

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**GATEWAY SCIENCE**

**B721/02**

**ADDITIONAL SCIENCE B**

Unit B721: 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

**Duration:** 1 hour 15 minutes

**Other Materials Required:**

- Pencil
- Ruler (cm/mm)

Candidate Forename		Candidate Surname	
--------------------	--	-------------------	--

Centre Number						Candidate Number				
---------------	--	--	--	--	--	------------------	--	--	--	--

**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**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 for each question 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.

Examiner's Use Only:			
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8			
<b>Total</b>			

## EQUATIONS

energy = mass × specific heat capacity × temperature change

energy = mass × specific latent heat

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

wave speed = frequency × wavelength

power = voltage × current

energy supplied = power × time

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

distance = average speed × time

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

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

force = mass × acceleration

weight = mass × gravitational field strength

work done = force × distance

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

power = force × speed

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

momentum = mass × velocity

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

GPE = mgh

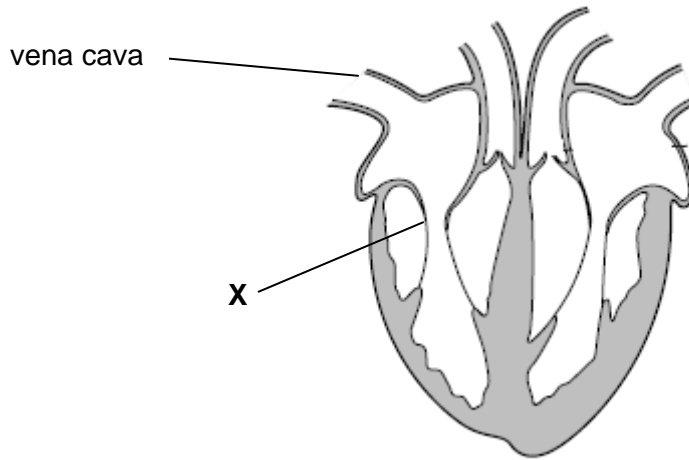
mgh =  $\frac{1}{2} mv^2$

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

Answer **all** the questions.

**Section A – Module B3**

1 Look at the diagram of a heart.



(a) Write down the **name** of part **X**.

..... [1]

(b) The vena cava is the main vein entering the right side of the heart.  
Veins contain valves, arteries do not.

Explain why arteries do not need valves.

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

**[Total: 3]**



3 Look at the picture.

It shows rice being planted in China.



© iStockphoto.com/Christian Wagner

(a) Rice belongs to the plant kingdom.

Write down the name of **one** structure found in a plant cell that is **not** found in a bacterial cell.

..... [1]

(b) (i) Scientists have taken the genes that control beta-carotene production and placed them into rice.

This rice is called Golden Rice.

Give **two** reasons why genetic engineering is used in this process and not selective breeding.

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

(ii) Some people are opposed to Golden Rice because it may have unexpected harmful effects.

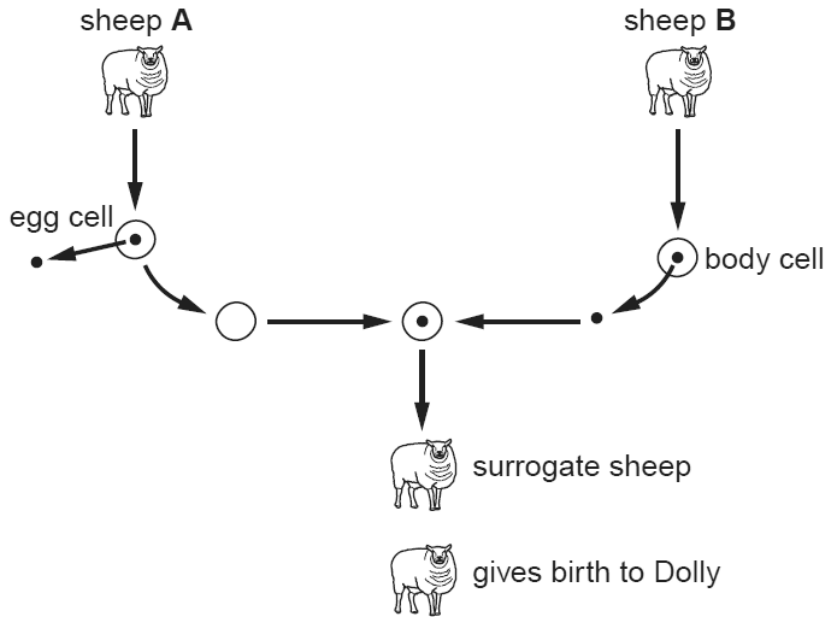
Suggest how scientists could gather evidence to try to overcome this opposition.

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

[Total: 4]

4 Look at the diagram.

It shows the cloning technique used to produce Dolly the sheep.



(a) Is Dolly a clone of sheep A or B?

Explain your answer.

Dolly is a clone of sheep .....

reason why .....

..... [1]

(b) Since Dolly was born, many other animals have been cloned.

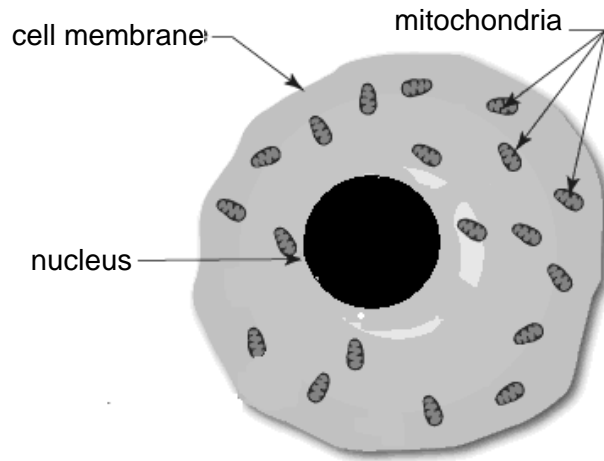
Write down **one** possible use of cloning.

.....

..... [1]

[Total: 2]

5 The diagram shows an animal cell.



(a) Write down the function of mitochondria in the cell.

..... [1]

(b) (i) It is possible to work out the volume of the cell shown in the diagram.

One millimeter on the diagram equals one micrometer in real life.

Assuming it is a sphere, the volume is  $\frac{4}{3} \pi r^3$ , where r is the radius.

So the cell volume =  $\frac{4}{3} \times 3.14 \times 23^3 = 50939 \text{ micrometers}^3$

Measure the radius of the **nucleus** and work out the volume of the nucleus using the same formula.

.....  
.....  
.....

answer = ..... micrometres<sup>3</sup> [2]

(ii) A group of scientists studied the effect of poisoning by the metal cadmium.

They thought that the metal caused the ratio  $\frac{\text{volume of nucleus}}{\text{volume of cell}}$  to **decrease**.

The ratio is normally between 0.1 and 0.05 for this type of cell.

Has the cell shown been poisoned with cadmium?

Explain your answer.

.....

.....

..... [2]

[Total: 5]



6 Kara plays basketball for a club every day of the week.



(a) Kara finds a way to estimate her basal metabolic rate (BMR).  
She uses this formula:

$$\text{BMR} = 655 + (9.6 \times \text{body mass in kg}) + (1.8 \times \text{height in cm}) - (4.7 \times \text{age in years})$$

What effect does getting older have on BMR?

Describe how you can tell this from the formula.

.....

..... [1]

(b) Kara gets injured and cannot do any sport.



Kara knows her total energy requirement is dependent on her BMR and her activity.  
 Now that she is not exercising she does not want to eat too much and put on weight.  
 Kara calculates her BMR as 6000kJ per day.  
 The table gives a measure of activity called an **activity factor**.

level of activity	activity factor
little or no exercise	1.20
light exercise / plays sport 1-3 times a week	1.40
moderate exercise / plays sport 3-5 times a week	1.55
very active / plays sport 6-7 times a week	1.75

The total energy Kara needs is found by multiplying her BMR by her activity factor.

The energy Kara needs is released by respiration.

During aerobic respiration 6.6 kJ is released per gram of glucose.

(i) Calculate how much less glucose Kara needs to take in per day now she has stopped doing sport.

.....  
 .....

answer = .....g of glucose [3]

(ii) Kara wants to calculate how much glucose she needs to play a game of basketball.

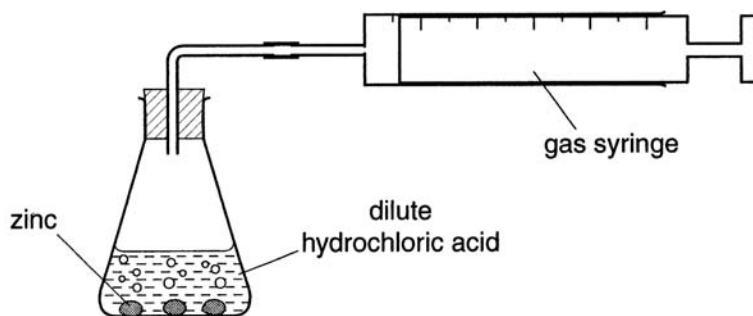
Suggest why Kara should **not** use a figure of 6.6 kJ per gram of glucose to do this calculation.

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

[Total: 5]

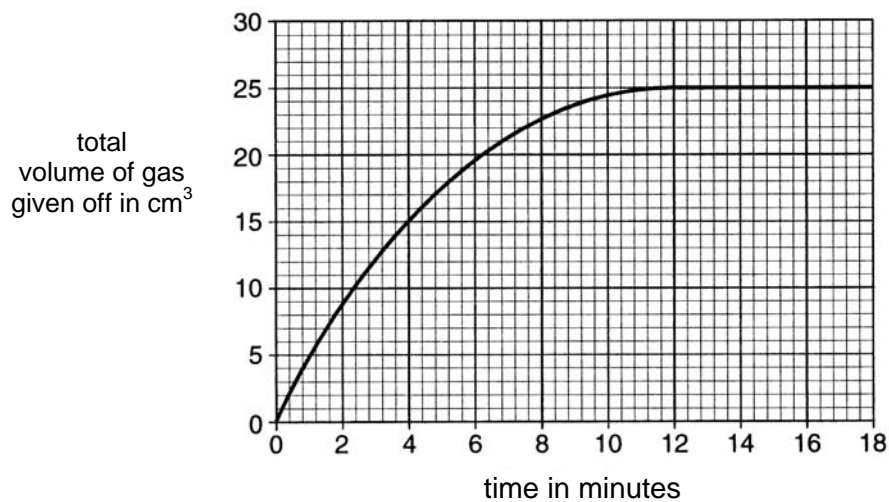
## Section B – Module C3

- 7 Colin and Ann investigate the reaction between zinc lumps and hydrochloric acid. Hydrogen and a solution of zinc chloride are made. The diagram shows the apparatus they use.



Look at the graph.

It shows their results when 1 g of zinc lumps reacts with 20 cm<sup>3</sup> of dilute hydrochloric acid.



- (a) How long does it take for the reaction to stop?

..... minutes [1]

- (b) (i) Calculate the average rate of reaction during the first 4 minutes.  
Quote your answer to **three** significant figures.

.....

answer.....unit ..... [2]

- (ii) How does the average rate of reaction for the first 4 minutes compare to the average rate between 4 and 8 minutes?

Show how you calculated your answer.

.....

.....

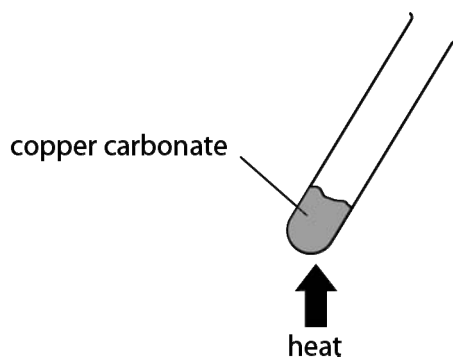
..... [1]



- 8 Copper carbonate decomposes when heated.  
Copper oxide and carbon dioxide are made.



- (a) Tim investigates this decomposition.  
Look at the apparatus he uses.



Tim heats 1.24 g of copper carbonate in the test-tube.  
He predicts that he should make 0.80g of copper oxide  
He actually makes 0.70 g.  
Calculate his percentage yield.

.....

.....

.....

answer ..... % [2]

(b) A factory manufactures copper oxide by heating copper carbonate.

The carbon dioxide made is a waste product.

Look at the table of relative formula masses,  $M_r$ .

substance	relative formula mass, $M_r$
$\text{CuCO}_3$	124
$\text{CuO}$	80
$\text{CO}_2$	44

Calculate the atom economy for the manufacture of copper oxide.

.....

.....

.....

.....

..... [2]

(c) It is important for the factory to have a high percentage yield and a high atom economy.

Explain why each of these is important.

.....

.....

.....

..... [2]

[Total: 6]

9 Diamond and graphite have different properties and different uses.

Look at the table.

It shows some information about the properties of diamond and graphite.

property	diamond	graphite
state at room temperature	solid	solid
appearance at room temperature	colourless, clear and lustrous	dull black
melting point	very high	very high
hardness	very hard	soft
solubility in water	insoluble	insoluble
electrical conductivity	does not conduct	good conductor

(a) Mark decides to use graphite electrodes in the electrolysis of sodium chloride solution.

Use information in the table and your own knowledge to give reasons for his decision.

.....

.....

..... [2]

(b) Diamond and graphite both have very high melting points.

Explain why.

.....

.....

.....

..... [2]

(c) Diamond does not conduct electricity.

Explain why.

.....

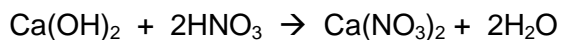
..... [1]

[Total: 5]



10 Clare prepares calcium nitrate.

She reacts calcium hydroxide with nitric acid.



(a) Calculate the mass of calcium nitrate that can be made from 3.15 g of pure nitric acid.

.....

.....

.....

.....

.....

.....

.....

answer ..... g [3]

(b) Clare reacts double the amount of nitric acid in an excess of calcium hydroxide.

What effect will this have on the amount of calcium nitrate made?

.....

..... [1]

[Total: 4]

## Section C – Module P3

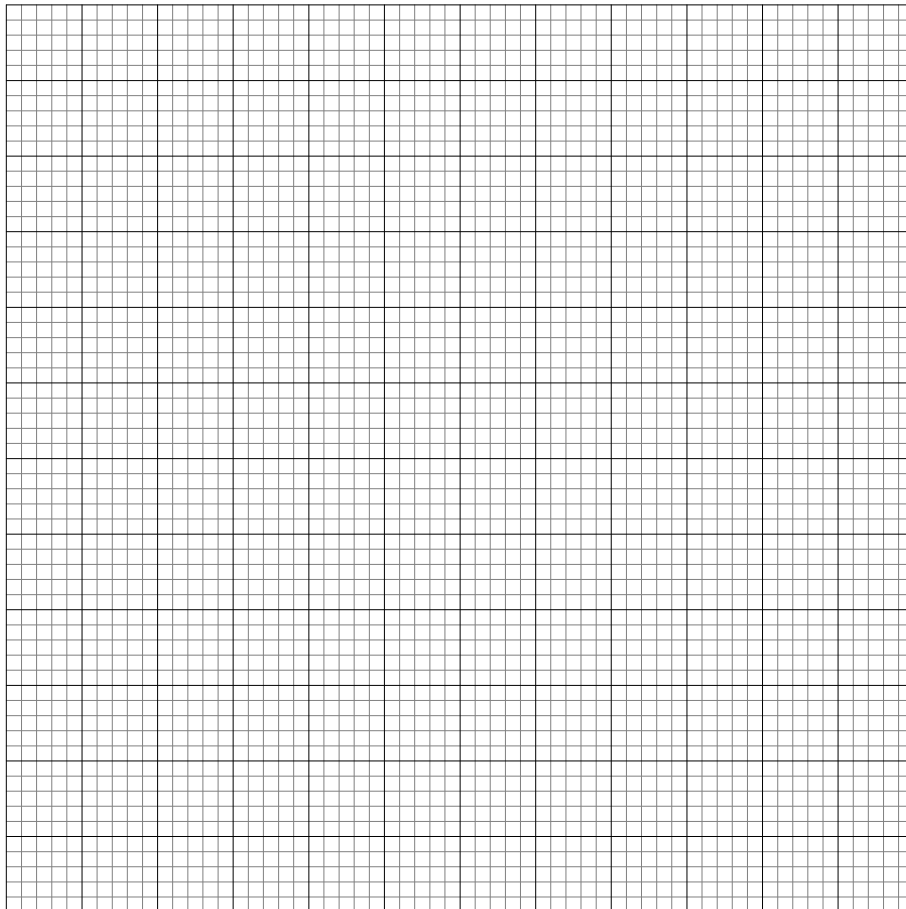
11 This question is about motion and speed.

Brian runs 100m.

(a) (i) Look at the table showing the **time** he takes to run 100m.

distance in metres	time in seconds
0	0
0	4
40	12
60	16
80	20
100	24

Use the table to draw a **distance-time** graph.



[2]

(ii) Use the graph to find Brian's **speed** between **8 seconds** and **24 seconds**.

.....  
.....

answer ..... m/s [1]

(iii) Brian runs the 100m again.

This time he runs the race **faster**.

He runs at a **steady speed**.

Draw the line for **this** race on the graph on the previous page.

**Label** this line 'faster speed'.

[1]

(b) Thomas runs a different race.

Thomas runs a **200m** race.

His average speed for the race is 3.8 m/s.

Thomas's personal best time for the 200m is 50 seconds.

Calculate Thomas's **time** for the race and decide if he has beaten his personal best time.

.....  
.....  
.....

..... [2]

[Total: 6]

12 Pat measures the speeds of two cars.

The diagram shows the speeds of the cars.



(a) Calculate the **relative velocity** of car **A** and car **B**.

.....

.....

Answer..... [1]

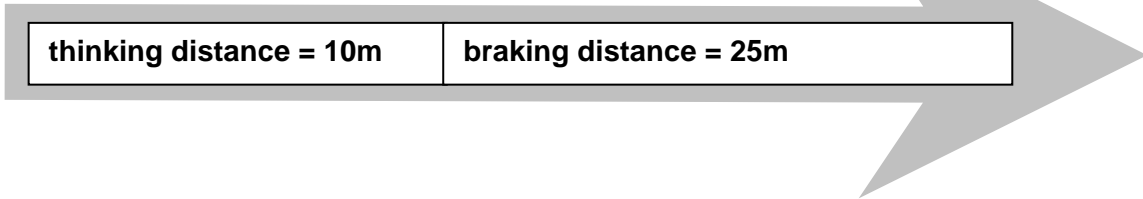
(b) Car **A** accelerates and, after 4 seconds, is travelling at the same speed as Car **B**.  
Calculate the acceleration of car **A**.

.....

.....

Answer.....Units.....[1]

- (c) The driver of car **B** presses the brakes. The car stops.  
Look at the information about the car stopping.



Explain what happens to thinking distance **and** the braking distance when the speed of the car **triples**.

.....

.....

.....

..... [2]

[Total: 4]

13 This question is about fuel consumption for different road vehicles.

- (a) Fuel consumption figures depend on the road conditions, driving style and vehicle speed.

Explain how **one other** factor affects fuel consumption figures.

Use ideas about **energy** in your answer.

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

- (b) Car manufacturers are required to publish environmental and running cost data about the cars they manufacture. This is to help car buyers choose which car to buy.

car	fuel consumption in kilometres per litre	engine size (capacity) in cc	fuel costs in £ per 20 000 kilometres	CO <sup>2</sup> emissions in grams/kilometre	noise levels in dB
V	23.5	999	1103	122	73.0
W	20.4	1149	1273	138	72.4
X	18.2	1498	1428	158	72.0
Y	17.1	1598	1516	165	73.7
Z	16.7	1390	1559	172	70.0

Ronan and Anna want to buy a new car.

They want a car which provides the best balance between economic and environmental impact.

Ronan says 'We should buy car **Z**, because this car has the lowest fuel consumption and is the quietest model'. Anna realises that Ronan is wrong.

Use the data in the table to explain why Ronan is wrong. Which car should Anna and Ronan choose? Give the reasons for your choice.

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

(c) The main fuels for road vehicles are petrol and diesel from crude oil.

Describe how and why we may have to change the way vehicles are powered in the future.

.....

.....

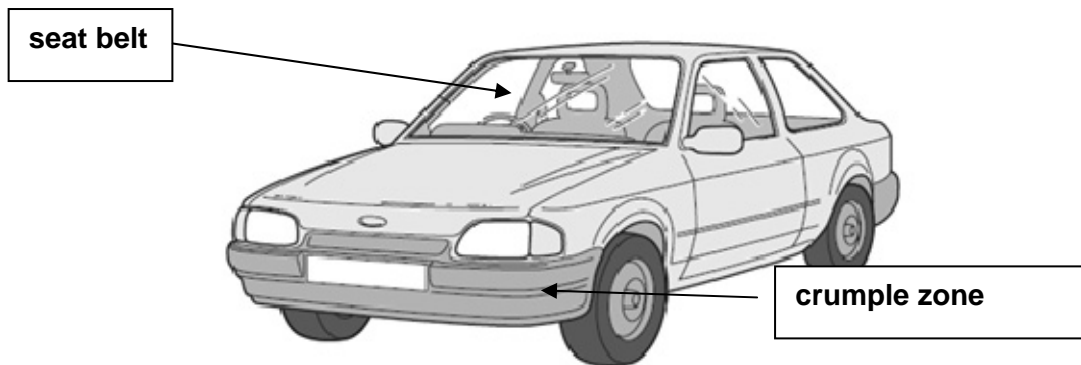
..... [2]

**[Total: 7]**

14 This question is about car safety.

Modern cars have many safety features.

Look at the diagram.



Safety features need to be tested to make sure they are effective.

Describe how test data could be **gathered** and **evaluated** and the **factors** that should be considered to produce safer seatbelt and crumple zone designs.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[6]

[Total: 6]



15 Britney is a skydiver.

Britney jumps out of a plane.

Gravity acts on Britney.

Britney's speed increases for several seconds.

Britney then reaches a **terminal velocity (terminal speed)**.



Explain why Britney's speed changes and why she reaches terminal velocity as she falls.

.....

.....

..... [2]

[Total: 2]

[Paper Total: 75]

**END OF QUESTION PAPER**

**BLANK PAGE**

**PLEASE DO NOT WRITE ON THIS PAGE**

PLEASE DO NOT WRITE ON THIS PAGE



**Copyright Information:**

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

## PERIODIC TABLE

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

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

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**GATEWAY SCIENCE**

**B721/02**

**ADDITIONAL SCIENCE B**

Unit B721: Additional Science modules B3, C3, P3 (Higher Tier)

**MARK SCHEME**

**Duration:** 1 hour 15 minutes

**MAXIMUM MARK      75**

**Guidance for Examiners**

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/ = alternative and acceptable answers for the same marking point

(1) = separates marking points

**not/reject** = answers which are not worthy of credit

**ignore** = statements which are irrelevant – applies to neutral answers

**allow/accept** = answers that can be accepted

(words) = words which are not essential to gain credit

words = underlined words must be present in answer to score a mark

ecf = error carried forward

AW/owtte = alternative wording

ora = or reverse argument

eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)

work done = 0 marks


work done lifting = 1 mark

change in potential energy = 0 marks

gravitational potential energy = 1 mark

5. If a candidate alters his/her response, examiners should accept the alteration.
6. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

Question		Expected answers	Marks	Additional guidance
1	(a)	<u>tricuspid</u> (valve) (1)	1	
	(b)	because valves prevent backflow (1) but pressure is always high enough in arteries to prevent backflow / push blood forwards (1)	2	<b>answers must link high pressure to no requirement for valves to gain full credit</b> <b>points may be in either order</b> <b>allow</b> pressure is higher in arteries than veins (1)
		<b>Total</b>	<b>3</b>	

Question	Expected answers	Marks	Additional guidance
2 	<p><b>Level 3</b> Answer describes in detail the nature of the genetic code and the possible impact on amino acid sequence of a change in base sequence. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks)</p> <p><b>Level 2</b> Answer describes correctly the importance of base sequence but the detailed knowledge of the triplet code is missing. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks)</p> <p><b>Level 1</b> Answer describes correctly the importance of DNA in protein coding but knowledge of base sequence is lacking. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks)</p> <p><b>Level 0</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• genes are sections of DNA</li> <li>• code for the amino acid sequence of a protein</li> <li>• consist of a string of organic bases</li> <li>• four different bases</li> <li>• A, T, G and C</li> <li>• the order of bases codes for the order of amino acids</li> <li>• triplet code</li> <li>• mutation may cause a change in the order of bases</li> <li>• different amino acids may be coded for</li> <li>• changes the amino acid sequence of the protein</li> <li>• protein functions differently or is not made</li> </ul>
	<b>Total</b>	<b>6</b>	




Question		Expected answers	Marks	Additional guidance
3	(a)	chloroplast / vacuole / mitochondrion / nucleus (1)	1	
	(b) (i)	beta-carotene genes not found in rice / AW (1) genetic engineering is quicker (1) more control over making sure the desired characteristic is present in the offspring (1) selective breeding can lead to reduction in genetic variation (1)	2	assume answer refers to genetic engineering unless stated
	(ii)	carry out controlled tests (1)	1	<b>allow</b> examples of controlled testing eg testing humans to see if it makes them ill compared to a control group / doing field trials to make sure that it does not impact plants growing around <b>ignore</b> reference to arguing / writing articles
		<b>Total</b>	<b>4</b>	

Question		Expected answers	Marks	Additional guidance
4	(a)	<b>B</b> (no mark) because the DNA / genes / chromosomes came from sheep <b>B</b> (1)	1	correct sheep and explanation for 1 mark <b>ignore</b> nucleus <b>ignore</b> codes / information with no reference to genes
	(b)	mass producing animals with desirable characteristics / producing animals that have been genetically engineered to provide human products / producing human embryos to supply stem cells for therapy (1)	1	
		<b>Total</b>	<b>2</b>	

Question		Expected answers	Marks	Additional guidance
5	(a)	respiration (1)	1	
	(b) (i)	measurement of radius = 8mm (1) calculation = 2144 (micrometers <sup>3</sup> ) (1)	2	
	(ii)	correct calculation of ratio using answer from (i) $\frac{2144}{50939} = 0.042$ (1)  answer: poisoned as ratio is less than 0.05 (1)	2	<b>allow</b> not poisoned if ECF gives result above 0.05
<b>Total</b>			<b>5</b>	

Question		Expected answers	Marks	Additional guidance
6	(a)	(getting older) reduces the BMR can tell this because the part of the formula involving age is given a negative value (1)	1	
	(b) (i)	(6000 x 1.75) = 10500 OR (6000 x 1.20) = 7200 (1)  (10500 – 7200) = 3300kJ (1)  (3300 / 6.6) = 500 g (1)	3	evidence of calculation of a BMR worth 1 mark  <b>allow</b> alternative calculation for 1 <sup>st</sup> and 2 <sup>nd</sup> marks (1.75-1.20) x 6000 = 3300kJ (2)  final answer of 500g with no working shown can gain full credit
	(ii)	idea of some of the glucose will be used in anaerobic respiration which does not produce as much energy / some of the energy released will be from anaerobic respiration so less energy is made per gram (1)	1	
<b>Total</b>			<b>5</b>	

Question		Expected answers	Marks	Additional guidance
7	(a)	answer in range 11 to 12 (minutes) (1)	1	
	(b)	(i) 3.75 (1) cm <sup>3</sup> /minute (1)	2	
		(ii) rate faster in first 4 minutes as rate during 4-8 minutes is $12.5/4 = 3.125$ / AW (1)	1	<b>allow</b> rate faster in first 4 minutes as gradient of graph is less steep between 4-8 minutes / AW <b>allow</b> rate faster in first 4 minutes as there is less gas produced in the same time for 4-8 minutes

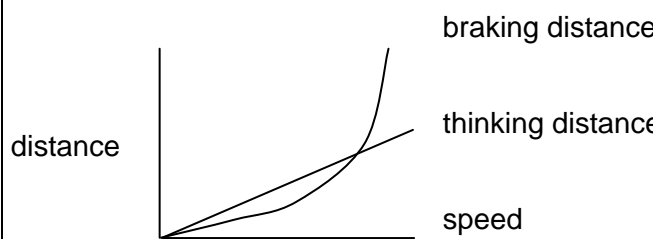
Question			Expected answers	Marks	Additional guidance
7	(c)		<p><b>Level 3</b> Applies understanding of the reacting particle model to give a detailed explanation in terms of collisions why two of the variables increase rate of this reaction. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks)</p> <p><b>Level 2</b> Applies understanding of the reacting particle model to give a limited explanation. Explanation may be limited by addressing only one variable or limited use of collision theory. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks)</p> <p><b>Level 1</b> Answer attempts an explanation for one variable using some correct chemistry involving particle behaviour. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks)</p> <p><b>Level 0</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p><b>relevant points include:</b> more collisions between particles results in faster reaction <b>temperature of hydrochloric acid</b></p> <ul style="list-style-type: none"> <li>idea that acid particles move faster / acid particles have more energy</li> <li>idea of increased collisions between acid and zinc particles</li> <li>idea of increased collision frequency and more successful or energetic collisions between acid and zinc particles</li> </ul> <p><b>concentration of hydrochloric acid</b></p> <ul style="list-style-type: none"> <li>idea of more crowded acid particles / more acid particles in the same volume / more H<sup>+</sup> ions in the same volume</li> <li>idea of increased collisions between acid and zinc particles</li> <li>increased collision frequency between acid and zinc particles</li> </ul> <p><b>ignore</b> reference to 'more particles'</p> <p><b>powdered zinc</b></p> <ul style="list-style-type: none"> <li>idea of increased surface area of zinc</li> <li>more exposed zinc particles</li> <li>idea of increased collisions between acid and zinc particles.</li> <li>increased collision frequency between acid and zinc particles</li> </ul>
<b>Total</b>				<b>10</b>	

Question		Expected answers	Marks	Additional guidance
8	(a)	87.5 % (2)  If correct answer not given:  $\% \text{ yield} = \frac{\text{actual mass}}{\text{predicted mass}} \times 100 /$ $\% \text{ yield} = \frac{0.7}{0.8} \times 100 \text{ (1)}$	2	<b>allow</b> 87.5 and 88 for full marks even if the expression for the percentage yield is not quoted
	(b)	64.51 % (2)  If correct answer not given:  $\text{atom economy} = \frac{M_r \text{ of desired products}}{\text{sum of } M_r \text{ of all products}} \times 100 /$ $\text{atom economy} = \frac{80}{124} \times 100 \text{ (1)}$	2	<b>allow</b> full marks for the correct answer even if the equation for atom economy is not stated <b>allow</b> 65 / 64.5 / up to the calculator value
	(c)	high percentage yield: to reduce cost/increase efficiency, by, not wasting starting materials/reducing the need to recycle unreacted reactants (1)  high atom economy: to make the process more sustainable / greener / to reduce the processing of unwanted products (1)	2	answers in terms of cost/efficiency alone are not worthy of credit
		<b>Total</b>	<b>6</b>	

Question		Expected answers	Marks	Additional guidance
9	(a)	graphite is a good electrical conductor so will be able to transfer the electrical current without loss (from the wires to the electrolyte) (1) graphite has a high melting point / solid / insoluble / inert so will not dissolve / melt / react during electrolysis (mixing with the electrolyte) (1)	2	<b>allow</b> higher level answers above target level relating to the structure of graphite eg delocalised electrons allow current to flow (1)
	(b)	they both have strong (covalent) bonds (1) <b>if this mark scored then in addition:</b> which need lots of energy to break (before melting can take place) (1)	2	<b>not</b> reference to intermolecular bonds <b>second mark only awarded if linked to bonds in first marking point</b>
	(c)	because there is no movement of (free/delocalised) electrons / AW (1)	1	<b>allow</b> because there are no delocalised electrons / because there are no free electrons / because it is a covalently bonded giant structure
		<b>Total</b>	<b>5</b>	


Question		Expected answers	Marks	Additional guidance
10	(a)	$M_r$ of $\text{HNO}_3 = 63$ and of $\text{Ca}(\text{NO}_3)_2 = 164$ (1) Moles of $\text{HNO}_3 = 0.05$ and moles of $\text{Ca}(\text{NO}_3)_2 = 0.025$ / 126 g of $\text{HNO}_3$ makes and 164 g of $\text{Ca}(\text{NO}_3)_2 = 0.025$ (1) Mass of $\text{Ca}(\text{NO}_3)_2 = 4.1$ g (1)	3	<b>allow</b> full marks for 4.1 g <b>allow</b> ecf from wrong $M_r$ values
	(b)	doubles (1)	1	<b>ignore</b> just increases
		<b>Total</b>	<b>4</b>	

Question			Expected answers	Marks	Additional guidance
11	(a)	(i)	correct axes / time on x axis <b>and</b> distance on y axis (1)  all points plotted correctly (1)	2	<b>allow</b> +/- ½ square tolerance if points only plotted correctly (with no line), award the mark
		(ii)	5 (m/s) (1)	1	no ecf
		(iii)	straight line with steeper gradient (1)	1	must be clear this is the (labelled) faster speed graph if no line drawn <b>allow</b> a description of steeper line does not have to start at 4 seconds
	(b)		52.6 (s) (1) has not beaten his PB (1)	2	<b>allow</b> 53 (s) or 52.63 (s) (1) <b>allow</b> comparison of PB speed with race speed (1)
			<b>Total</b>	<b>6</b>	

Question		Expected answers	Marks	Additional guidance
12	(a)	6 (m/s) (1)	1	
	(b)	1.5m/s <sup>2</sup> (1)	1	
	(c)	<p>thinking distance increases linearly so will treble (1)</p> <p>braking distance increases as a squared relationship so will be 9 times greater (1)</p>	2	<p><b>allow</b> thinking distance is (10 X 3 =) 30m</p> <p><b>allow</b> braking distance is (25 X 9 =) 225m</p> <p><b>allow</b> graph <b>but</b> axes and lines must be clearly shown eg</p>  <p><b>allow</b> lines correct but no labels on axes (1)</p> <p><b>allow</b> thinking distance line with gradient &gt; braking distance curve gradient (1)</p>
		<b>Total</b>	<b>4</b>	






Question		Expected answers	Marks	Additional guidance
13	(a)	<p>more mass (1) requires greater kinetic energy for a fixed speed, so more fuel needed to supply energy / ora, (1)</p> <p><b>OR</b></p> <p>streamlining (1) leads to less energy wasted against drag, so less fuel needed to overcome energy wasted / ora (1)</p>	2	<b>factor identified must be linked to change in energy requirement and resultant effect on fuel consumption to gain full credit</b>
	(b)	<p>Ronan has got fuel consumption back to front – more Km per litre is better / AW (1)</p> <p><b>no mark for choice of car, marks are for valid reasons</b> most economical / lowest economic impact is vehicle <b>V</b> OR best fuel consumption / lowest cost for fuel is car <b>V</b> (1)</p> <p>environmental impact is a choice between <b>Z</b> quietest and <b>V</b> lowest CO<sup>2</sup> emissions (1)</p>	3	<p><b>allow</b> idea that car <b>Z</b> will go the shortest distance on a set amount of fuel (1)</p> <p><b>answers must support choice of car to gain credit</b></p>
	(c)	<p>idea that petrol and diesel are finite sources of energy (1) <b>any one from:</b> instead we could use more <b>bio-fuelled</b> vehicles as they do not use fossil fuels but a renewable fuel (1) instead we could use more <b>solar powered</b> vehicles as they do not use fossil fuels but a renewable energy source (1)</p>	2	<p><b>marking points in either order can gain full credit, answers must include the need to replace petrol/diesel and how this may be done to gain full credit</b></p> <p><b>ignore</b> references to just 'electric cars' unless source of electricity explicitly does not involve use of fossil fuels.</p>
		<b>Total</b>	<b>7</b>	

Question		Expected answers	Marks	Additional guidance
14		<p><b>Level 3</b> Describes a broad range of ways in which test data could be gathered. Applies understanding of scientific approaches to describe in detail how data could be evaluated and applies understanding of forces and energy to describe relevant factors which produce a safer design. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks)</p> <p><b>Level 2</b> Describes a range of ways in which test data could be gathered. Applies understanding of scientific approaches to describe in limited detail how data could be evaluated and applies understanding of energy or forces to describe some factors which produce a safer design. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks)</p> <p><b>Level 1</b> Describes a limited range of ways in which test data could be gathered and applies understanding of scientific approaches to suggest a method of evaluation. Some appreciation that reducing injury is an important factor. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks)</p> <p><b>Level 0</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p><b>relevant points include:</b></p> <p><b>test data gathered</b></p> <ul style="list-style-type: none"> <li>• use of crash test dummies</li> <li>• use of slow motion films</li> <li>• use of sensors on the dummies</li> <li>• use of different size crash test dummies</li> <li>• tests carried out with and without seatbelts on</li> <li>• tests carried out with and without crumple zones</li> <li>• tests carried out in different cars</li> <li>• tests carried out at different speeds</li> <li>• tests repeated several times / means taken from the data</li> <li>• use of calibration</li> </ul> <p><b>evaluation of data</b></p> <ul style="list-style-type: none"> <li>• use of appropriate format to present the data</li> <li>• use of statistics</li> <li>• use of data from different sources</li> <li>• comparisons with real road accident data</li> </ul> <p><b>factors for safer designs</b></p> <ul style="list-style-type: none"> <li>• to reduce injury</li> <li>• to absorb more energy</li> <li>• to reduce forces on the body</li> <li>• to increase stopping or collision time</li> <li>• to decrease acceleration</li> </ul> <p><b>allow</b> named examples of different crash test dummies eg SID (side impact dummy) bioRID (rear impact) CRABI (child) and THOR (dummy with greatest range of sensors especially around the face)</p>
<b>Total</b>			<b>6</b>	

Question		Expected answers	Marks	Additional guidance
15		idea that initially speed changes because weight > drag or air resistance (1)  idea that she reaches terminal velocity because weight = drag or air resistance (1)	2	<b>answers must link speed to difference in forces to gain each marking point</b>  <b>allow</b> gravity for weight <b>allow</b> friction for air resistance
		<b>Total</b>	<b>2</b>	

**Assessment Objectives Grid (AO)**  
(includes quality of written communication )

Question	AO1	AO2	AO3	Total
1 (a)	1			1
1 (b)	1	1		2
2 	6			6
3 (a)	1			1
3 (b) (i)		2		2
3 (b) (ii)		1		1
4 (a)		1		1
4(b)	1			1
5 (a)	1			1
5 (b) (i)		2		2
5 (b) (ii)		1	1	2
6 (a)		1		1
6(b) (i)		2	1	3
6 (b) (ii)		1		1
7(a)		1		1
7(b)(i)		2		2
7(b)(ii)		1		1
7(c) 	3	3		6
8(a)	1	1		2
8(b)	1	1		2
8(c)	2			2
9(a)			2	2
9(b)	2			2
9(c)	1			1
10(a)		3		3
10(b)		1		1
11(a)(i)		2		2
11(a)(ii)		1		1
11(a)(iii)		1		1
11(b)	1	1		2
12(a)		1		1
12(b)		1		1
12(c)	2			2
13(a)	2			2
13(b)		1	2	3
13(c)	2			2
14 	3	3		6
15	2			2
<b>Totals</b>	<b>33</b>	<b>36</b>	<b>6</b>	<b>75</b>