OCR
Oxford Cambridge and RSA

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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

* B 7 4 2 0 2 *

* 6 7 5 4 0 2 0 9 9 4 *

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. 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.

CO_2 Na Mg^{2+} Zn F^-

(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.

.....

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

(d) Sodium reacts with oxygen to make sodium oxide, Na_2O.

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]**

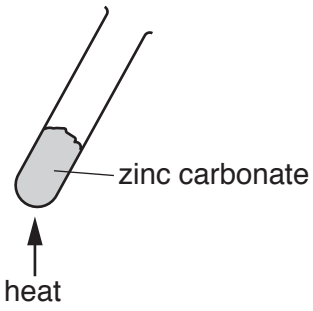
(d) An atom of an element has an electronic structure of 2.8.6.

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?

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..... **[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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..... **[4]**

5 Phil is investigating the reactions of the halogens with solutions of metal halides.

Look at the table. It shows his results.

Halogen	Reaction with		
	sodium chloride	**sodium bromide**	**sodium iodide**
chlorine, Cl_2	no reaction	orange solution made	brown solution made
halogen, $\mathbf{X_2}$	no reaction	no reaction	no reaction
halogen, $\mathbf{Y_2}$	no reaction	no reaction	brown solution made
halogen, $\mathbf{Z_2}$	pale green solution made	orange solution made	brown solution made

What is the order of reactivity (most reactive first) of the four halogens in the table?

Explain your answer.

Include a **balanced symbol** equation for the reaction between chlorine and sodium bromide.

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

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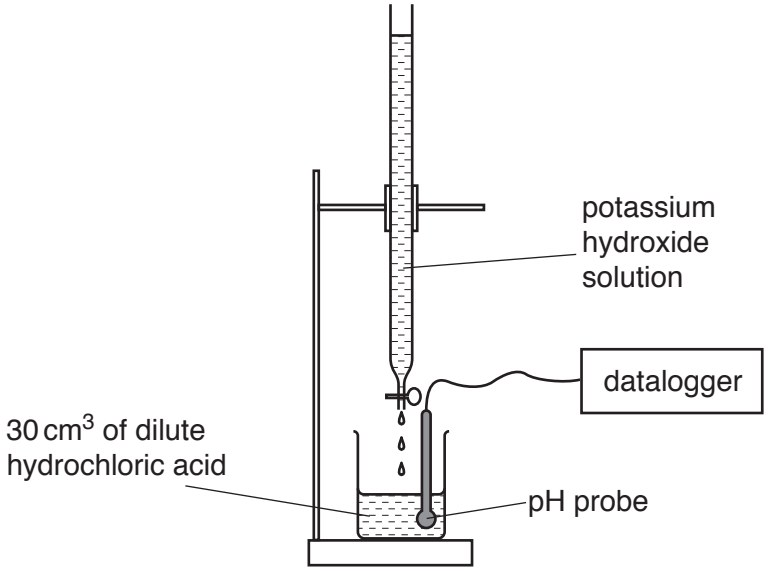
..... **[6]**

SECTION B – Module C5

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

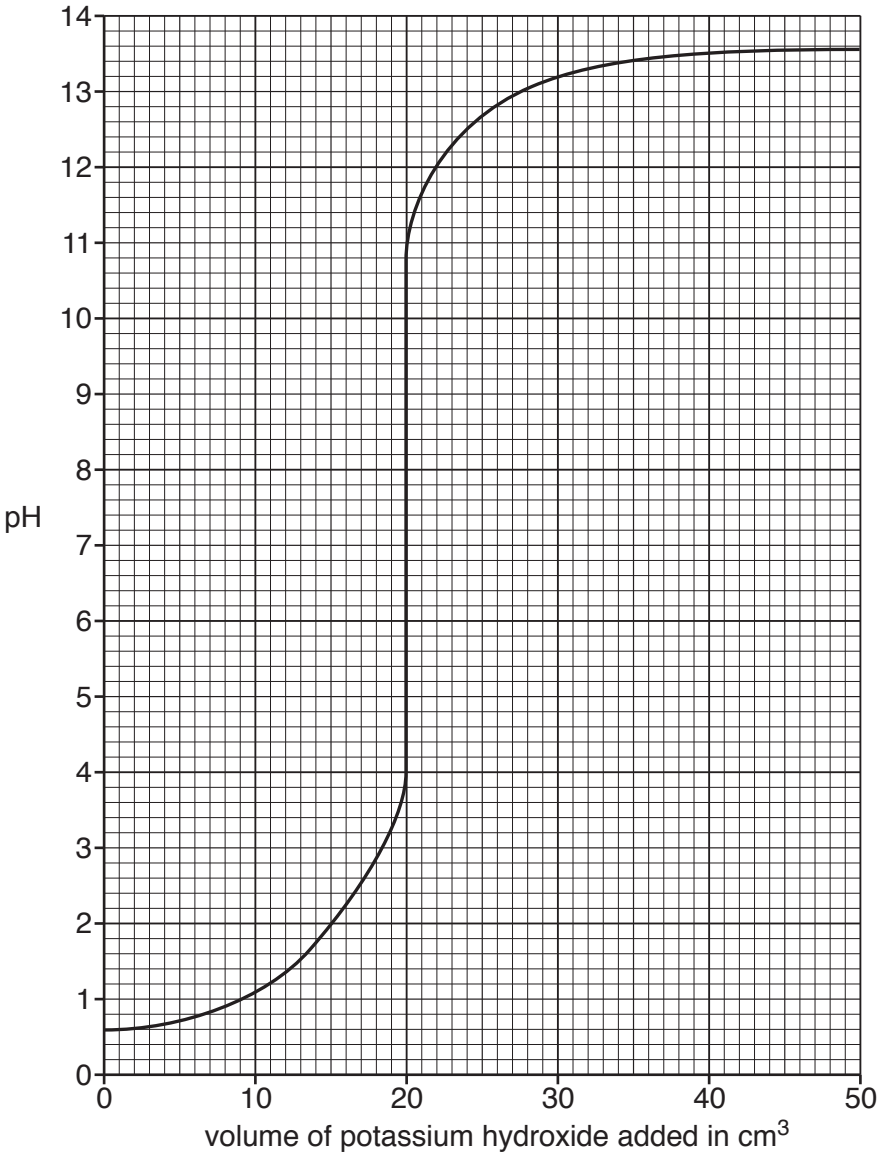
Look at the diagram of the apparatus she uses.



(a) Sara slowly adds 50 cm^3 of potassium hydroxide solution to 30 cm^3 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?

..... cm^3 **[1]**

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

..... cm^3 **[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.

$$HCl + KOH \rightarrow KCl + H_2O$$

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 42 g of magnesium carbonate contains 12 g 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.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

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.

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..... **[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.

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

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

$$\text{zinc} + \text{hydrochloric acid} \rightarrow \text{zinc chloride} + \text{hydrogen}$$

They do the experiment four times.

Each time they use 1.0 g of zinc.

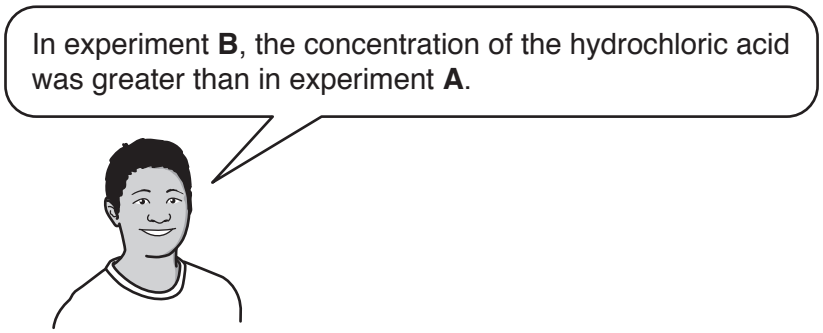
They use the same volume of different concentrations of hydrochloric acid.

They measure the total volume of hydrogen made every minute.

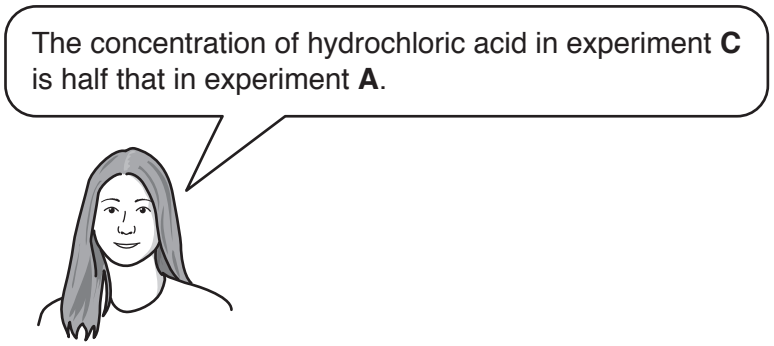
Look at the table of their results.

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



Sue concludes



Are each of the conclusions correct?

Explain your answers.

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..... **[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 cm^3.

Calculate the mass of 48 cm^3 of hydrogen, H_2, at room temperature and pressure.

The volume of 1 mole of any gas is 24 dm^3 at room temperature and pressure.

The relative formula mass of H_2 = 2.

mass of hydrogen = ... g **[2]**

10 Lead iodide is an insoluble salt.

Jenna wants to make a pure, dry sample of lead iodide, PbI_2.

Jenna uses solutions of lead nitrate and sodium iodide in a **precipitation** reaction.

Lead nitrate contains lead ions, Pb^{2+}.

Sodium iodide contains iodide ions, I^-.

Describe the stages that Jenna uses to prepare a **pure**, **dry** sample of lead iodide.

Include an **ionic** equation for the reaction.

You may wish to draw a **labelled** diagram.

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

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

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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.

.....

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..... **[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

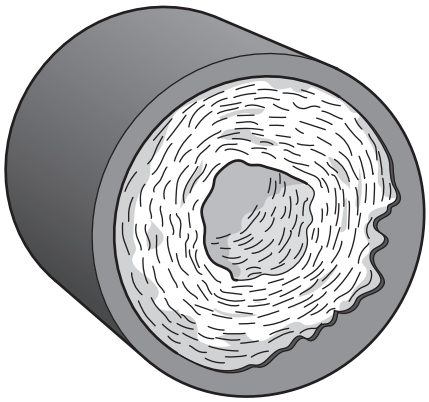
calcium sulfate

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

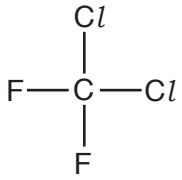
alkenes

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.

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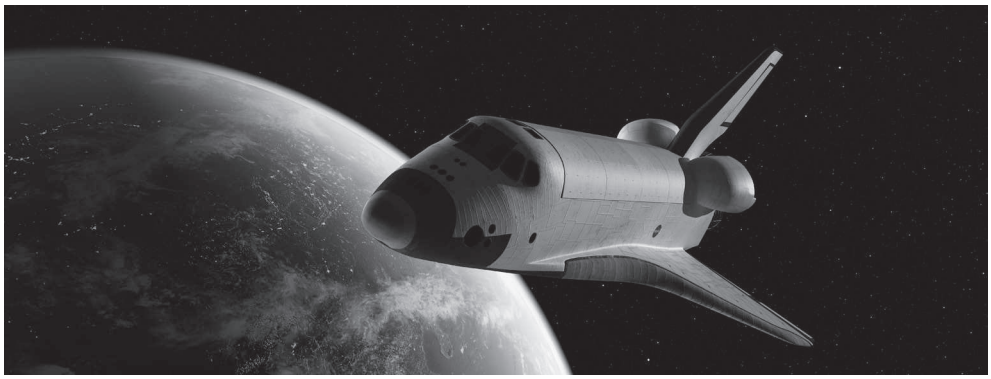
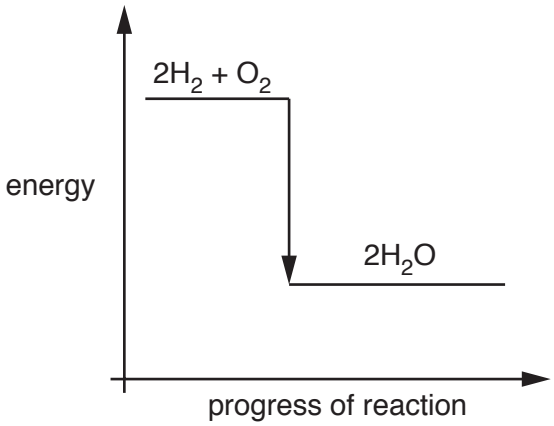
..... **[2]**

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.

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

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

$$H_2 \rightarrow 2H^+ + 2e^-$$

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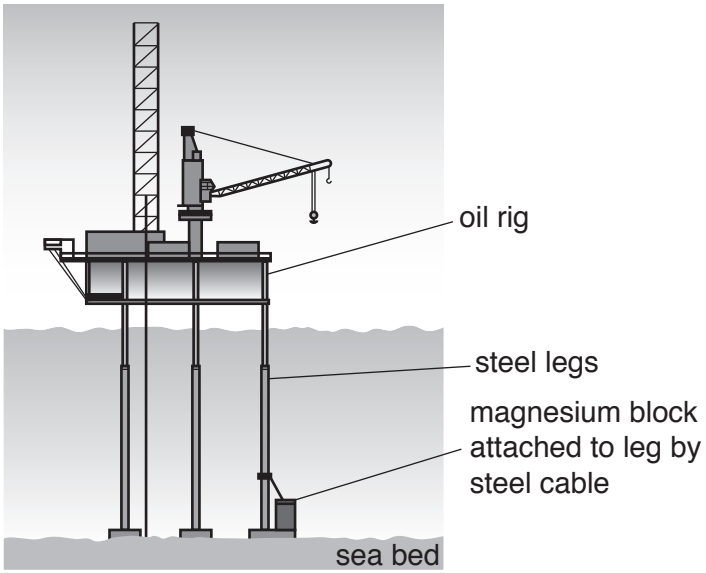
..... **[2]**

(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.

$$3Mg + 2Fe^{2+} \rightarrow 2Fe + 3Mg^{2+}$$

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

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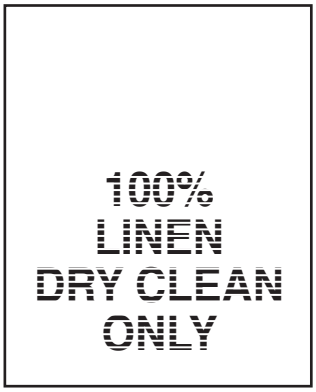
..... **[6]**

(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.

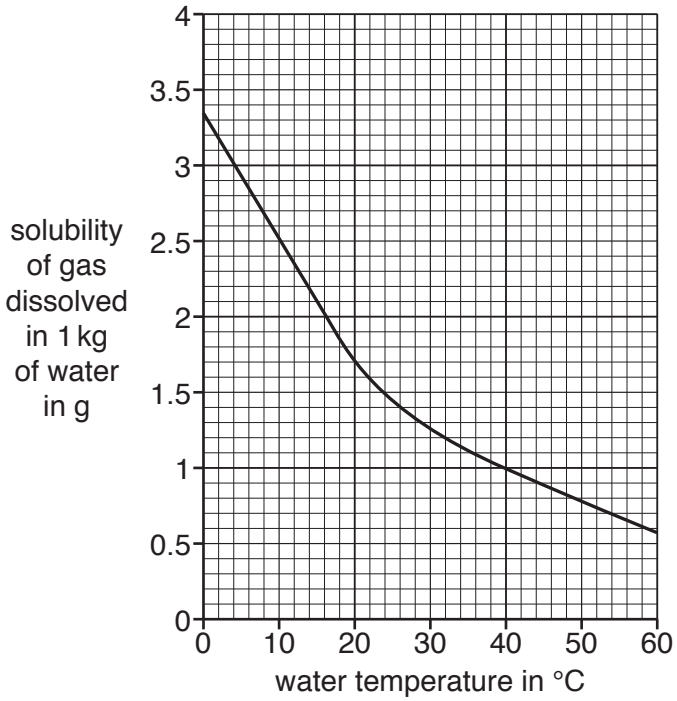
The solubility of these gases in water changes with temperature.

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 3.0 kg of water at 10 °C.

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

Is she correct?

Explain your answer using information from the graph.

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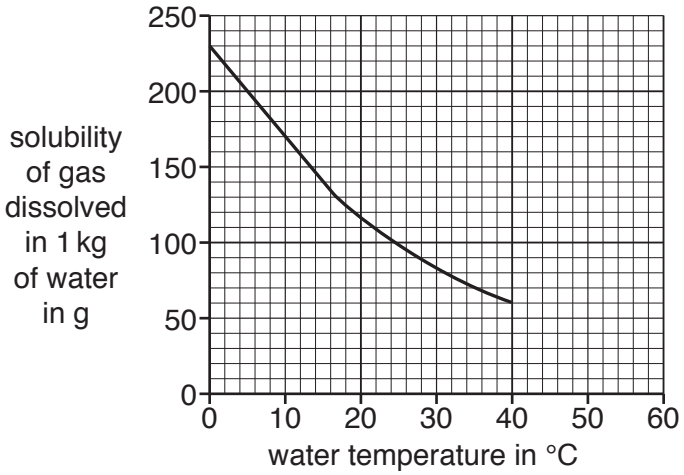
..... **[2]**

(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**.

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..... **[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**.

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

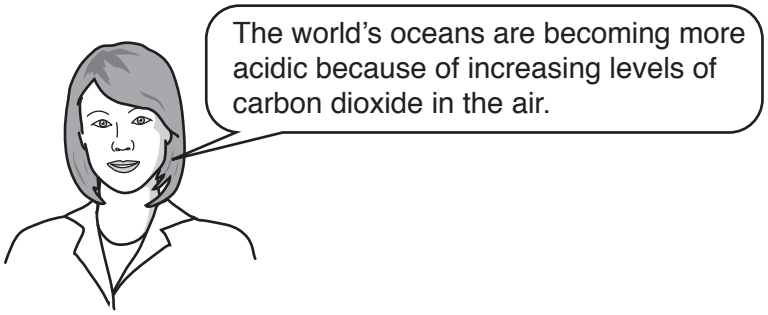
(c) Look at the table.

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.

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

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

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..... **[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).

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.