OCR
Oxford Cambridge and RSA

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Wednesday 15 June 2016 – 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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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 **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

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

SECTION A – Module B3

1 (a) Mike competes in the triathlon.

This event involves swimming, cycling and running.

He records his heart rate in beats per minute (bpm) during each stage of the triathlon.

Look at his results in the table.

	Heart rate in bpm
Swimming	163
Cycling	165
Running	160

The maximum heart rate is the highest heart rate that is achievable during exercise.

One method to calculate a predicted maximum heart rate uses this formula:

predicted maximum heart rate = 220 – age

(i) Mike is 29 years old.

Calculate his heart rate during **cycling** as a percentage of his predicted maximum heart rate.

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

(ii) Mike will gain the most benefit from his training if his heart rate stays within a certain range.

This range is called the target heart rate zone and is between 60% and 85% of his maximum heart rate.

Heart rates above the target heart rate zone mean that anaerobic respiration will be used.

Will Mike gain maximum benefit from his cycling training?

Explain your answer using ideas about respiration.

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

(b) Blood doping is a way of cheating in sport.

The drug EPO increases the amount of haemoglobin in the blood.

Explain why taking EPO gives athletes an unfair advantage.

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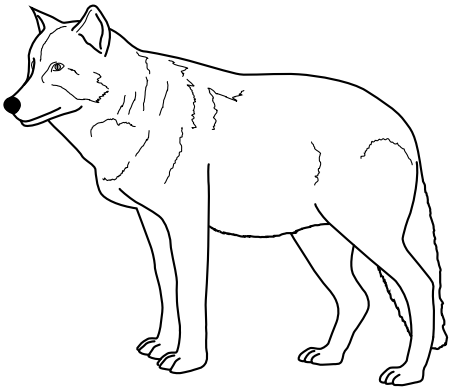
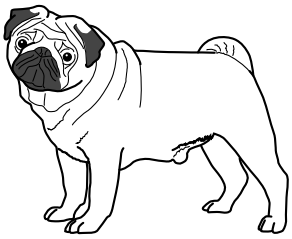
..... **[2]**

[Total: 6]

2 Look at the pictures below.



grey wolf



pug

The grey wolf is a wild animal.

All dog breeds like the pug are thought to have been bred originally from the grey wolf.

(a) As a result of selective breeding, some pug dogs have breathing problems.

Suggest why pug dogs have breathing problems and explain why continued selective breeding could result in other health problems.

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

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

(b) (i) Write down the name of the type of cell division that makes dog sperm cells.

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

(ii) Put a (ring) around the word that describes dog skin cells.

acrosome **diploid** **fertilised** **gamete** **zygote**

[1]

[Total: 8]

Question 3 begins on page 8

3 (a) This question is about enzymes.

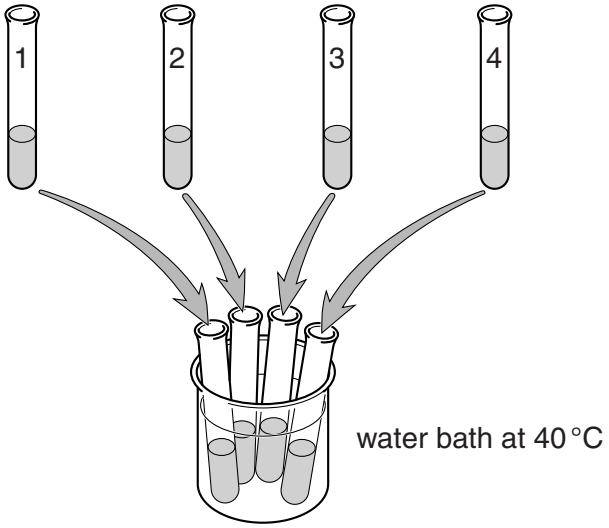
Pepsin is an enzyme that breaks down protein.

Egg-white is a protein that makes water cloudy.

Look at the table below.

It shows an investigation into the effect of adding the enzyme pepsin to egg-white.

Tube 1	Tube 2	Tube 3	Tube 4
5 cm^3 egg-white	5 cm^3 egg-white	5 cm^3 egg-white	5 cm^3 egg-white
3 drops distilled water	3 drops hydrochloric acid	3 drops hydrochloric acid	3 drops hydrochloric acid
1 cm^3 pepsin	1 cm^3 distilled water	1 cm^3 pepsin	1 cm^3 of boiled pepsin



The tubes were put in a water bath at 40 °C for 5 minutes.

Look at the results below.

Tube	Contents	Observations of tube contents	
		At start	At end
1	egg-white, water and pepsin	cloudy	almost clear
2	egg-white, hydrochloric acid and water	cloudy	cloudy
3	egg-white, hydrochloric acid and pepsin	cloudy	clear
4	egg-white, hydrochloric acid and boiled pepsin	cloudy	cloudy

(i) Write a conclusion explaining what the results show about the conditions pepsin needs to work.

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

(ii) How does the 'lock and key' mechanism explain why pepsin will **only** break down protein and **not** other food groups like starch?

You may draw a diagram to help your answer.

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

Turn over for the remainder of question 3

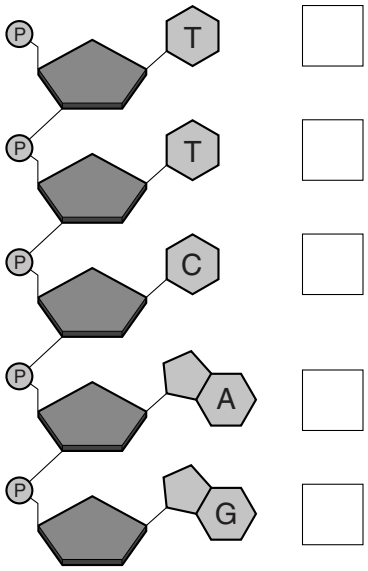
(b) DNA is important in the production of different enzymes.

There are four bases in DNA.

The bases are A, C, G and T.

The diagram below shows one strand of DNA.

Write down in each box, the letter of the base that would be found on the complementary strand of DNA.



[2]

(c) The table below shows the order of bases on DNA that code for different amino acids.

Base order	Amino acid	Base order	Amino acid	Base order	Amino acid	Base order	Amino acid
AAA	Phenylalanine	AGA	Serine	ATA	Tyrosine	ACA	Cysteine
AAG		AGG		ATG		ACG	
AAT	Leucine	AGT					
AAC		AGC				ACC	Tryptophan
GAA		GGA	Proline	GTA	Histidine	GCA	Arginine
GAG		GGG		GTG		GCG	
GAT		GGT		GTT	Glutamine	GCT	
GAC		GGC		GTC		GCC	
TAA	Isoleucine	TGA	Threonine	TTA	Asparagine	TCA	Serine
TAG		TGG		TTG		TCG	
TAT		TGT		TTT	Lysine	TCT	Arginine
TAC	Methionine	TGC		TTC		TCC	
CAA	Valine	CGA	Alanine	CTA	Aspartic acid	CCA	Glycine
CAG		CGG		CTG		CCG	
CAT		CGT		CTT	Glutamic acid	CCT	
CAC		CGC		CTC		CCC	

11

This is part of the DNA base sequence that codes for the enzyme pepsin.

TAACCACTG

(i) Write down the order of amino acids that are coded for by this section of DNA.

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

(ii) Explain why the order of amino acids is important for the correct function of pepsin.

.....

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

(iii) A gene mutation causes a change in the DNA.

TATCCACTG

What effect will this have on the function of pepsin?

Explain your answer.

.....

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

[Total: 11]

SECTION B – Module C3

4 Pete and Helen investigate the reaction between sodium carbonate, Na_2CO_3, and ethanoic acid, $C_2H_4O_2$.

Sodium ethanoate, $C_2H_3O_2Na$, carbon dioxide and water are made.

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

Na_2CO_3	+	$2C_2H_4O_2$	→	.....		.....		.....

[2]

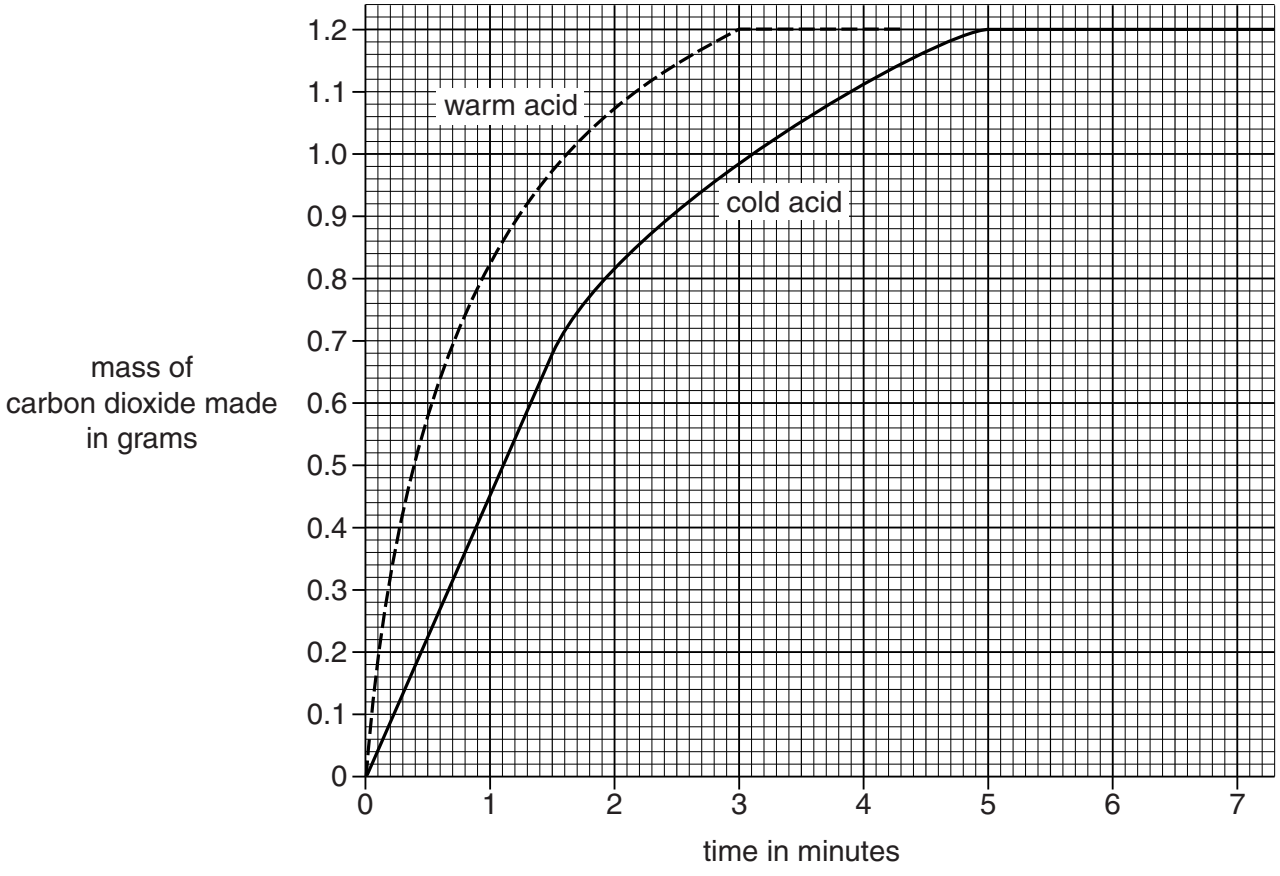
(b) Pete and Helen measure the mass of carbon dioxide made every 30 seconds during the reaction.

They do the experiment again.

They use the same amount of acid and sodium carbonate.

This time they use **warm** ethanoic acid instead of cold ethanoic acid.

Look at the graph below. It shows their results.



Look at the graph for the **warm** acid.

How long does it take for the reaction to finish?

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

(c) (i) Look at the graph for the **cold** acid.

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

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

.....

.....

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

(ii) The rate of reaction during the first 1.5 minutes is **greater** than at 4 minutes.

How can you tell this from the graph?

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

(d) The reaction with **cold** ethanoic acid is **slower** than the reaction with warm ethanoic acid.

Explain, in terms of the reacting particle model, why this reaction is slower with cold acid.

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

(e) Complete the sentence.

The ethanoic acid is all used up at the end of the reaction because it is the

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

[Total: 10]

5 Soldiers use 'flameless heaters' to heat their meals.

The 'flameless heater' heats the food safely and quickly without using a flame.

The heater uses a chemical reaction between magnesium metal and water.

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

(a) Use the balanced symbol equation to show that **mass is conserved** during this reaction.

The relative atomic mass, A_r, of H = 1, Mg = 24 and O = 16.

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

(b) The reaction between magnesium and water is an **exothermic** reaction.

Explain why, using ideas about bond breaking and bond making.

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

(c) Soldiers need the 'flameless heaters' to heat 227 g of food by 56 °C in less than 12 minutes.

A scientist investigates 'flameless heaters'.

Look at her results below.

Heater	Mass of food heated in g	Temperature rise of food in °C	Time taken in minutes
A	200	40	8
B	227	45	10
C	227	24	6
D	227	30	5

Which heater will heat 227 g of food by 56 °C in less than 12 minutes?

.....

Explain your answer.

.....

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

[Total: 6]

6 Pensby pharmaceuticals are making a new painkiller.

They make the drug using a **batch** process rather than a continuous process.

(a) Explain why batch processes are used for making pharmaceutical drugs.

.....

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

(b) It is often expensive to make and develop new drugs.

Explain **two** reasons why.

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

(c) Pensby pharmaceuticals investigate four different methods of making the new painkiller.

Look at the table below.

It gives information about the four methods they use.

Method	Predicted mass in g	Actual mass in g	Percentage yield	Atom economy	Cost of raw materials per gram
A	6.7	5.0	75%	50%	£1.92
B	14.2	8.5	60%	85%	£1.30
C	11.5	6.9	.....	40%	£2.16
D	13.3	12.0	90%	80%	£1.36

Use the information to calculate the percentage yield for method **C**.

Decide which method they should use to make the painkiller and explain your choice.

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

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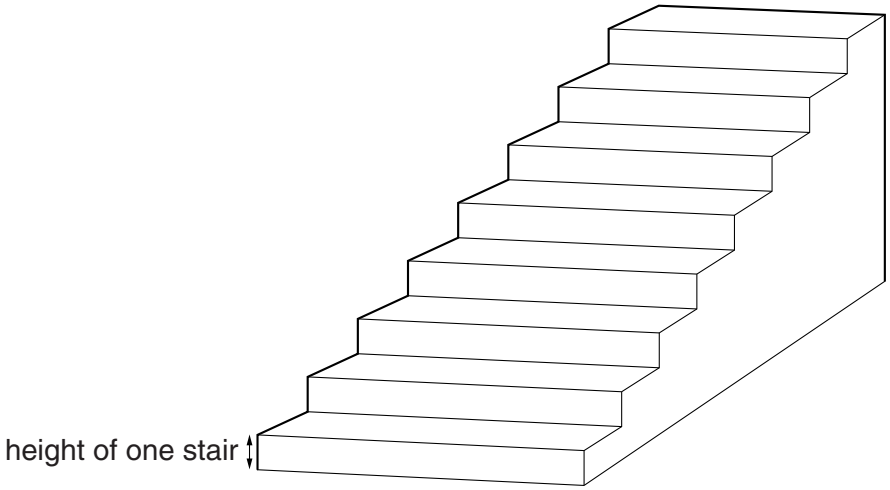
..... **[6]**

[Total: 9]

SECTION C – Module P3

7 This question is about work and power.

(a) Janna walks upstairs.



The height of one stair is 0.15 m.

Janna walks up **four** stairs. She has a mass of 50 kg.

Assume that the gravitational field strength (g) is 10 N/kg.

(i) Calculate the **work** done by Janna using this data.

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answer ..... J **[3]**

(ii) Janna thinks she does **more** work than the value calculated using the data above.

Suggest a reason why.

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

(b) Janna walks up to the top of the eight stairs every day.

She walks at different speeds each day.

Look at the information below.

Day	Number of stairs	Power developed in watts
Monday	8	107
Tuesday	8	104
Wednesday	8	108
Thursday	8	112
Friday	8	91

Janna takes the shortest time to reach the top of the stairs on Thursday.

Explain why.

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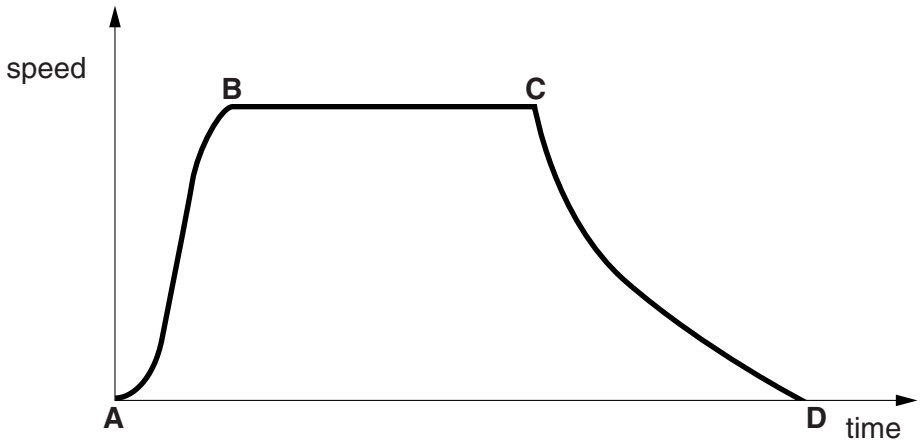
..... **[2]**

[Total: 6]

8 Look at the speed-time graph below for a journey.



Describe the changes in acceleration during the journey and explain how to calculate the distance travelled between time **B** and **C**.

Use letters **A**, **B**, **C** and **D** in your answer.

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 9 begins on page 22

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9 Seat belts are a safety feature in cars.

The design of seat belts has changed since they were first fitted in cars.

(a) Scientists collect test data to help them design new seat belts.

(i) Suggest some methods the scientists use to collect valid test data for seat belts.

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

(ii) Why is it important for scientists to publish the test data they collect?

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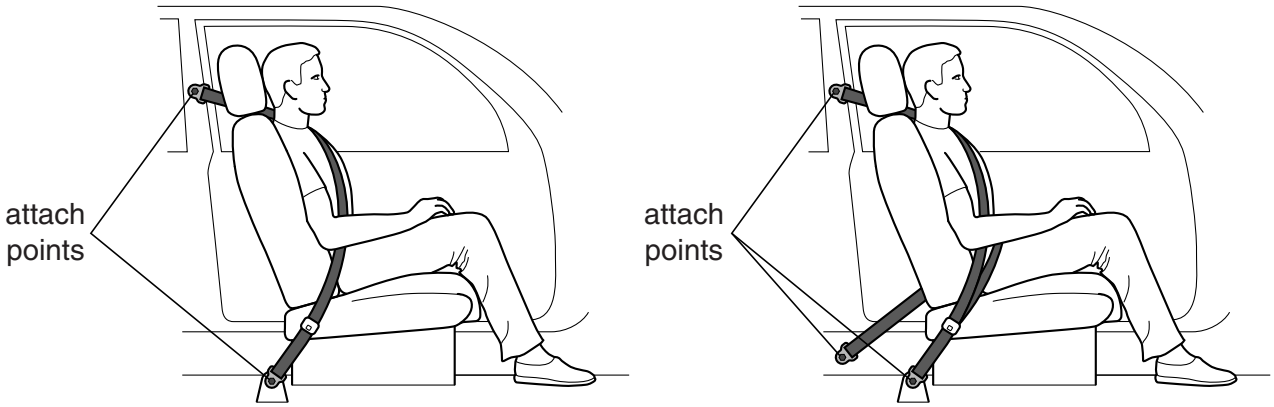
..... **[2]**

(b) Some seat belts are attached to the car in two places.

Others are attached in three places.

Look at the diagram below.



2-point seat belt **3-point seat belt**

Suggest why 3-point seat belts are better at reducing injuries.

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

(c) Test data produced by scientists show that the material which seat belts are made from is important.

Write down one property which seat belt material must have and explain why this property is useful in an accident.

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

(d) Pregnant women can find it uncomfortable to wear a seat belt.

Describe one risk **and** one benefit of a pregnant woman wearing a seat belt.

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

[Total: 8]

10 Taran wants to buy a new car.

He uses the internet to find data about fuel consumption and emissions.

Look at the table below with the information he finds about two different car models.

Model R	Model S
Fuel consumption in litres per 100 km: • In town 5.7 • On motorways 4.1 • Combined 4.6	**Fuel consumption in litres per 100 km:** • In town 8.2 • On motorways 5.2 • Combined 6.3
Average carbon dioxide emission 124.0 g/km	**Average carbon dioxide emission** 149.0 g/km

(a) This data is collected using cars that have been driven with the same driving styles and speeds.

Write down another condition that is kept constant to allow the cars to be compared.

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

(b) (i) **Model S** has a higher carbon dioxide emission than **Model R**.

Use the data to suggest why.

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

(ii) Suggest why the carbon dioxide emissions quoted in the table are **average** values.

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

(c) Taran's friend, Charlie, has a van.

Charlie's van has double the mass of Taran's old car.

Charlie says 'when my van goes twice the speed of your car, it will have four times as much kinetic energy (KE)'.

Is Charlie correct?

Explain your answer.

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

[Total: 5]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

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.