SPECIMEN MATERIAL

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher Tier Paper 3H

Specimen 2018 Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a calculator
- the periodic table (enclosed)
- the Physics equation sheet (enclosed).

Instructions

- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- There are 100 marks available on this paper.
- 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.
- When answering questions 02.2, 02.5 and 08 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

Advice

- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.

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

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0 1 The rate of chemical reactions can be changed by changing the conditions.

0 1 . 1 Methane burns in oxygen to produce carbon dioxide and water.

The activation energy for the reaction is 2648 kJ/mol.

The reaction gives out 818 kJ/mol of energy.

Figure 1 shows the reaction profile for this reaction.

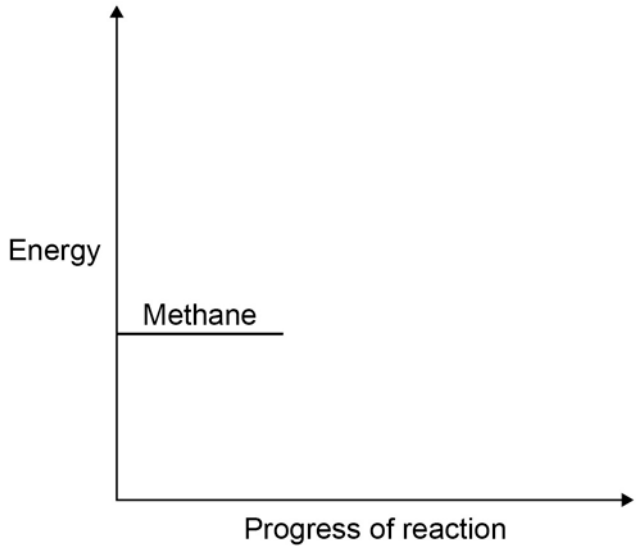
Complete the reaction profile.

Draw arrows to represent:

- the activation energy
- the energy given out.

[4 marks]

Figure 1



0 1 . 2 What percentage of the activation energy is the energy given out?

[1 mark]

0 1 . 3 Calcium carbonate decomposes when it is heated:

The decomposition of calcium carbonate is an endothermic reaction.

How would the reaction profile for decomposition of calcium carbonate be different from the reaction profile of methane burning in oxygen?

[1 mark]

0 1 . 4 Catalysts are used in chemical reactions in industry.

Give **two** properties of catalysts.

For each property, explain why it makes the catalyst useful in industry.

[4 marks]

0 1 . 5 Enzymes are biological catalysts.

What type of molecule is an enzyme?

[1 mark]

Tick **one** box.

- Carbohydrate ☐
- Hydrocarbon ☐
- Lipid ☐
- Protein ☐

0 1 . 6 If enzymes are denatured they stop working.

Give **two** ways an enzyme can be denatured.

[2 marks]

1 _____

2 _____

0 1 . 7 An enzyme called lactase catalyses the reaction that breaks down lactose to smaller molecules.

One model used to explain how enzymes affect reactions is called the lock and key model.

Use the lock and key model to explain why lactase cannot be used to speed up **all** chemical reactions.

[3 marks]

_____

_____

_____

_____

_____

_____

0 2 This question is about speed.

0 2 . 1 What is a typical value for the speed of sound?

[1 mark]

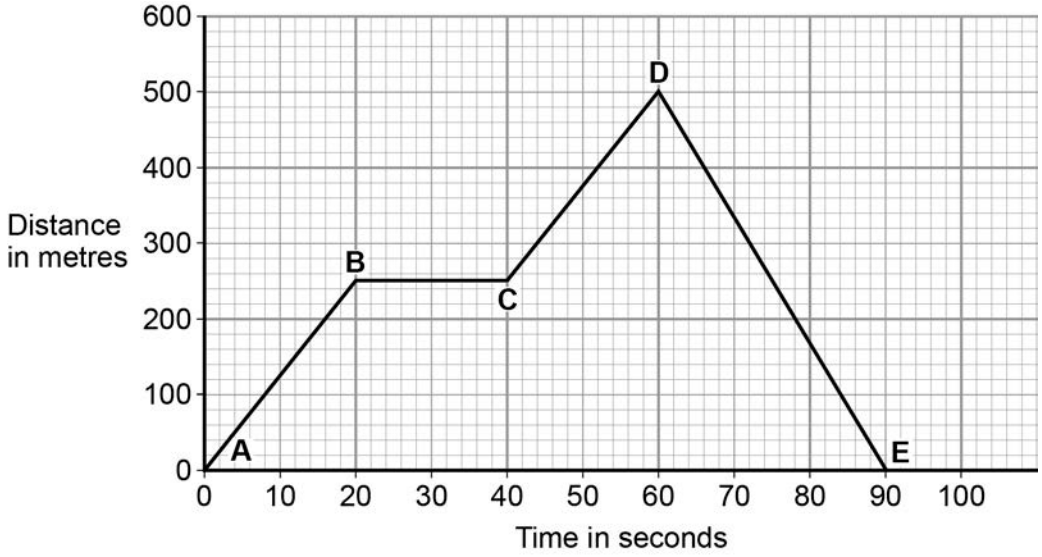
Tick **one** box.

- 3.3 m/s ☐
- 3.3×10^2 m/s ☐
- 3.3×10^3 m/s ☐
- 3.3×10^6 m/s ☐

Question 2 continues on the next page

0 2 . 2 **Figure 2** shows a distance–time graph of a car.

Figure 2



Explain what **Figure 2** shows about the motion of the car between point **A** and point **E**.

You should use values from **Figure 2** in your answer.

[4 marks]

0 2 . 3 The kinetic energy of a moving car depends on the car's mass and speed.

Write down the equation that links kinetic energy, mass and speed.

[1 mark]

0 2 . 4 A car has a mass of 1 650 kg.

Table 1 shows the kinetic energy of the car moving at 11 m/s.

Table 1

Mass of car in kg	Speed in m/s	Kinetic energy in J
1 650	11	99 825
1 650	30	

Calculate the missing value in **Table 1**.

Give your answer in kilojoules (kJ).

[2 marks]

Kinetic energy = _____ kJ

0 2 . 5 A man is driving his car at a constant speed on a wet road.

He sees a fallen tree on the wet road and tries to stop quickly to prevent an accident.

Figure 3

Explain why the man may not be able to stop in time.

[6 marks]

Turn over for the next question

0 3 **Figure 4** shows an ice skater standing on the ice.

Figure 4

0 3 . 1 Write down the equation that links acceleration, change in velocity and time.

[1 mark]

0 3 . 2 As the skater pushes away across the ice there is a small frictional force.

After pushing, the skater starts to move with a velocity of 5 m/s.

He slows to 3 m/s in 6 seconds.

Calculate the acceleration of the skater.

[2 marks]

Acceleration = _____ m/s^2

0 3 . 3 Write down the equation that links acceleration, force and mass.

[1 mark]

0 3 . 4 Friction reduces the speed of the skater.

Calculate the frictional force acting on the skater to slow him down.

[2 marks]

Frictional force = _____ N

0 3 . 5 The skater stands still on the ice.

He throws his bag to a friend.

As he throws his bag forwards, the skater moves backwards across the ice.

Use the idea of conservation of momentum to explain why he moves backwards.

[4 marks]

There are no questions printed on this page

0 4 Iron is a metal that has many uses.

0 4 . 1 Iron is extracted from iron ore. Part of the process involves reduction of the ore with carbon monoxide.

Iron ore contains iron oxide (Fe_2O_3).

Write a balanced equation for the reaction of iron oxide with carbon monoxide.

[3 marks]

0 4 . 2 Explain why this reaction is a redox reaction.

[2 marks]

Steel is an alloy of iron. Steel is used to make cars.

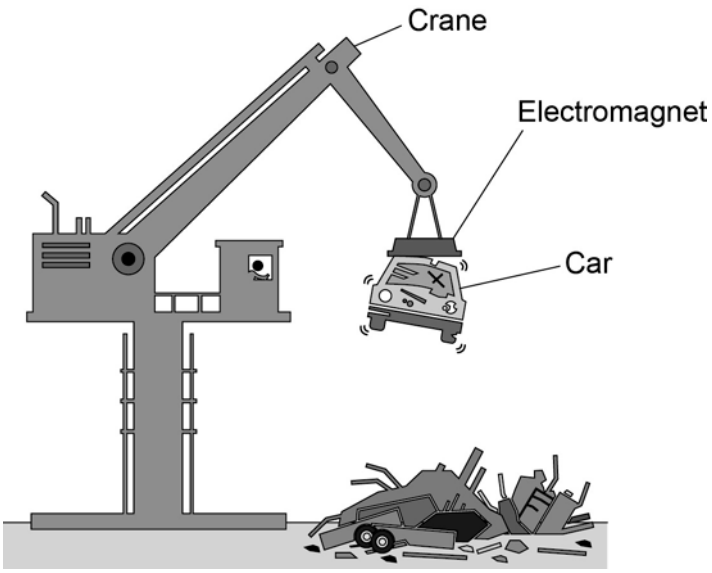
After its useful life a car is taken to a scrapyard for recycling.

0 4 . 3 Suggest **four** benefits of recycling a car body.

[4 marks]

Figure 5 shows an electromagnet being used to lift a car in a scrapyard.

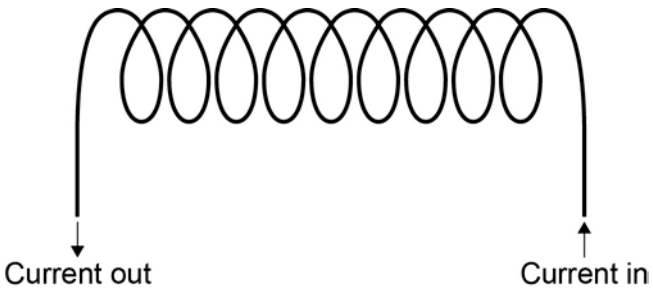
Figure 5



0 4 . 4 An electromagnet is made up of a solenoid.

Figure 6 shows a solenoid.

Figure 6



Draw the magnetic field of the solenoid on **Figure 6**.

[2 marks]

0 4 . 5 In a scrapyard, an electromagnet is used to lift and release cars so they can be moved around.

Suggest **two** ways a solenoid could be made to lift and release cars in a scrapyard.

Explain why each suggestion would be useful in the scrapyard.

[4 marks]

Turn over for the next question

There are no questions printed on this page

0 5 In 1869 there were 60 known elements.

Mendeleev arranged the elements in order of their atomic mass (atomic weight).

He realised that elements with similar properties occurred at regular intervals.

0 5 . 1 Suggest why one of the groups that is on today's periodic table was not in Mendeleev's periodic system.

[1 mark]

0 5 . 2 Explain the arrangement of the first 20 elements in today's periodic table.

You should answer in terms of atomic structure.

[2 marks]

Question 5 continues on the next page

A student put some potassium bromide solution in a test tube.

She added a few drops of chlorine solution and observed the result.

She repeated the process using different potassium halide salts and different halogens.

Table 2 shows the student's results.

Table 2

Solution of halogen	Potassium chloride solution	Potassium bromide solution	Potassium iodide solution
Chlorine		Orange colour forms	Brown colour forms
Bromine	No reaction		Brown colour forms
Iodine	No reaction	No reaction	

0 5 . 3 Give the order of reactivity of the halogens from the results in **Table 2.**

Explain how you used the results to show this order of reactivity.

[2 marks]

Order _____

Explanation _____

_____

_____

_____

0 5 . 4 Write a balanced ionic equation for the reaction of chlorine with bromide ions in solution.

[3 marks]

0 5 . 5 Explain the order of reactivity of Group 7 elements.

Include information about atomic structure.

[2 marks]

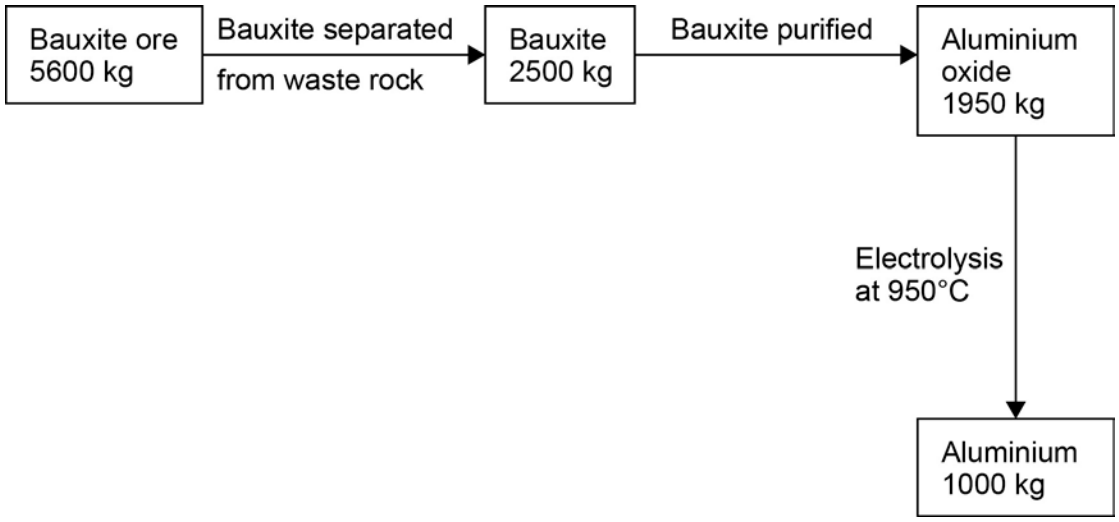
Turn over for the next question

0 6 Aluminium is produced from an ore called bauxite.

Bauxite contains aluminium oxide.

Look at **Figure 7**.

Figure 7



0 6 . 1 Calculate the percentage of bauxite that is converted into aluminium oxide.

[2 marks]

Percentage = _____

0 6 . 2 Show by calculation that the mass of aluminium produced is less than that expected from 1 950 kg aluminium oxide (Al_2O_3).

You should state the difference in the mass of aluminium expected and the mass of aluminium produced to three significant figures.

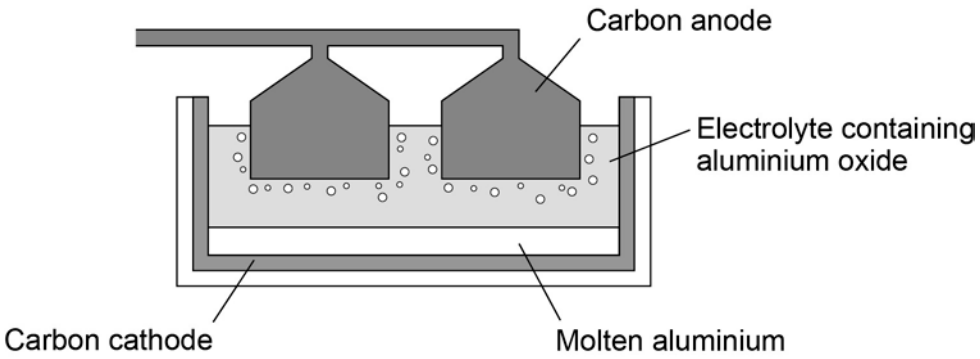
Relative atomic masses (A_r): O = 16; Al = 27

[3 marks]

Question 6 continues on the next page

Figure 8 shows an electrolysis cell used to extract aluminium.

Figure 8



0 6 . 3 Why does the carbon anode used in the electrolysis cell need to be continually replaced?

[3 marks]

0 6 . 4 In an electrolysis cell the current is 1.5×10^5 A, at a potential difference of 4V.

Calculate the energy transferred by the electrolysis cell in 24 hours.

[5 marks]

Energy transferred = _____ J

0 6 . 5 The half equation at the cathode is:

$Al^{3+} + 3\ e^- \longrightarrow Al$

Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

Relative atomic mass (A_r): Al = 27

[3 marks]

Answer = _____ moles

Turn over for the next question

0 7 Ammonium nitrate (NH_4NO_3) is produced by reacting ammonia with nitric acid.

A student measured the mass of ammonium nitrate that dissolves in 100 cm^3 of water at different temperatures.

Table 3 shows the student's results.

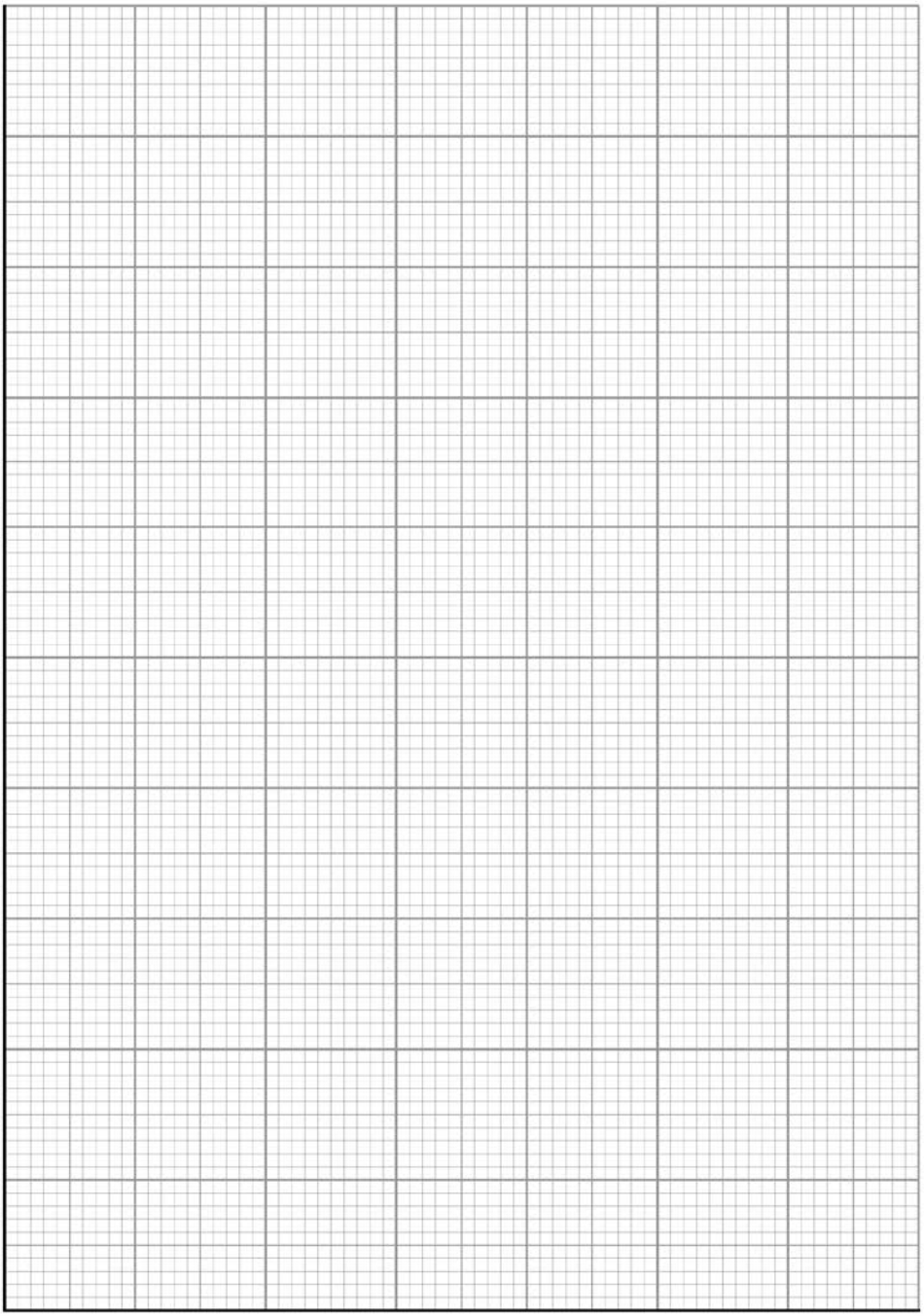
Table 3

Temperature in °C	0	20	40	60	80	100
Mass of ammonium nitrate in g that dissolves in 100 cm^3 water	119	190	286	321	630	1 024

0 7 . 1 Use **Table 3** to plot a graph of the solubility of ammonium nitrate on **Figure 9**.

[4 marks]

Figure 9



Question 7 continues on the next page

0 7 . 2 At 20 °C, 190 g of ammonium nitrate dissolves in 100 cm^3 of water.

Calculate the amount of ammonium nitrate (in moles) that dissolves in 1 dm^3 of water at 20 °C.

Relative atomic masses (A_r): H = 1; N = 14; O = 16

[3 marks]

Amount of dissolved ammonium nitrate = _____ mol

0 7 . 3 Farmers use ammonium nitrate as a fertiliser.

Farmers want to slow down the rate at which ammonium nitrate fertiliser dissolves in the water in the soil.

Suggest why they spread the fertiliser in the form of small beads instead of a fine powder.

[2 marks]

0 7 . 4 Ammonia is needed to make ammonium nitrate.

The reaction used to make ammonia is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

At equilibrium, about 35% of the nitrogen and hydrogen are converted to ammonia at 450 °C and 200 atmospheres pressure.

Explain the effects of increasing the temperature, or increasing the pressure, on the amount of ammonia produced at equilibrium.

[4 marks]

Turn over for the next question

0 8 Carbon nanotubes are cylindrical fullerenes.

Explain the properties of carbon nanotubes.

Answer in terms of structure and bonding.

[6 marks]

END OF QUESTIONS

There are no questions printed on this page

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