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Tuesday 22 January 2013 – Morning

GCSE GATEWAY SCIENCE
ADDITIONAL SCIENCE B

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

1521769651

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

MODIFIED LANGUAGE

B721 02

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

- Your 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 **28** 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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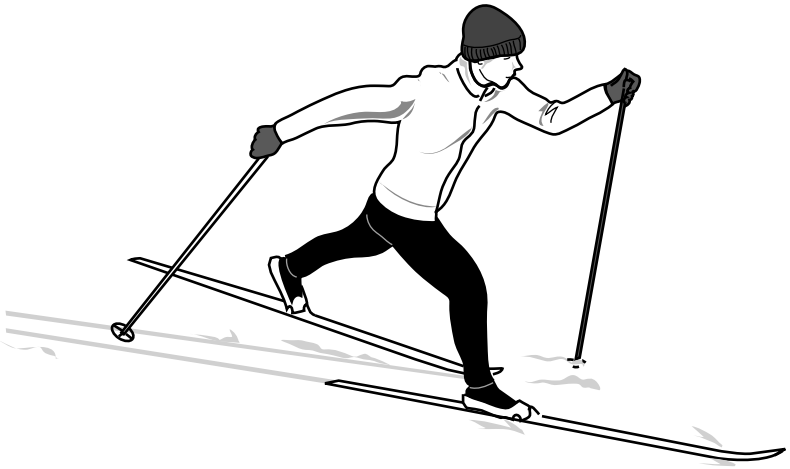
Answer **all** the questions.

SECTION A – Module B3

1 Cross-country skiers have to be very fit.



(a) Cross-country skiers have high numbers of mitochondria in the muscles of their arms and legs.

Runners only have increased numbers in their leg muscles.

Explain this difference.

.....

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

(b) One way of measuring the fitness of a person is to measure the maximum rate that they can use oxygen.

This is called their **VO_2 Max**.

The table shows typical ranges of VO_2 Max for different men.

	Range of VO_2 Max
non-sportsman	43–52
cross-country skier	65–94
runner	60–85
weightlifter	43–52

(i) Weightlifters only take a few seconds to lift weights.

Their muscles respire anaerobically.

Explain why the VO_2 Max of a weightlifter is the same as a non-sportsman.

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

(ii) It is hard to measure VO_2 Max.

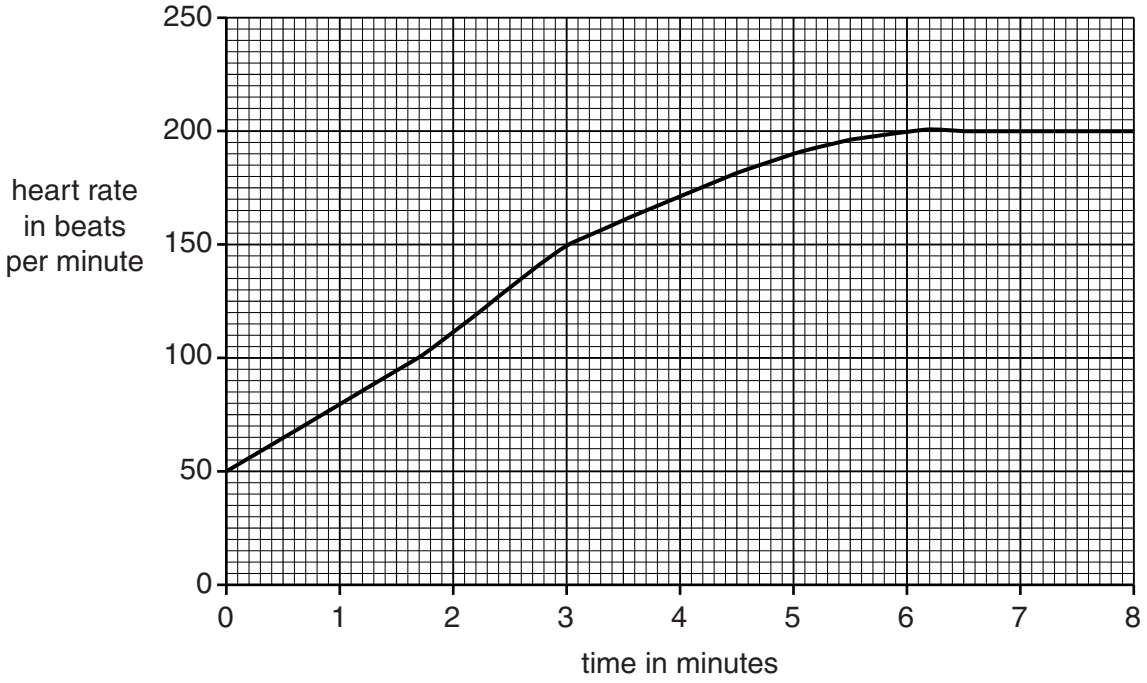
It can be estimated using the formula below.

$$\textbf{VO}_2\textbf{ Max} = \frac{\textbf{15} \times \textbf{maximum heart rate}}{\textbf{resting heart rate}}$$

Toby is training to become a cross-country skier.

He starts from rest and exercises as hard as he can for 8 minutes.

The graph shows his heart rate as he exercises.



Work out Toby's VO_2 Max.

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

(iii) Is Toby fit enough yet to be a successful cross-country skier?

Justify your answer, using evidence from the table and the graph.

.....

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

Turn over for the remainder of question 1

(c) Read the article.

Heart fear for cross-country skiers

Cross-country skiers have bigger hearts that are bigger than average. This helps the skiers to compete.

However, this might cause problems.

The top two chambers of the heart may start to beat in an unusual way. This is called fibrillation.

A study looked at 78 retired skiers: 13 of these skiers had fibrillation.

About 15 percent of 75 year-old men in the whole population have fibrillation.

However, the skiers developed the condition at a younger age than most men.

(i) What is the name of the chambers that are developing fibrillation?

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

(ii) Explain how the results of the study could be used to show that there is **no** link between skiing and fibrillation.

.....

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

[Total: 8]

2 Look at the advertisement about storing stem cells from umbilical cords.

Store your baby's stem cells

Now for a single payment you can have your baby's stem cells stored.

There are stem cells in the baby's umbilical cord.

These stem cells are **not** embryonic stem cells but are similar to adult stem cells.

They could still prove lifesaving to your child later in life.

The stem cells can be frozen and stored in case they are needed.

Write about why people might want to have their baby's stem cells stored and why embryonic stem cells might be more useful.

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

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

[Total: 6]

3 Haemoglobin is found in blood.

(a) Explain how haemoglobin supplies the tissues of the body with oxygen.

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

(b) Cyril has a disorder called sickle cell anaemia.

The haemoglobin in his blood has a different structure to normal haemoglobin.

This is due to a mutation.

Explain how a mutation can cause a change in the haemoglobin molecule.

.....

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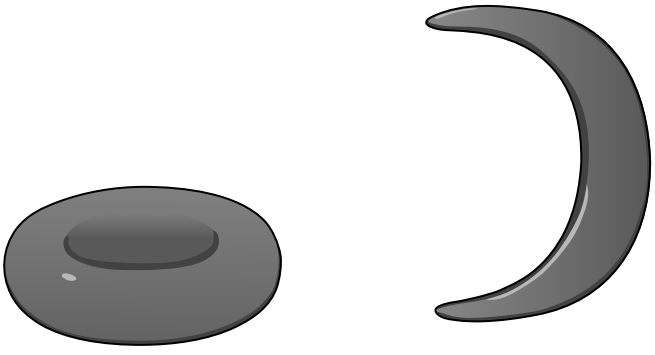
..... **[2]**

(c) Haemoglobin is found in red blood cells.

During exercise, the blood flowing through Cyril's muscles becomes more acidic.

This affects Cyril's haemoglobin and makes his red blood cells change shape.



normal red blood cell sickled red blood cell

Explain why Cyril's red blood cells do **not** work so well after they change shape.

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

[Total: 7]

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Question 4 begins on page 10

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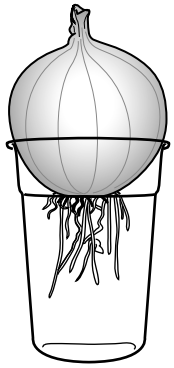
4 Noel investigates the growth of onions.

He puts an onion bulb in a jar of water.

The bulb starts to grow roots.



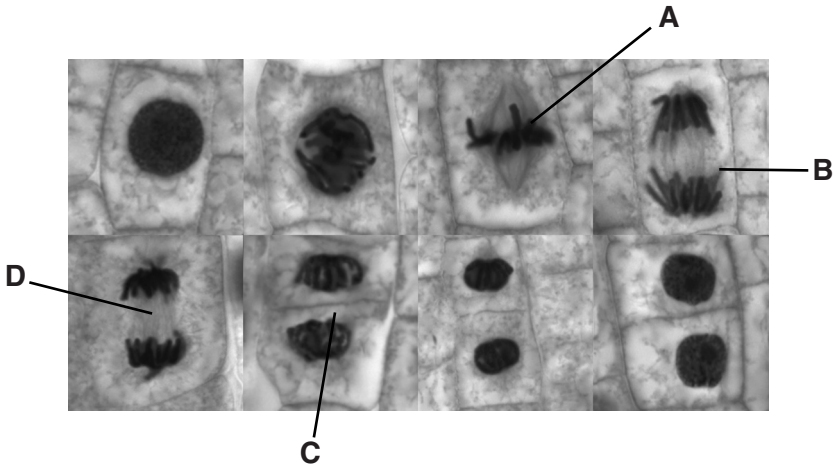
(a) Cell division is happening in the tips of the roots to make new cells for growth.

What is the name of this type of cell division?

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

(b) Noel then makes a slide of the onion root and looks at it with a light microscope.

He sees chromosomes inside dividing cells.



(i) Cells **A**, **B**, **C** and **D** are in different stages of cell division.

Put the stages in order.

One has been done for you.

		D	

[2]

(ii) Noel cannot see ribosomes in the onion cells.

What is the most likely reason for this?

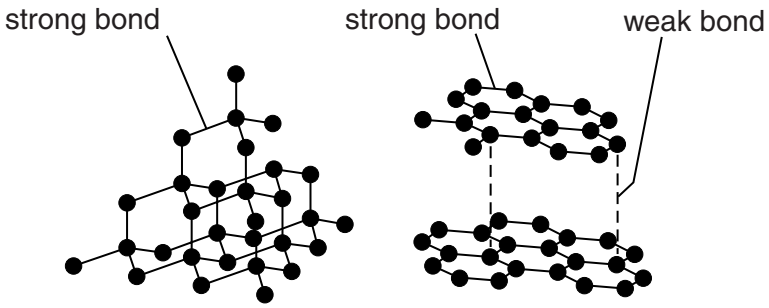
..... **[1]**

[Total: 4]

Question 5 begins on page 12

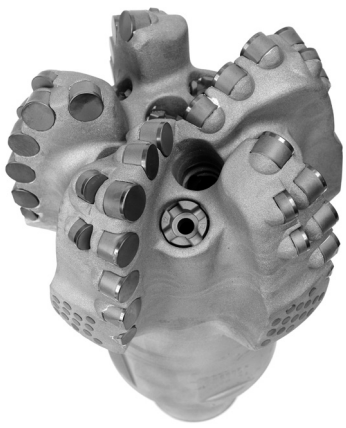
SECTION B – Module C3

5 Look at the diagrams. They show the structures of diamond and graphite.



diamond **graphite**

(a) Diamond is used in tools made for cutting.



Explain why.

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

(b) Graphite is slippery.

Explain why.

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

[Total: 3]

6 Aspirin is a medicine used to control pain.

Look at the equations. They show how aspirin can be made.

salicylic acid + ethanoyl chloride → aspirin + hydrogen chloride

$C_7H_6O_3$ + C_2H_3OCl → $C_9H_8O_4$ + HCl

Look at the table. It shows some information about the compounds used in making aspirin.

Compound	Formula	Relative formula mass
salicylic acid	$C_7H_6O_3$	138
ethanoyl chloride	C_2H_3OCl	78.5
aspirin	$C_9H_8O_4$	180
hydrogen chloride	HCl	36.5

(a) Calculate the **atom economy** of this reaction.

.....

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.....

answer = ... % **[2]**

(b) A company is making a new medicine.

They want the atom economy to be as high as possible.

Explain why.

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

(c) It is difficult to develop and test new medicines so that they are safe to use.

Explain why.

.....

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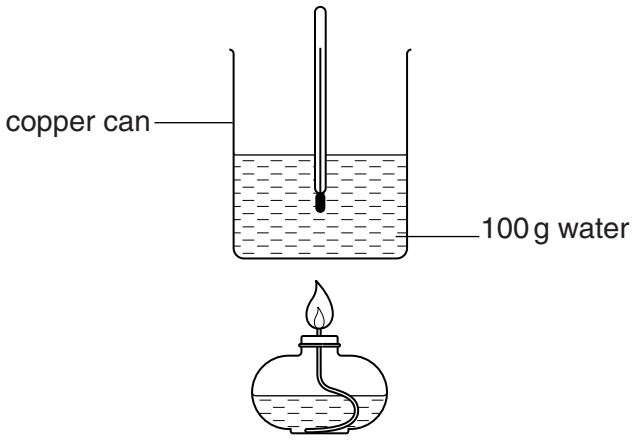
..... **[2]**

[Total: 6]

7 Nick and Lesley are comparing the energy content of three fuels.

Look at the diagram. It shows the apparatus they use.



Look at their results.

Fuel	Temperature at start in °C	Temperature at end in °C	Mass of fuel burned in g	Energy transferred per gram in J
A	20	30	0.5	8400
B	18	43	0.8	
C	22	42	0.4	

Write about how Nick and Lesley do the experiment.
Calculate the energy transferred per gram for fuels **B** and **C** to show which fuel gives out the most energy per gram.

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

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

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

[Total: 6]

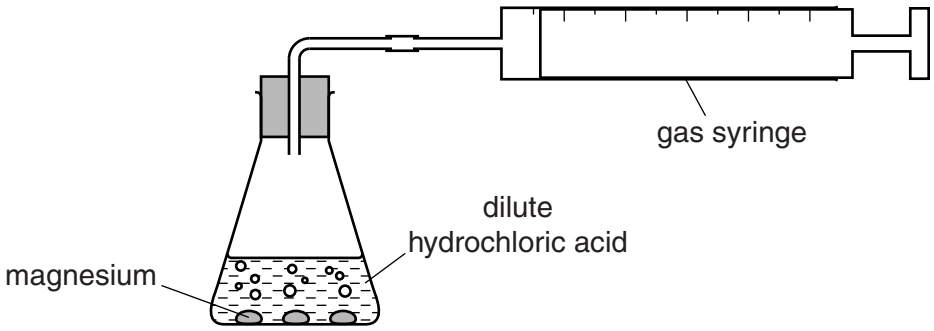
8 Jan and Mike investigate the reaction between magnesium lumps and hydrochloric acid, HC*l*.

Magnesium chloride solution, MgCl_2, and hydrogen gas, H_2, are made.

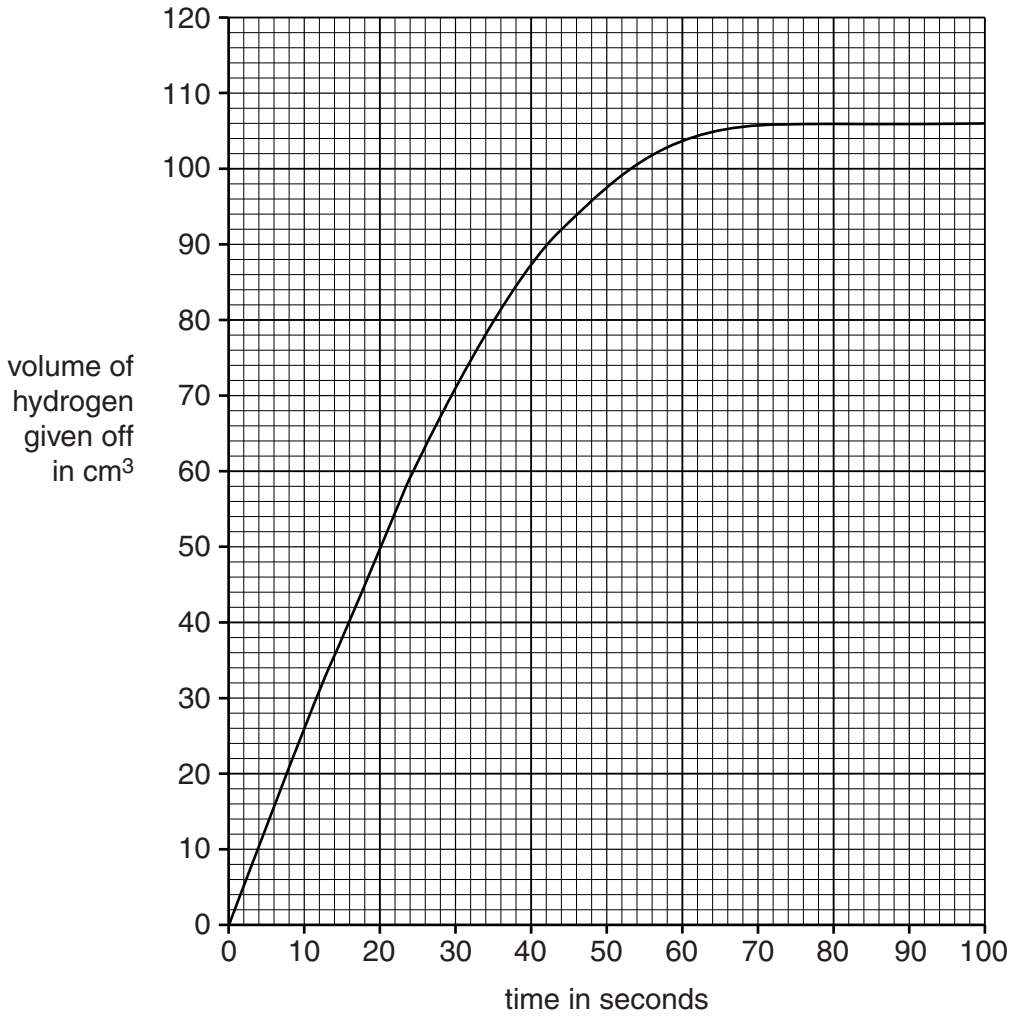
(a) Write a **balanced symbol** equation for this reaction.

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

(b) Look at the diagram. It shows the apparatus they use.



Look at the graph of their results



(i) When the reaction has finished what volume of gas is made?

..... cm^3 **[1]**

(ii) Calculate the rate of reaction during the first 20 seconds.

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rate of reaction = ... **[2]**

(c) Increasing the temperature of the hydrochloric acid increases the rate of the reaction.

Use the reacting particle model to explain why.

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

(d) Breaking the lumps of magnesium into a **powder** increases the rate of the reaction.

Use the reacting particle model to explain why.

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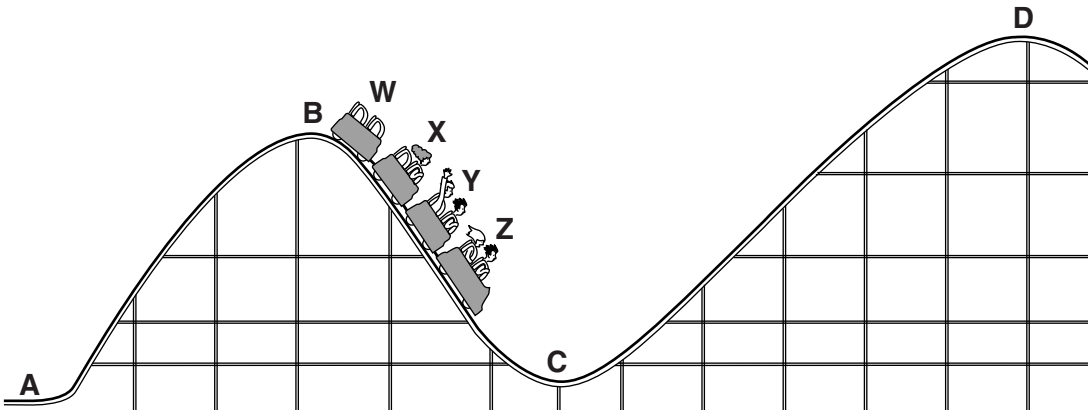
..... **[2]**

[Total: 10]

SECTION C – Module P3

9 Five people ride on a roller coaster.



(a) At position **D**, the roller coaster has the greatest **gravitational potential energy** (GPE).

Explain why, using the equation:

GPE = mgh

.....

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

(b) Roller coaster car **W** is empty**.**

Josef thinks that the roller coaster car **W** has **no** momentum as it moves down the slope.

Is he correct?

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Explain your answer.

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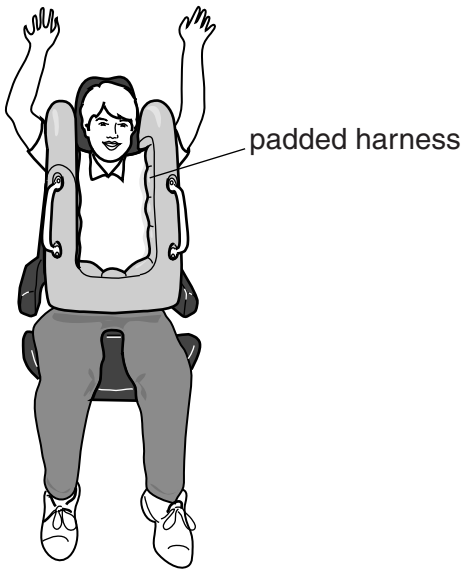
..... **[1]**

(c) All the people in the roller coaster cars wear a padded harness.



If the roller coaster comes to a sudden stop, the **padded** harness reduces the risk of an injury.

Explain why.

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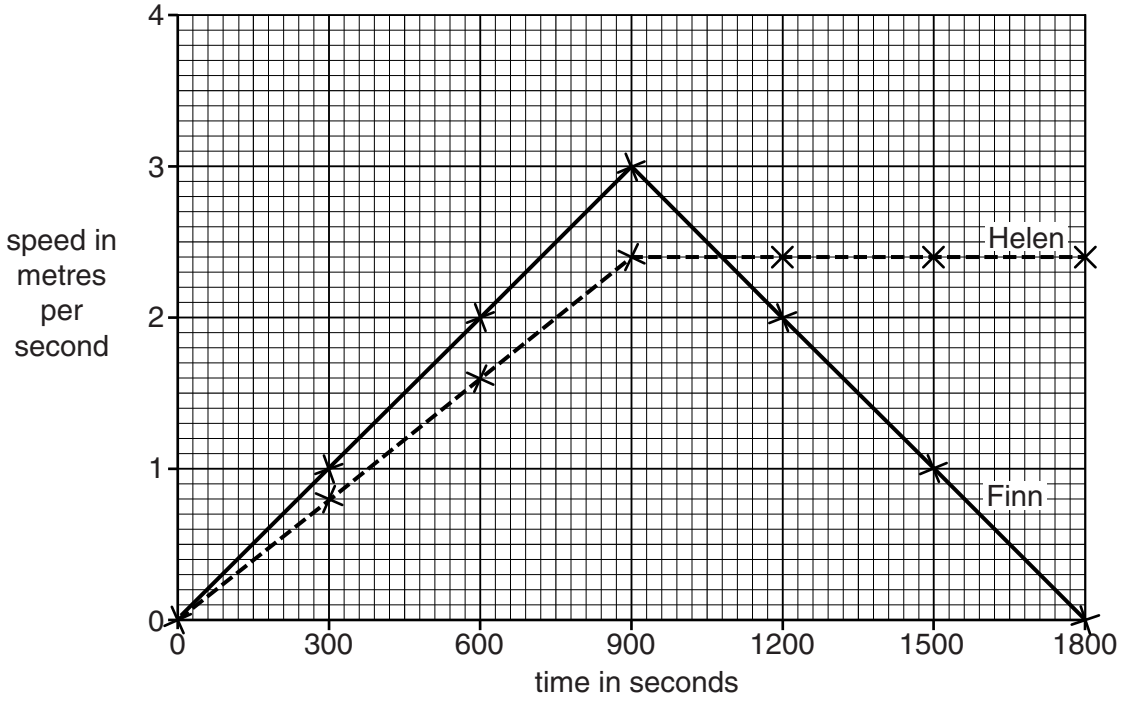
..... **[2]**

[Total: 4]

10 Helen and Finn take part in a cross-country run.

Look at the information about their run.

Their speeds have been plotted on a graph.



Use the graphs to compare Helen's and Finn's **acceleration** over the whole run.

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

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

[Total: 6]

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Question 11 begins on page 22

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11 There are many different types of cars.

Look at the information.

Conventional cars use fossil fuels.

Bio-fuel hybrid electric cars use bio-fuels and an electric motor.
They can be plugged into a power supply to recharge the battery.

Plug-in hybrid electric cars use fossil fuels and an electric motor.
They can be plugged in to recharge the battery.

Electric cars only use a battery.
They can be plugged in to recharge the battery.

Type of car	**CO_2 emissions in kg per 160 km**
conventional	39.5
bio-fuel hybrid electric	25.9
plug-in hybrid electric	28.2
electric	24.5

(a) The CO_2 emissions could come from a power station and also directly from the fuel in the car.

Use this information to explain the differences in CO_2 emissions for the four different types of car.

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..... **[4]**

(b) When road conditions are poor, fuel consumption figures for the four different types of car increase.

Explain what factors, other than road conditions, need to be considered when comparing fuel consumption figures.

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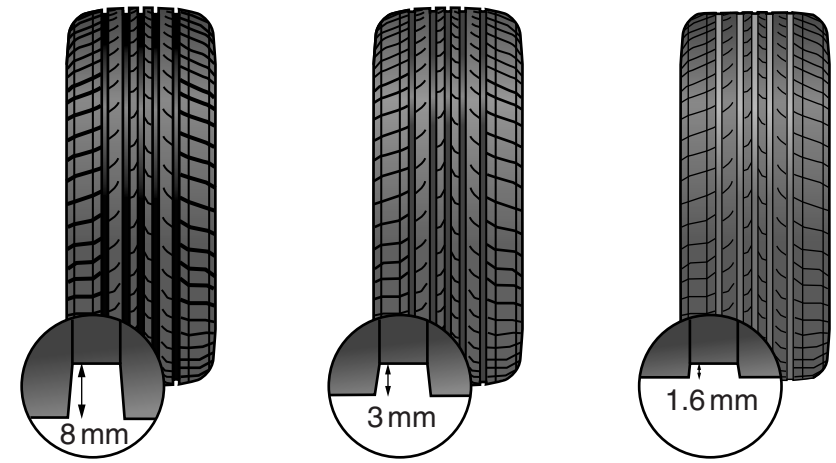
..... **[3]**

[Total: 7]

Question 12 begins on page 24

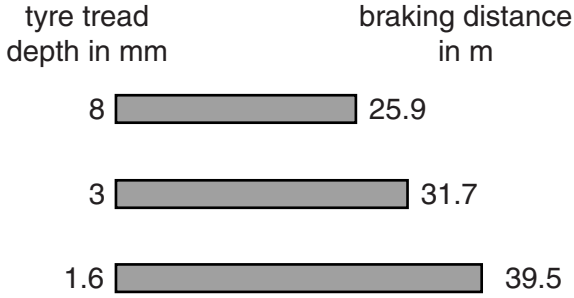
12 Car tyres have tread.

As tyres become worn the amount of tyre tread decreases**.**



magnified view of tyre tread showing depth

(a) Look at the braking distance chart for the **same** car with different tyre tread depths.



(i) What is the braking distance for the car with a tyre tread depth of **8 mm** when the speed is **doubled**?

.....

.....

braking distance ..... m **[1]**

(ii) Speed affects **braking distance**.

Doubling the speed of the car with a tyre depth **below** 1.6 mm is a significant concern in terms of road safety.

Explain why.

.....

.....

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

(b) The data in the table shows the advice about depth of tyre tread.

Depth of tyre tread in mm	Advice
8	tyre is legal
4	tyre is legal
3	consider replacing
1.6	legal limit

A new tyre has been made.

The tread on the new tyre is more resistant to wear **but** when the thread depth reaches 4 mm, the rate of wear rapidly increases.

Describe a benefit of using this new tyre, and suggest a way of limiting the **risks** of using it.

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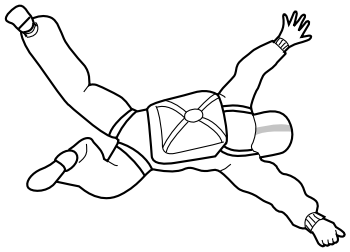
..... **[2]**

[Total: 5]

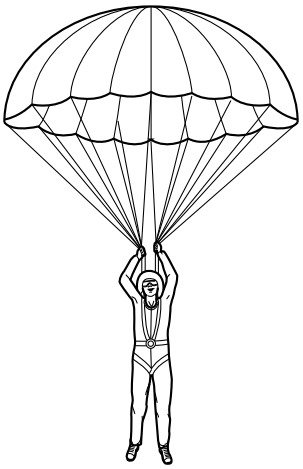
13 David is a parachutist.

He jumps out of an aeroplane.



(a) David's terminal speed is 60 m/s **before** he opens the parachute.

David opens the parachute.



Explain, in terms of balanced forces acting on David, why his terminal speed is different before **and** after he opens his parachute.

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

(b) The acceleration due to gravity is given the symbol **g**.

Describe what happens to the value of **g** as David jumps out from the aeroplane at very high altitude and falls all the way to Earth.

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

[Total: 3]

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.