

**Thursday 24 May 2012 – Morning**

**GCSE GATEWAY SCIENCE  
SCIENCE B**

**B622/02** Unit 2 Modules B2 C2 P2 (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**



Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**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 number of marks is given in brackets [ ] at the end of each question or part question.
- A list of physics equations is printed on page two.
- The Periodic Table is printed on the back page.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

**EQUATIONS**

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{energy} = \text{mass} \times \text{specific heat capacity} \times \text{temperature change}$$

$$\text{energy} = \text{mass} \times \text{specific latent heat}$$

$$\text{fuel energy input} = \text{waste energy output} + \text{electrical energy output}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{energy supplied} = \text{power} \times \text{time}$$

$$\text{energy (kilowatt hours)} = \text{power (kW)} \times \text{time (h)}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Answer **all** the questions.

**Section A – Module B2**

1 The photograph shows an island fox.

These foxes live on a number of small islands off the coast of California.



(a) In which class of vertebrates is the fox classified?

How can you tell this from the photograph?

class .....

reason ..... [2]

(b) Read this information about the island fox.

The island fox lives on six small islands.  
 The foxes on each island are all slightly different.  
 For example, on one island they have more bones in their tail than the foxes on other islands.  
 However, all the foxes are part of the same species.

Recently, the foxes have almost disappeared on the two northern-most islands.  
 At first, biologists could not find the reason for the deaths.  
 Finally, a long feather was found beside a dead fox – a golden eagle feather.

In the past, bald eagles lived on the islands and killed other birds.  
 Bald eagles did not prey on the island fox.  
 The bald eagles on the northern islands disappeared due to the effects of a pesticide.  
 Without the bald eagles, golden eagles were attracted to the northern islands.  
 The golden eagles found the island fox easy to catch.

Finish the following sentence.

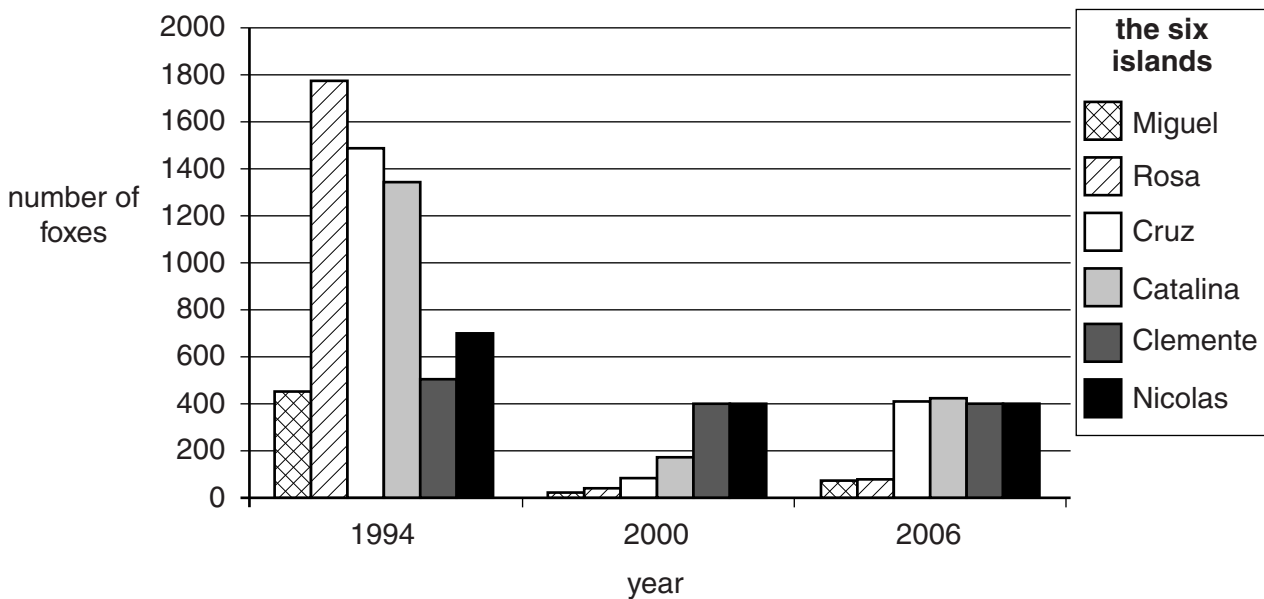
Choose the correct word from this list.

- class            community            ecosystem            population            species**

The foxes on each island form a separate ..... [1]

(c) The graph shows changes in the number of foxes on the six different islands.

Use the graph and the information in (b) to answer the questions.



(i) What are the names of the two northern islands?  
..... and ..... [1]

(ii) Explain how you can tell this from the graph.  
.....  
..... [1]

(iii) Put ticks (✓) next to **any** conservation methods that could be used to help the fox.

- captive breeding of foxes
  - shooting bald eagles
  - captive breeding of golden eagles
  - capturing golden eagles and releasing them a long distance away
- [1]

(d) Scientists have found that some of the foxes on the southern islands have died from a virus spread from a dog.

However, they think that fairly soon all the foxes on the southern islands will be resistant to this virus.

Use ideas about natural selection to explain how an entire group of foxes can become resistant to a virus.

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

[Total: 9]

- 2 The photograph shows part of a mistletoe plant.



Mistletoe plants have green leaves and live attached to the branches of trees, such as apple trees.

- (a) Mistletoe plants can photosynthesise.

Write the word equation for photosynthesis.

..... [2]

- (b) Mistletoe is described as a partial parasite as it obtains some sugar from the apple tree.

What word is used to describe an organism that is fed on by a parasite?

..... [1]

- (c) Some scientists investigate two different species of mistletoe growing on a tree.

They provide **the tree** with carbon dioxide that contains radioactive carbon.

They then measure how much of the sugar that the tree produces stays in the tree and how much sugar is passed into the mistletoe.

They also measure the chlorophyll content of the mistletoe.

The results are shown in the table.

species of mistletoe	chlorophyll content in mg/g of tissue	sugar containing radioactive carbon content in mg/g of tissue	
		in tree	in mistletoe
dwarf mistletoe	0.4	306	120
eastern mistletoe	0.9	420	2

- (i) Which species of mistletoe is likely to cause most damage to the tree that it grows on?

Explain your answer.

species .....

reason .....

..... [1]

- (ii) Suggest an explanation for the difference in the chlorophyll content of the two types of mistletoe.

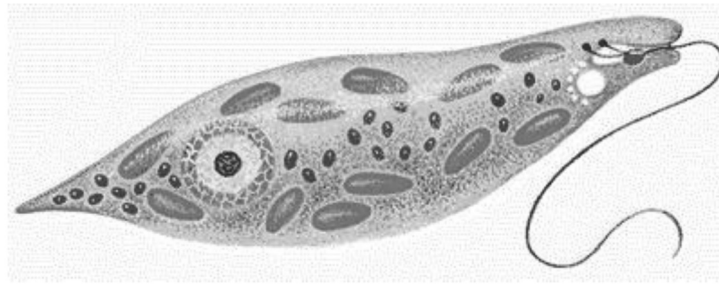
.....

.....

..... [2]

[Total: 6]

3 *Euglena* is a small single-celled organism.



(a) Write down why it is difficult to classify *Euglena*.

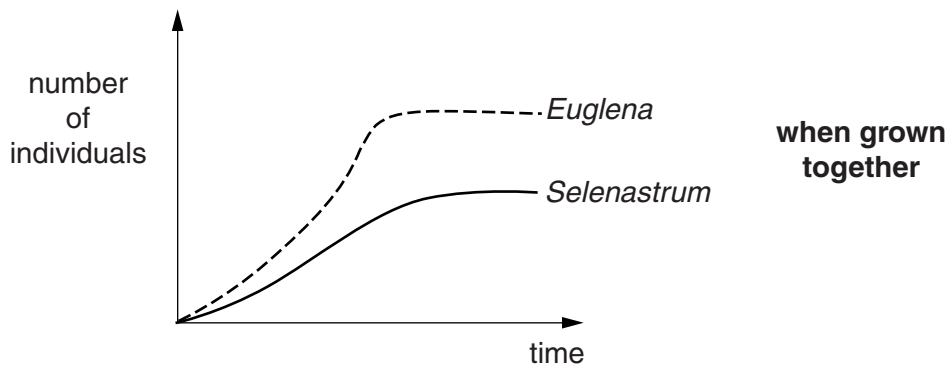
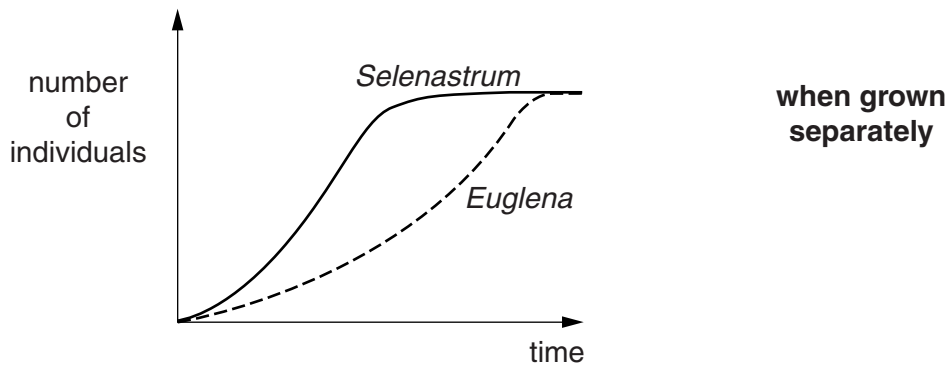
.....  
 ..... [1]

(b) Scientists investigate the growth of *Euglena* and another single-celled organism called *Selenastrum*.

They grow cultures of the two organisms separately and then together.

They count the number of organisms over several days.

The graphs show the results.





(i) Put ticks (✓) in the table to show the best description of the results of each experiment.

Only tick **two** boxes.

description	when grown separately	when grown together
<i>Euglena</i> reproduces more slowly than <i>Selenastrum</i> but achieves the same number of individuals eventually.		
<i>Euglena</i> reproduces faster than <i>Selenastrum</i> but achieves the same number of individuals eventually.		
<i>Euglena</i> reproduces faster than <i>Selenastrum</i> and exists in larger numbers throughout the experiment.		
<i>Euglena</i> reproduces more slowly than <i>Selenastrum</i> and exists in smaller numbers throughout the experiment.		

[2]

(ii) Complete these sentences to provide an explanation for the results of the experiment.

*Euglena* and *Selenastrum* are similar organisms and have similar requirements.

They occupy a similar ecological .....

When grown together, *Euglena* will ..... *Selenastrum* for the same resources.

[2]

[Total: 5]

## Section B – Module C2

4 This question is about pigments in paints.

Pigments give paints their colour.

Look at the table. It shows some information about some pigments used in paints.

pigment	colour	effect of light	effect of increasing the temperature	type of paint made
<b>A</b>	green	colour fades	no change	emulsion
<b>B</b>	red	keeps its colour	changes to yellow	emulsion
<b>C</b>	yellow	absorbs light and later gives off light	no change	oil based
<b>D</b>	blue	keeps its colour	no change	oil based

(a) Write down one use for a paint made using pigment **B**.

..... [1]

(b) Pigments **A** and **B** are used to make an emulsion paint.

What is the **solvent** used in an emulsion paint?

..... [1]

(c) Pigment **C** is a **phosphorescent** pigment.

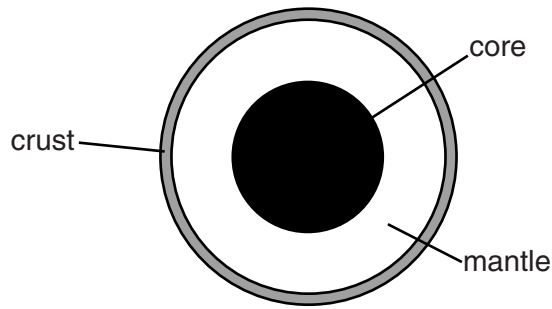
Modern phosphorescent pigments are better than those used 50 years ago.

Explain why.

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

[Total: 4]

5 Look at the diagram of the Earth.



(a) The tectonic plates are found on top of the mantle.

Explain why.

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

(b) The outer part of the Earth includes the crust and the outer part of the mantle.

What is this outer part of the Earth called?

..... [1]

(c) The outer part of the Earth is divided into tectonic plates.

What causes the tectonic plates to move?

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

(d) Volcanoes happen at tectonic plate boundaries.

Geologists study volcanoes.

Write down **two** reasons why geologists study volcanoes.

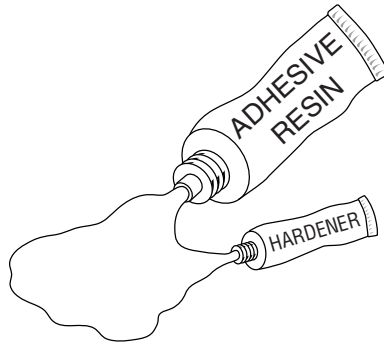
1 .....  
2 ..... [2]

[Total: 5]

6 Epoxy glues are used to stick surfaces together.

Epoxy glues come in two parts

- resin
- hardener.



A chemical reaction happens when the resin and hardener are mixed.

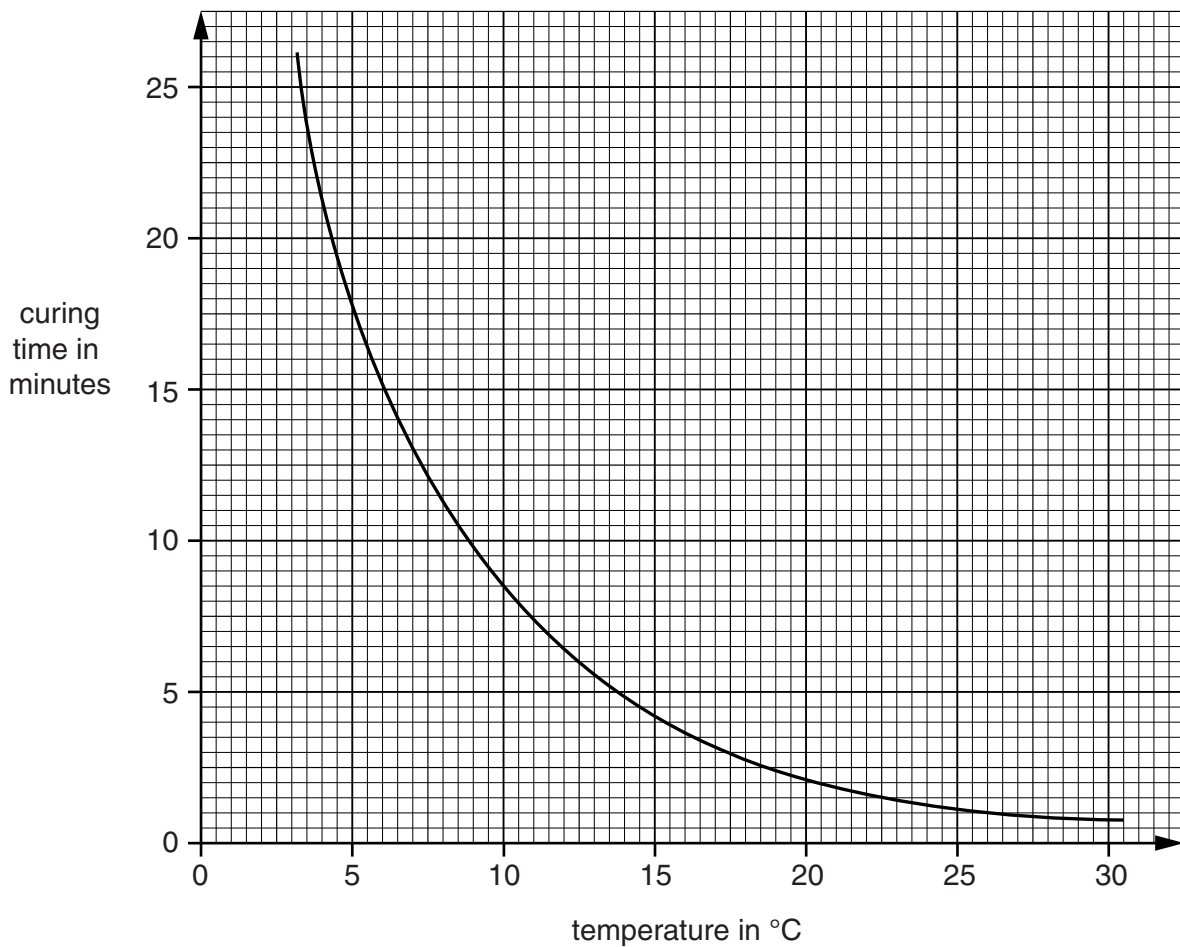
This reaction is called **curing**.

When curing finishes, the glue sets hard.

The time it takes for this to happen is called the **curing time**.

Look at the graph. It shows the effect of temperature on the curing time.

The mixture contains 5% hardener.



(a) What is the temperature needed for a curing time of 5 minutes?

..... °C [1]

(b) The rate of the reaction increases as the temperature increases.

At a higher temperature the particles of resin and hardener have more energy and move faster.

Explain how this makes the reaction faster.

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

(c) A second mixture of hardener and resin is used at a temperature of 5 °C.

This mixture contains 10% hardener.

This mixture has a higher concentration of hardener than the first mixture.

Suggest the **curing time** of this second mixture.

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

[Total: 4]

7 Look at the table. It gives information about some metals and alloys.

metal	appearance	melting point in °C	relative strength	relative conductivity of heat	observation after being left in moist air
copper	shiny red/ brown	1083	4.8	5.7	tarnishes very slowly
aluminium	dull light grey	660	2.6	10.5	has protective oxide layer
brass	shiny yellow	710	4.5	3.2	tarnishes
zinc	dull light grey	420	4.3	1.0	tarnishes
lead	dull dark grey	328	1.5	5.9	tarnishes
iron	dull dark grey	1535	8.2	0.3	rusts

(a) A decorative pan is used to heat water on an open fire.

Which metal is best for making the decorative pan?

.....

Explain your choice.

.....

.....

.....

..... [3]

(b) Car bodies can be made from aluminium or iron.

One advantage of using iron is that it is cheaper than aluminium so the car is cheaper to make.

(i) Write down one **other** advantage of using **iron** rather than aluminium to make car bodies.

Explain your answer. Use the table to help you.

advantage of iron .....

explanation .....

..... [2]

(ii) Write down one advantage of using **aluminium** rather than iron to make car bodies.

Explain your answer. Use the table to help you.

advantage of aluminium .....

explanation .....

..... [2]

[Total: 7]

Section C – Module P2

8 (a) The picture shows two wind turbines on the island of Madeira.



Finish the sentence.

When the Sun warms the air, convection currents are produced. This produces wind.

Wind turbines transfer the ..... energy of the wind into electricity. [1]

(b) Describe one advantage and one disadvantage of using wind turbines to generate electricity.

advantage .....  
.....

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

(c) Solar energy can be harnessed in other ways.

Finish the sentences by choosing the best words from this list.

- |                |               |               |               |
|----------------|---------------|---------------|---------------|
| <b>fibres</b>  | <b>glass</b>  | <b>images</b> | <b>lenses</b> |
| <b>mirrors</b> | <b>prisms</b> | <b>sound</b>  | <b>wood</b>   |

Using ..... in a building allows passive solar heating to take place.

In a solar furnace, light from the Sun can be reflected to a focus by curved  
..... [2]

[Total: 5]



9 Coal and oil are fossil fuels. They can be burned to release energy as heat.

Biomass can also be burned to release energy as heat.

Fuel rods in a nuclear reactor release energy as heat.

(a) (i) Write down the name of a **nuclear** fuel.

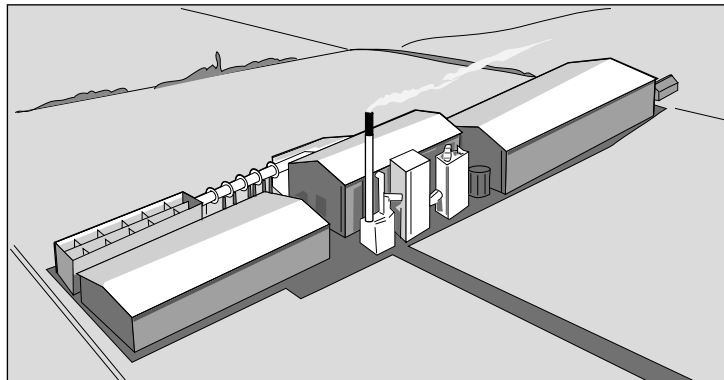
..... [1]

(ii) Ionising radiation is emitted by the waste from a nuclear power station.

It can damage living cells in humans.

What can this damage cause? ..... [1]

(b) (i) The 38 MW power station in Ely is the largest straw-burning power station in the world.



The power station generates electricity continuously.

Calculate the **energy** generated in **kWh** in one week.

The equations on page 2 may help you.

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

answer ..... kWh [2]

(ii) Biomass can produce fuel for a power station **without being burned**.

Describe how.

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

[Total: 5]

Turn over

10 People have been exploring space for many years.

(a) Asteroids are rocks which orbit the Sun between Mars and Jupiter.

They are left over from the formation of the Solar System.

Why was the asteroid belt formed near Jupiter?

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

(b) The first spacecraft was launched in 1957. It was **unmanned**.

(i) Explain two **disadvantages** of using unmanned spacecraft to explore distant parts of the Solar System.

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

(ii) Information can be sent back by an unmanned spacecraft orbiting a planet.

Write down **two different** examples of information that might be sent back.

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

(c) Most of the scientific community think that the Universe began with a “Big Bang”.

Observations of light from stars support this theory.

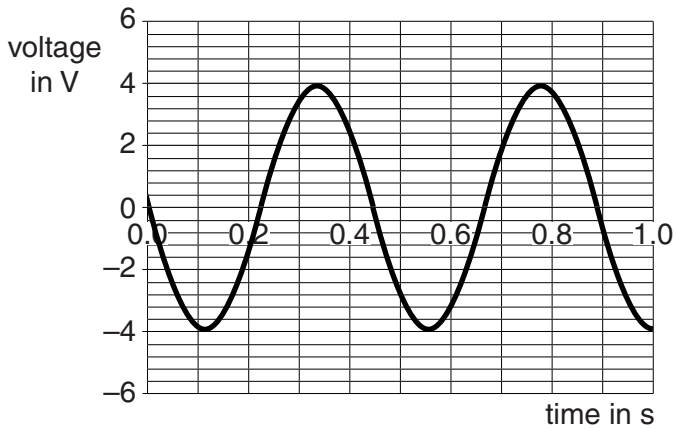
Explain how.

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

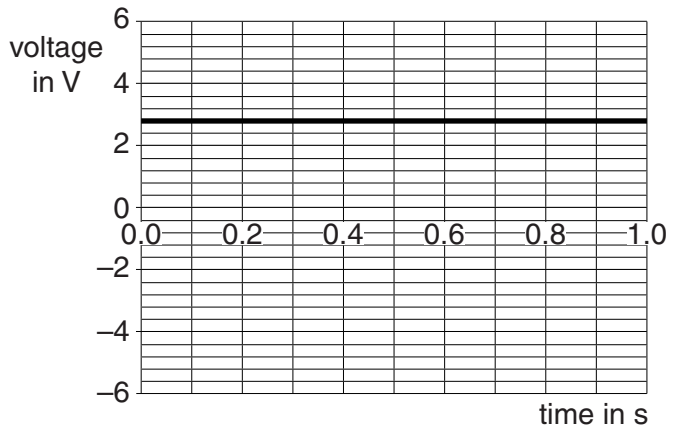
[Total: 7]

11 Michael connects two different sources of electricity to a data-logger.

The data-logger prints out **voltage-time** graphs.



source A



source B

(a) What is the maximum voltage from the AC supply?

..... [1]

(b) Michael makes a simple AC generator in the laboratory.

Describe what he must do to produce AC from his generator.

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

[Total: 3]

**END OF QUESTION PAPER**



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# The Periodic Table of the Elements

	1	2	Key										3	4	5	6	7	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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	7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	88 <b>Sr</b> strontium 38	137 <b>Ba</b> barium 56	[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	65 <b>Zn</b> zinc 30	63.5 <b>Cu</b> copper 29	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	111 <b>Ag</b> silver 47	106 <b>Pd</b> palladium 46	103 <b>Rh</b> rhodium 45	101 <b>Ru</b> ruthenium 44	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	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[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	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	112 <b>Cd</b> cadmium 48	65 <b>Zn</b> zinc 30	59 <b>Ni</b> nickel 28	59 <b>Co</b> cobalt 27	56 <b>Fe</b> iron 26	55 <b>Mn</b> manganese 25	52 <b>Cr</b> chromium 24	48 <b>Ti</b> titanium 22	45 <b>Sc</b> scandium 21	45 <b>Sc</b> scandium 21	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	178 <b>Hf</b> hafnium 72	139 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	89 <b>Y</b> yttrium 39	89 <b>Y</b> yttrium 39	178 <b>Hf</b> hafnium 72	181 