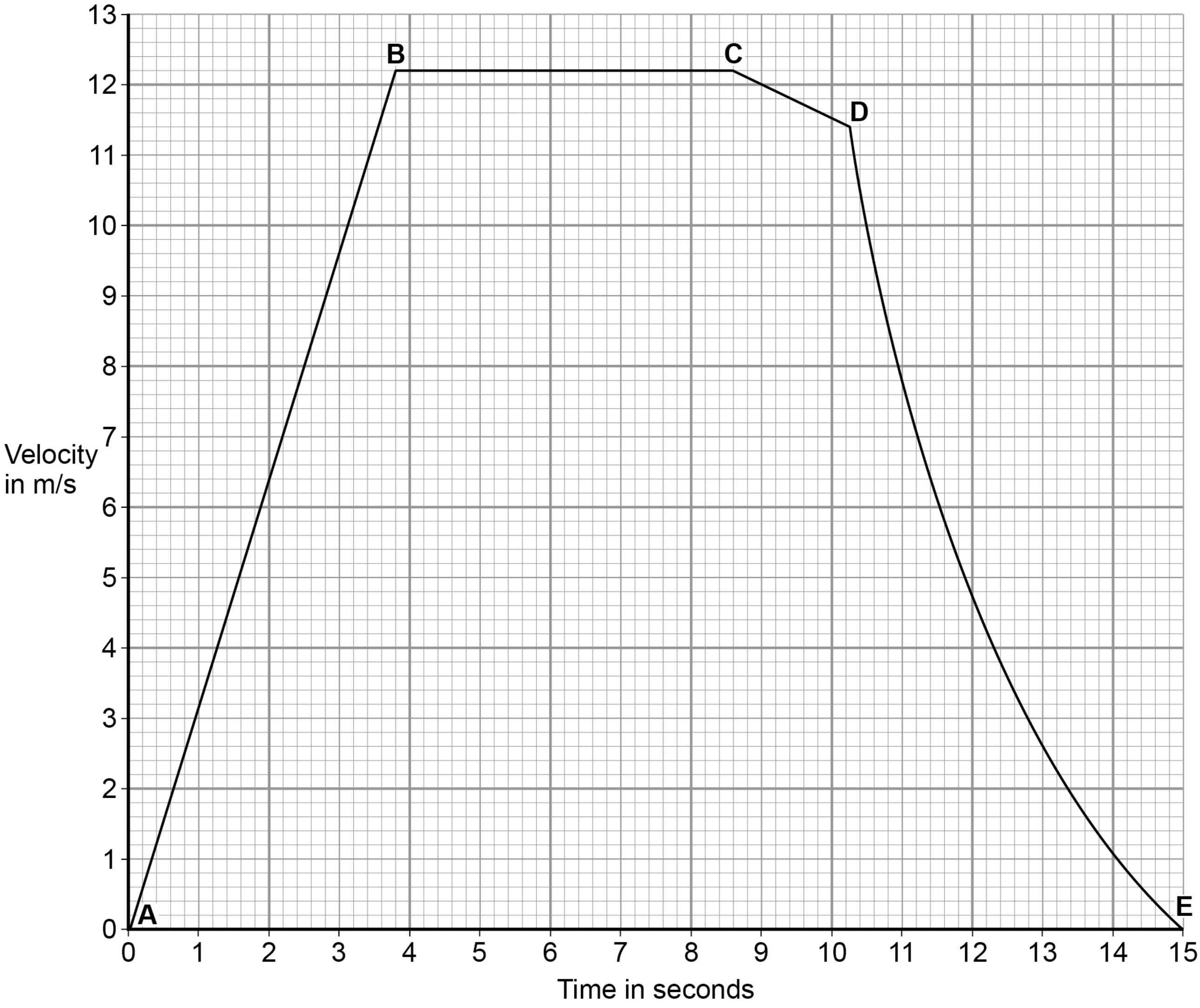
16

Turn over ►

0 8 An athlete takes part in a race on a straight, horizontal running track.

Figure 5 shows the velocity-time graph for the athlete during the race.

Figure 5



0 8 . 1 What is the main force that opposes the athlete's forward motion?

[1 mark]

____

____

Do not write outside the box

0 8 . 2 Which section of the graph represents a part of the race where the resultant force on the athlete is zero?

[1 mark]

Tick **one** box.

A–B	**B–C**	**C–D**	**D–E**
☐	☐	☐	☐

0 8 . 3 The athlete has a mass of 94.8 kg

Calculate the momentum of the athlete at a time of 6.0 s

Use **Figure 5**.

[3 marks]

____

____

____

____

Momentum = ________________ kg m/s

0 8 . 4 The acceleration is **not** constant from **D** to **E**.

Determine the acceleration at a time of 12.0 s

Use **Figure 5**.

Give the unit.

[5 marks]

____

____

____

____

____

____

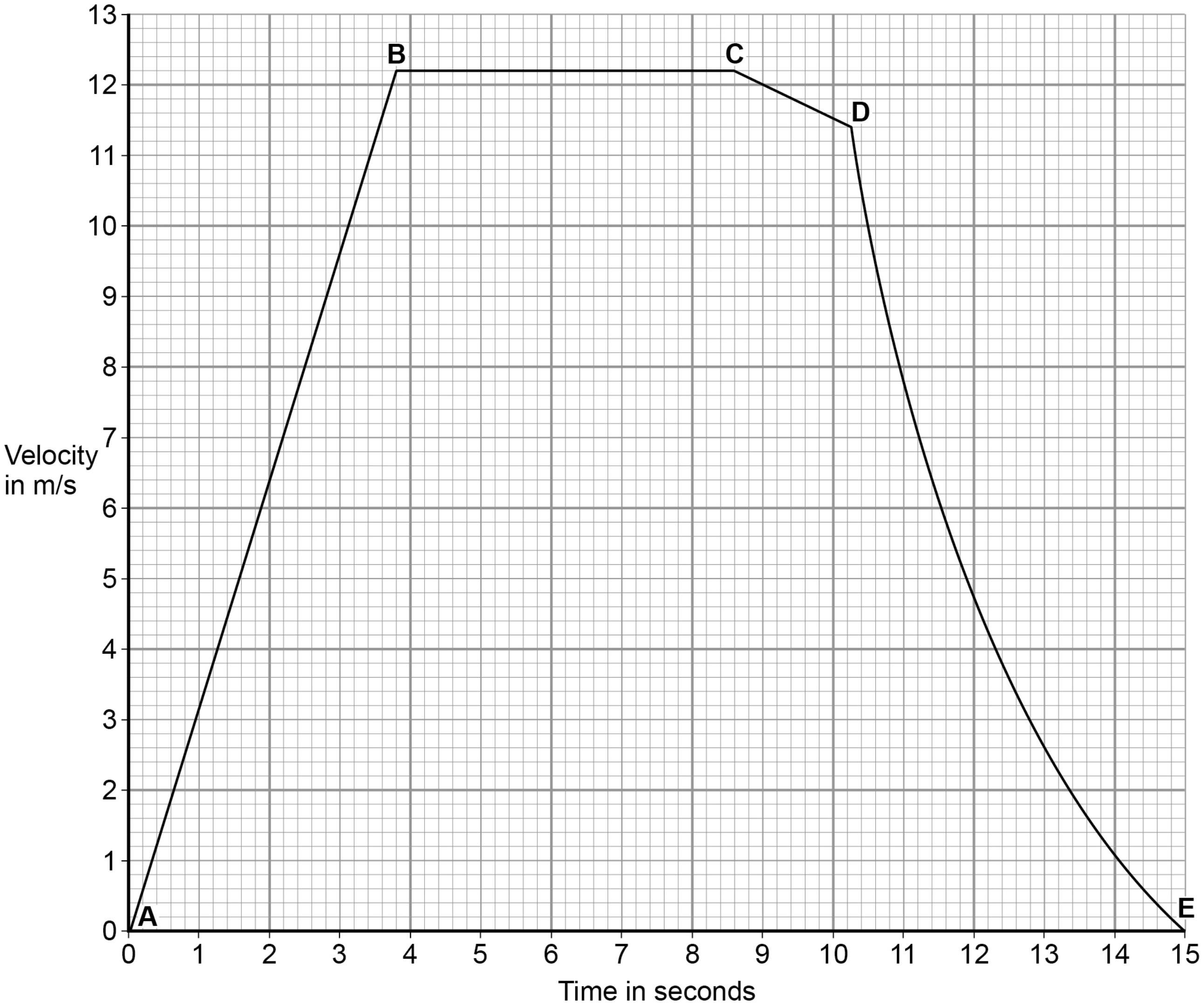
Acceleration = ____________________ Unit __________

Turn over ►

Do not write outside the box

Figure 6 is a copy of **Figure 5** to help you answer the following questions.

Figure 6



A second athlete starts the race at the same time as the first athlete.

The second athlete moves with a constant acceleration of 1.6 m/s^2 for the first 6.0 seconds of the race.

The first athlete travels further than the second athlete during the first 6.0 seconds.

Do not write outside the box

0 8 . 5 Draw a line on **Figure 6** to represent the motion of the second athlete for the first 6.0 seconds of the race.

[2 marks]

0 8 . 6 Determine the extra distance travelled by the first athlete over the first 6.0 seconds of the race.

Use **Figure 6**.

[4 marks]

Extra distance travelled by first athlete = ______________ m

16

END OF QUESTIONS

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