OCR
Oxford Cambridge and RSA

H

Tuesday 9 June 2015 – 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

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 bar codes.

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

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

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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Answer **all** the questions.

SECTION A – Module B3

1 This question is about exercise and heart rate.

(a) (i) A 20 year old athlete has a maximum heart rate of 200 beats per minute.

Anaerobic respiration will occur when the athlete's heart rate is above 80% of their maximum heart rate.

The athlete exercises with a heart rate of 130 beats per minute.

Is the athlete respiring anaerobically? Explain your answer.

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

(ii) Exercising above 80% of the athlete's maximum heart rate will cause fatigue and pain.

What causes fatigue in muscle cells?

.....

.....

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

(b) (i) Aerobic respiration is important during exercise.

Finish the symbol equation for aerobic respiration.

$C_6H_{12}O_6$ + ... $\rightarrow$ ..... + $6H_2O$ **[2]**

(ii) Why do the muscle cells of an athlete need many mitochondria?

.....

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

(iii) Some athletes use a treatment called hyperbaric oxygen therapy (HBOT) to improve performance.

With HBOT absorption rates of oxygen inside cells increase from 25% to 50%.

Explain how this helps to provide more energy to help improve performance.

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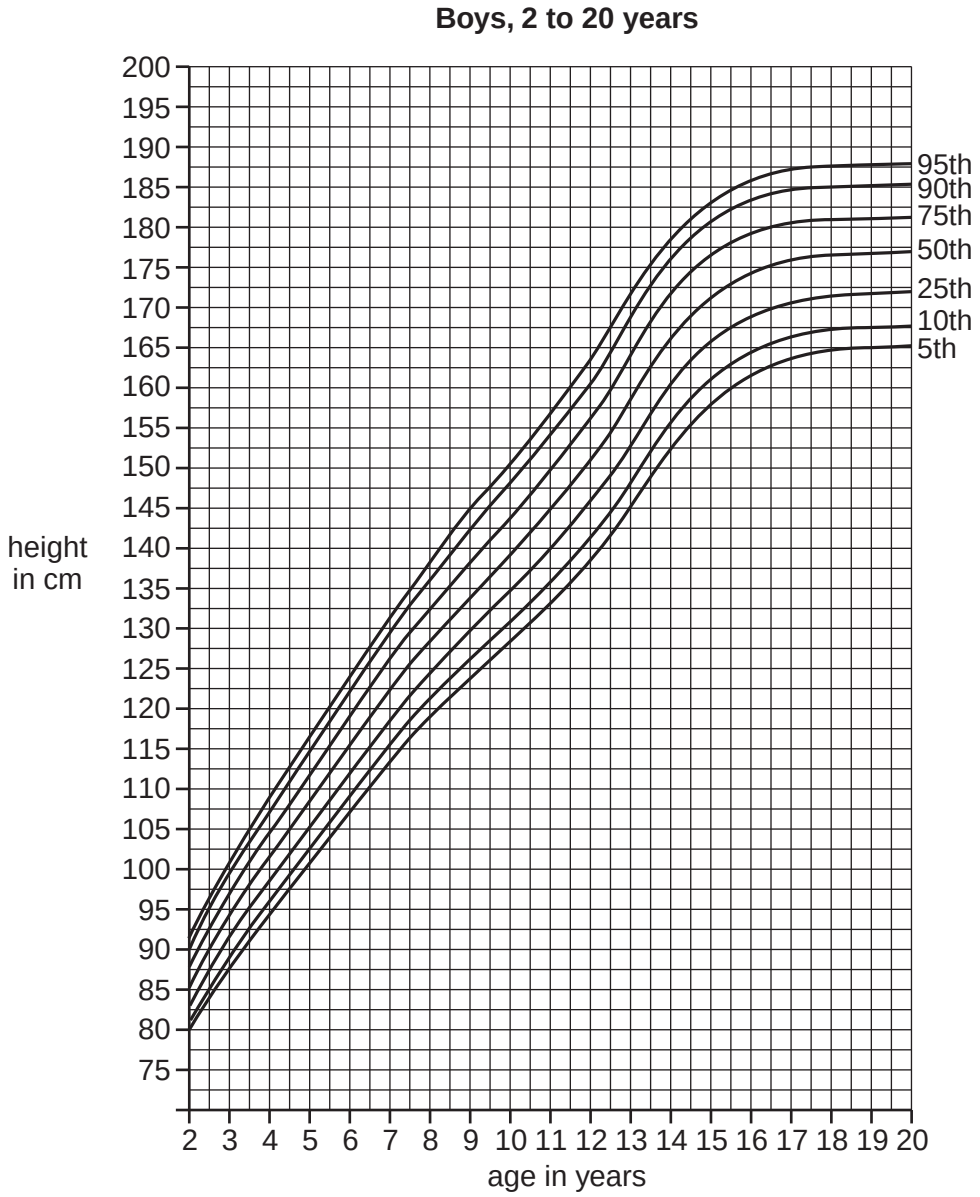
..... **[2]**

2 Look at the graph.

It shows growth in boys between the ages of 2 and 20 years.

The lines show percentiles.

For example the top line shows the 95th percentile. This means 95% of boys are at or below that height.



(a) (i) What is the range in height between the 5th and 95th percentile for boys aged 13?

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

(ii) Suggest why the range for boys at age 13 is greater than the range for boys aged 2.

.....

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

(b) New cells grow by mitosis.

Just before mitosis, DNA replication occurs.

Explain how this occurs.

You can use diagrams to help.

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

3 Look at the picture of a firefly.

The firefly is able to give out flashes of bright light to attract a mate.

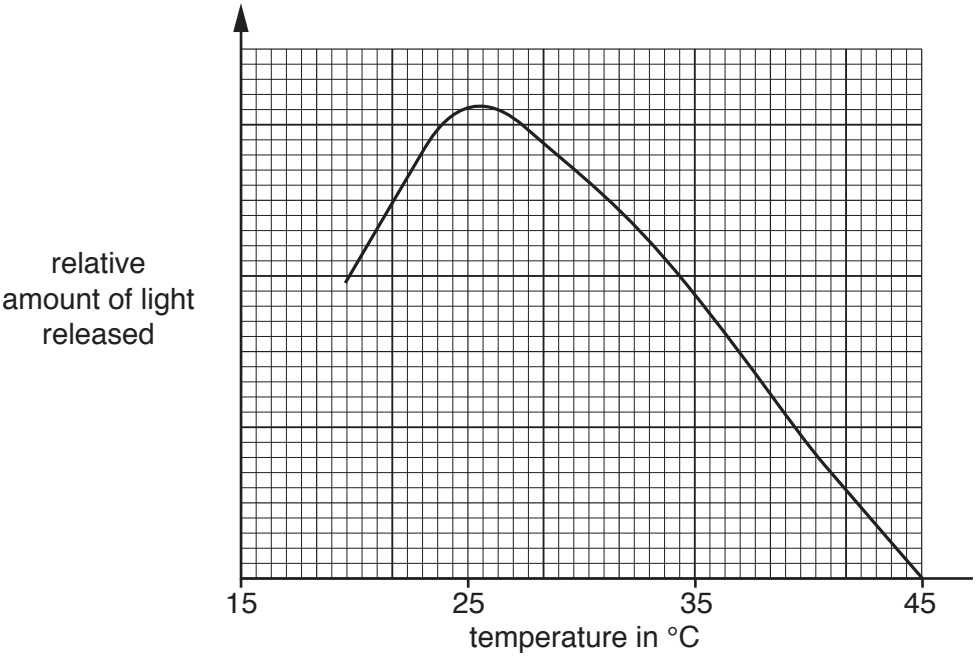
Just after dark is the best time to see fireflies flashing light.

The reaction that releases the light involves the breakdown of a chemical.

An enzyme called luciferase is needed for this reaction.

Look at the graph.

It shows how temperature affects the reaction that releases light.



(a) Use data from the graph to **explain** the effect of temperature on luciferase and explain why it is **only** luciferase enzyme that will catalyse this reaction.

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

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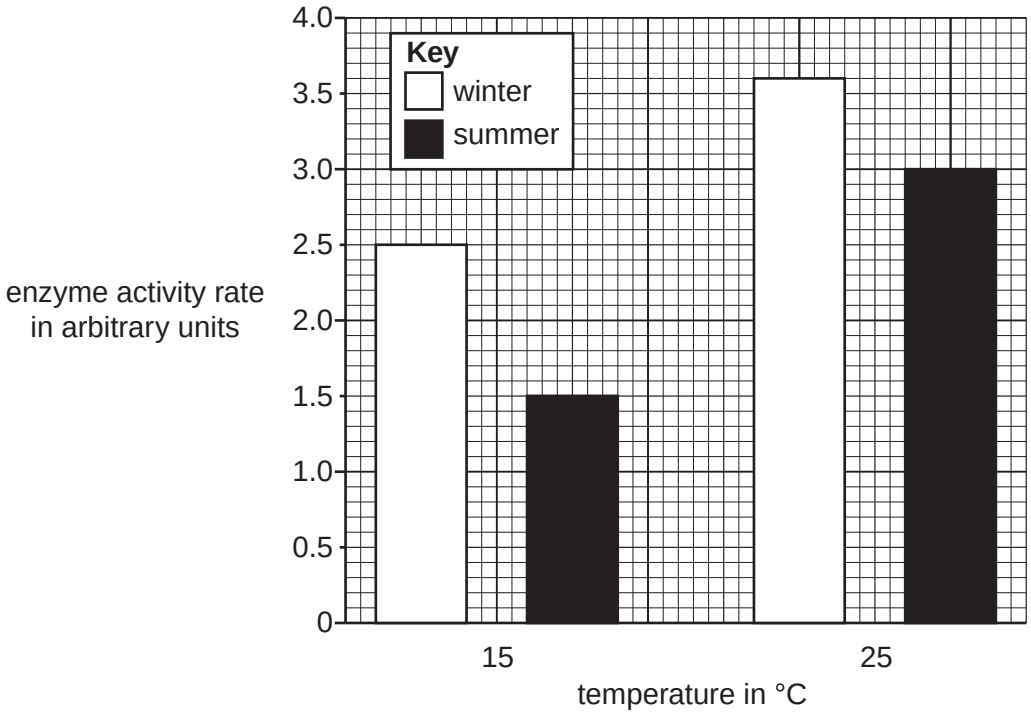
..... **[6]**

(b) Alligators do not control their body temperature.

Look at the graph.

It shows the rate of mitochondrial enzyme activity in alligators in winter and summer.



Compare the effect of temperature on enzyme activity rate at the different times of the year.

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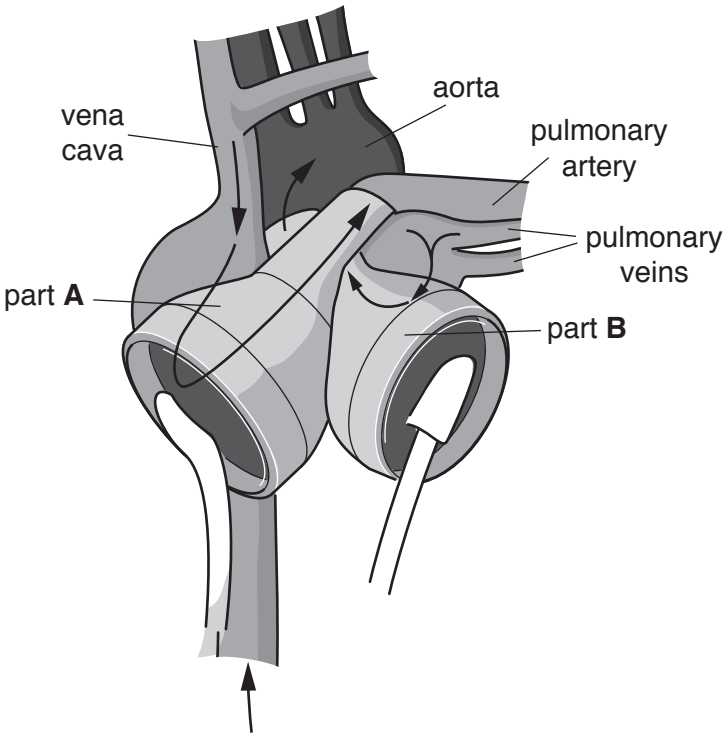
..... **[3]**

4 Look at the picture.

It shows an artificial heart.



(a) What structure in the real heart does part **A** replace?

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

(b) Part **A** and part **B** in the artificial heart pump blood to different places.

Part **B** has to work the hardest.

Explain why.

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

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SECTION B – Module C3

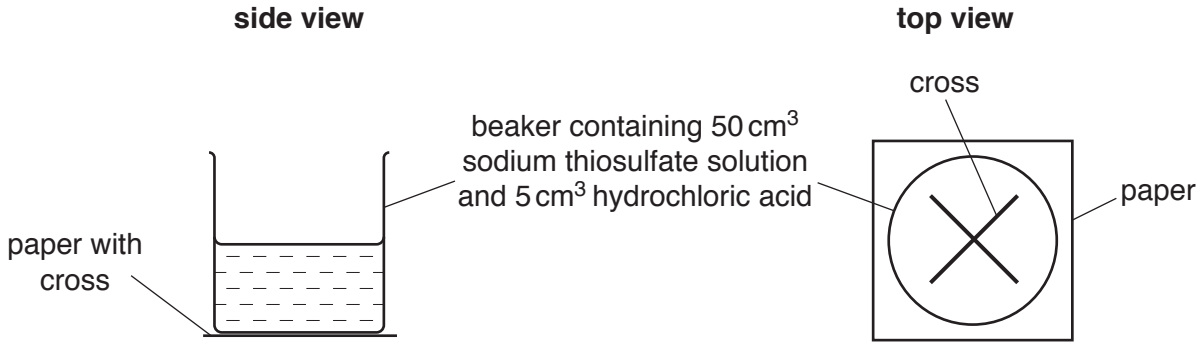
5 Harneet and Mike investigate the reaction between sodium thiosulfate, $Na_2S_2O_3$, and hydrochloric acid, HC*l*.

Sodium chloride NaC*l*, sulfur dioxide SO_2, sulfur S and water H_2O are made.

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

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

(b) Look at the diagram. It shows their experiment.



Harneet and Mike look down at the cross.

The liquid in the beaker goes cloudy.

After a time they cannot see the cross on the paper.

Harneet and Mike measure this time. This is the reaction time.

They do the experiment at four different temperatures.

They repeat the experiment at each temperature.

Look at their results.

Temperature in °C	Reaction time in seconds	
	1st	2nd
20	51.9	48.2
30	39.7	40.1
40	29.2	27.9
50	16.7	17.4

At which temperature is the reaction **fastest**?

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

(c) Mike thinks the reaction will be faster if they use a **more concentrated** solution of sodium thiosulfate.

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

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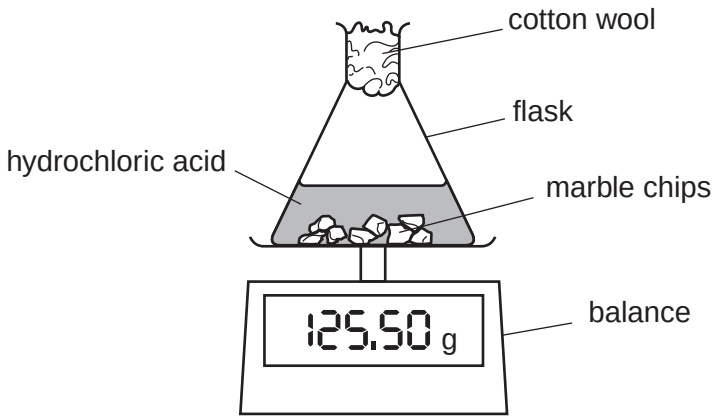
(d) Harneet also investigates the reaction of marble chips with hydrochloric acid.



The total mass of the flask and its contents decreases during the experiment.

Harneet records this decrease every 4 minutes.

She does the experiment with large marble chips.

She repeats the experiment with small marble chips.

Look at her results.

Time in minutes	Loss in mass in g	
	Large marble chips	Small marble chips
0	0	0
4	0.4	0.8
8	0.8	1.4
12	1.2	1.6
16	1.5	1.7
20	1.7	1.7

(i) Look at the results for **small** marble chips.

How long does it take for the reaction to finish?

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

(ii) Harneet wants to choose the best way to present her results.

How should she present her results?

Choose from the list.

bar chart

histograph

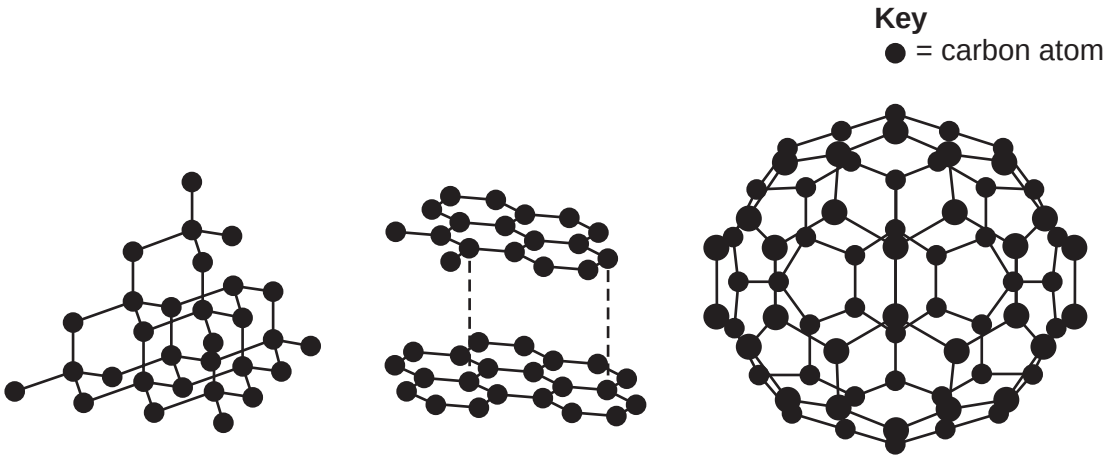
line graph

pie chart

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

6 Look at the diagrams.

They show the structures of diamond, graphite and Buckminster fullerene.



diamond **graphite** **Buckminster fullerene**

(a) Diamond, graphite and Buckminster fullerene are **allotropes** of carbon.

Explain what is meant by allotropes.

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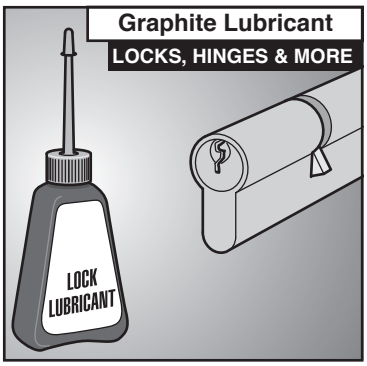
..... **[1]**

(b) Graphite is used in lubricants.



Use the structure of graphite to explain why.

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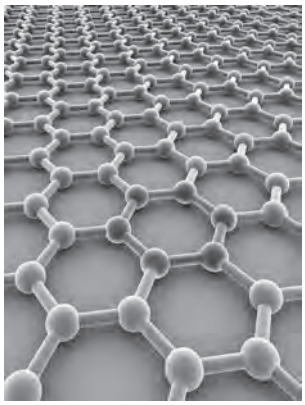
..... **[1]**

(c) Graphene is another allotrope of carbon.

The carbon atoms in graphene are arranged in a regular hexagon pattern, similar to graphite.

Graphene is different to graphite because it only has one layer of carbon atoms.



Scientists are developing graphene batteries that re-charge very quickly.

A mobile phone powered by a graphene battery could charge in only 5 seconds.

Graphite and graphene both conduct electricity.

Suggest why graphene conducts electricity.

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7 Magnesium chloride is sold to owners of indoor horse riding arenas.

It is mixed with the sand on the floor of the arena to control dust.

The equations show one method of making magnesium chloride.

hydrochloric acid + magnesium hydroxide → magnesium chloride + water

$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$

(a) Look at the table.

It shows some information about the compounds used to make magnesium chloride.

Compound	**Formula**	**Relative formula mass, M_r**
hydrochloric acid	HCl	36.5
magnesium hydroxide	$Mg(OH)_2$	58
magnesium chloride	$MgCl_2$	95
water	H_2O	18

Calculate the **atom economy** of this reaction.

The water made is a **waste product**.

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atom economy = ... % **[2]**

(b) The company making magnesium chloride wants as high an atom economy as possible.

Explain why.

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

(c) When hydrochloric acid reacts with magnesium hydroxide bonds are broken.

What type of process is bond breaking?

Choose from the list.

batch

catalytic

continuous

endothermic

exothermic

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

8 Megan is investigating the energy given out by four different liquid fuels.

She wants to compare the energy transferred when 1.0 g of each fuel is burned.

Look at her table of results.

Fuel	Temperature of water at start in °C	Temperature of water at end in °C	Mass of fuel burned in g	Energy transferred to the water in J
A	19	44	0.6	7875
B	21	41	1.2	6300
C	18	48	1.8	9450
D	20	46	1.0	8190

Megan knows that the energy transferred is related to the mass of water used.

energy transferred = mass × specific heat capacity × temperature change

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

In each experiment Megan uses the same mass of water.

(a) Describe, using a diagram, the experiment Megan did to obtain these results.

Use Megan's results to calculate the **mass of water** that she used in her experiment.

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

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(b) Look at the results for fuel **B**.

Calculate the energy transferred **per gram** of fuel **B**.

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answer ..... J/g **[2]**

(c) Megan decides that fuel **D** is the best fuel to use in a camping stove.

Is she correct?

Use the results from Megan's experiments to explain your answer.

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

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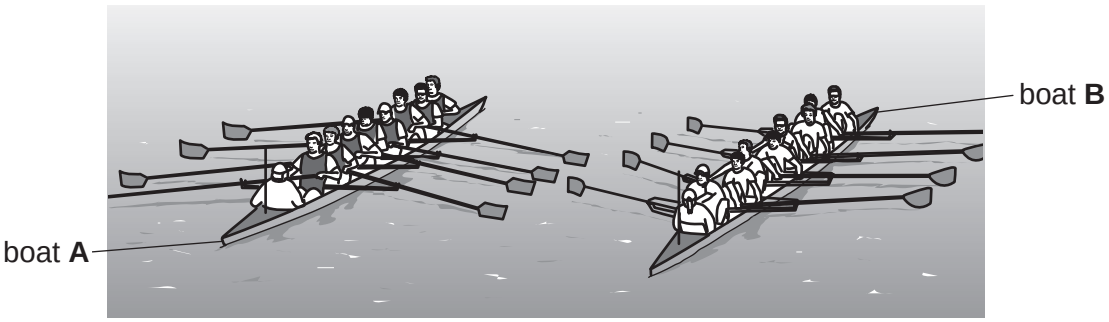
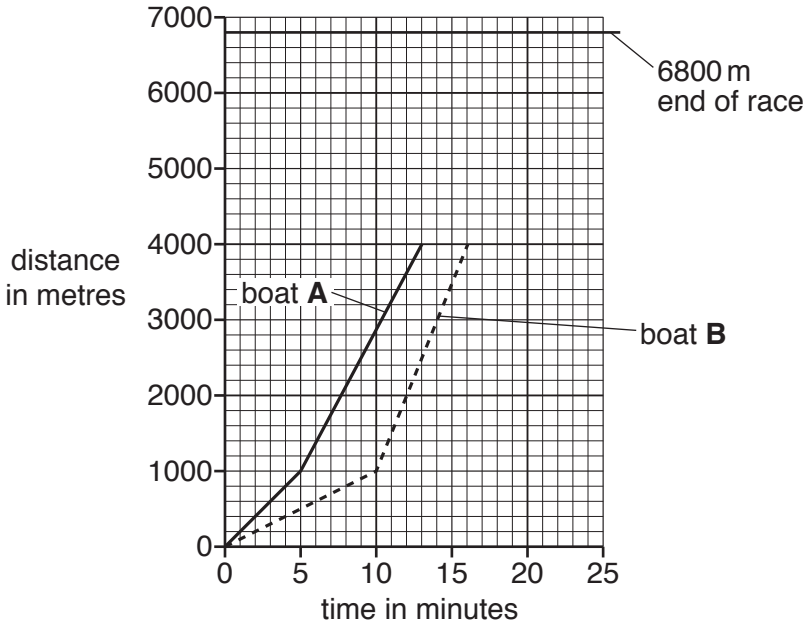
SECTION C – Module P3

9 Two boats race over a distance of 6800 m.



Here is the distance–time graph for part of the race.



Boat **A** and boat **B** travel at different constant speeds between 1000 m and 6800 m.

(a) Which boat won the **6800 m** race?

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Explain your answer.

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

(b) Use the gradients of the graphs to **compare** the speeds of boats **A** and **B** in metres per second throughout the **whole** race.

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

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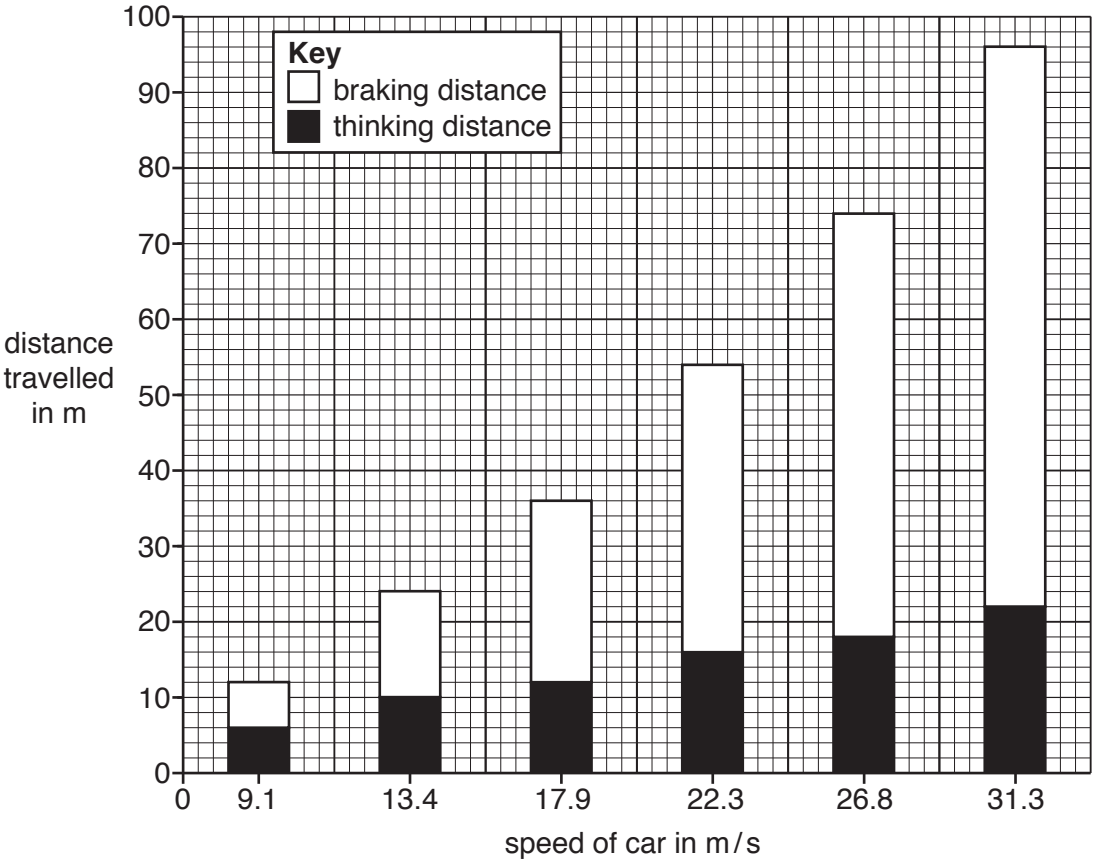
..... **[6]**

10 Here is some scientific evidence about drivers stopping cars safely.



(a) Look at the claim.

'As the speed of the car increases both the braking distance and the thinking distance increase.'

Is this claim supported by the scientific evidence?

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Explain your answer **using data** from the graph.

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

(b) The following factors were kept constant when the evidence was collected.

amount of alcohol in driver's blood

driver tiredness

driver distractions

condition of the tyres

One of these factors is kept constant because it will change the braking distance of the car.

(i) Which factor affects **braking** distance?

Choose from the list.

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

(ii) Increasing speed increases braking distance.

Write down another factor that **increases** braking distance and explain why.

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

(c) A car manufacturer carried out a survey in the United States.

They asked car drivers why they chose **not** to use seat belts.

Here are the results.

I forgot to put it on	11%
It is my personal freedom	8%
The chances of a crash are low	14%
There is no law to make me use one	10%
The seat belt is uncomfortable	57%

The car manufacturer wants to increase the number of drivers who use seatbelts.

(i) Use this data to suggest the most effective change car manufacturers can make to encourage drivers to wear seatbelts.

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

(ii) Describe the risks and benefits this change would have for drivers.

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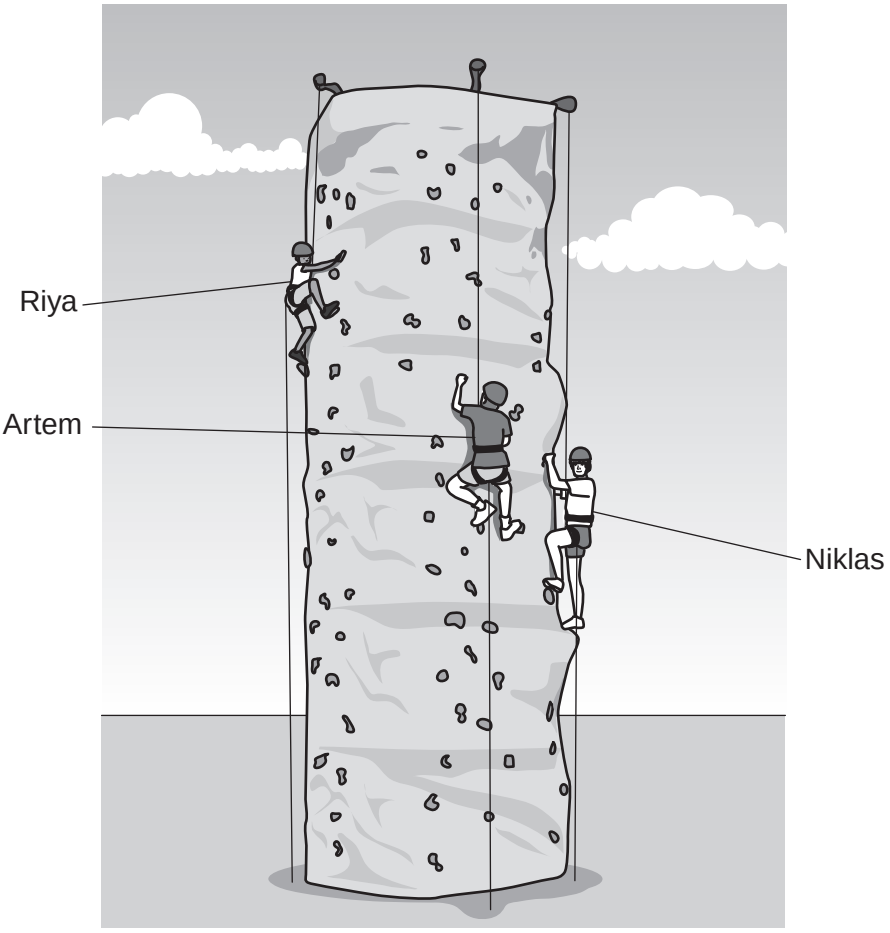
..... **[2]**

11 Riya, Artem and Niklas climb a rock wall.



Here is information about their climb.

Name	Weight in N	Height of climb in m	Time to climb in s
Riya	300	7.0	120
Artem	350	5.0	180
Niklas	700	4.0	

(a) (i) Calculate the power developed by Riya during her climb.

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.....

power = ... watts **[2]**

(ii) Suggest **two** different ways Riya can increase her power.

1 .....

2 .....

[1]

(b) Niklas climbs 4.0 metres, does 2800 joules of work and has a power of 28 watts.
He thinks he has climbed in the shortest time.

Show that Niklas is correct.

.....

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

12 Camille is a skydiver.

(a) She is falling through the atmosphere at terminal speed.

(i) What is happening to her kinetic energy (KE)?

Choose from

does not increase

doubles

halves

increases linearly

quarters

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

(ii) During her fall her gravitational potential energy (GPE) decreases.

Describe how this energy is dissipated.

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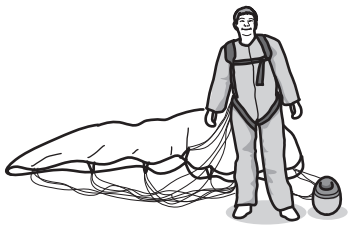
..... **[1]**

(b) Camille uses a parachute and lands safely on the Earth.



Compare the size and direction of the forces acting on her.

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

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.