SPECIMEN MATERIAL

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier Paper 3F

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 04.3, 10.2 and 10.5 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 ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

0 1 This question is about forces.

0 1 . 1 Force is a vector quantity.

Which is a correct statement about a vector quantity?

[1 mark]

Tick **one** box.

Has direction only ☐

Has direction and magnitude ☐

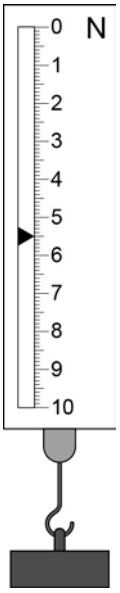
Has magnitude only ☐

Has neither magnitude nor direction ☐

0 1 . 2 A newtonmeter measures the weight of an object.

Look at **Figure 1**.

Figure 1



What is the weight of the object in **Figure 1**?

[1 mark]

Weight = _____ N

0 1 . 3 An object has a weight of 6.4 N.

Calculate the mass of the object.

Use the equation

mass = weight ÷ gravitational field strength (g)

gravitational field strength = 9.8 N/kg

[1 mark]

Mass = _____ kg

0 1 . 4 The mass of a bag of sugar is 1 kg.

- On Earth the weight of this bag of sugar is 10 N.
- On Mars the weight of this bag of sugar is 4 N.

Suggest why the weight of the bag of sugar is different on Earth and on Mars.

[1 mark]

Turn over for the next question

0 2 The elements in the periodic table are arranged in groups.

0 2 . 1 What is similar about the elements in the same group?

[1 mark]

Tick **one** box.

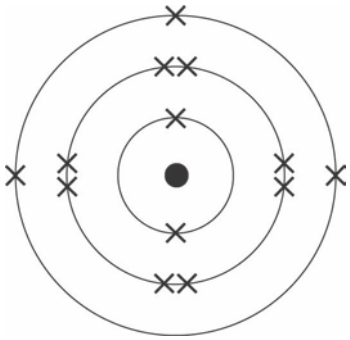
Chemical properties ☐

Atomic numbers ☐

Relative atomic masses ☐

0 2 . 2 **Figure 2** shows the arrangement of electrons in an atom.

Figure 2



What group of the periodic table is this atom in?

[1 mark]

Group _____

0 2 . 3 Why are the elements in Group 0 unreactive?

[1 mark]

Tick **one** box.

They are all gases at room temperature ☐

They all have the same atomic number ☐

They are all in the same group of the periodic table ☐

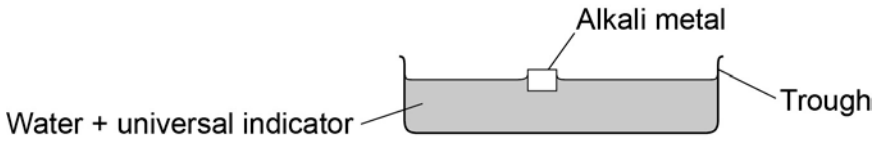
They all have a stable arrangement of electrons ☐

Question 2 continues on the next page

A teacher demonstrates the reaction of some alkali metals with water.

Look at **Figure 3**.

Figure 3



The students write what they see.

1. The alkali metals float on water.
2. The alkali metals fizz when they react with water.
3. The universal indicator changes from green to purple.
4. The sodium disappears faster than the lithium.

0 2 . 4 Give a reason for each of the four things that the students see.

[4 marks]

1. The alkali metals float on water.

Reason _____

2. The alkali metals fizz when they react with water.

Reason _____

3. The universal indicator changes from green to purple.

Reason _____

4. The sodium disappears faster than the lithium.

Reason _____

Turn over for the next question

0 3 This question is about the reactions of acids.

0 3 . 1 When dilute hydrochloric acid is reacted with sodium hydroxide solution there is a temperature change.

Explain how the temperature changes.

[2 marks]

0 3 . 2 Acids produce hydrogen ions in aqueous solutions.

What is the ionic equation for neutralisation reactions?

[1 mark]

Tick **one** box.

$H^+(aq) + H_2O(l) \rightarrow H_3O^+(aq)$ ☐

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ ☐

$2\,H_2O(l) \rightarrow H_3O^+(aq) + OH^-(aq)$ ☐

$H_2O(l) \rightarrow 2\,H^+(aq) + O^{2-}(aq)$ ☐

0 3 . 3 Sulfuric acid reacts with copper carbonate to produce a salt, water and carbon dioxide.

$$H_2SO_4 + CuCO_3 \longrightarrow CuSO_4 + H_2O + CO_2$$

What is the name of the salt produced?

[1 mark]

A student reacted four metals with water and with a dilute acid to work out the order of reactivity of the metals.

Table 1 shows some of the observations.

Table 1

Metal	Reaction with water	Reaction with dilute acid
Calcium	Bubbles of gas	**X**
Copper	**Y**	No bubbles of gas
Magnesium	Few bubbles of gas	Bubbles of gas
Zinc	No bubbles of gas	Bubbles of gas

0 3 . 4 Write the observations for **X** and **Y**.

[2 marks]

Observation at **X**

Observation at **Y**

0 3 . 5 Write the four metals, calcium, copper, magnesium and zinc, in order of reactivity.

Start with the **most** reactive metal.

[2 marks]

0 3 . 6 Some gases given off in reactions can be identified by chemical tests.

Draw **one** line from each chemical test to the name of the gas.

[3 marks]

Chemical test	Gas
Put in a lighted splint. The gas burns with a pop sound.	Carbon dioxide
	Chlorine
Put in a glowing splint. The gas relights the splint.	Hydrogen
	Nitrogen
Put into limewater. The gas turns limewater cloudy.	Oxygen

0 3 . 7 Acids react with bases to produce salts and water (H_2O).

The electronic structure of a hydrogen atom is 2,1

The electronic structure of an oxygen atom is 2,6

Draw a diagram to show the arrangement of the outer shell electrons in a molecule of water.

[2 marks]

0 4 The area around a magnet is called the magnetic field.

0 4 . 1 The Earth has a magnetic field.

What causes the Earth's magnetic field?

[1 mark]

Tick **one** box.

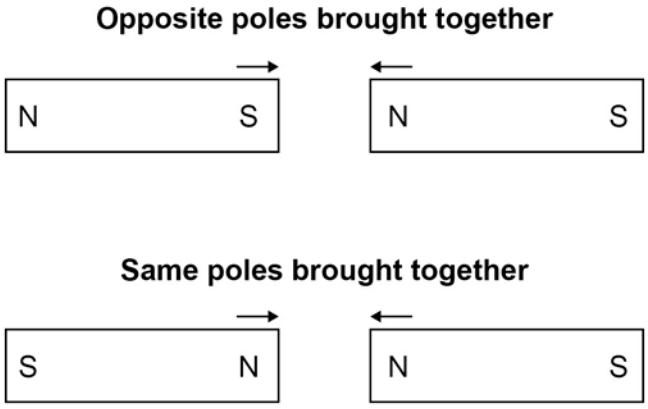
The movement of liquid iron in the Earth's outer core ☐

The gravitational field of the Earth ☐

The permanent magnet in the Earth's core ☐

0 4 . 2 Look at **Figure 4**.

Figure 4



What will happen in each case when the poles of two magnets are brought close together?

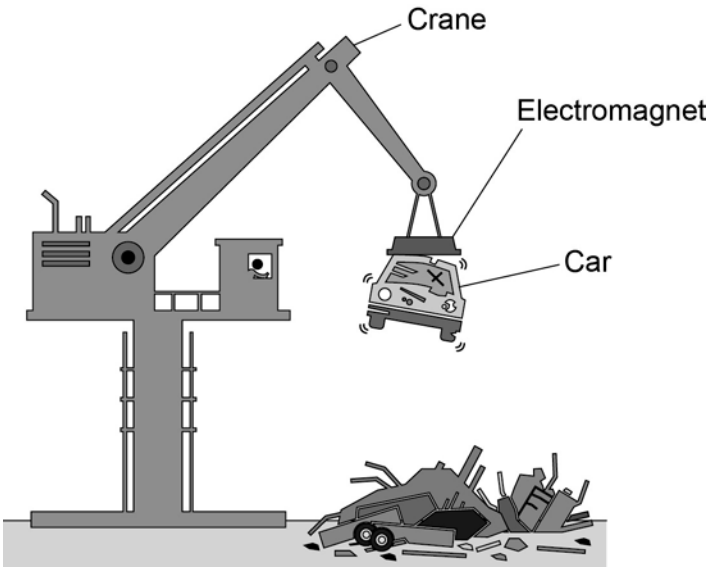
[2 marks]

Opposite poles brought together _____

Same poles brought together _____

0 4 . 3 **Figure 5** shows an electromagnet being used to lift a car in a scrapyard.

Figure 5



An electromagnet is a solenoid.

Explain why it is better to use an electromagnet rather than a permanent magnet in a scrapyard.

You should include a comparison of the properties of electromagnets and permanent magnets in your answer.

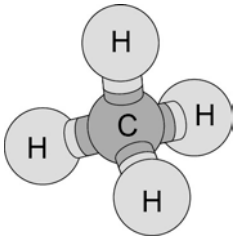
[4 marks]

Turn over for the next question

0 5 There are several different forms of carbon and many different carbon compounds.

0 5 . 1 **Figure 6** shows a 3D model of a molecule of methane (CH_4).

Figure 6



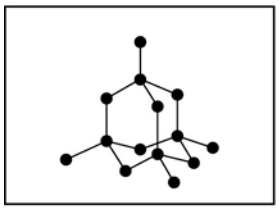
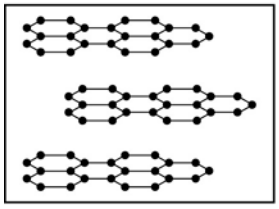
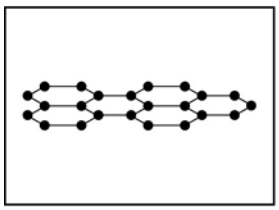
Draw the 2D structure of a methane molecule.

[1 mark]

0 5 . 2 Different forms of carbon have different bonding and structure.

Draw **one** line from the form of carbon to the bonding and structure.

[3 marks]

Form of carbon	Bonding and structure
	Each carbon atom is bonded to three other carbon atoms in a single layer
	Each carbon atom is bonded to four other carbon atoms
	Layers of carbon atoms with no covalent bonds between the layers
	Carbon ions held together by strong electrostatic forces
	Pairs of carbon atoms with no covalent bonds between the molecules

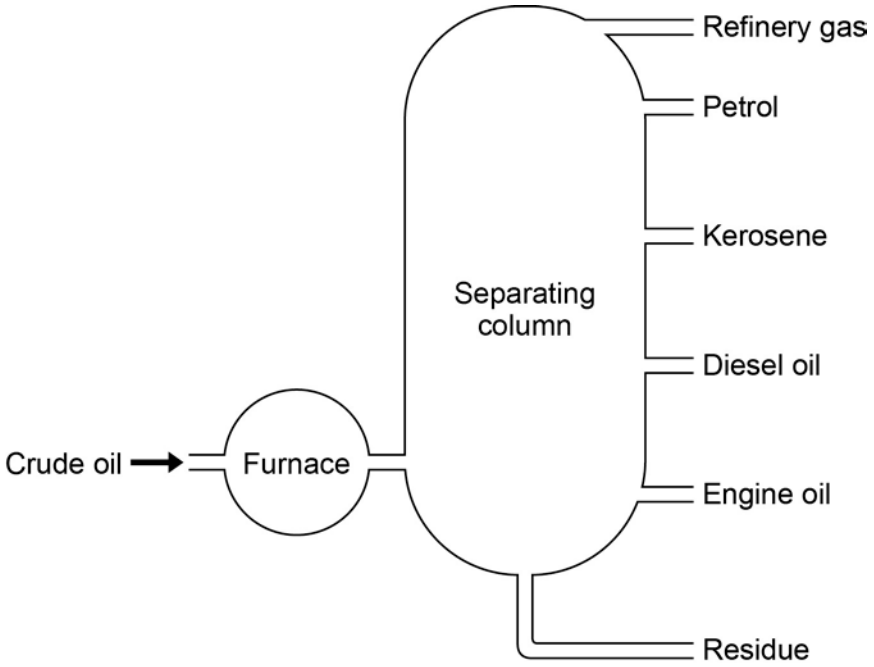
Question 5 continues on the next page

Crude oil is a mixture of many different carbon compounds.

Crude oil can be separated into useful fractions by fractional distillation.

Figure 7 shows a column used to separate crude oil.

Figure 7



0 5 . 3 Complete the sentences.

Use words from the box.

[2 marks]

condense	**evaporate**	**freeze**

Crude oil is heated so that most of the compounds _____ .

At different temperatures the compounds cool and _____ .

0 5 . 4 Which fraction is the most **viscous**?

[1 mark]

Tick **one** box.

- Engine oil ☐
- Diesel oil ☐
- Kerosene ☐
- Petrol ☐

0 5 . 5 Which fraction is the most **flammable**?

[1 mark]

Tick **one** box.

- Diesel oil ☐
- Kerosene ☐
- Petrol ☐
- Refinery gas ☐

0 5 . 6 Why does kerosene separate out of the mixture before diesel oil?

[1 mark]

Turn over for the next question

There are no questions printed on this page

0 6 An electric current is a flow of electrical charge through a circuit.

0 6 . 1 Complete the sentence.

Use a word from the box.

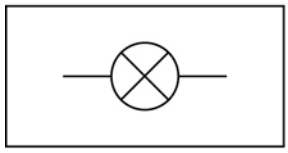
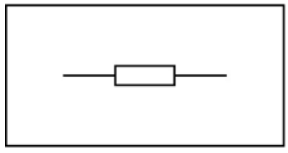
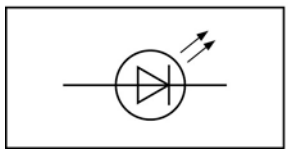
[1 mark]

atoms	**electrons**	**ions**	**molecules**

Metals are good conductors of electricity because electrical charge is transferred by delocalised _____ .

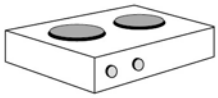
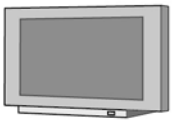
0 6 . 2 Draw **one** line from each symbol to the name of the component.

[3 marks]

Standard symbol	**Name of component**
	Battery
	Lamp
	LED
	Resistor
	Switch

0 6 . 3 **Table 2** shows information about some electrical appliances.

Table 2

Electrical appliance	Power in watts
Hairdryer	1500
Kettle	2500
 Electric hob	3000
 Television	360

A student plugs all four of the appliances into one multi-way socket.

The mains electricity is 230 V.

The highest safe current in the socket is 30 A.

Explain why it is not safe to use all four appliances at the same time.

In your answer you should:

- calculate the total power needed
- use the equation

current = power ÷ potential difference

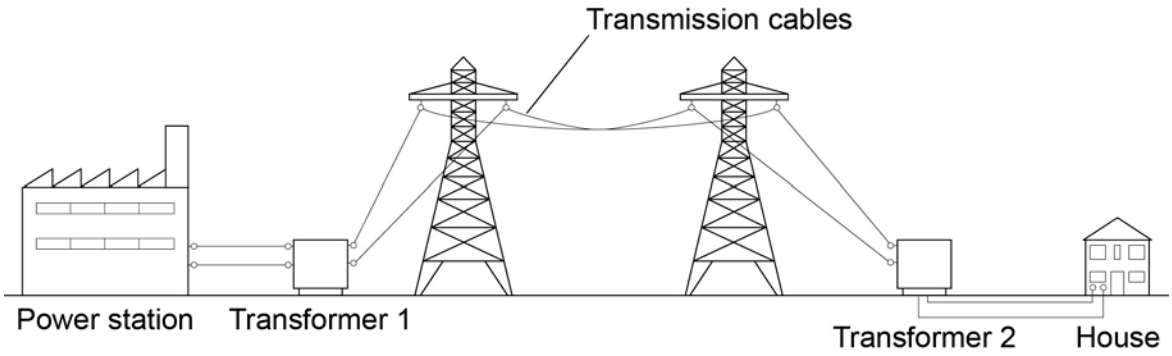
to calculate the total current needed.

[4 marks]

Question 6 continues on the next page

Figure 8 shows how electrical power is transferred from power stations to consumers using the National Grid.

Figure 8



0 6 . 4 Transformer 1 is a step-up transformer.

Explain why step-up transformers are used in the National Grid.

[3 marks]

0 6 . 5 What is the purpose of Transformer 2?

[1 mark]

0 6 . 6 In a power station 900 MJ of thermal energy were released by burning natural gas.

Write down the equation that links efficiency, useful input energy transfer and useful output energy transfer.

[1 mark]

0 6 . 7 In a power station 900 MJ of thermal energy were released by burning natural gas.

Only 405 MJ was generated.

Calculate the efficiency of this energy transfer.

[2 marks]

Efficiency = _____

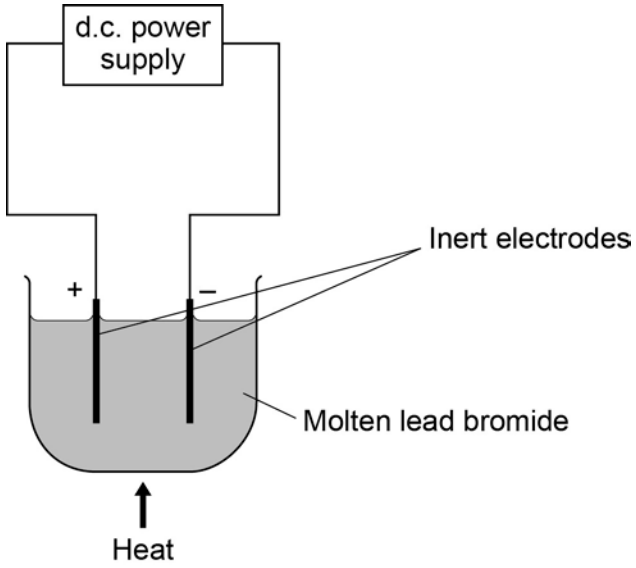
Turn over for the next question

There are no questions printed on this page

0 7 This question is about the electrolysis of two compounds.

Figure 9 shows the electrolysis of molten lead bromide.

Figure 9



0 7 . 1 The electrolyte contains lead ions (Pb^{2+}) and bromide ions (Br^-).

Complete the sentences.

Use words from the box.

[3 marks]

atoms	**bromide**	**bromine**	**ions**
lead	**molecules**	**oxygen**	

At the positive electrode the gas produced is _____ .

At the negative electrode lead _____ gain electrons and

turn into lead _____ .

A student measured the volumes of each gas produced during the electrolysis of water.

Table 3 shows the student's results.

Table 3

Time in minutes	Volume of gas produced in cm^3	
	Hydrogen	**Oxygen**
0	0	0
2	11.2	5.4
4	20.1	11.4
6	32.5	17.6
8	40.0	23.7
10	60.9	30.0

0 7 . 2 The student plotted a graph of the results for oxygen. **Figure 10** shows the graph.

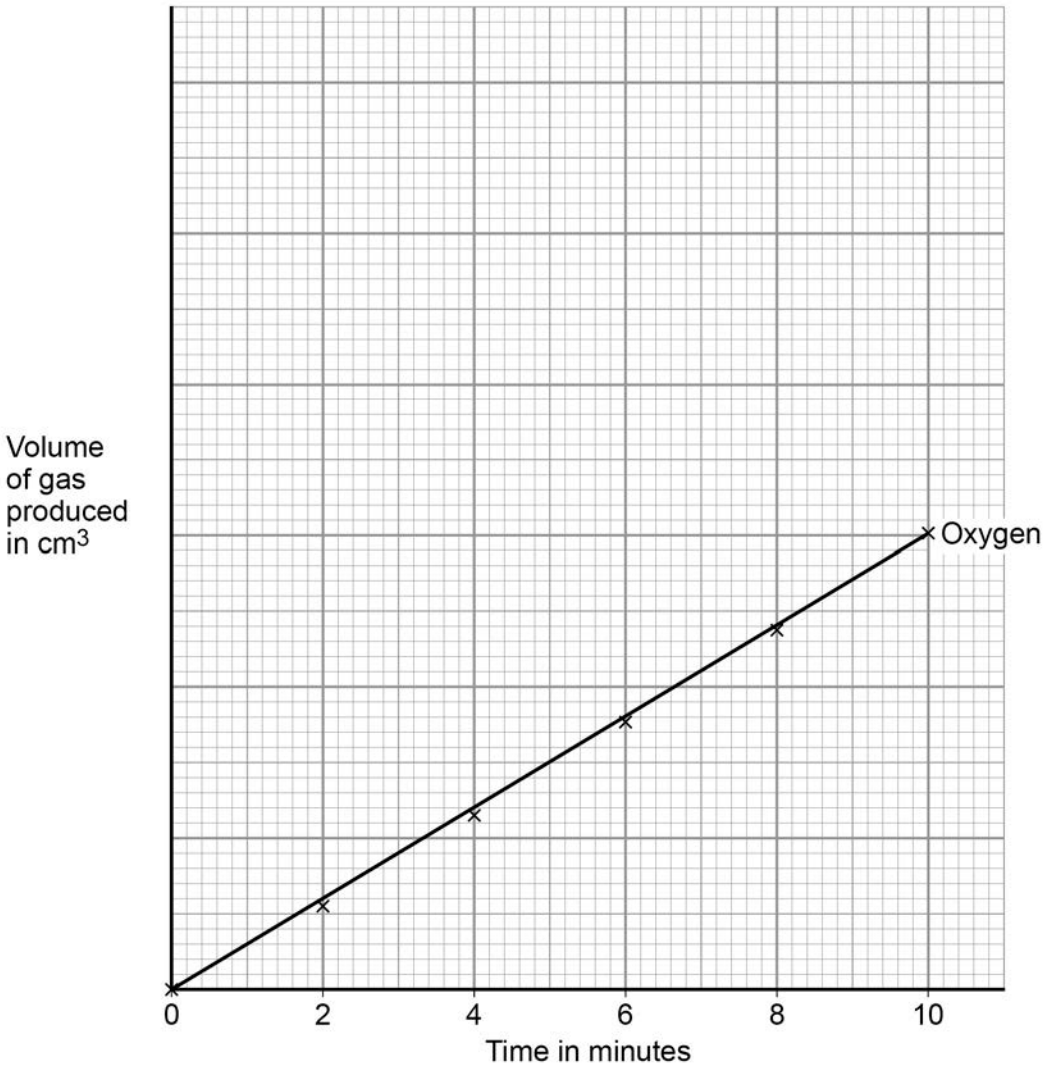
The student did not put a scale on the *y* axis.

On the graph in **Figure 10**:

- complete the scale for the *y* axis
- plot the results for hydrogen
- include a line of best fit.

[3 marks]

Figure 10



0 7 . 3 Use the graph to calculate the mean volume of oxygen produced per second.

[3 marks]

Mean volume of oxygen produced = _____ cm^3/s

0 8 Formulae and equations are used to describe chemical reactions.

0 8 . 1 Aluminium reacts with sulfuric acid (H_2SO_4) to produce aluminium sulfate, $Al_2(SO_4)_3$ and hydrogen (H_2).

Complete and balance the equation for this reaction.

[2 marks]

____ Al + _____ ⟶ _____ + _____

0 8 . 2 Calcium carbonate reacts with nitric acid to produce calcium nitrate.

Calculate the relative formula mass (M_r) of calcium nitrate, $Ca(NO_3)_2$

Relative atomic masses (A_r): N = 14; O = 16; Ca = 40

[2 marks]

_____

_____

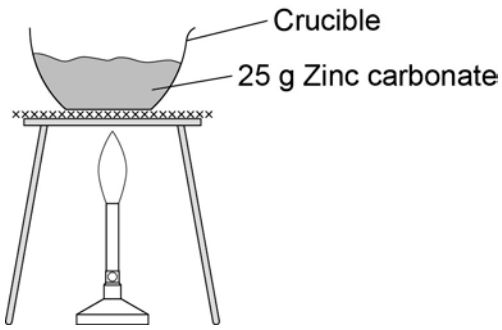
Relative formula mass (M_r) = _____

Zinc carbonate decomposes when heated.

A student heated 25 g zinc carbonate ($ZnCO_3$).

Figure 11 shows how he set up the apparatus.

Figure 11



The balanced chemical equation for the decomposition reaction is:

$ZnCO_3$ (s) ⟶ ZnO (s) + CO_2 (g)

The student measured the mass of solid product after heating until there was no further change in mass.

The student did the experiment four times. **Table 4** shows the results.

Table 4

Experiment	1	2	3	4
Mass of solid product in g	17.4	19.7	17.6	16.9

0 8 . 3 Calculate the mean mass of the solid product.

Do **not** use any anomalous results in your calculation.

[2 marks]

Mean mass = _____ g

0 9 The rate of chemical reactions can be changed by changing the conditions.

0 9 . 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 12 shows the reaction profile for this reaction.

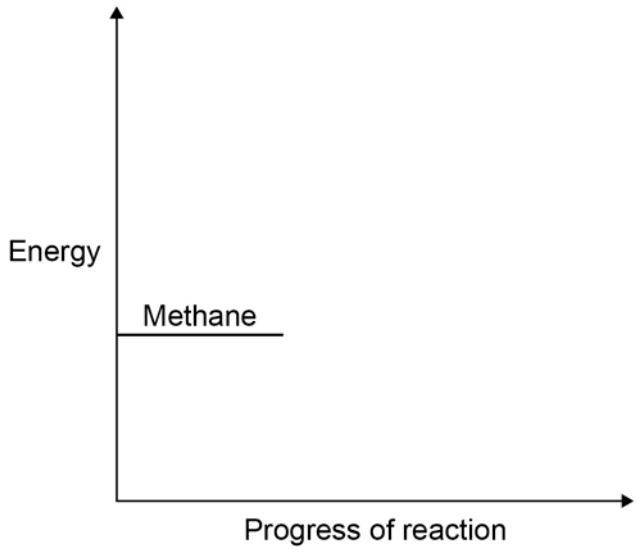
Complete the reaction profile.

Draw arrows to represent:

- the activation energy
- the energy given out.

[4 marks]

Figure 12



0 9 . 2 What percentage of the activation energy is the energy given out?

[1 mark]

0 9 . 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 9 . 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 9 . 5 Enzymes are biological catalysts.

What type of molecule is an enzyme?

[1 mark]

Tick **one** box.

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

0 9 . 6 If enzymes are denatured they stop working.

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

[2 marks]

1 _____

2 _____

0 9 . 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]

_____

_____

_____

_____

_____

_____

1 0 This question is about speed.

1 0 . 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 ☐

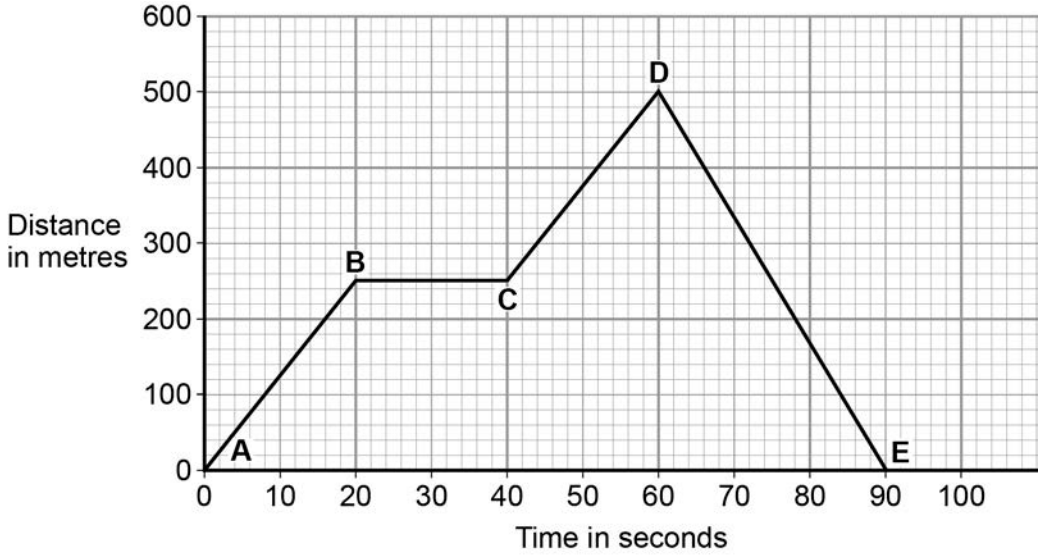
3.3×10^3 m/s ☐

3.3×10^6 m/s ☐

Question 10 continues on the next page

1 0 . 2 **Figure 13** shows a distance–time graph of a car.

Figure 13



Explain what **Figure 13** shows about the motion of the car between point **A** and point **E**.

You should use values from **Figure 13** in your answer.

[4 marks]

1 0 . 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]

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

Table 5 shows the kinetic energy of the car moving at 11 m/s.

Table 5

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 5**.

Give your answer in kilojoules (kJ).

[2 marks]

Kinetic energy = _____ kJ

Question 10 continues on the next page

1 0 . 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 14

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

[6 marks]

END OF QUESTIONS

There are no questions printed on this page

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