

Thursday 17 January 2013 – Afternoon

**GCSE GATEWAY SCIENCE
SCIENCE B**

B712/02 Science modules B2, C2, P2 (Higher Tier)

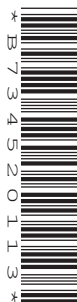
Candidates answer on the Question Paper.
A calculator may be used for this paper.

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.

2

EQUATIONS

energy = mass × specific heat capacity × temperature change

energy = mass × specific latent heat

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

wave speed = frequency × wavelength

power = voltage × current

energy supplied = power × time

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

distance = average speed × time

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

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

force = mass × acceleration

weight = mass × gravitational field strength

work done = force × distance

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

power = force × speed

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

momentum = mass × velocity

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

GPE = mgh

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

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

3

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Question 1 begins on page 4

PLEASE DO NOT WRITE ON THIS PAGE

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?

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..... [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.

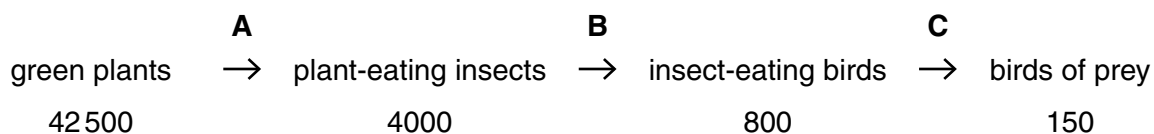
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[Total: 6]

5

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

The numbers show the energy at each stage in $\text{kJ/m}^2/\text{year}$.



- (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]

- 3 *Waimanu manneringi* is the oldest known species of penguin.

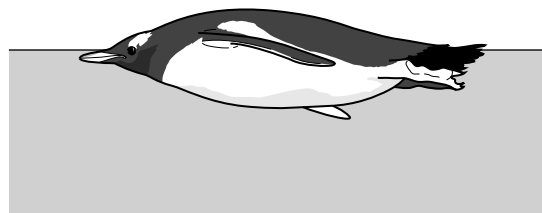
It lived around 62 million years ago in what is now New Zealand.

Scientists have used its fossils to reconstruct what they think it looked like.

The Gentoo penguin is a species of penguin that is alive today.



Waimanu manneringi



Gentoo penguin

Scientists think that *Waimanu manneringi* was a **less** efficient swimmer than the Gentoo penguin.

One reason for this is that *Waimanu manneringi* was **not** as streamlined as the Gentoo penguin.

- (a) Scientists think that the Gentoo penguin species evolved from a species that looked very similar to *Waimanu manneringi*.

Explain how the Gentoo penguin species could have evolved from this different species.



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

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..... [6]

- (b) What genus does *Waimanu manneringi* belong to?

..... [1]

- (c) *Waimanu manneringi* 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.

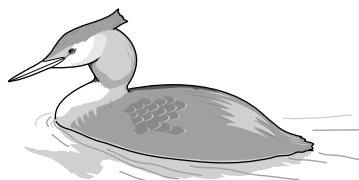
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 [2]

- (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]

8

- (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.

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..... [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	NH_3	colourless	gas	soluble
Ammonium phosphate	$(\text{NH}_4)_3\text{PO}_4$	white	solid	soluble
Calcium carbonate	CaCO_3	white	solid	insoluble
Potassium sulfate	K_2SO_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.

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..... [2]

11

- (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.

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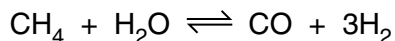
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[Total: 8]

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.

With a catalyst	Temperature in °C	Pressure in atmospheres		
		20	30	40
	300	60%	42%	34%
	500	67%	49%	42%
	700	70%	64%	58%

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

Without a catalyst	Temperature in °C	Pressure in atmospheres		
		20	30	40
	300	60%	42%	34%
	500	67%	49%	42%
	700	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?

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..... [3]

13

- (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.

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..... [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 (1 = low, 10 = high)	3	8
magnetic attraction	not attracted	attracted
hardness (1 = soft, 10 = hard)	5	8
strength (1 = weak, 10 = strong)	4	9
electrical conductivity (1 = poor, 10 = good)	8	7
other properties	malleable and a good conductor of heat	malleable and a good conductor of heat

15

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]

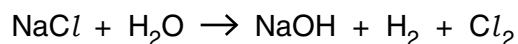
Question 7 begins on page 16

- 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.

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..... [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.

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..... [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.

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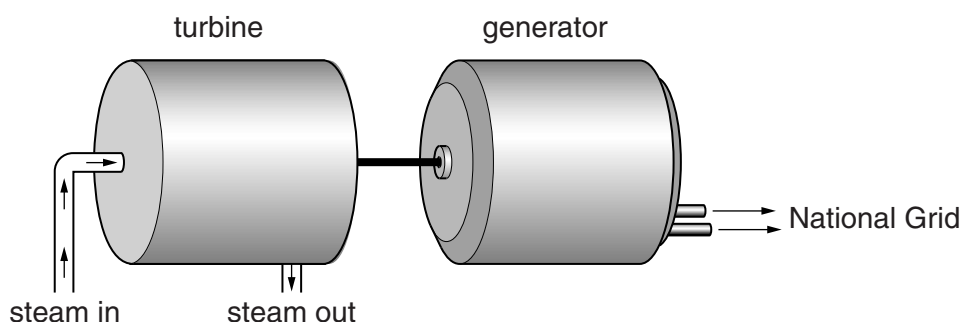
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..... [2]

[Total: 3]

SECTION C – Module P2

9 Power stations generate electricity.



A turbine drives a generator.

(a) Describe how the generator produces electricity.

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..... [2]

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

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

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

Calculate the efficiency of the power station.

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answer [2]

19

- (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.

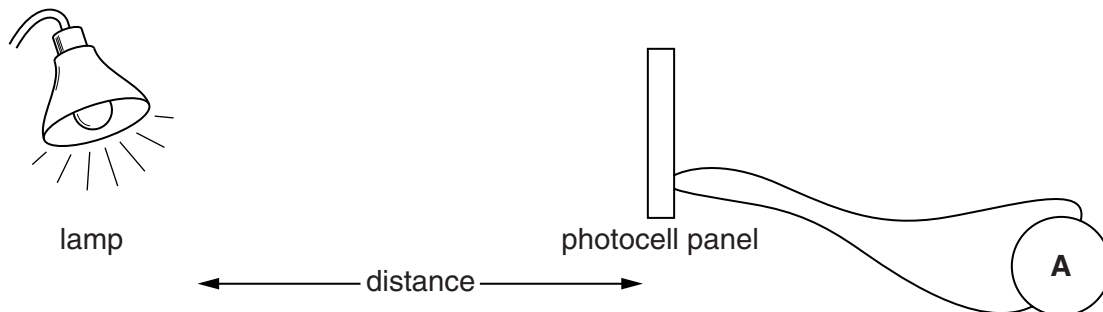
.....

answer.....cm²

[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

21

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.

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..... [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.

Waste containing...	Level of radiation	Half-life	Type of radiation given out
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]

23

- (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.

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..... [2]

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

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

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..... [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?

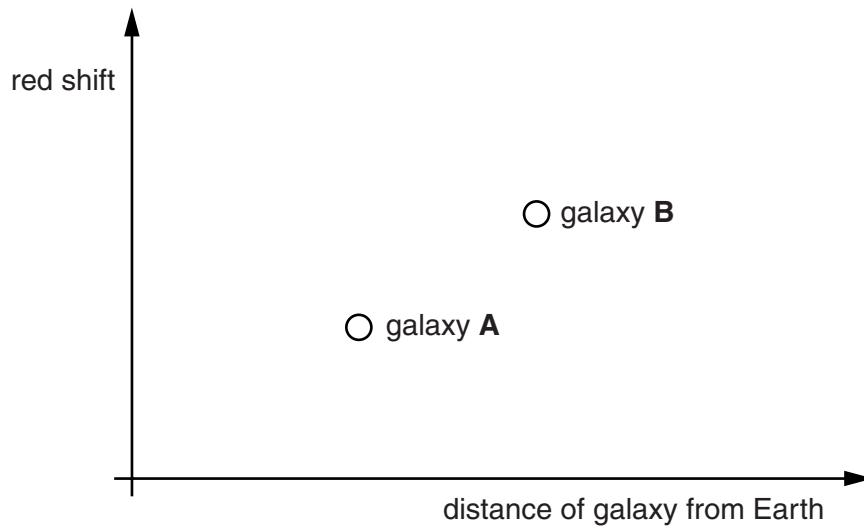
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..... [1]

- (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**?

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..... [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.

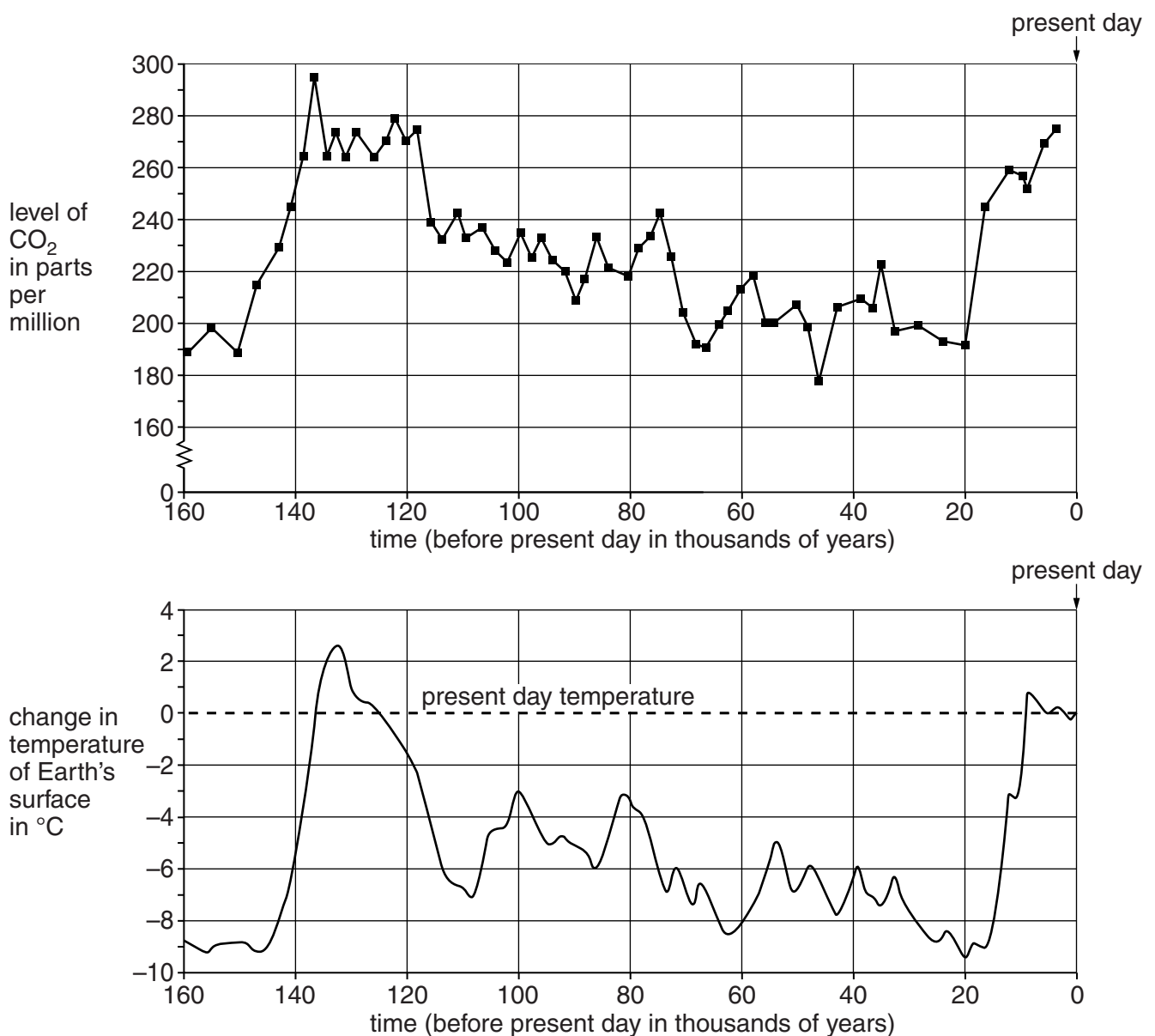
Some scientists say that an increase in global warming is part of a natural cycle.

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.



27

- (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.

.....

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..... [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		24 983	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]

29

(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.

Gas	Lifetime in years	Global warming potential	Current level in the air in parts per million
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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[Total: 10]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2	Key										3	4	5	6	7	0							
		relative atomic mass atomic symbol name atomic (proton) number																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

1
H
hydrogen
1

* 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.