OCR
Oxford Cambridge and RSA

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Tuesday 7 November 2017 – Afternoon

GCSE GATEWAY SCIENCE
ADDITIONAL SCIENCE B

B721/02 Additional Science modules B3, C3, P3 (Higher Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour 15 minutes

* B 7 2 1 0 2 *

* 5 9 6 4 5 4 8 3 9 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil (✎).
- A list of equations can be found on page 2.
- The Periodic Table can be found on the back page.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **75**.
- This document consists of **32** pages. Any blank pages are indicated.

EQUATIONS

energy = mass × specific heat capacity × temperature change

energy = mass × specific latent heat

$$\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$$

wave speed = frequency × wavelength

power = voltage × current

energy supplied = power × time

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

distance = average speed × time

$$s = \frac{(u + v)}{2} \times t$$

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time taken}}$$

force = mass × acceleration

weight = mass × gravitational field strength

work done = force × distance

$$\text{power} = \frac{\text{work done}}{\text{time}}$$

power = force × speed

$$KE = \frac{1}{2}mv^2$$

momentum = mass × velocity

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

GPE = mgh

$$mgh = \frac{1}{2}mv^2$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

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Question 1 begins on page 4

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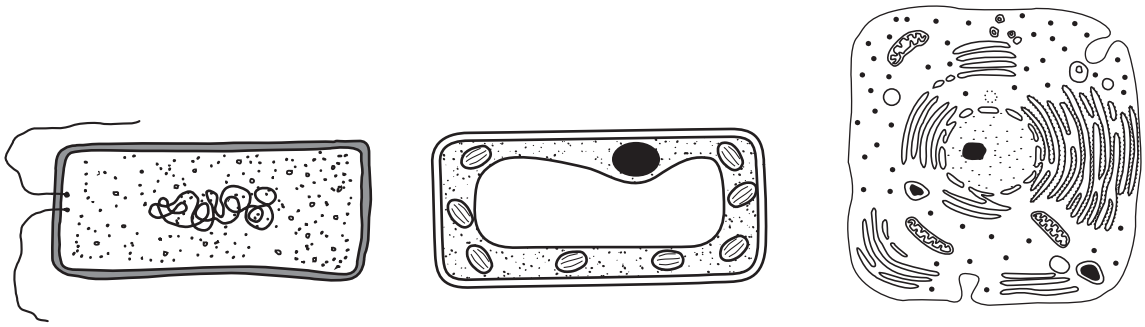
Answer **all** the questions.

SECTION A – Module B3

1 **(a)** Look at the diagrams of three cells.

The diagrams are not drawn to the same scale.



Cell **A** Cell **B** Cell **C**

Which cell is a bacterium?

Cell .....

Give **two** reasons for your choice.

.....

..... **[2]**

(b) **(i)** All three cells contain DNA.

When DNA replicates, new strands are made by complementary base pairing.

Look at the section of DNA.

Old Strand	**A**	**G**	**A**	**C**	**T**	**C**	**A**	**G**	**G**
New Complementary Strand									

Complete the complementary base pairing on the new strand. **[2]**

(ii) A mutation in the **old strand** causes the cytosine bases (**C**) to be substituted with thymine (**T**).

Complete the new complementary strand when this mutated DNA replicates.

New Complementary Strand									

Explain how this change might affect the cell.

.....

..... **[2]**

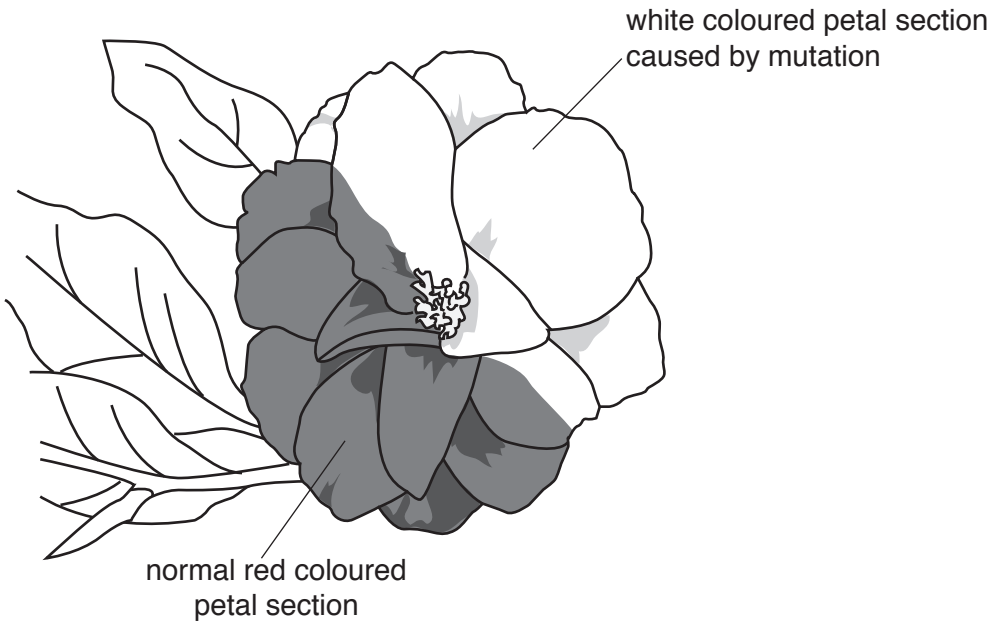
(c) Mutations occur spontaneously, but they can be made to happen more often.

Write down **one** way mutations can be made to happen more often.

..... **[1]**

(d) Look at the picture.

It shows a flower which has a gene mutation.



Suggest how the gene mutation causes parts of the flower to have two different colours.

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..... **[1]**

(e) Flowering plants are multicellular organisms.

Write about the advantages of being multicellular.

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..... **[2]**

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Question 2 begins on page 8

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2 Mia and Sam are discussing growth and development in plants and animals.
They look at pictures of a bean seedling and a chicken embryo.

bean seedling

chicken embryo

Has Mia or Sam given the best description of differentiation and development in the bean and the chicken?

Support your answer by writing about how plants and animals grow and differentiate.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

3 **(a)** Scientists sometimes clone plants to mass produce plants that are difficult to grow from seed.

(i) One method of cloning plants is using plant tissue culture.

Describe how plant tissue culture is used to clone plants.

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..... **[2]**

(ii) Explain why cloning plants is easier than cloning animals.

.....

..... **[1]**

(iii) Write down one **disadvantage** of cloning plants.

..... **[1]**

(b) Cloning techniques can also be used on humans.

Suggest how cloning techniques could benefit humans **and** why some people are against using them.

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..... **[2]**

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Question 4 begins on page 12

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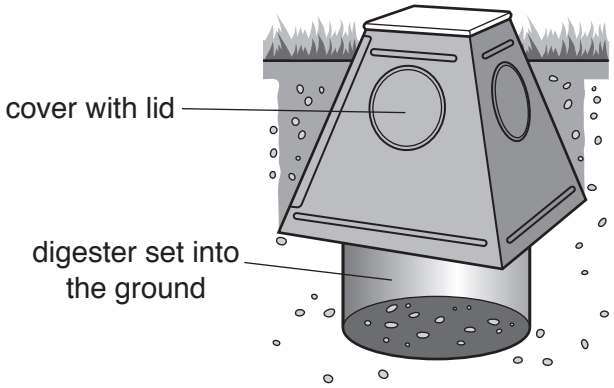
4 Look at the picture.

It shows a dog waste digester.

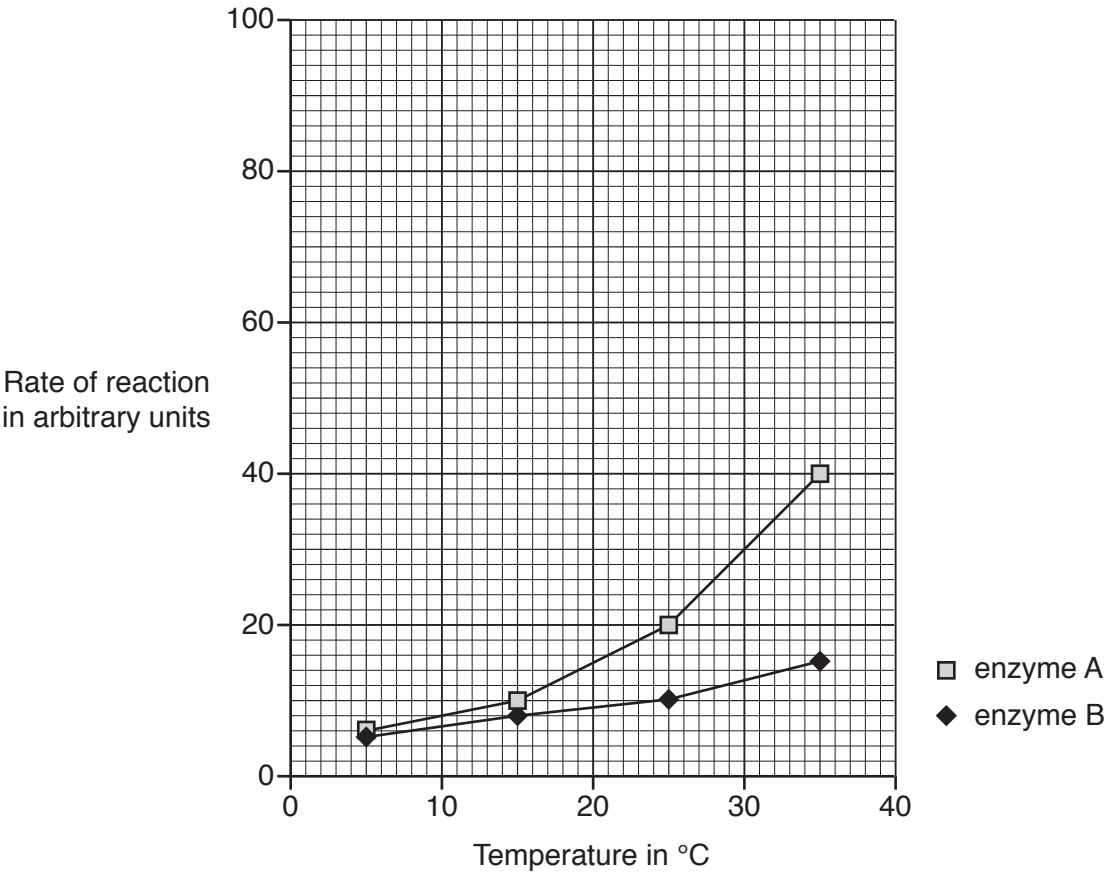


Read this information about the digester.

- After your pet has deposited 'waste', place it in the digester.
- Add an enzyme mixture and water, then place lid back on the digester.
- Digesters work outside, set into the ground.
- Some areas of the country can only use their digesters in warmer months.

Look at the graph.

It shows the rate of reaction for two different enzymes that could be used in the dog waste digester.



Calculate the Q_{10} of each enzyme between 25 °C and 35 °C and use this to explain which enzyme would be best to use in the dog waste digester.

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..... **[3]**

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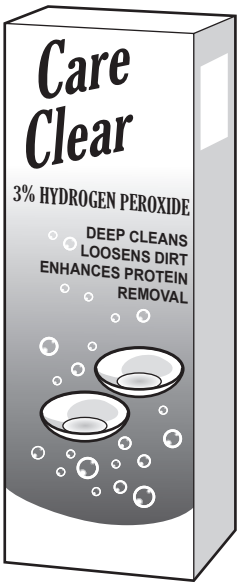
SECTION B – Module C3

5 Louise wears contact lenses.

She uses a solution of hydrogen peroxide to sterilise her contact lenses.



Hydrogen peroxide, H_2O_2, slowly breaks down to make water and oxygen, O_2.

(a) (i) Write the **balanced symbol** equation for this reaction.

..... **[2]**

(ii) Manganese(IV) oxide is a **catalyst** for this reaction.

What is meant by a catalyst?

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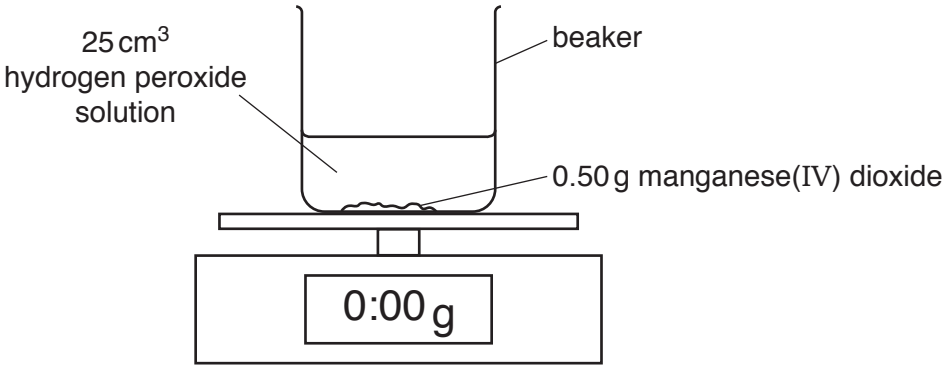
..... **[2]**

(b) Louise investigates the breakdown of hydrogen peroxide solution.

She puts 25 cm^3 of hydrogen peroxide solution into a beaker.

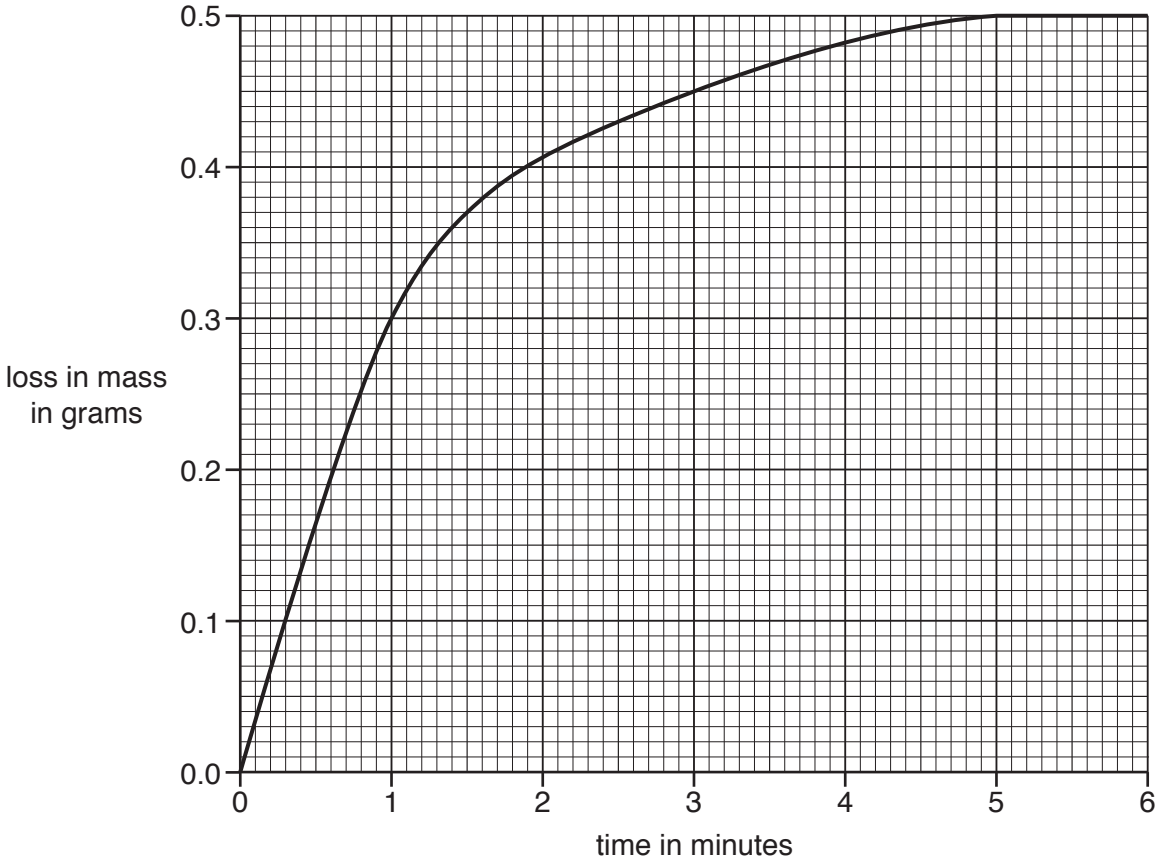
She places the beaker on a balance.

Louise then puts 0.50 g of manganese(IV) oxide into the hydrogen peroxide solution.



Louise records the loss in mass.

Louise plots a graph of her results.



(i) What time did the reaction finish?

answer ..... minutes **[1]**

(ii) Look at the graph.

Calculate the average rate of this reaction during the first 1.5 minutes of the experiment.

Give your answer to **2 significant figures**.

answer ..... grams/minute **[2]**

(iii) How does the average rate of reaction for the first 1.5 minutes compare to the average rate between 1.5 and 2.5 minutes?

Explain your answer.

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..... **[1]**

(c) Louise wants to make the breakdown of hydrogen peroxide faster.

She uses hydrogen peroxide at a higher temperature.

The reaction is faster at a higher temperature.

Explain why the reaction is faster in terms of the reacting particle model.

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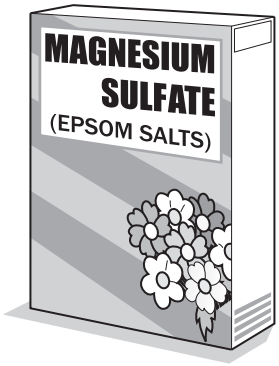
..... **[3]**

6 Magnesium sulfate is used by gardeners to help improve plant growth.



Look at the equations.

They show different reactions which make magnesium sulfate, $MgSO_4$.

Reaction 1 $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

Reaction 2 $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

Reaction 3 $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

(a) (i) John calculates the atom economy for **reactions 1** and **2**.

	Atom economy
Reaction 1	98.4%
Reaction 2	87.0%

Show, by calculation, that the atom economy for **reaction 3** is 65.9%.

Water, H_2O, and carbon dioxide, CO_2, are waste products.

The relative formula mass, M_r, of $MgCO_3$ = 84, of H_2SO_4 = 98, of $MgSO_4$ = 120, of H_2O = 18 and of CO_2 = 44.

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..... **[1]**

(ii) **Reaction 1** has the highest atom economy.

Suggest why this makes it more likely that a company making magnesium sulfate will use reaction 1.

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..... **[1]**

(b) John makes some magnesium sulfate, $MgSO_4$, using **reaction 2**.

He measures out enough sulfuric acid to make 3.6 g of magnesium sulfate.

John reacts the sulfuric acid with excess magnesium oxide.

He filters the mixture and leaves the magnesium sulfate solution to crystallise.

(i) Which chemical was the **limiting reactant**?

..... **[1]**

(ii) John predicts he should make 3.6 g of magnesium sulfate.

He actually makes 2.7 g.

Calculate his percentage yield.

answer ..... **[2]**

(c) Magnesium sulfate is made using a continuous process.

Other chemicals, such as pharmaceutical drugs, are made in a batch process.

Suggest why a **continuous** process is used to make magnesium sulfate.

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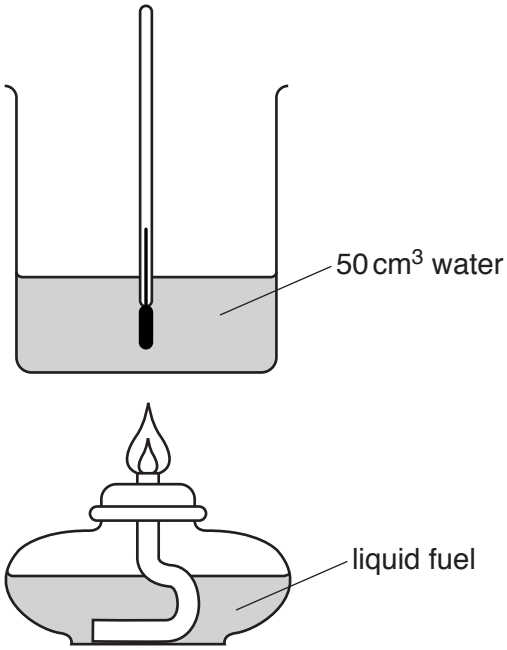
..... **[1]**

7 Caitlin investigates the energy given out by four different liquid fuels.

She wants to compare the energy transferred when 1 g of each fuel is burned.



Look at her table of results.

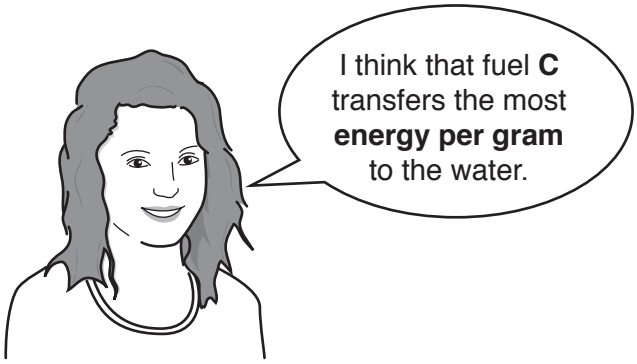
Fuel	Temperature rise of water in °C	Mass of fuel burned in g	Energy transferred to the water in J
A	22	0.5	.....
B	19	0.4	3990
C	26	1.0	5460
D	14	0.7	2940

Caitlin uses the following equation to calculate the energy transferred to the water.

energy transferred = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g °C.

(a) Caitlin uses her results to make a conclusion.



Calculate the energy transferred by fuel **A** and use Caitlin's results to explain if her conclusion is correct.

The quality of written communication will be assessed in your answer to this question.

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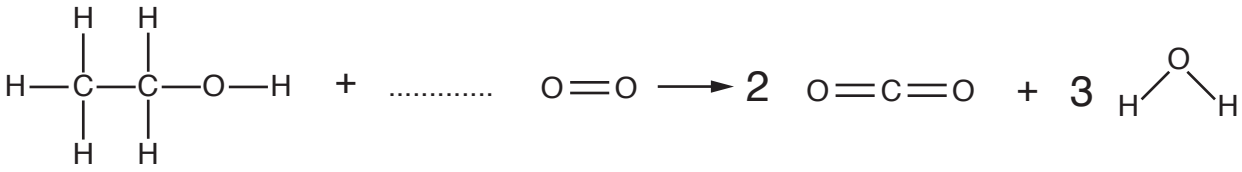
..... **[6]**

(b) Fuel **D** is ethanol.

(i) Complete the **balanced symbol** equation for the burning of ethanol.



[1]

(ii) Bonds are made when carbon dioxide and water are formed in this reaction.

What type of process is **bond making**?

Choose from the list.

batch

combustion

continuous

endothermic

exothermic

answer ..... **[1]**

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Question 8 begins on page 24

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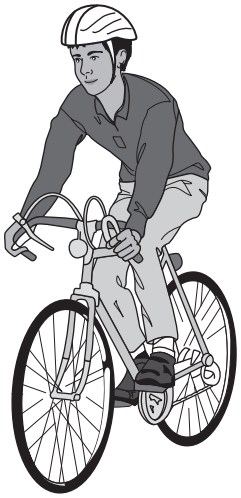
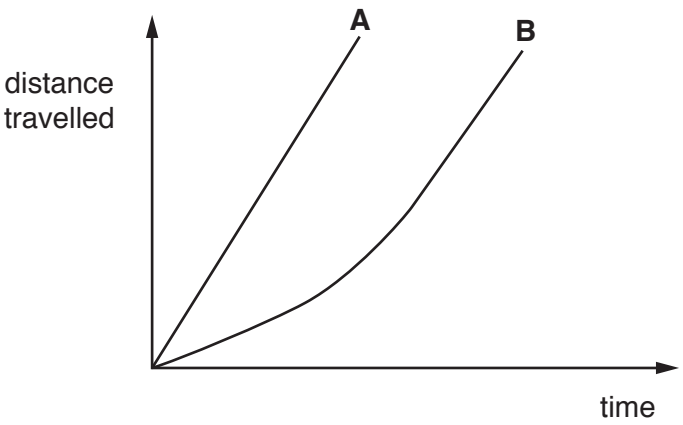
SECTION C – Module P3

8 Rajiv cycles to school and to his friend's house.



Rajiv measures the distance he travels during two different journeys, **A** and **B**.

He uses these measurements to draw distance-time graphs on the same axes.



(a) The gradients (steepness) of the distance-time graphs are different.

Use the gradients of the distance-time graphs to explain the difference between the two journeys.

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..... **[2]**

(b) Direction is important when describing the journeys Rajiv makes.

(i) Rajiv and his friend Chen cycle in the same direction.

The arrows show the direction they cycle.

Calculate their relative velocity.

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.....

Relative velocity ..... m/s **[1]**

(ii) Rajiv and Chen keep cycling at the same **speed** of 15 m/s and 12 m/s, **but** their relative velocity changes.

Suggest what Rajiv has done to change their relative velocity.

.....

..... **[1]**

(iii) Rajiv decelerates at 0.50 m/s^2 from 15 m/s to 12 m/s.

How long does he decelerate for?

Put a (ring) around the correct answer.

0.17 s **1.5 s** **3.0 s** **6.0 s** **7.5 s**

[1]

9 Claire is a builder and she needs a new van.

She finds information about four different vans.

Van	Mass in kg	Maximum driving force created by the engine in N
Boom	4000	3000
Class	3500	3000
Drag	3000	3000
Effect	2500	3000

(a) Claire wants a van with the greatest **acceleration**.

Which van should she choose?

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Explain your answer using calculations.

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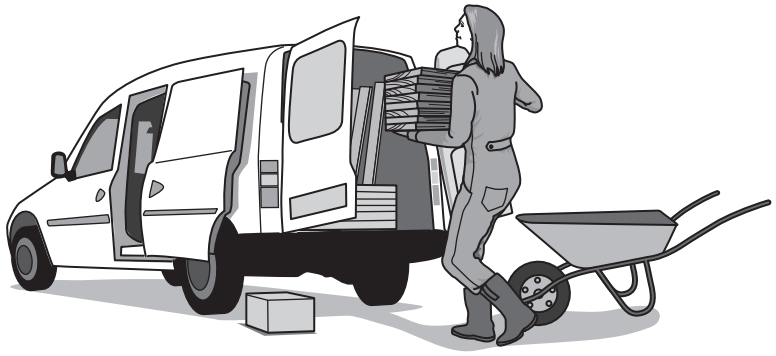
..... **[2]**

(b) (i) Claire puts building materials into her new van.



After loading the van, Claire finds that when driving at a speed of 10 m/s the braking distance is 12 m.

Suggest what the braking distance will be when Claire drives at a speed of 30 m/s.

Explain your answer.

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..... **[2]**

(ii) The manufacturer of van brakes uses new technology developed by teams of engineers.

Suggest some benefits of using **teams** of engineers to develop safety systems such as brakes.

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..... **[2]**

10 Car manufacturers test cars.

(a) They publish fuel consumption figures and environmental information.

Car	Fuel consumption in km per litre	Greenhouse gas emission in tonnes per year	Fuel cost per year in £
A	10.2	8.4	1030
B	8.1	9.1	1370
C	24.6	3.5	525
D	6.4	6.9	1695

These cars are all different types

- type **1** car has a large engine size, a roof box and uses petrol
- type **2** car has a high power rating, pulls a caravan and uses a low emission fuel
- type **3** is a hybrid (electrically powered and uses petrol)
- type **4** has a medium engine size and uses petrol.

Evaluate the data in the table to link cars **A**, **B**, **C** and **D** to the different types of cars in the list.

The quality of written communication will be assessed in your answer to this question.

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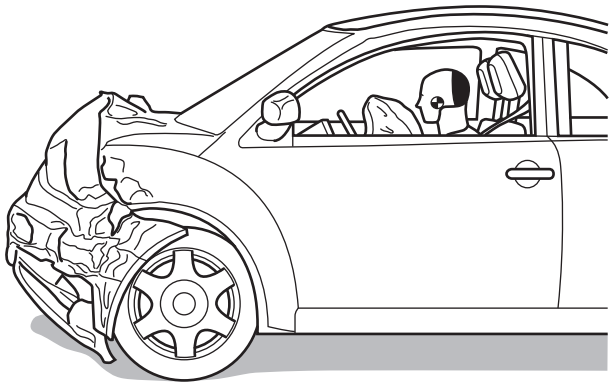
..... **[6]**

(b) Crumple zones are also tested.



Explain, in terms of change in momentum **and** acceleration, how crumple zones reduce the chance of an injury during a crash.

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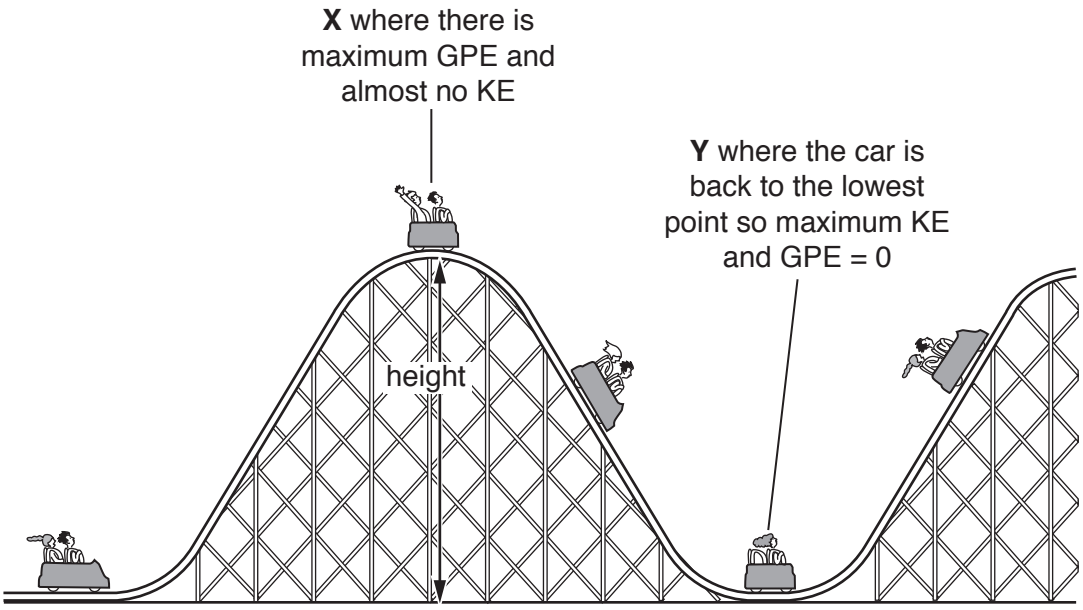
11 The kinetic energy (KE) and gravitational potential energy (GPE) of a roller coaster car change during a roller coaster ride.



(a) (i) The maximum GPE of the car at **X** is 4.5×10^5 J.

The mass of the loaded car is 1000 kg.

Use g = 10 m/s^2.

Calculate the height of the car at **X**.

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answer ..... m **[2]**

(ii) In part **(i)** you used g = 10 m/s^2.

The car moves to the bottom of the ride.

What happens to the value of g acting on the car at the bottom of the ride?

..... **[1]**

(b) What is the increase in KE of the car from **X** to **Y**?

Assume that there is no wasted energy as the car moves along the roller coaster.

answer ..... J **[1]**

(c) What happens to the KE of the car if the mass of the car is doubled?

Choose from

KE doubles

KE halves

KE quadruples

KE stays the same

answer ..... **[1]**

END OF QUESTION PAPER

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.