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**Thursday 17 January 2013 – Afternoon**

**GCSE GATEWAY SCIENCE  
SCIENCE B**

**B712/02** Science 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 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.

**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

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

momentum = mass × velocity

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

GPE = mgh

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

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

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**Question 1 begins on page 4**

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Answer **all** the questions.

**SECTION A – Module B2**

**1** This question is about gases in the atmosphere.

**(a)** Carbon dioxide is added to the atmosphere when fossil fuels are burnt.

**(i)** Describe how else carbon dioxide is added to the atmosphere.

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

**(ii)** What process removes carbon dioxide from the atmosphere?

..... [1]

**(b)** Sulfur dioxide is also added to the atmosphere when fossil fuels are burnt.

**(i)** What are the consequences of adding sulfur dioxide to the atmosphere?

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

**(ii)** Air can be chemically tested to monitor sulfur dioxide levels.

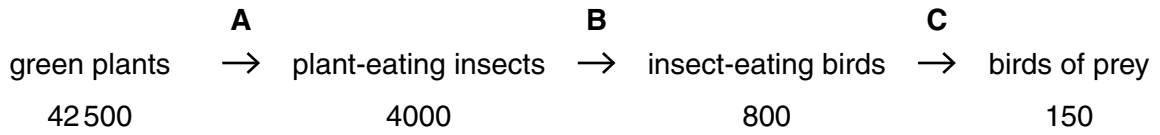
Write down **one other** way of monitoring sulfur dioxide levels in the air.

..... [1]

**[Total: 6]**

2 The diagram shows some of the energy transfers through a countryside ecosystem.

The numbers show the energy at each stage in kJ/m<sup>2</sup>/year.



(a) Calculate the efficiency for each energy transfer **A**, **B** and **C**.

efficiency of **A** ..... %

efficiency of **B** ..... %

efficiency of **C** ..... %

[2]

(b) Which energy transfer is least efficient? .....

Suggest why this energy transfer is least efficient.

.....

.....

..... [2]

(c) There are only four stages to this chain.

In terms of energy transfer, explain why there can **not** be any more stages.

.....

..... [1]

[Total: 5]



(b) What genus does *Waimanu manningi* belong to?

..... [1]

(c) *Waimanu manningi* lived around 3 million years after the mass extinction of about 85% of the world's species.

This mass extinction included most of the world's dinosaurs.

After the extinction there was a relatively rapid evolution of many new species which included the first penguins.

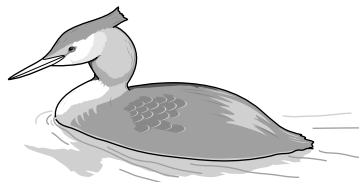
Suggest why there was a rapid evolution of many new species at this time.

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

(d) Scientists used to think that penguins were closely related to some other water birds such as grebes.

They thought this because of similarities between the two types of bird.

However, new evidence now suggests that penguins and grebes are **not** closely related.



grebe

(i) Explain why penguins and grebes have similarities although they are **not** closely related.

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

(ii) Suggest what new evidence could be used to show that penguins and grebes are **not** closely related.

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

(e) Penguins use a counter-current system to keep their feet cooler than the rest of the body.

This reduces heat loss from their feet.

Describe how the counter-current system works.

.....

.....

..... [1]

**[Total: 14]**



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**Question 4 begins on page 10**

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## SECTION B – Module C2

4 Sarah is a farmer.

Look at the table.

It shows information about some of the chemicals Sarah uses while farming.

| Chemical           | Formula                      | Colour     | State at room temperature | Solubility in water |
|--------------------|------------------------------|------------|---------------------------|---------------------|
| Ammonia            | $\text{NH}_3$                | colourless | gas                       | soluble             |
| Ammonium phosphate | $(\text{NH}_4)_3\text{PO}_4$ | white      | solid                     | soluble             |
| Calcium carbonate  | $\text{CaCO}_3$              | white      | solid                     | insoluble           |
| Potassium sulfate  | $\text{K}_2\text{SO}_4$      | white      | solid                     | soluble             |

(a) How many **atoms** are there in the formula for ammonium phosphate,  $(\text{NH}_4)_3\text{PO}_4$ ?

..... [1]

(b) Sarah uses one of the **solid** chemicals to neutralise acid soils.

Which one?

..... [1]

(c) David is a scientist who works with fertilisers. Potassium sulfate is a fertiliser.

It is important that potassium sulfate is soluble in water.

Explain why.

..... [1]

(d) David wants to make some potassium sulfate solution.

He decides to neutralise an acid with potassium hydroxide.

(i) Which **acid** should he use?

..... [1]

(ii) Describe the experimental method he should use to make potassium sulfate solution.

.....

.....

.....

..... [2]

(e) Some scientists want farmers all over the world to use more fertiliser.

Other scientists want farmers all over the world to use less fertiliser.

Evaluate the use of fertilisers in terms of which view will have the best outcome for the majority of people.

.....

.....

.....

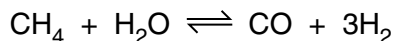
..... [2]

[Total: 8]

Question 5 begins on page 12

5 Stowmarket Synthetics want to manufacture hydrogen from methane and water.

Look at the balanced symbol equation for this reaction.



Phil is a research chemist who works for Stowmarket Synthetics.

He investigates how the **percentage yield (%)** of this process changes with temperature and with pressure.

He does this with and without a catalyst.

Look at the percentage yield (%) **with** a catalyst.

|                        | Temperature<br>in °C | Pressure in atmospheres |     |     |
|------------------------|----------------------|-------------------------|-----|-----|
|                        |                      | 20                      | 30  | 40  |
| <b>With a catalyst</b> | <b>300</b>           | 60%                     | 42% | 34% |
|                        | <b>500</b>           | 67%                     | 49% | 42% |
|                        | <b>700</b>           | 70%                     | 64% | 58% |

Look at the percentage yield (%) **without** a catalyst.

|                           | Temperature<br>in °C | Pressure in atmospheres |     |     |
|---------------------------|----------------------|-------------------------|-----|-----|
|                           |                      | 20                      | 30  | 40  |
| <b>Without a catalyst</b> | <b>300</b>           | 60%                     | 42% | 34% |
|                           | <b>500</b>           | 67%                     | 49% | 42% |
|                           | <b>700</b>           | 70%                     | 64% | 58% |

(a) What conclusions can Phil make about the effect of:

- using the catalyst
- changing the temperature
- changing the pressure

on the percentage yield?

.....

.....

.....

.....

.....

..... [3]

(b) Stowmarket Synthetics know that many factors affect the cost of making hydrogen.

The high temperature and high pressure are two of these factors.

Explain how two **other** factors can reduce the cost of making hydrogen.

.....

.....

.....

..... [2]

[Total: 5]

Question 6 begins on page 14

- 6 The body of a railway carriage can be made from either aluminium or steel.



Look at the table. It shows some of the properties of aluminium and steel.

| Property   | Aluminium                              | Steel                                  |
|--|--|--|
| corrosion in moist conditions                    | does not corrode                       | slowly rusts                           |
| density<br>(1 = low, 10 = high)                  | 3                                      | 8                                      |
| magnetic attraction                              | not attracted                          | attracted                              |
| hardness<br>(1 = soft, 10 = hard)                | 5                                      | 8                                      |
| strength<br>(1 = weak, 10 = strong)              | 4                                      | 9                                      |
| electrical conductivity<br>(1 = poor, 10 = good) | 8                                      | 7                                      |
| other properties                                 | malleable and a good conductor of heat | malleable and a good conductor of heat |

Evaluate the advantages and disadvantages of using aluminium and of using steel to make the bodies of railway carriages.



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

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..... [6]

**[Total: 6]**

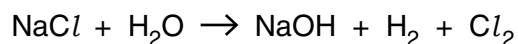
**Question 7 begins on page 16**

7 Sodium chloride is found in sea water.

It is an important raw material used in the chemical industry.

Sodium chloride solution can be electrolysed to make sodium hydroxide, chlorine and hydrogen.

(a) Look at the symbol equation for this reaction. It is **not** balanced.



Write down the **balanced symbol** equation for this reaction.

..... [1]

(b) Look at the equations for the electrode reactions that happen during this electrolysis.



The electrolysis of sodium chloride solution involves **both** oxidation and reduction.

Explain which reaction shows oxidation and which reaction shows reduction.

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

[Total: 3]



- 8 The theory of plate tectonics explains many of the geological events that occur on the Earth's surface.

The theory was first proposed in 1914, by a scientist called Wegener.

In 1914, not many scientists believed Wegener's theory.

- (a) It took almost 50 years until scientists widely accepted the theory of plate tectonics.

Explain why.

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

- (b) The theory of plate tectonics explains what happens when a continental and an oceanic plate collide.

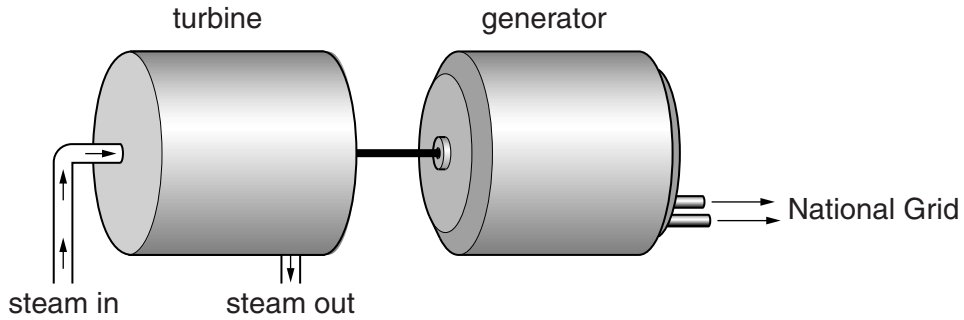
Describe what happens when these plates collide.

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

[Total: 3]

SECTION C – Module P2

9 Power stations generate electricity.



A turbine drives a generator.

(a) Describe how the generator produces electricity.

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

(b) In a power station a large amount of energy is wasted.

For every  $1.0 \times 10^6$  J of energy supplied in coal only  $2.8 \times 10^5$  J are changed to electrical energy.

$7.2 \times 10^5$  J of energy are wasted.

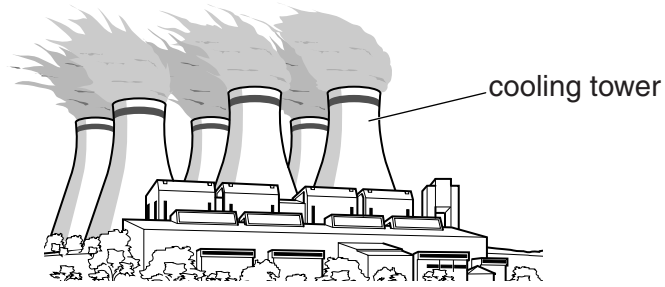
Calculate the efficiency of the power station.

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

answer ..... [2]

(c) A community group says that they can make the existing power station more efficient.

They can use steam from the cooling towers to heat local homes.



This will increase the efficiency of the power station.

Explain how.

.....

..... [1]

[Total: 5]

Question 10 begins on page 20

10 Hannah investigates photocells.

(a) She finds that a panel of photocells 30 cm × 20 cm produces 20 watts of power.

Hannah needs to produce 50 watts of power.

Calculate the panel area of photocells she must use.

.....

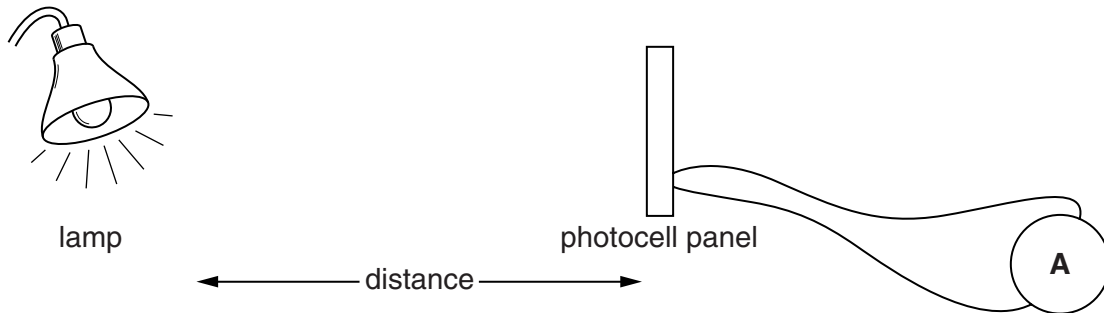
.....

answer.....cm<sup>2</sup>

[2]

(b) Hannah now investigates a small panel of photocells.

Look at the diagram of the apparatus she uses.



Hannah experiments to find out how the current produced by the panel changes as she moves the lamp away.

Look at the table of her results.

| Distance of lamp from panel in cm | Current in mA |
|-----------------------------------|---------------|
| 5                                 | 120.0         |
| 10                                | 30.0          |
| 15                                | 13.3          |
| 20                                | 7.5           |
| 30                                | 3.3           |
| 40                                | 2.2           |
| 60                                | 1.5           |
| 80                                | 1.4           |

Hannah makes a conclusion from her results.

'When I double the distance from the lamp, the current from the panel is a quarter of the original value.'

Is this a sensible conclusion for **all** her results?

.....

Use the data to explain your answer.

.....

.....

..... [3]

[Total: 5]

**Question 11 begins on page 22**

11 This question is about dealing with radioactive materials safely.

(a) Radioactive waste is produced by some industries and hospitals.

Half-life is the time it takes for the waste to become half as radioactive.

Look at the information in the table.

| <b>Waste containing...</b>      | <b>Level of radiation</b> | <b>Half-life</b>  | <b>Type of radiation given out</b> |
|---------------------------------|---------------------------|-------------------|------------------------------------|
| uranium                         | very radioactive          | 700 000 000 years | alpha                              |
| iodine                          | very radioactive          | 8 days            | beta and gamma                     |
| a mix of sources from hospitals | slightly radioactive      | up to 20 years    | alpha, beta and gamma              |

Suggest how each type of waste can be disposed of safely, giving reasons for your answer.



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

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..... [6]

(b) There are many useful applications for radioactive sources.

Alpha radiation is used in smoke detectors.

(i) Write down one use of beta radiation.

..... [1]

(ii) Write down one use of gamma radiation.

..... [1]

[Total: 8]

12 (a) Comets orbit our Sun.

The speed of a comet increases as it gets closer to the Sun.

Explain why.

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

(b) Near Earth Objects (NEOs) are threats to the Earth.

Suggest what actions can be taken to reduce the threat from these objects.

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

[Total: 4]

13 (a) The Big Bang theory accounts for the start of the Universe.

Light observed from distant galaxies is shifted towards the red end of the spectrum.

How do these observations support the Big Bang theory?

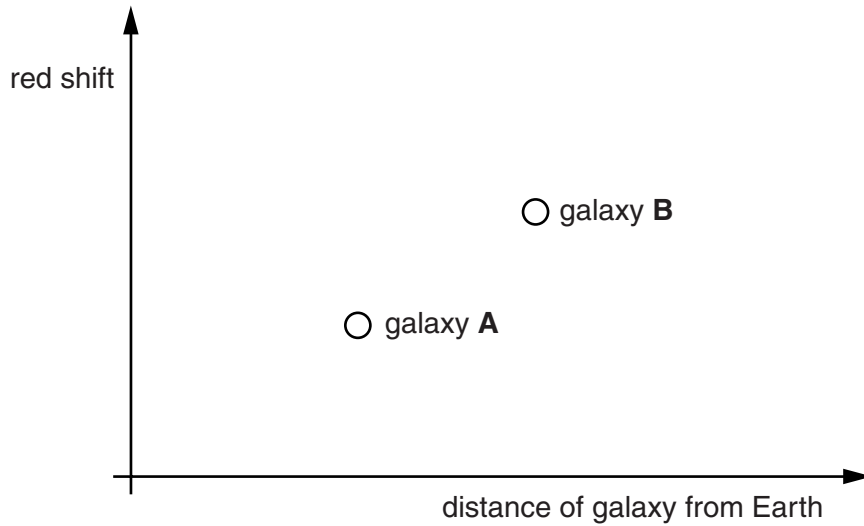
.....

.....

.....

..... [1]

(b) Look at the graph.



The graph shows that galaxy B is further away from Earth than galaxy A.

What conclusions can be made about galaxies A and B?

.....

.....

..... [2]

[Total: 3]



**25**  
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**Question 14 begins on page 26**

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## SECTION D

14 This question is about the greenhouse effect and global warming.

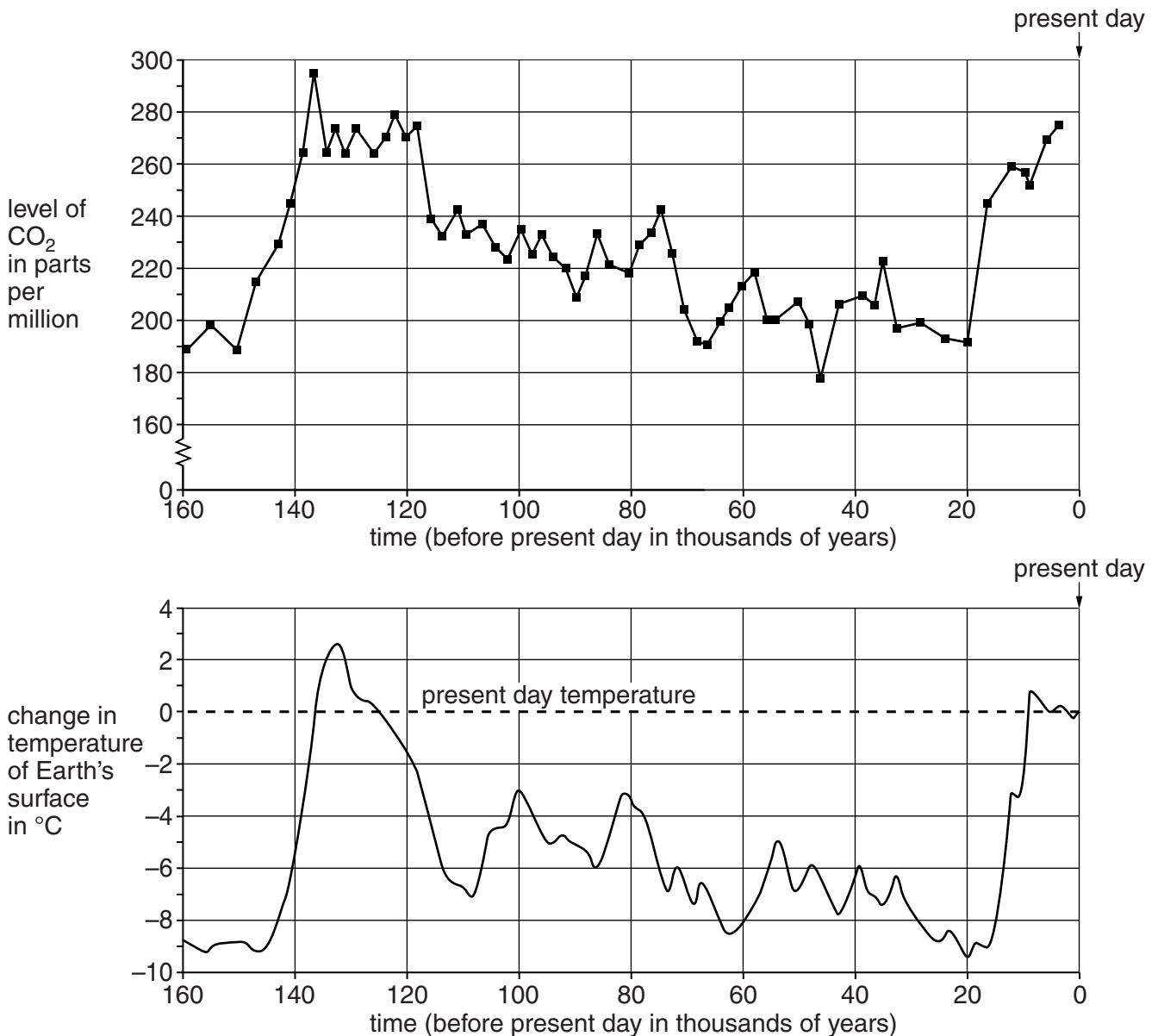
Some scientists say that an increase in global warming is part of a natural cycle.

Other scientists think that an increase in global warming will be disastrous for the world. They think that the surface temperature of the Earth is increasing and that this is because more fossil fuels are being burned.

Burning fossil fuels makes a lot of carbon dioxide.

Look at the graphs.

They show how the amount of carbon dioxide in the air and the temperature of the Earth have changed over the last 160 000 years.



- (a) Is there a link between the surface temperature of the Earth and the level of carbon dioxide in the air?

Explain your answer. Use information from the graphs.

.....

.....

..... [2]

**Question 14(b) begins on page 28**

(b) Look at the table. It shows the carbon dioxide emissions for some countries in 2003.

It also shows the population for these countries in 2003.

| Country    | Continent | Carbon dioxide emissions in million tonnes per year | Population in millions | Carbon dioxide emissions per million of population in millions of tonnes |
|------------|-----------|---|------------------------|--|
| Botswana   | Africa    | 4   | 2                      | 2.0  |
| China      | Asia      | 3762  | 1254                   | 3.0  |
| France     | Europe    | 390   | 62                     | 6.3  |
| Germany    | Europe    | 854   | 82                     | 10.4   |
| Ghana      | Africa    | 7   | 23                     | 0.3  |
| India      | Asia      | 1050  | 1064                   | 1.0  |
| Indonesia  | Asia      | 318   | 215                    | 1.5  |
| Japan      | Asia      | 1201  | 128                    | 9.4  |
| Mozambique | Africa    | 2   | 21                     | 0.1  |
| Russia     | Asia      | 1527  | 143                    | 10.7   |
| UK         | Europe    | 540   | 59                     | 9.2  |
| USA        | America   | 5729  | 291                    | 19.7   |
| World      |           | 24983   | 6268                   | 3.9  |

(i) What percentage of the world emissions of carbon dioxide in 2003 was made by the USA?

Give your answer correct to **one** decimal place.

.....  
 .....

answer ..... % [2]

(ii) Comment on any patterns you can see in the table between carbon dioxide emissions and population.

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

(c) Other gases can contribute to global warming.

Look at the table.

It shows how long each gas remains in the air (lifetime), its global warming potential and the current level of each gas in the air.

| <b>Gas</b>     | <b>Lifetime in years</b> | <b>Global warming potential</b> | <b>Current level in the air in parts per million</b> |
|----------------|--------------------------|---------------------------------|--|
| carbon dioxide | 1                        | 1                               | 388.0  |
| methane        | 12                       | 72                              | 1.7  |
| nitrous oxide  | 114                      | 289                             | 0.3  |

Evaluate the likely contribution of each gas to global warming.

.....

.....

.....

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.....

.....

..... [3]

[Total: 10]

**END OF QUESTION PAPER**

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# The Periodic Table of the Elements

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

|                                |
|--------------------------------|
| 1<br><b>H</b><br>hydrogen<br>1 |
|--------------------------------|

|   |
|---|
| relative atomic mass<br>atomic symbol<br>name<br>atomic (proton) number |
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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.