

Monday 19 June 2017 – Morning

**GCSE GATEWAY SCIENCE
CHEMISTRY B**

B742/02 Chemistry modules C4, C5, C6 (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	
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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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil (✎).
- 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 **28** pages. Any blank pages are indicated.

Answer **all** the questions.

SECTION A – Module C4

1 Look at the formulas.



(a) Which formula represents a metal ion?

.....

[1]

(b) Use the formulas to write down the formula of magnesium fluoride.

.....

[1]

(c) The electronic structure of lithium is 2.1.

Lithium is a reactive metal.

Explain **how** and **why** a lithium atom forms a lithium ion.

.....

 [2]

(d) Sodium reacts with oxygen to make sodium oxide, Na₂O.

Draw a 'dot and cross' diagram to show the ionic bonding in sodium oxide.

Show all of the electrons in each ion.

The electronic structure of sodium is 2.8.1.

The electronic structure of oxygen is 2.6.

Show the charges on each ion.

[3]

2 This question is about atoms.

(a) Atoms are made up of protons, neutrons and electrons.

Complete the table.

Particle	Relative mass	Relative charge
electron	0.0005	-1
proton
neutron

[2]

(b) Atoms are neutral.

Explain why.

.....
 [1]

(c) Which of these describes the approximate radius and mass of an atom?

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

	Radius in metres	Mass in grams
A	10^{-2}	10^{-20}
B	10^{-5}	10^{-15}
C	10^{-10}	10^{-23}
D	10^{-20}	10^{-35}

answer

[1]

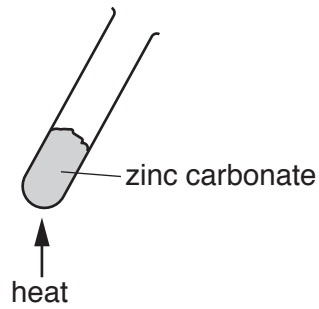
(d) An atom of an element has an electronic structure of 2.8.6.

To which **group** of the periodic table does the element belong?

..... [1]

3 Ian heats some zinc carbonate, ZnCO_3 .

Look at the diagram. It shows the apparatus he uses.



What happens to the zinc carbonate when it is heated?

.....

.....

.....

..... [3]

4 Ammonia has the formula, NH_3 .

Ammonia has a **simple molecular** structure.

Predict **two** physical properties of ammonia.

Explain your answers.

.....

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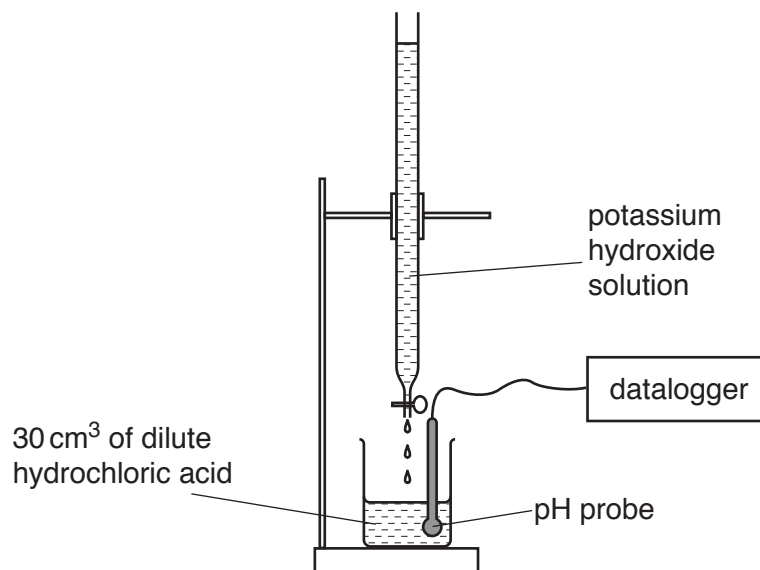
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..... [4]

SECTION B – Module C5

- 6 Sara is neutralising dilute hydrochloric acid with potassium hydroxide solution.

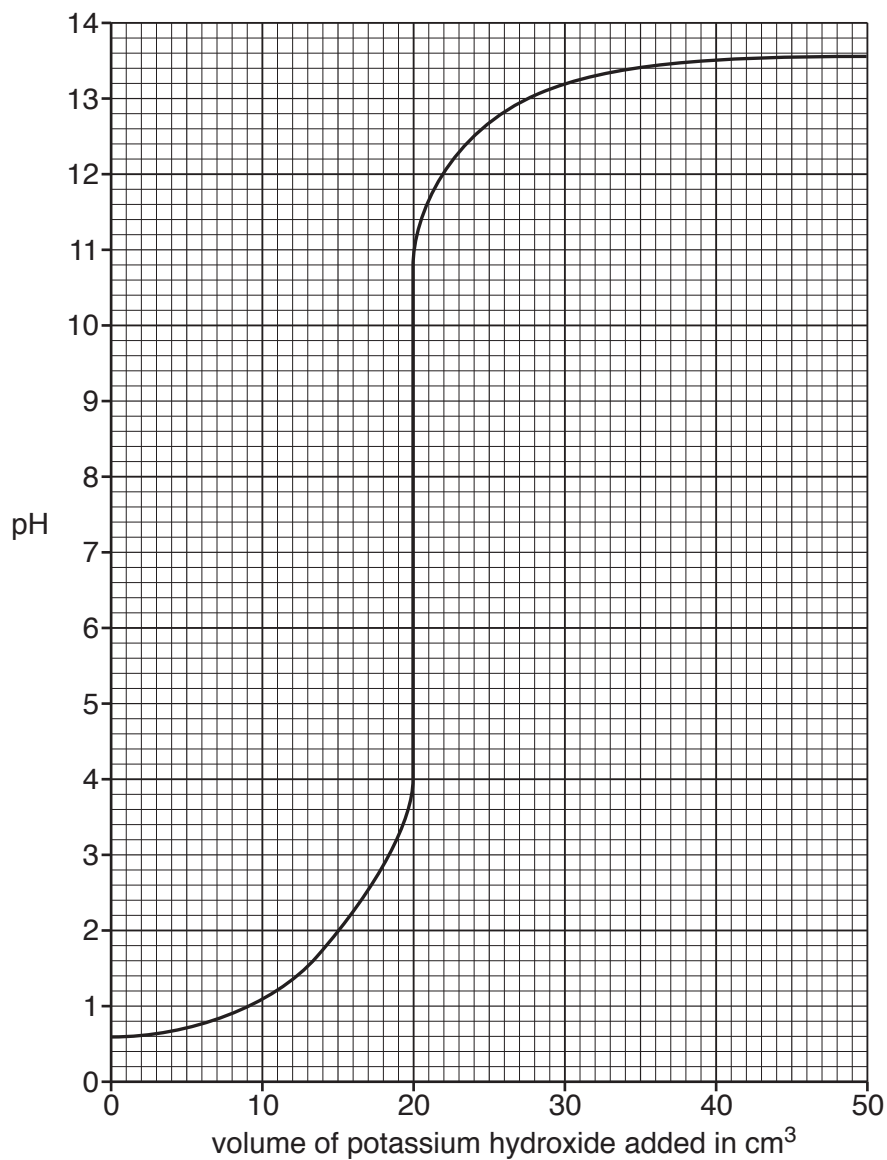
Look at the diagram of the apparatus she uses.



- (a) Sara slowly adds 50 cm³ of potassium hydroxide solution to 30 cm³ of dilute hydrochloric acid.

She measures the pH of the solution in the flask as the potassium hydroxide solution is added.

Look at the graph of her results.



(i) What volume of potassium hydroxide solution must be added to get a pH of 12?

..... cm³

[1]

(ii) What volume of potassium hydroxide solution is needed to exactly neutralise the hydrochloric acid?

..... cm³

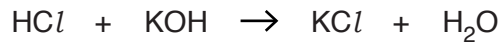
[1]

- (b) (i) The concentration of the hydrochloric acid is 0.30 mol/dm^3 .

Show that 30 cm^3 of this solution contains 0.009 moles of hydrochloric acid.

.....
 [1]

- (ii) Look at the equation for the reaction.



Use your answers to parts (a)(ii) and (b)(i) to calculate the concentration of the potassium hydroxide solution.

concentration of potassium hydroxide solution = mol/dm^3 [2]

- 7 Magnesium is an element in the periodic table.

Magnesium has a **relative atomic mass** of 24.

- (a) What is meant by the relative atomic mass of an element?

.....

 [1]

- (b) A sample of 42g of magnesium carbonate contains 12g of magnesium.

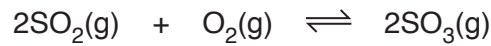
Calculate the percentage by mass of magnesium in magnesium carbonate.

Quote your answer to **one** decimal place.

percentage by mass = % [2]

- 8 Look at the equation for the reaction between sulfur dioxide and oxygen.

Sulfur trioxide is made.



The reaction is reversible.

- (a) When sulfur dioxide is mixed with oxygen, eventually an **equilibrium** mixture is made.

Explain why, and under what conditions, the mixture reaches an equilibrium.

.....

.....

.....

..... [3]

- (b) More oxygen is added to the reaction mixture at equilibrium.

What happens to the **position** of the equilibrium?

..... [1]

- (c) This reaction is used in the Contact Process to make sulfuric acid.

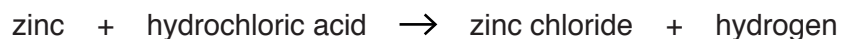
One of the conditions used is a low pressure of about five atmospheres.

Describe **two** other conditions used in the Contact Process.

.....

..... [2]

- 9 Pete and Sue investigate the reaction between zinc and hydrochloric acid.



They do the experiment four times.

Each time they use 1.0g of zinc.

They use the same volume of different concentrations of hydrochloric acid.

They measure the total volume of hydrogen made every minute.

Look at the table of their results.

Experiment	Total volume of hydrogen in cm ³ made after					
	1 min	2 min	3 min	4 min	5 min	6 min
A	10	20	27	29	30	30
B	15	25	32	39	40	40
C	5	10	12	15	15	15
D	18	27	35	40	44	48

- (a) Pete concludes

In experiment **B**, the concentration of the hydrochloric acid was greater than in experiment **A**.



Sue concludes

The concentration of hydrochloric acid in experiment **C** is half that in experiment **A**.



Are each of the conclusions correct?

Explain your answers.

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

(b) Look at experiment D.

It is not possible to deduce the total volume of hydrogen at the end of the experiment.

Use the results to explain why.

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

(c) In experiment D, the volume of hydrogen made after 6 minutes is 48 cm³.

Calculate the mass of 48 cm³ of hydrogen, H₂, at room temperature and pressure.

The volume of 1 mole of any gas is 24 dm³ at room temperature and pressure.

The relative formula mass of H₂ = 2.

mass of hydrogen = g [2]

13
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SECTION C – Module C6

11 Sophie investigates the hardness of water.

She finds out how many drops of soap solution are needed to produce a lather.

She does this with four samples of water.

Look at her results.

Water sample	Number of drops of soap solution needed to produce a lather	
	before boiling water sample	after boiling water sample
A	30	1
B	25	25
C	1	1
Distilled water	1	1

(a) One sample of water contains **temporary** hardness.

Which one? Explain your answer using information from the table.

.....

.....

..... [2]

(b) **Permanent** hardness in water is caused when some compounds dissolve in the water.

Which dissolved compound causes permanent hardness in water?

Choose from the list.

calcium carbonate

calcium hydrogencarbonate

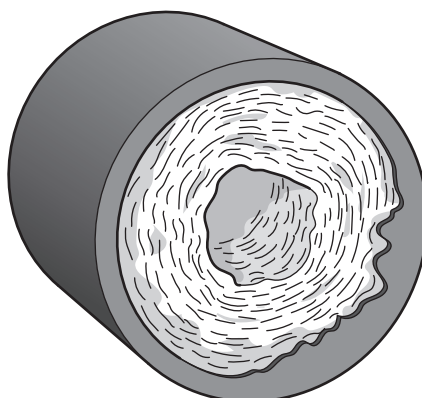
calcium sulfate

carbon dioxide

sodium chloride

answer [1]

- (c) In hard water areas limescale can clog up pipes.



Limescale is calcium carbonate.

Calcium carbonate can be removed by reacting it with hydrochloric acid.

Calcium chloride, carbon dioxide and water are made.

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

..... [2]

12 This question is about CFCs.

The use of CFCs was banned in the UK in 1989.

(a) Since 1989 safer alternatives to CFCs have been used.

Write down **one** type of compound that has replaced CFCs.

Choose from the list.

alcohols

alkanes

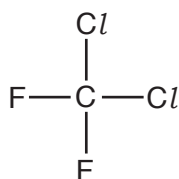
alkenes

dibromo compounds

enzymes

..... [1]

(b) Look at the displayed formula of a CFC.



A carbon-chlorine bond in the CFC can break to form highly reactive chlorine atoms.

Explain how, using ideas about electrons.

.....
 [1]

(c) CFCs were discovered in the 1930s.

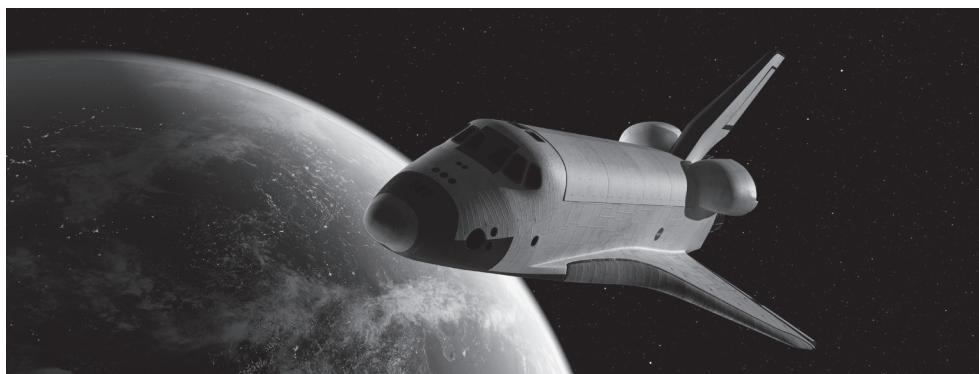
Describe and explain how scientists' attitude to CFCs has changed since their discovery.

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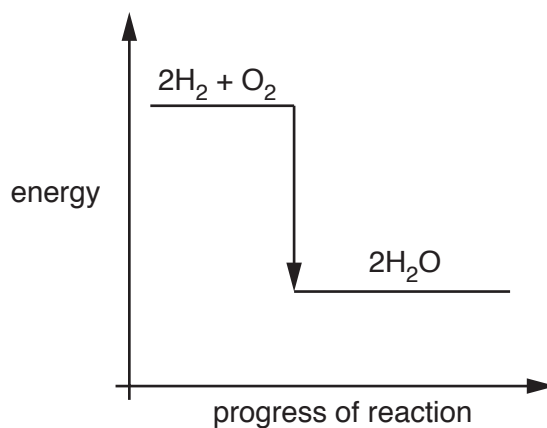
 [2]

13 This question is about fuel cells.

Fuel cells are used in spacecraft.



(a) Look at the energy level diagram for the reaction between hydrogen and oxygen in a fuel cell.



Is the reaction in the fuel cell exothermic or endothermic?

Use the energy level diagram to explain why.

.....
 [1]

(b) Hydrogen gas, H_2 , forms hydrogen ions, H^+ , at one electrode in a fuel cell.



The hydrogen ions react with oxygen gas, O_2 , at the other electrode.

Water, H_2O , is made in this reaction.

Write the **balanced symbol** equation for the reaction between oxygen and hydrogen ions.

Use e^- to represent an electron.

..... [2]

14 This question is about the rusting of iron and steel.

One disadvantage of ships made from iron is that iron rusts.



(a) Oxygen and water are needed for iron to rust.

Hydrated iron(III) oxide is made.

Write a **word equation** for the rusting of iron.

..... [1]

(b) Iron can be **galvanised** to stop it from rusting.

Explain **how** galvanising stops iron from rusting.

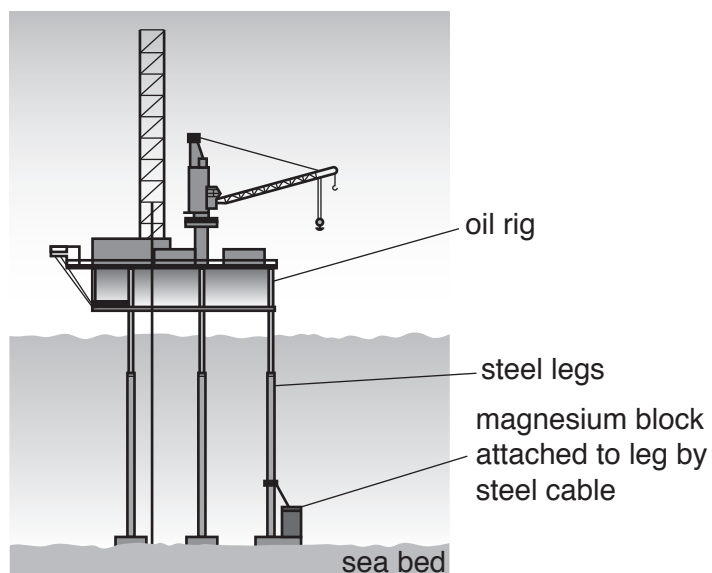
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..... [2]

(c) Oil rigs have large steel legs.

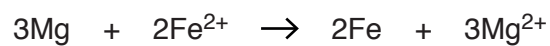
These legs are too large to be protected from rusting using galvanising.

The legs are protected from rusting by attaching a sacrificial metal to them.

A metal such as magnesium is often used.



Look at the equation for the reaction that happens.



Explain why this is a **redox** reaction.

.....

.....

..... [2]

15 Pete is investigating four different washing powders.

He tests the washing powders by washing dirty clothes at 40 °C.

Look at the table. It shows his results.

Washing powder	Number of washes per pack	Price per pack in £	Overall stain removal (5 = excellent, 1 = poor)	Whiteness (5 = excellent, 1 = poor)	Prevents colour fading (5 = excellent, 1 = poor)
A	20	3.19	5	4	3
B	25	2.39	5	5	3
C	25	3.00	5	5	4
D	30	3.00	3	2	4

(a) Pete thinks that washing powder **C** is the best to use to wash his clothes.

Is he correct? Explain your answer using information from the table.

Explain how detergents can remove oil stains from clothes.



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

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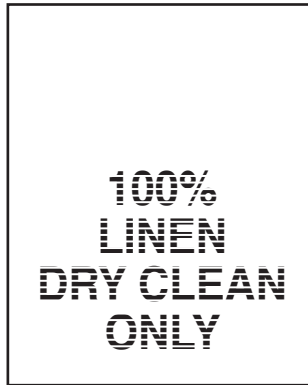
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(b) Pete looks at the washing label on his jacket.



Describe what is meant by dry cleaning and suggest why Pete's jacket must be dry cleaned.

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..... [2]

SECTION D

16 The acidity of sea water is increasing.

Scientists think that increased levels of carbon dioxide and sulfur dioxide in the air cause this increase.

Both these gases dissolve in water to make acidic solutions.

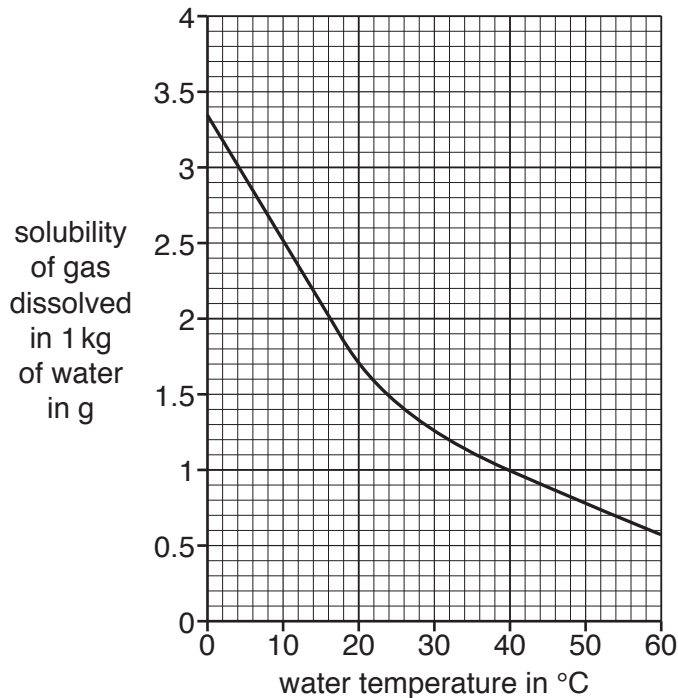
The solubility of these gases in water changes with temperature.

The more gas that dissolves in water the more acidic the solution.

(a) Look at graph 1.

It shows the solubility of carbon dioxide in water at different temperatures.

Graph 1 – solubility of carbon dioxide



(i) At what temperature is the solubility of carbon dioxide 1.4 g dissolved in 1 kg of water?

..... °C

[1]

(ii) Julie has 3.0kg of water at 10 °C.

She predicts she can dissolve 7.5g of carbon dioxide in this water.

Is she correct?

Explain your answer using information from the graph.

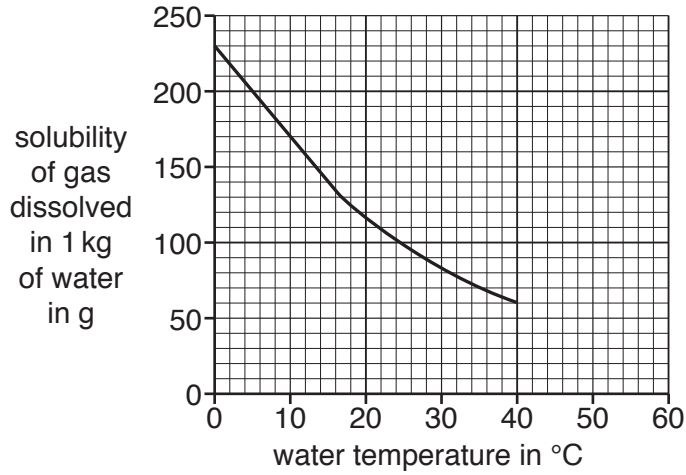
.....

[2]

(b) Look at graph 2.

It shows the solubility of sulfur dioxide in water at different temperatures.

Graph 2 – solubility of sulfur dioxide



(i) Sulfur dioxide is at least fifty times more soluble in water than carbon dioxide.

Explain how you can tell from graphs 1 and 2.

.....

.....

.....

..... [2]

(ii) Use the graph to estimate the solubility of sulfur dioxide at 60°C.

..... g of gas dissolved per kg of water [1]

(iii) The Arctic Ocean is very cold.

The Indian Ocean is quite warm.

Suggest why the Arctic Ocean is more acidic than the Indian Ocean.

Use information from graphs 1 and 2.

.....

.....

..... [1]

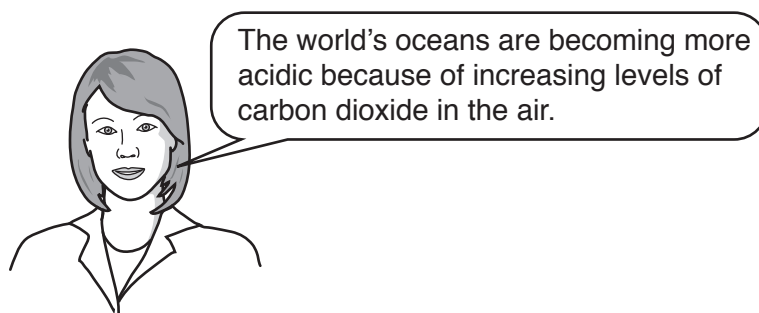
(c) Look at the table.

It shows information obtained on sea water near a remote island in the Atlantic Ocean.

Year	pH of sea water	Percentage (%) by volume of carbon dioxide in the air	Mass of carbon dioxide in 1 kg of sea water in g
1990	8.00	0.035	1.50
1995	7.98	0.036	1.51
2000	7.95	0.037	1.52
2005	7.96	0.038	1.53
2010	7.90	0.039	1.55

Ann knows that the lower the pH the more acidic a solution.

Ann makes a conclusion.



Nick thinks that the data in the table is not reliable or valid.

(i) He thinks that the temperature of the ocean should have been recorded in the table.

Suggest why Nick is correct.

.....
 [1]

(ii) Suggest **two other** reasons why Ann's conclusion may not be reliable or valid.

.....

 [2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing, consisting of 25 horizontal dotted lines. A solid vertical line runs down the left side of the page, creating a margin. The lines are evenly spaced and extend across the width of the page.

A vertical table structure consisting of 26 rows and 2 columns. The columns are separated by a solid vertical line on the left, and the rows are separated by horizontal dotted lines. The table is currently empty.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.



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The Periodic Table of the Elements

	1	2	3	4	5	6	7	0										
	7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18								
	19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36
	37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	43 Tc technetium 43	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54
	55 Cs caesium 55	56 Ba barium 56	57 La* lanthanum 57	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 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						

1 H hydrogen 1

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.