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Tuesday 10 June 2014 – Afternoon

GCSE GATEWAY SCIENCE
ADDITIONAL SCIENCE B

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

1200380384

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

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

- 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.

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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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Question 1 begins on page 4

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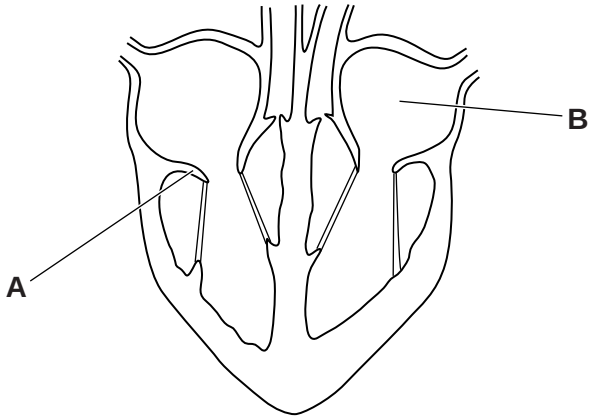
Answer **all** the questions.

SECTION A – Module B3

1 **(a)** This question is about blood and circulation.

Look at the diagram of a heart.



(i) Write down the names of **A** and **B**.

A .....

B .....

[2]

(ii) The heart pumps blood out of the left and right ventricles.

Explain why the left ventricle has a thicker muscle wall than the right ventricle.

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

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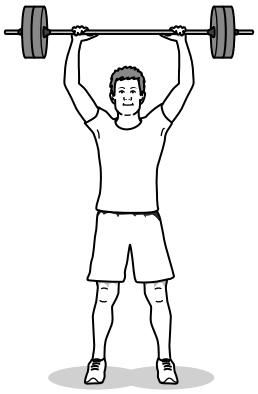
(b) Look at the weightlifter.



During a competition he must hold the weights above his head with straight arms.

This requires his muscles to use both aerobic and anaerobic respiration.

(i) Write down the balanced symbol equation for **aerobic** respiration.

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

(ii) For a successful lift, the weightlifter only needs to hold the weights above his head for three seconds. Weightlifters find it difficult to hold the weights in this position for longer than three seconds.

Explain why.

.....

.....

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

(c) Weightlifting can damage muscle cells which need to be repaired.

Muscle cells in weightlifters contain a large number of ribosomes.

Explain why.

.....

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

[Total: 9]

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2 **(a)** Pepsin and trypsin are enzymes in the digestive system that break down proteins.

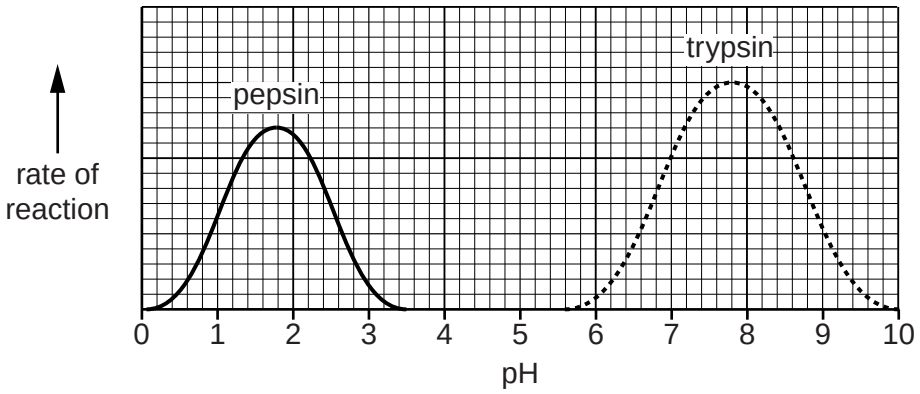
In the stomach, the pH is between 1 and 2.

In the small intestine, the pH is between 7 and 8.

Look at the graph.

It shows the rate of reaction of these enzymes when the pH is changed.

Pepsin works in the stomach. Trypsin works in the small intestine.



Pepsin stops working when it reaches the small intestine.

Trypsin will **not** work in the stomach.

Explain these two observations.

Use data from the graph in your answer.

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

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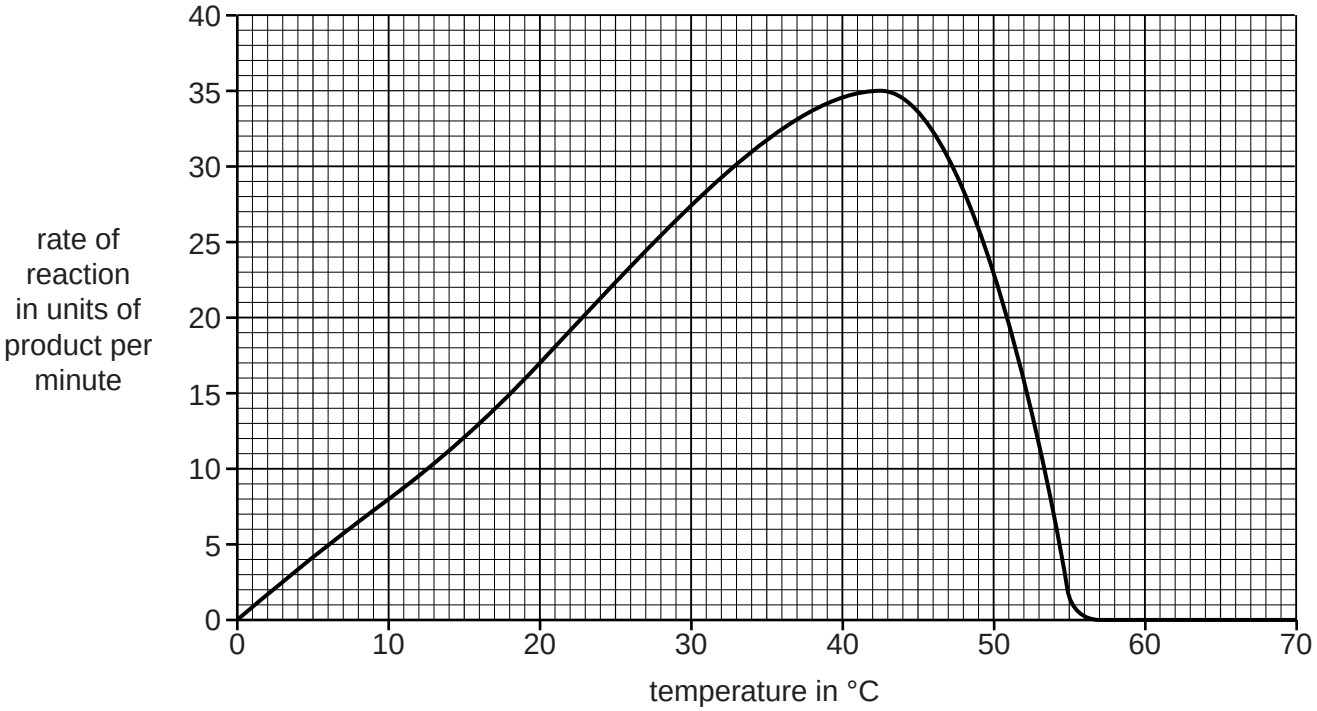
(b) The rate of reaction for pepsin is also affected by temperature.

Look at the graph.



(i) Calculate the Q_{10} between 10 °C and 20 °C.

Use the formula:

$$Q_{10} = \frac{\text{rate at higher temperature}}{\text{rate at lower temperature}}$$

Q_{10} = ... **[2]**

(ii) The rate of reaction between 10 °C and 20 °C increases.

Explain what the Q_{10} value in part **(i)** tells you about this increase.

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

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(iii) The table below shows Q_{10} data for different enzymes between 40 °C and 50 °C.

Enzyme	Q_{10} value between 40 °C and 50 °C
A	2.0
B	1.5
C	1.8
D	1.6

Enzyme **A** is most likely to come from bacteria that live in hot springs.

Use your knowledge of enzyme action to justify this statement.

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

[Total: 8]

3 The picture shows a crop of corn growing in a field.

Farmers try to produce the largest yield of corn.

The corn plants grow tall and need space between rows.

Weeds grow in the spaces and insects quickly spread and damage the crop.

Farmers usually spray their crops with chemicals to kill the weeds and insects.

Scientists can genetically engineer corn plants to increase the yield.

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(a) Describe and explain the different ways in which the corn could be improved and describe the steps needed to genetically engineer the corn.

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

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

(b) The genetically engineered corn can be cloned to make more, identical corn plants.

DNA replication is needed for cloning to happen.

DNA unzips to form single strands.

Then new double strands of DNA form.

Explain how the double strands of DNA form from the single strands.

.....

.....

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

[Total: 8]

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SECTION B – Module C3

4 This question is about allotropes of carbon.

(a) Diamond is one allotrope of carbon.

Diamond is used in jewellery.

Explain why.

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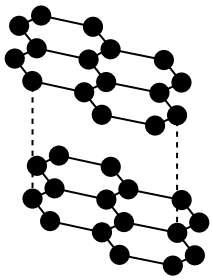
..... **[1]**

(b) Graphite is another allotrope of carbon.

Graphite is used in pencil leads.

Look at the structure of graphite.



Explain, using ideas about structure and bonding, why graphite is used in pencil leads.

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

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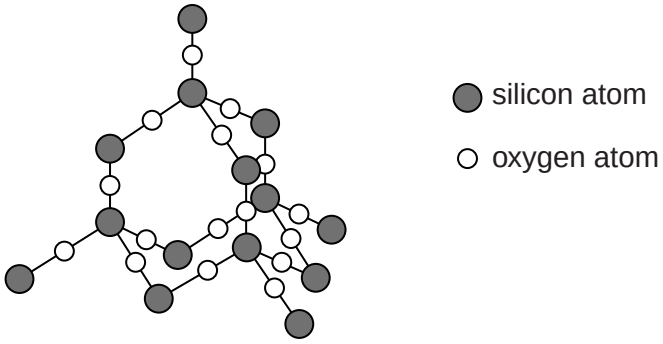
(c) Both diamond and graphite have **giant molecular structures**.

Silicon dioxide also has a giant molecular structure.

Look at the structure of silicon dioxide.



Explain, using ideas about structure and bonding, why silicon dioxide has a high melting point.

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

[Total: 5]

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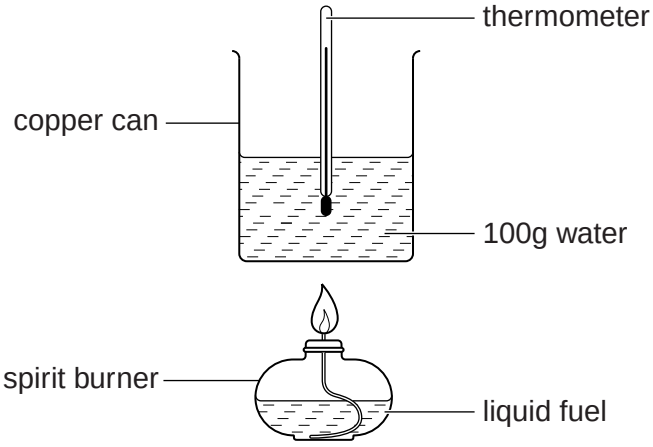
5 Tim and Liz investigate the energy given out by different fuels.

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



Tim and Liz record their results in a table.

Fuel	Start temperature of water in °C	Final temperature of water in °C	Temperature change in °C
ethanol	20	35	15
propanol	22	.....	.....
butanol	19	40	21

(a) Look at the results for **propanol**.

Tim and Liz calculate that propanol transfers **7560 J** of energy to the water.

Use the equation

energy = mass × specific heat capacity × temperature change

to calculate the **final temperature of water** in the experiment with propanol.

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

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final temperature of water = ... °C **[2]**

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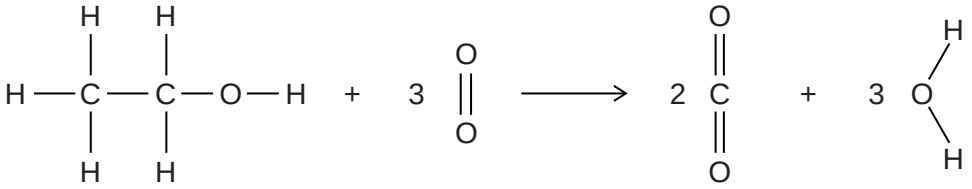
(b) Look at the equation for the burning of ethanol.



During the reaction, bonds are broken and new bonds are made.

(i) Complete the sentence.

Choose words from this list.

absorbed

destroyed

magnified

neutralised

released

When bonds are broken, energy is ..... **[1]**

(ii) Complete the sentence.

Choose words from this list.

catalytic

continuous

endothermic

exothermic

limiting

Making new bonds is ..... **[1]**

[Total: 4]

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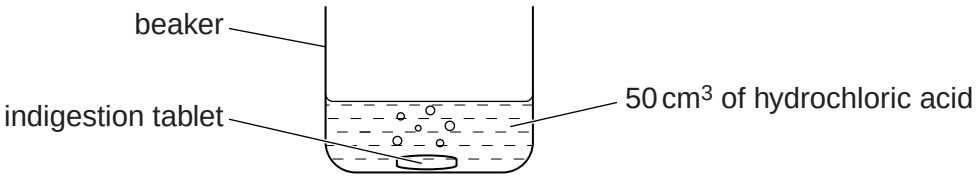
6 This question is about rates of reaction.

Indigestion tablets neutralise acids.

Chris investigates indigestion tablets.

He adds an indigestion tablet to 50 cm^3 of hydrochloric acid.



(a) The indigestion tablet contains calcium carbonate, $CaCO_3$.

Calcium carbonate reacts with hydrochloric acid, HCl.

Calcium chloride, $CaCl_2$, water and carbon dioxide are made.

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

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

(b) The indigestion tablet is the **limiting reactant**.

What is meant by the limiting reactant?

.....

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

(c) Chris measures the time it takes for the indigestion tablet to react completely.

He then calculates the relative rate of reaction.

He does four experiments.

Look at his results.

Experiment	Volume of acid in cm^3	Relative concentration of acid	Temperature of acid in °C	Relative rate of reaction
1	50	2.0	40	8
2	100	2.0	20	2
3	50	2.0	20	2
4	50	1.0	20	1

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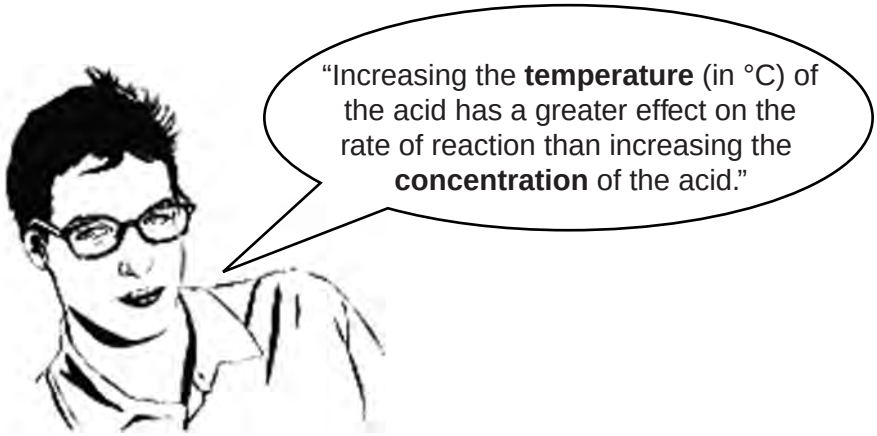
Chris uses his results to make a conclusion.



Is Chris correct? Use his results to justify your answer.

Explain, using the reacting particle model, why **increasing** the temperature **increases** the rate of reaction.

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

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

[Total: 9]

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7 This question is about pharmaceutical drugs.

(a) Aspirin is a painkiller used to treat headaches and reduce fevers.

A pharmaceutical company makes aspirin using the following reaction.

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + C_2H_4O_2$$

aspirin **ethanoic acid**

The ethanoic acid is a **waste product**.

Look at the table of relative formula masses.

substance	relative formula mass, M_r
$C_7H_6O_3$	138
$C_4H_6O_3$	102
$C_9H_8O_4$	180
$C_2H_4O_2$	60

Calculate the **atom economy** for the manufacture of aspirin.

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.....

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

(b) The pharmaceutical company wants as high an atom economy as possible.

Explain why this makes the process 'greener'.

.....

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

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(c) The pharmaceutical company makes several batches of aspirin.

They test the melting point of each batch to check that it is pure.

The melting point of pure aspirin is 135 °C.

Look at their results.

Batch	Melting point in °C
A	128
B	131–134
C	134
D	138

Which batch contains the purest sample of aspirin?

Answer .....

Explain your answer.

.....

.....

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

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(d) Aluminium sulfate, $Al_2(SO_4)_3$, is used to help relieve the pain caused by bites and stings.

Look at the equation. It shows how aluminium sulfate can be made.

$$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$$

(i) Show that the relative formula mass, M_r, of aluminium sulfate is 342.

The relative atomic mass, A_r, of Al = 27, O = 16 and S = 32.

.....

.....

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

(ii) Look at the table of relative formula masses, M_r.

Formula	M_r
$Al(OH)_3$	78
H_2SO_4	98
$Al_2(SO_4)_3$	342
H_2O	18

Use the information in the table, and the balanced symbol equation, to show that **mass is conserved** when aluminium sulfate is made.

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

[Total: 7]

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Question 8 begins on page 20

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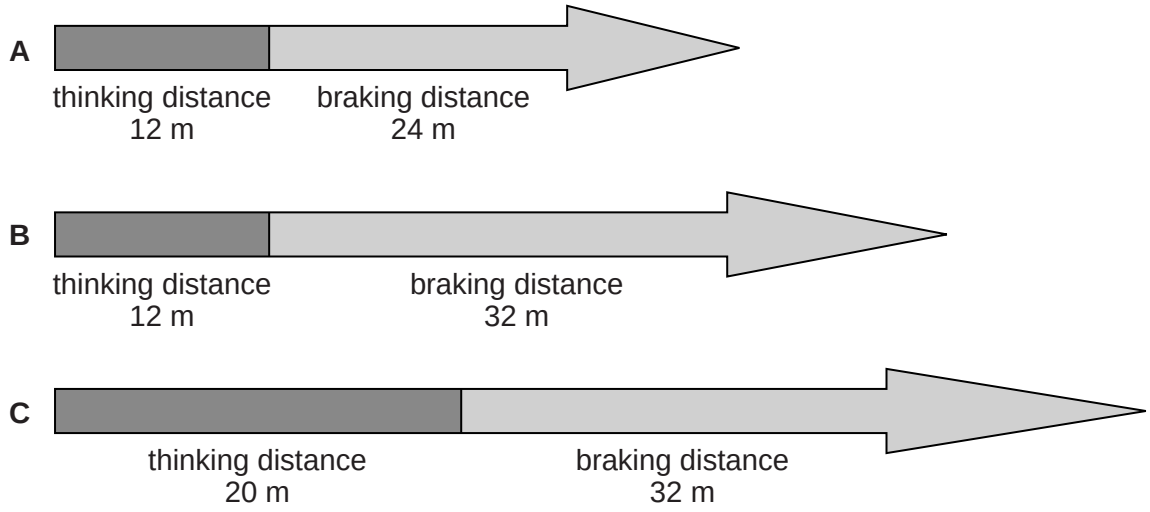
SECTION C – Module P3

8 Look at the diagrams **A**, **B** and **C**.

They show the stopping distances for the same car.



(a) On different days the car travels along the same road at the same speed.

The stopping distances for the journeys are shown in diagrams **A**, **B** and **C**.

(i) Name two factors that may have caused the increase in the **stopping distance** shown between diagram **A** and diagram **B**.

1 .....

2 .....

[2]

(ii) Name one factor that may have caused the increase in the **stopping distance** shown between diagram **B** and diagram **C**.

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

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(b) The speed of the car doubles.

How does this affect the thinking distance **and** the braking distance?

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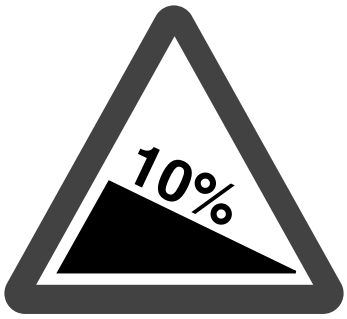
..... **[2]**

(c) Drivers are encouraged to drive slowly down steep hills.



Suggest why drivers are encouraged to drive slowly down steep hills.

.....

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

[Total: 6]

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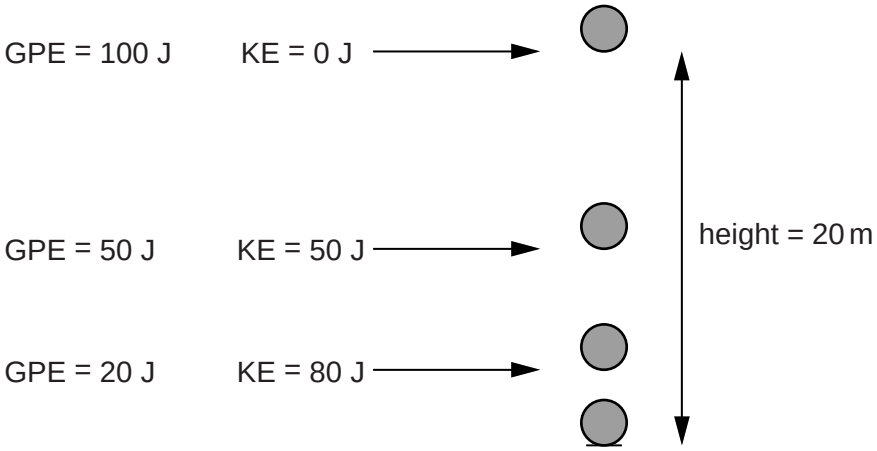
9 This question is about gravitational potential energy (GPE) and kinetic energy (KE).

Look at the diagram and information about a small ball falling from a height of 20 m.



Explain the changes in GPE and KE and describe what would happen to the GPE and KE if the mass of the ball was doubled.

Use equations to help explain 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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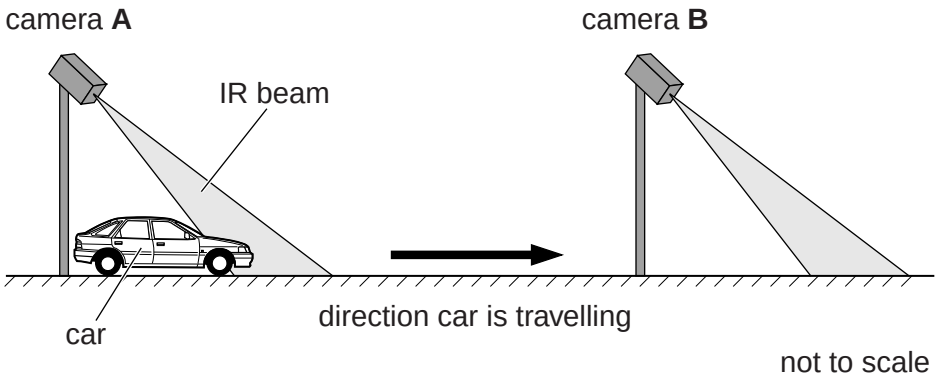
10 There are different types of speed cameras.

One type of speed camera is called an average speed camera. The two cameras work together using infrared (IR) beams.



(a) Both cameras record the time when a car passes through the IR beam.

Describe how average speed is calculated using camera **A** and camera **B**.

.....

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

(b) **(i)** The speed of a car at camera **A** is 12 m/s.

The car decelerates at a constant rate.

The time it takes for the car to travel between camera **A** and camera **B** is 2 minutes.

The distance between the cameras is 1200 m.

Calculate the speed of the car at camera **B**.

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Speed of car at camera **B** ..... m/s

[3]

(ii) A car with **double** the average speed travels along the road.

Explain what happens to the time recorded by the speed cameras.

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

[Total: 6]

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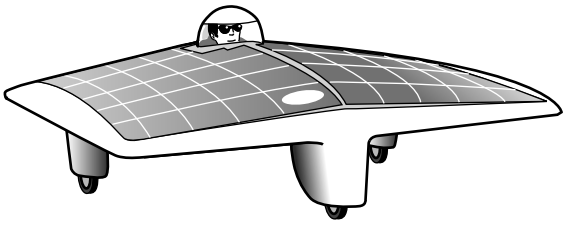
11 Look at the picture of a solar powered car.



(a) Solar powered cars may lead to an overall reduction in carbon dioxide emissions.

Look at this statement:

Solar powered cars reduce pollution but they also produce pollution.

Explain how solar powered cars can reduce **and** produce pollution.

.....

.....

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

(b) Solar powered cars race across Australia.

Explain how technology can be used to increase the top speed of these cars.

In your answer consider the risks and benefits this has for the drivers.

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

[Total: 4]

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Question 12 begins on page 26

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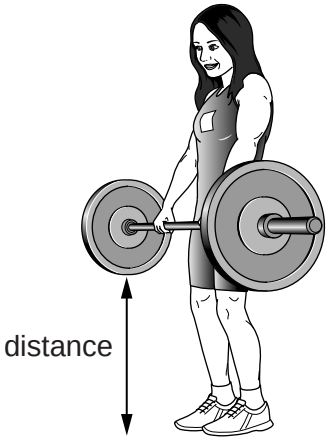
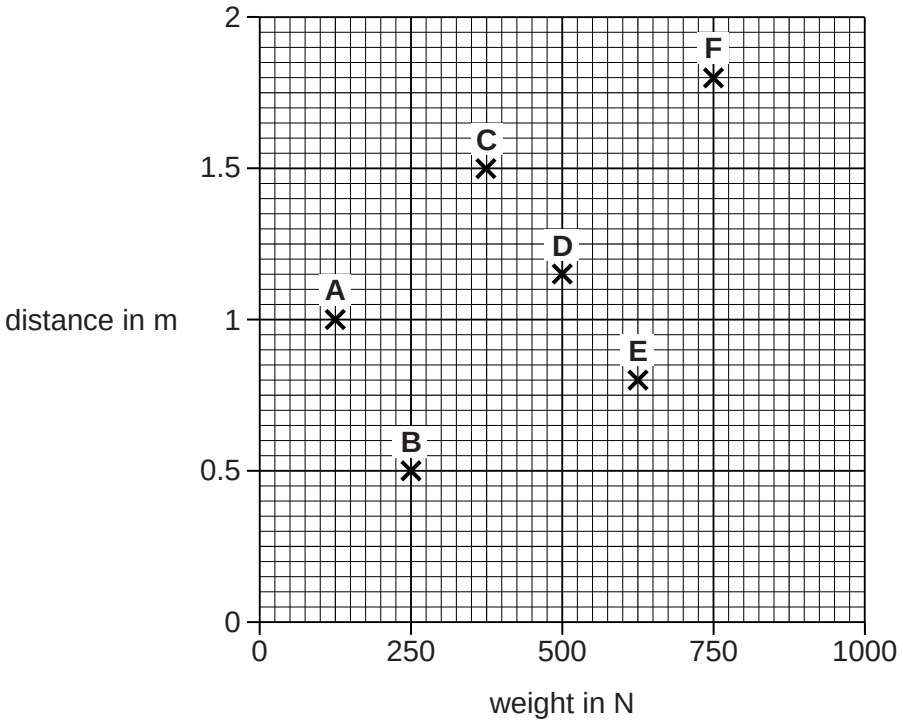
12 Deng is a weightlifter.



She lifts six different weights.

The plots on the graph show the distance she lifts each weight.



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The table shows the amount of time she takes to lift each of the six weights.

lift weight	time in seconds
A	3.7
B	3.7
C	4.2
D	4.2
E	3.6
F	3.6

Deng does work lifting each weight.

The speed she lifts the weights shows how powerful the lift is.

Which is Deng's most powerful lift?

Choose from

A **B** **C** **D** **E** **F**

Lift .....

Use the graph and the table to help explain your answer.

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[3]

[Total: 3]

END OF QUESTION PAPER

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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.

PMT