

Wednesday 5 June 2013 – Afternoon

**GCSE GATEWAY SCIENCE
ADDITIONAL SCIENCE B**

B722/02 Additional Science modules B4 C4 P4 (Higher Tier)

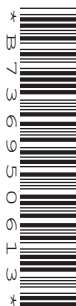
Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: 1 hour 30 minutes



Candidate forename		Candidate surname	
Centre number		Candidate number	

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- 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 **85**.
- This document consists of **32** pages. Any blank pages are indicated.

2

EQUATIONS

energy = mass $\times$ specific heat capacity $\times$ temperature change

energy = mass $\times$ specific latent heat

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

wave speed = frequency $\times$ wavelength

power = voltage $\times$ current

energy supplied = power $\times$ time

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

distance = average speed $\times$ time

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

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

force = mass $\times$ acceleration

weight = mass $\times$ gravitational field strength

work done = force $\times$ distance

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

power = force $\times$ speed

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

momentum = mass $\times$ velocity

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

GPE = mgh

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

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

3

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Question 1 begins on page 4

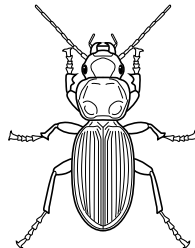
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4

Answer **all** the questions.**SECTION A – Module B4**

1 Lily investigates animals in the school grounds.

(a) One of the animals is the ground beetle.

Lily investigates ground beetles living in two different areas, area **A** and area **B**.

Both areas are the same size.

Lily uses the capture-recapture method to estimate the population size of ground beetles in each area.

She catches ground beetles from each area, counts them, marks them, and then lets them go. This is the first sample.

The next night, Lily catches ground beetles from each area again. This is the second sample.

The table shows her results.

	Area A	Area B
Number of ground beetles caught in the first sample	16	8
Number of ground beetles caught in the second sample	10	7
Number of ground beetles in the second sample that were previously marked	4	2

(i) Use the formula below to calculate an estimate of the population size in **each** area.

$$\text{population size} = \frac{\text{number in 1st sample} \times \text{number in 2nd sample}}{\text{number in 2nd sample previously marked}}$$

population in area **A** = population in area **B** =**[2]**

5

- (ii) Lily used different coloured paints to mark the ground beetles from the two areas.

For ground beetles in area **A** she used white paint.

For ground beetles in area **B** she used brown paint.

Suggest and explain how using different coloured paints could have affected the accuracy of the estimates of population size.

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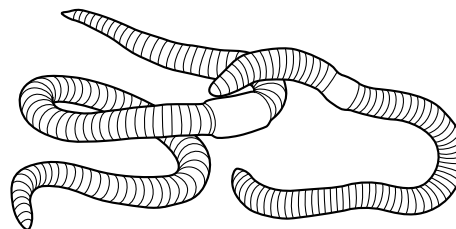
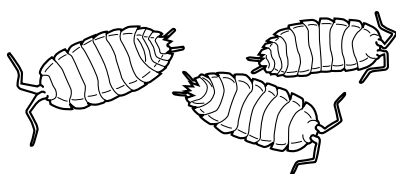
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..... [2]

- (b) Lily investigates woodlice and earthworms living in both areas.

Woodlice and earthworms are detritivores.



Describe and explain how detritivores help provide plants with substances they need to build new cells.



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

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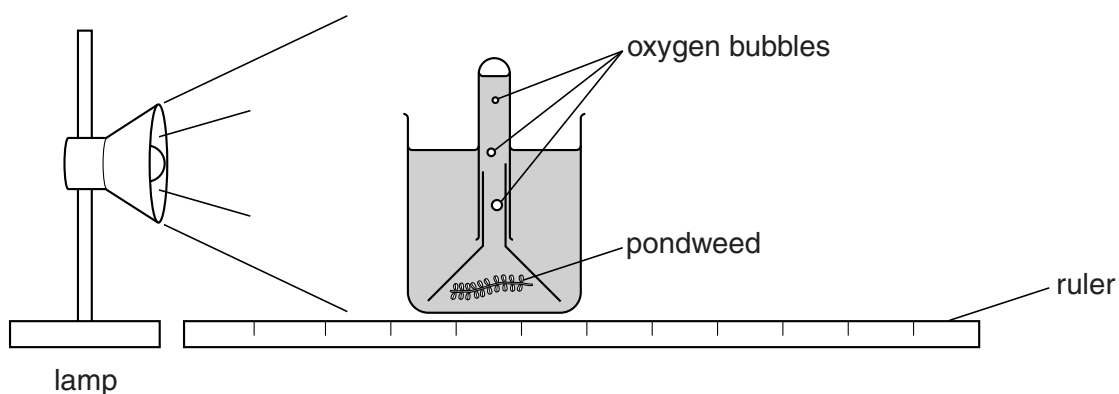
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[Total: 10]

Turn over

2 Sanjay investigates the amount of oxygen made by pondweed.

- (a) He counts how many bubbles of oxygen are given off by pondweed at different distances from a lamp.



The table shows his results.

Distance between lamp and pondweed in cm	Number of bubbles given off by pondweed in 1 minute
10	48
20	25
30	12
40	7
50	5

- (i) Describe and explain these results.

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..... [3]

7

- (ii) Sanjay's friend says that counting bubbles is **not** a very good method for measuring the amount of oxygen.

Explain how Sanjay could change his method to get more accurate results.

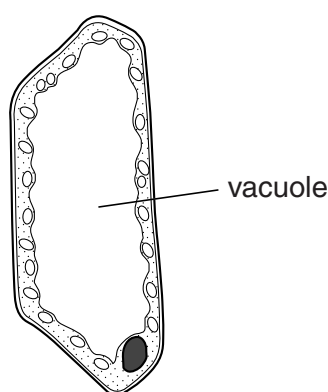
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..... [2]

- (b) Look at the diagram of a cell from the pondweed.



The cell contains a lot of water in its vacuole.

- (i) What word describes a cell that contains as much water as possible?

..... [1]

- (ii) It is important that cells of plants which live on **land** contain as much water as possible.

It is less important for pondweed to have cells that contain a lot of water.

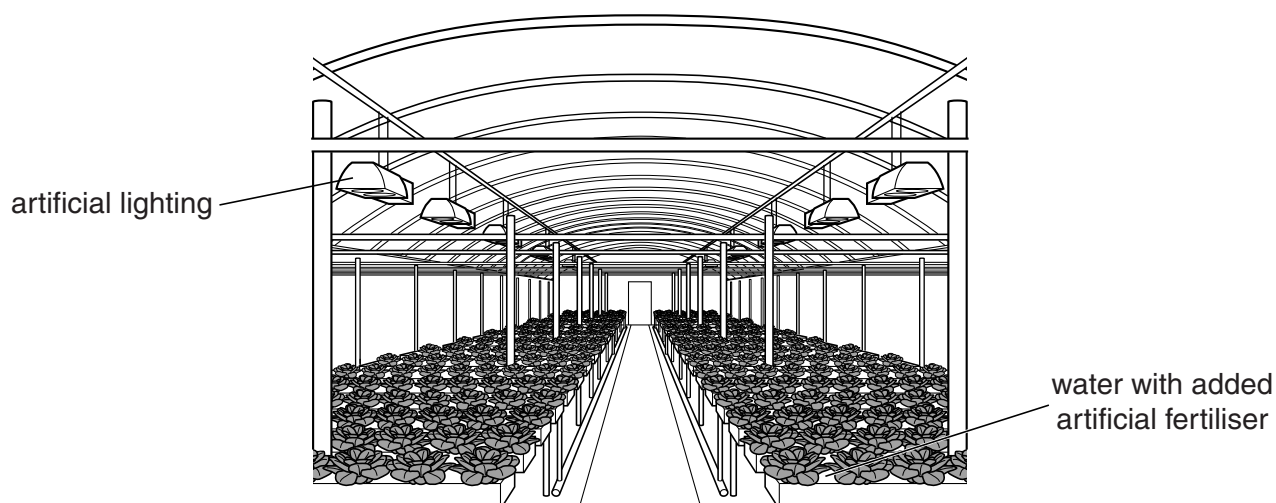
Suggest why it is more important for the cells of land plants to contain as much water as possible.

.....

..... [1]

[Total: 7]

- 3 Mary is a farmer. She grows lettuces in a glasshouse using hydroponics.



- (a) Adding artificial fertiliser to crops growing in fields can cause pollution in rivers.

This pollution does not occur when using hydroponics.

- (i) Suggest why using hydroponics does **not** cause fertiliser pollution in rivers.

.....
 [1]

- (ii) More people are concerned about pollution now than were in the past.

Suggest why.

.....
 [1]

- (b) In a hydroponics system, the concentration of artificial fertiliser in the water does **not** have to be very high.

Explain why.

.....

 [2]

9

- (c) When the lights are on in the glasshouse, the stomata on the lettuce leaves open.

This allows carbon dioxide to enter the leaves.

Describe how stomata open.

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..... [2]

- (d) Lettuce leaves contain xylem vessels.

Describe the structure of xylem vessels.

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..... [2]

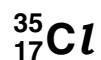
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Section B begins on page 10

SECTION B – Module C4

4 This question is about atomic structure.

(a) An atom of chlorine can be represented as:



Complete the following sentence.

This atom of chlorine contains protons, 17 electrons and neutrons. [2]

(b) Complete the table about the particles found in atoms.

Particle	Relative electric charge	Relative mass
Electron		0.0005
Neutron		1
Proton	+1	

[2]

[Total: 4]

5 This question is about structure and bonding.

- (a) Calcium chloride contains calcium ions, Ca^{2+} , and chloride ions, Cl^- .

Write down the **formula** for calcium chloride.

..... [1]

- (b) Sodium oxide, Na_2O , is an ionic compound.

Sodium has the electronic structure 2.8.1.

Oxygen has the electronic structure 2.6.

Use 'dot and cross' diagrams to draw the electronic structures of the two ions in Na_2O .

Include the charges on the ions.

[2]

- (c) Sodium oxide has a high melting point and does not conduct electricity as a solid.

Use ideas about structure and bonding to explain why.

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..... [2]

[Total: 5]

Turn over

- 6 Annie is concerned that the river near her house may be polluted.



She tests a sample of water from the river.

She tests the water with silver nitrate solution and also with barium chloride solution.

Look at her results.

Water sample	With silver nitrate solution	With barium chloride solution
	yellow precipitate	white precipitate

- (a) Annie thinks that the water contains both bromide ions and sulfate ions.

Is she correct?

Explain your answer.

.....

.....

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..... [2]

- (b) Barium chloride, BaCl_2 , reacts with sodium sulfate, Na_2SO_4 .

Barium sulfate, BaSO_4 , and sodium chloride, NaCl , are made.

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

..... [2]

[Total: 4]

7 This question is about Group 7 elements.

Look at the table.

It shows some information about the Group 7 elements.

Element	Molecular formula	Physical appearance	Melting point in °C	Boiling point in °C
fluorine	F ₂	pale yellow gas		-188
chlorine	Cl ₂	pale green gas	-101	-35
bromine	Br ₂	orange liquid	-7	59
iodine	I ₂		114	184

- (a) Complete the table to show the **physical appearance** of iodine. [1]
- (b) Use ideas about trends in a group to predict the **melting point** of fluorine. [1]
- (c) Sodium, in Group 1, reacts with bromine.

Write a **word** equation for this reaction.

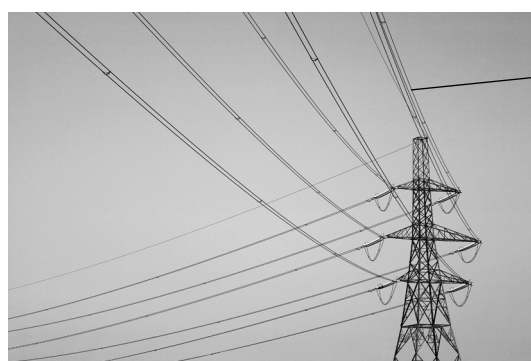
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[Total: 3]

8 This question is about metals.

(a) Look at the table. It gives information about five metals.

Metal	Melting point in °C	Relative electrical conductivity (1 = low, 70 = high)	Relative heat conductivity (1 = low, 250 = high)	Density in g/cm ³	Cost of one kg in £
A	660	40	118	2.7	1.3
B	1083	64	223	8.9	4.7
C	1535	11	42	7.9	0.3
D	962	67	235	10.5	602.8
E	420	18	67	7.1	1.2



overhead power cable

Suggest which metal would be best for making overhead power cables.

Choose from **A**, **B**, **C**, **D** or **E**.

Metal

Explain your answer. Use information from the table to help you.

.....

 [2]

(b) Some metals can be used as **superconductors**.

Superconductors conduct electricity with little or no electrical resistance.

Write about one **disadvantage** of superconductors.

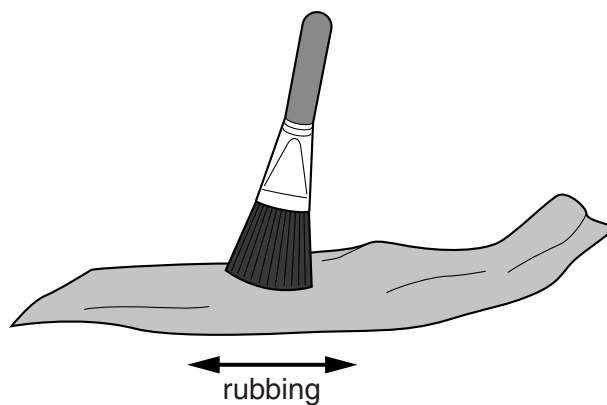
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[Total: 3]

SECTION C – Module P4

10 This question is about electrostatic charges.

(a) Connor rubs a cloth with a brush.



The cloth becomes **negatively** charged.

Explain why, and include in your answer what happens to the brush.

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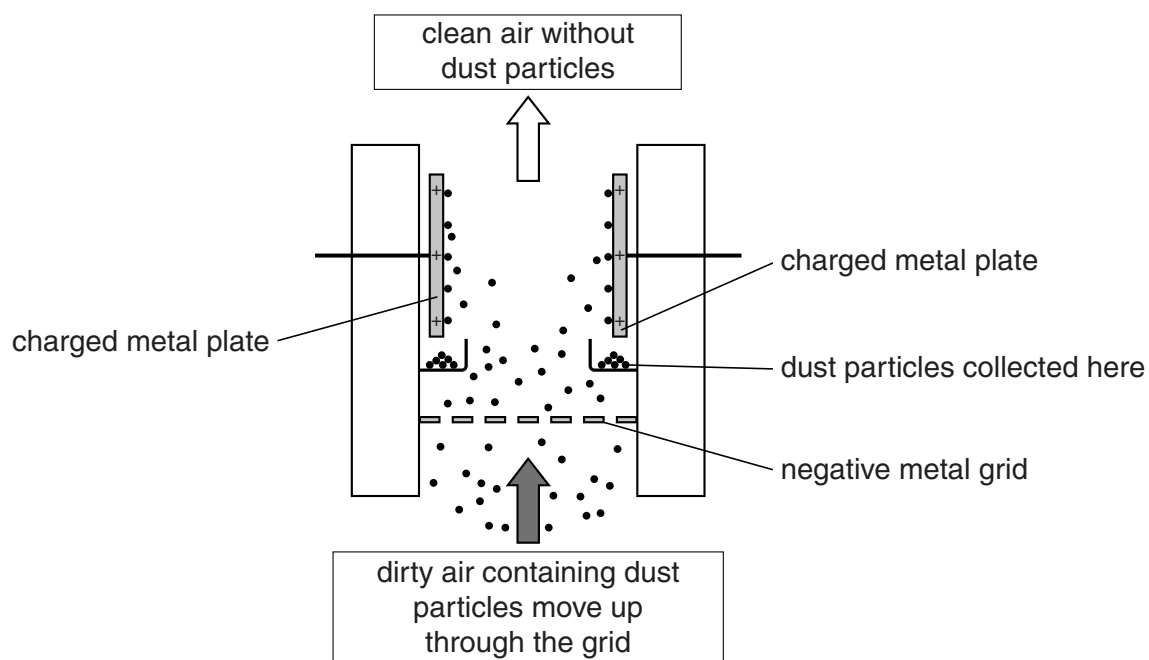
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17

(b) Large scale dust removal from chimneys is done using an electrostatic precipitator.

The diagram shows an electrostatic precipitator.



Complete the following sentences explaining how the precipitator works.

Choose words from the list.

The words can be used once, more than once or not at all.

attract

electrons

struck

negative

positive

protons

repel

rubbed

When the dust particles pass through the metal grid they gain and have a charge.

The metal plates then the charged dust particles.

The plates are so the dust falls down and is collected.

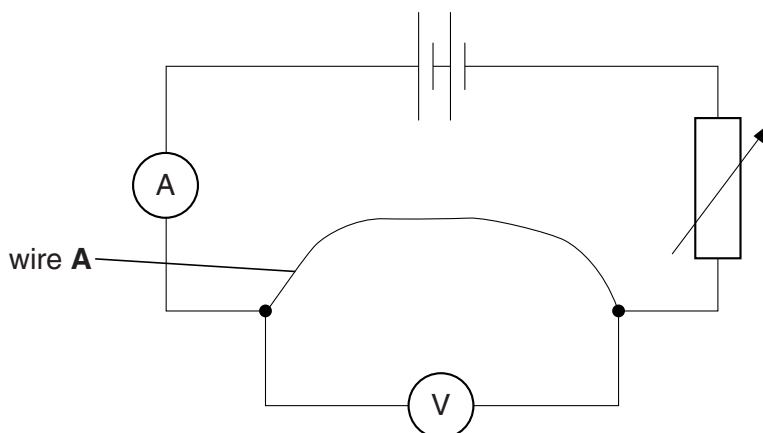
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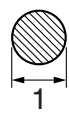
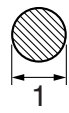
- 11 Manisha is investigating the resistance of three wires.

This is the electrical circuit she uses.



She measures the current and the voltage (p.d.) across each wire.

Look at her results for three wires **A**, **B** and **C** made from the **same material**.

Wire	p.d. in volts	Current in amps	Length of wire in cm	Thickness in mm	Resistance in ohms
A	5		100		2.5
B	5		50		1.25
C	5		100		10

- (a) Complete the table by calculating the current in each wire. [2]
- (b) By using the numbers in the table, compare the results for wire **A** with the results for wires **B** and **C**, and write conclusions about how the thickness and length affect the resistance of the wire.

.....

.....

.....

.....

.....

..... [3]

[Total: 5]

20

(b) Patrick is worried about the risk from the radiation.

His friend, Dermot, says there is a high risk that he will get cancer from the radiation used for the scan.

Sheng Li, Patrick's radiographer, advises Patrick to have the scan.

Sheng Li gives Patrick a leaflet.

It contains information about dose levels.

The dose levels are in units of **millisieverts (mSv)**.

Radiation exposure	Dose in mSv
Average background radiation experienced by people in the UK each year	2.5
Exposure for airline crew each year	5.0 – 9.0
Maximum dose each year for workers in nuclear industry	20.0
Patrick's scan	1.0

Patrick rejects Dermot's advice and accepts Sheng Li's advice.

Use the information to explain why.

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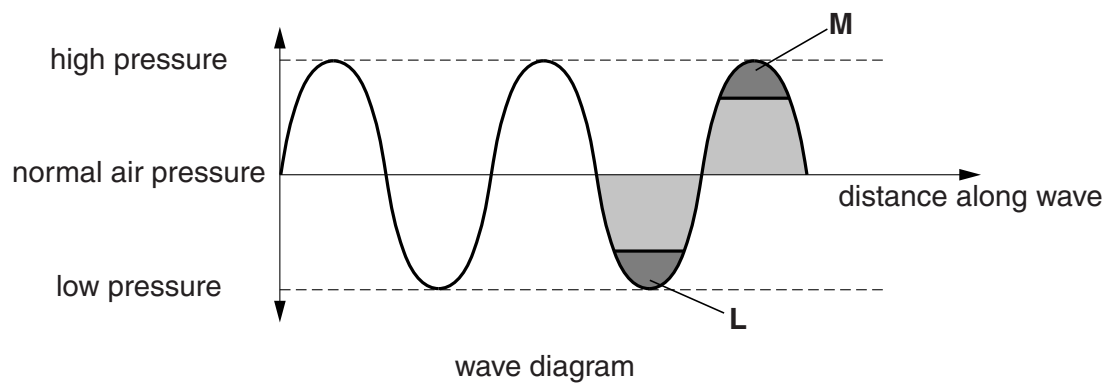
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21

(c) Different types of medical scans use ultrasound.

Look at the diagram of an ultrasound wave travelling in air.



Compare the separation of the air **particles** in areas **L** and **M** and explain how the diagram shows that this is a longitudinal wave.

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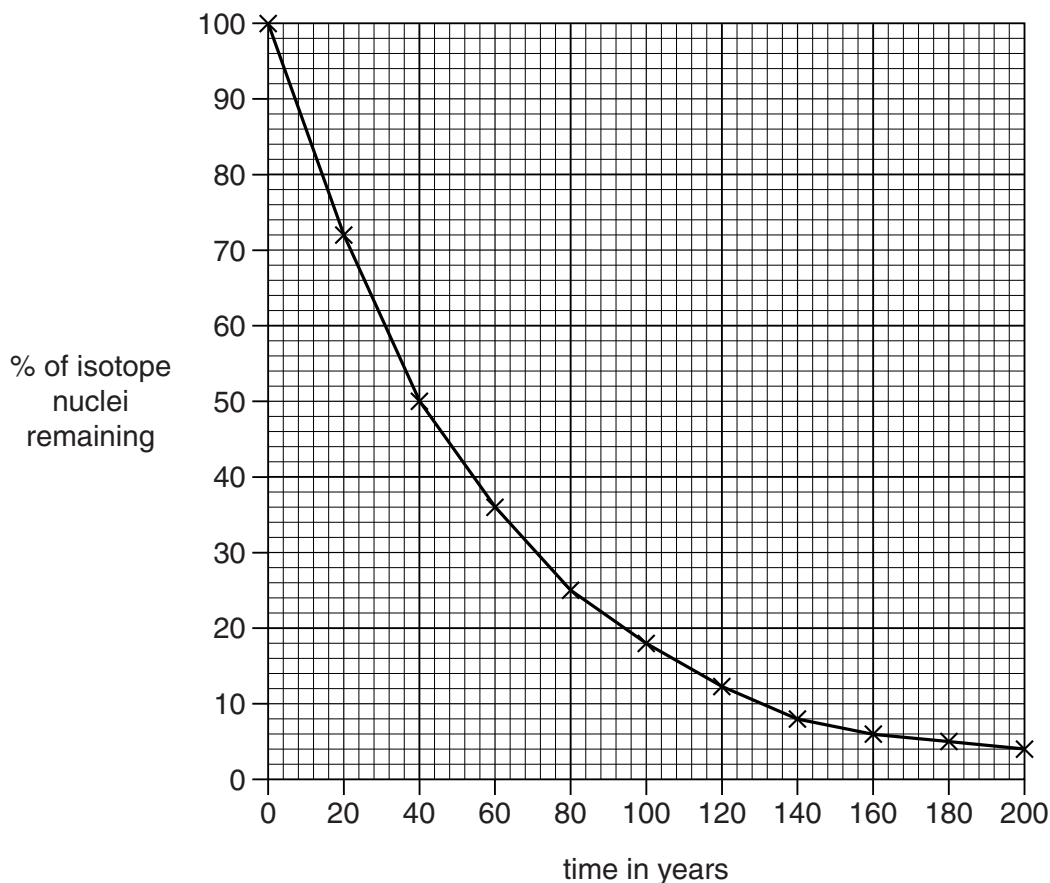
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[Total: 10]

13 Rosalind is studying nuclear reactions.

(a) Radioactive isotopes decay over a period of time.

(i) Look at the graph of isotope **X** decaying.



Calculate the half-life of isotope **X** using the graph.

Show how you calculated the value on the graph.

half-life of **X** = years [2]

(ii) The half-life of another radioactive isotope, neptunium (Np), is approximately 2.0×10^6 years.

A sample of this isotope has a mass of 200 g.

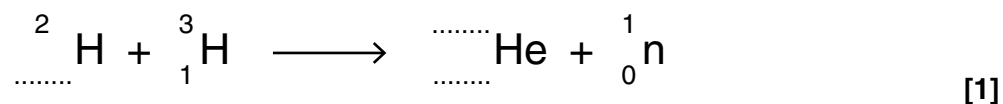
What mass of this isotope would be left after a period of 6 million years?

mass = g [1]

- (b) (i) Another type of nuclear reaction is **nuclear fusion**.

Nuclei of two different hydrogen isotopes react to produce helium (He) and a neutron (n).

Write the correct numbers on the dotted lines to complete the fusion reaction.



- (ii) To use this type of nuclear reaction for power generation, extreme conditions are required.

What two extreme conditions are needed for the reaction?

..... and [1]

[Total: 5]

SECTION D

14 Jenny and Bob are learning about the heart.

They have been reading about **cardiac output**.

This is the volume of blood that the heart pumps out every minute.

(a) There are three main ways in which doctors can measure cardiac output.

Method 1: A doctor injects a small amount of radioactive glucose solution into a blood vessel. She measures the radioactivity.

Method 2: A doctor takes blood samples from an artery. She measures the oxygen content.

Method 3: A doctor measures the blood flow using an ultrasound scan.

Doctors usually prefer to use **method 3**.

Suggest **one** reason why this is.

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

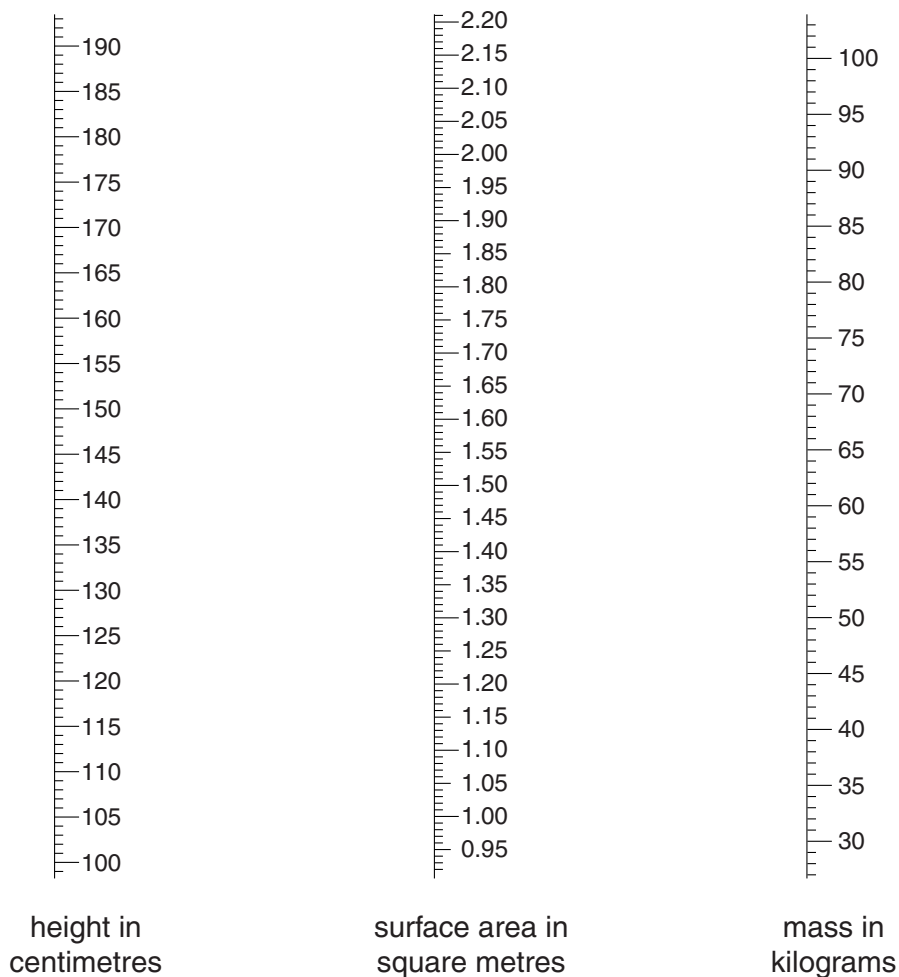
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(b) Jenny finds another way of measuring how well her heart works.

To do this she needs to find out her surface area.

(i) Jenny's body mass is 67 kg and her height is 135 cm.

She uses these scales to work out her surface area.



Draw a straight line from Jenny's height on the left scale to her mass on the right scale.

Where the line crosses the surface area scale, read off and record her surface area.

Jenny's surface area = m²

[1]

26

- (ii) Jenny's new method is called the **cardiac index**.

This is calculated using the formula:

$$\text{cardiac index} = \frac{\text{cardiac output}}{\text{surface area of the body}}$$

A cardiac index of 3.5 is normal.

Up to 0.7 higher or lower than 3.5 is still healthy.

Jenny's cardiac **output** is 6 litres per minute.

Calculate Jenny's cardiac index.

What does Jenny's cardiac index tell you about her heart?

cardiac index =

.....

..... [2]

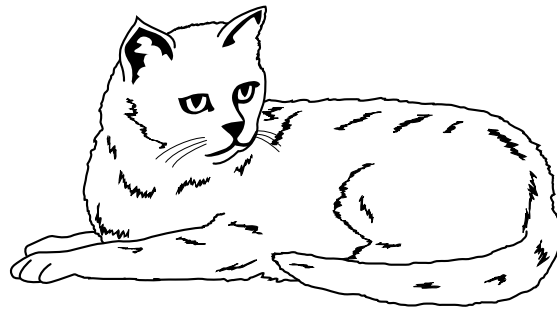
- (c) Jenny finds information about heart rate and life expectancy of different mammals.

She finds that the average heart rate multiplied by the life expectancy always gives the same number in all mammals.



mouse

average heart rate = 600 beats
per minute
life expectancy = 3 years



cat

average heart rate = ? beats
per minute
life expectancy = 15 years

Use this information to work out the average heart rate of a cat.

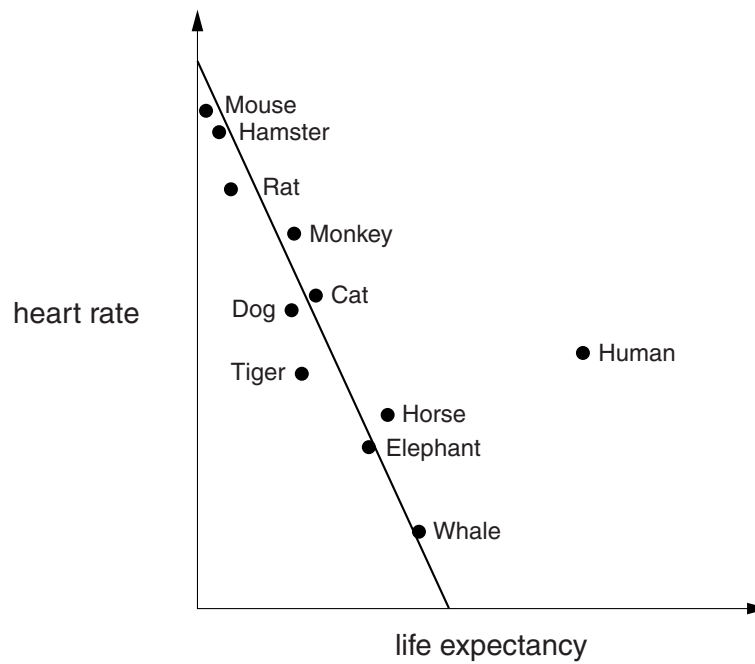
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answer = beats per minute

[2]

28

(d) Jenny looks at this graph. It shows the heart rate against life expectancy for different mammals.



(i) What patterns does the graph show about life expectancy, heart rate and size of mammals?

.....

 [2]

(ii) Humans do not fit the patterns shown in the graph.

Describe how the life expectancy of humans differs from the patterns and suggest a reason why.

.....

 [2]

[Total: 10]

END OF QUESTION PAPER

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*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.