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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

MODIFIED LANGUAGE

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.

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EQUATIONS

energy = mass × specific heat capacity × temperature change

energy = mass × specific latent heat

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

wave speed = frequency × wavelength

power = voltage × current

energy supplied = power × time

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

distance = average speed × time

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

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

force = mass × acceleration

weight = mass × gravitational field strength

work done = force × distance

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

power = force × speed

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

momentum = mass × velocity

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

GPE = mgh

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

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

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Question 1 begins on page 4

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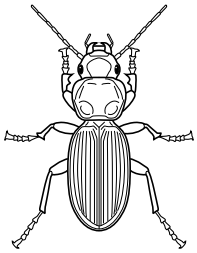
Answer **all** the questions.

SECTION A – Module 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]**

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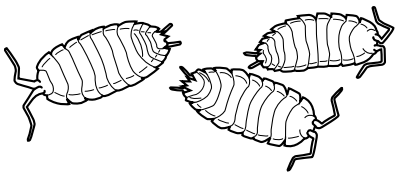
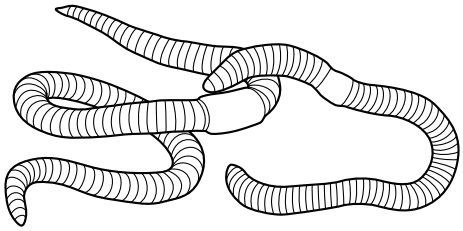
..... **[2]**

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

Woodlice and earthworms are detritivores.





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

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

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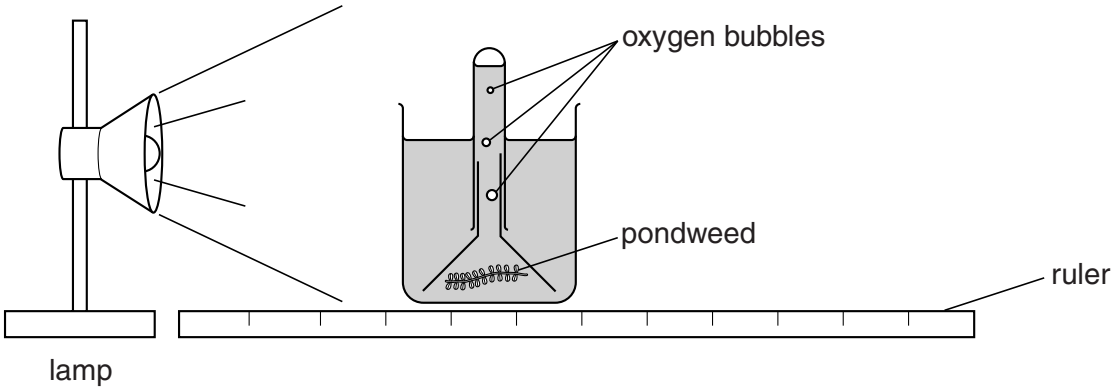
..... **[6]**

[Total: 10]

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]**

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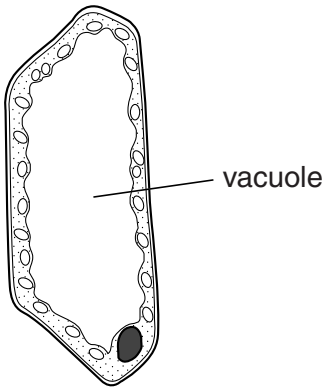
..... **[2]**

(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.

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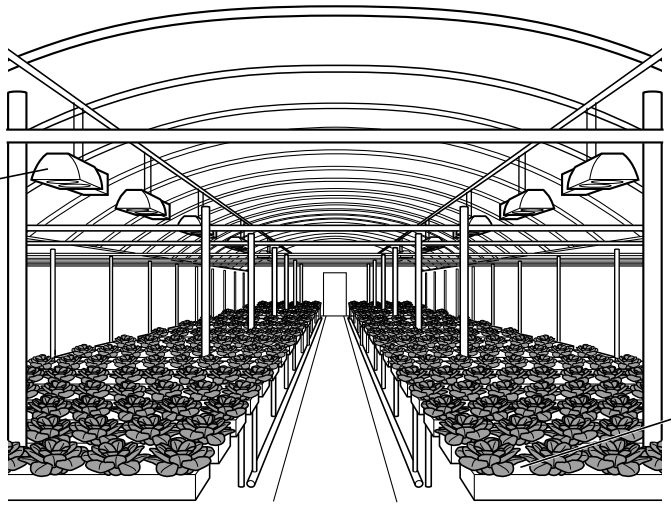
..... **[1]**

[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.

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

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

Suggest why.

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

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

Explain why.

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

(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]**

[Total: 8]

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:

$$^{35}_{17}Cl$$

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. Sodium oxide does not conduct electricity as a solid.

Use ideas about structure and bonding to explain these two facts.

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.....

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

[Total: 5]

6 Annie thinks 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.

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

[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

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.

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

[Total: 3]

9 Look at the table. It shows part of an early version of the Periodic Table of the Elements.

The numbers are the relative atomic masses of the elements.

H 1	Li 7	Be 9	B 11	C 12	N 14	O 16
F 19	Na 23	Mg 24	A*l* 27	Si 28	P 31	S 32
C*l* 35.5	K 39					

Three chemists helped to develop the Periodic Table.

One was Dobereiner, who noticed triads such as Li, Na and K.

The other two chemists were:

- Newlands
- Mendeleev.

Write about the evidence that **Newlands** and **Mendeleev** used to develop the Periodic Table.

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

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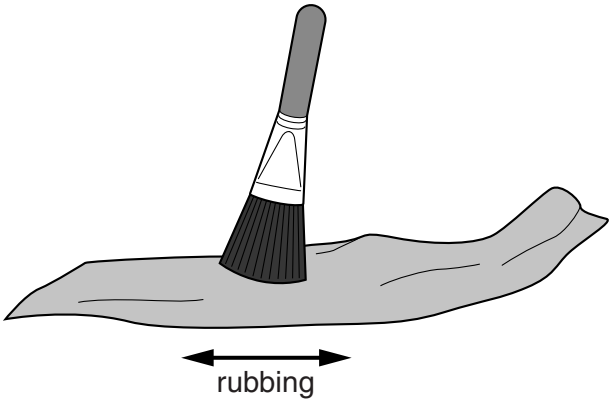
..... **[6]**

[Total: 6]

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. Include in your answer what happens to the brush.

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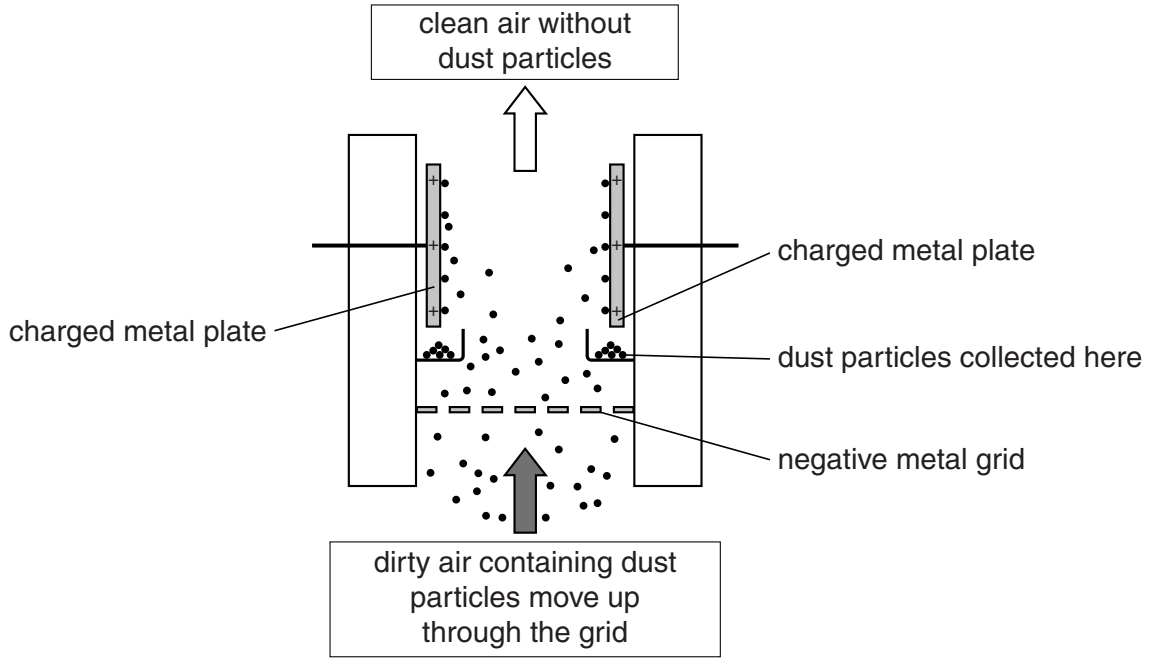
..... **[3]**

(b) Electrostatic precipitators are used in large-scale dust removal from chimneys.

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.

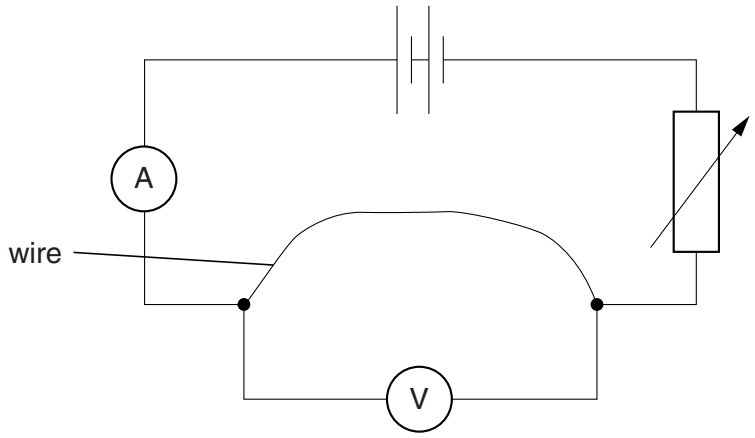
The metal plates then ..... the charged dust particles.

The plates are ..... so the dust falls down and is collected. **[2]**

[Total: 5]

11 Manisha is investigating the resistance of three wires.

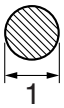
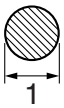
This is the electrical circuit she uses.



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

The three wires **A**, **B** and **C** are made from the **same material**.

The table shows her results.

Wire	p.d. in volts	Current in amps	Length of wire in cm	Thickness in mm	Resistance in ohms
A	5	.....	100	 1	2.5
B	5	.....	50	 1	1.25
C	5	.....	100	 0.5	10

(a) Complete the table by calculating the current in each wire. **[2]**

(b) Compare the results for wire **A** with the results for wires **B** and **C**. Write conclusions about how the **thickness and length** affect the resistance of the wire. Use numbers from the table in your answer.

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

[Total: 5]

12 Patrick's doctor wants him to have a scan of an internal organ in his body.

A radiographer will scan Patrick's internal organ.

(a) A radioactive isotope will be injected into Patrick.

It acts as a tracer so that the radiographer will be able to scan the internal organ.

Look at the table containing information about three radioactive isotopes.

Isotope	Half-life	Nuclear radiation emitted
A	10 days	alpha
B	12 years	beta
C	6 hours	gamma

Use information about *each* isotope to suggest and explain which isotope is the best one to use for the scan.

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

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

(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 accepts Sheng Li's advice to have the scan. He rejects Dermot's advice.

Use the information to explain why.

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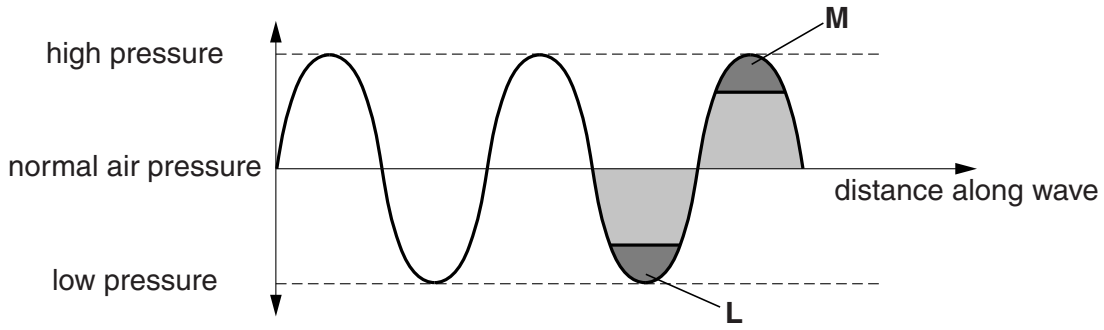
..... **[2]**

(c) Different types of medical scans use ultrasound.

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



wave diagram

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

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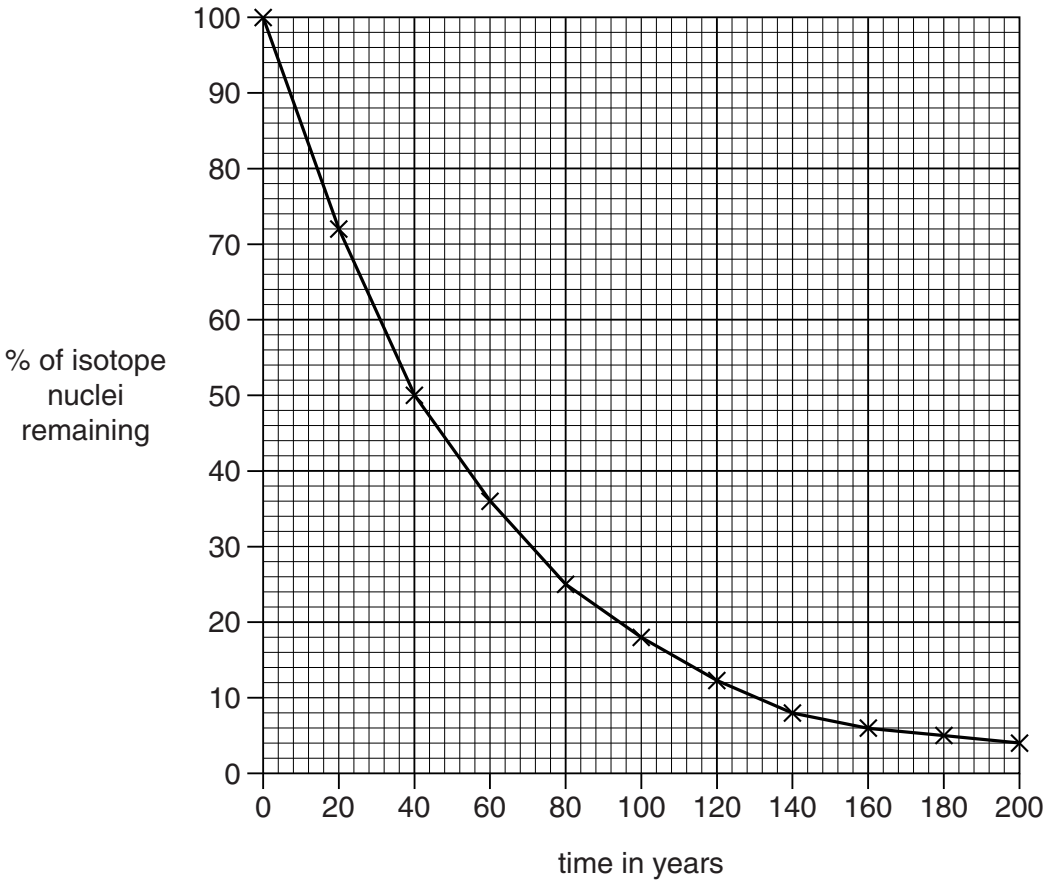
..... **[2]**

[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.

$$ {}^{2}_{\ldots\ldots}\mathrm{H} + {}^{3}_{1}\mathrm{H} \longrightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{He} + {}^{1}_{0}\mathrm{n} $$

[1]

(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.

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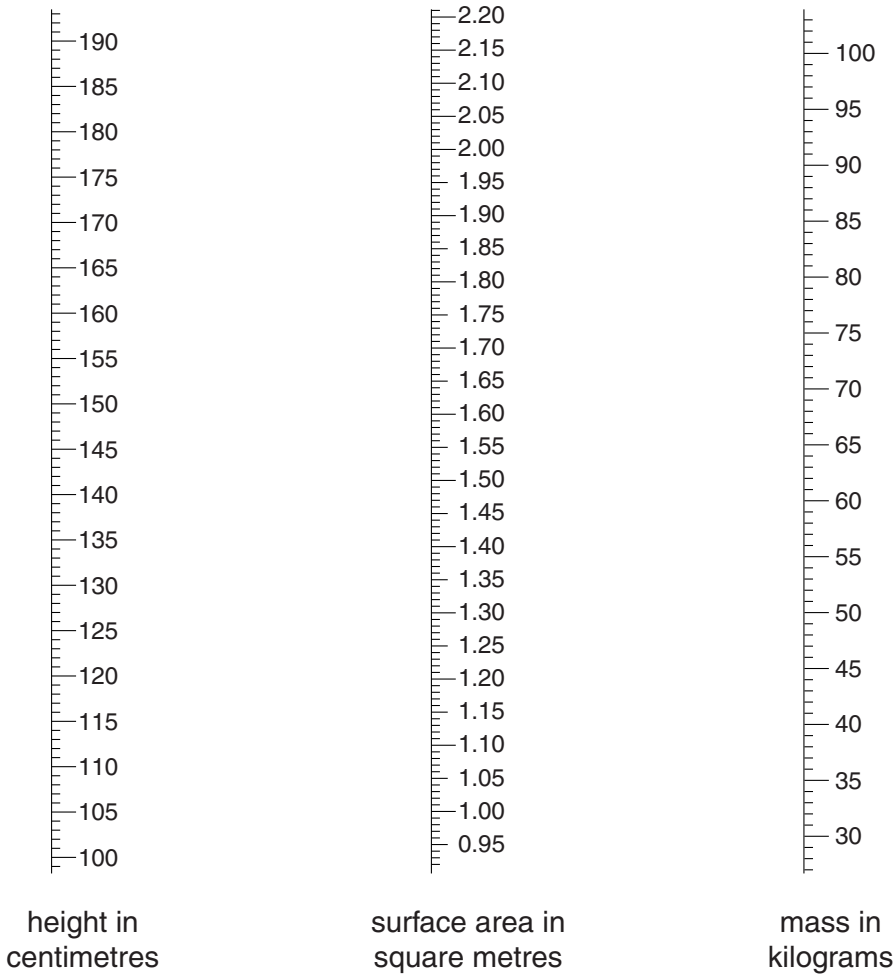
..... **[1]**

(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 = ... m^2 **[1]**

Turn over for the remainder of question 14

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

This is calculated using the formula:

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

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 = ...

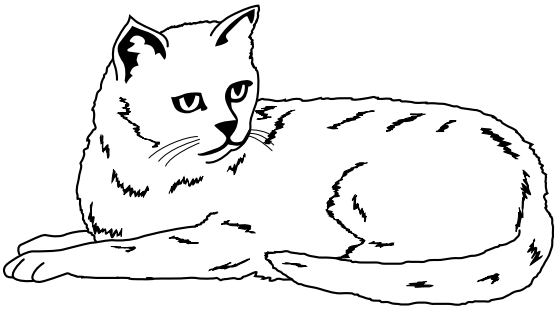
.....

..... **[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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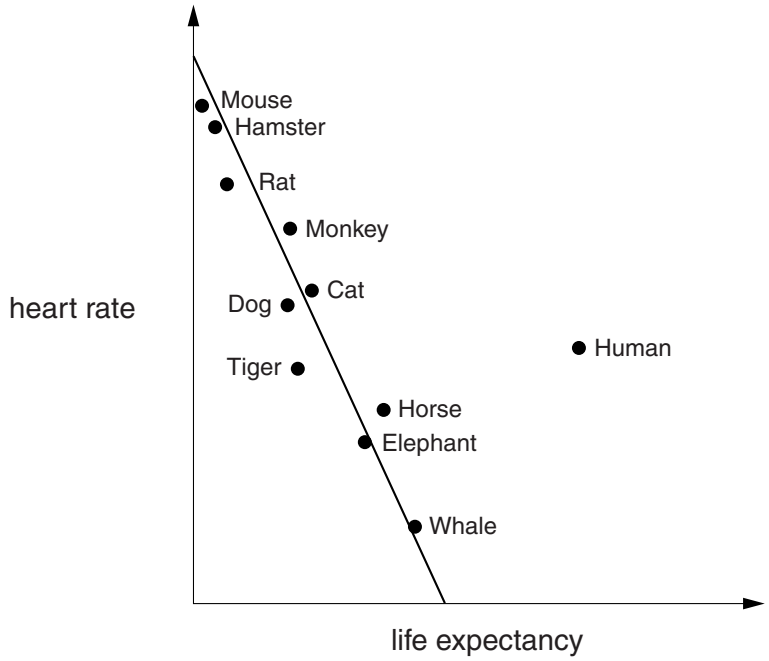
answer = ... beats per minute **[2]**

Turn over for the remainder of question 14

(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?

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..... **[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.

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

[Total: 10]

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.