FOR OFFICIAL USE

N5

National Qualifications 2015

Mark

X713/75/01

Chemistry
Section 1—Answer Grid And Section 2

THURSDAY, 28 MAY
9:00 AM – 11:00 AM

X7137501

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth
Day Month Year

Scottish candidate number

Total marks — 80

SECTION 1 — 20 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on *Page two*.

SECTION 2 —60 marks

Attempt ALL questions.

Necessary Data will be found in the Chemistry Data Booklet for National 5.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

X7137501 01

SECTION 1— 20 marks

The questions for Section 1 are contained in the question paper X713/75/02.
Read these and record your answers on the answer grid on *Page three* opposite.
Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

2. There is **only one correct** answer to each question.

3. Any rough work must be written in the additional space for answers and rough work at the end of this booklet.

Sample Question

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

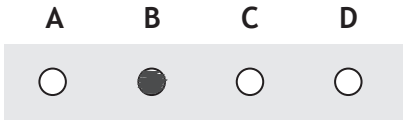
A fractional distillation

B chromatography

C fractional crystallisation

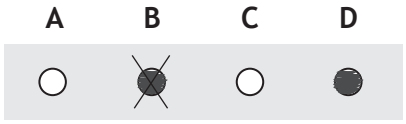
D filtration.

The correct answer is **B**—chromatography. The answer **B** bubble has been clearly filled in (see below).

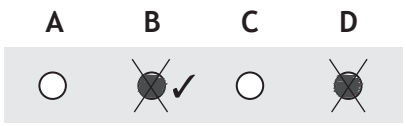


Changing an answer

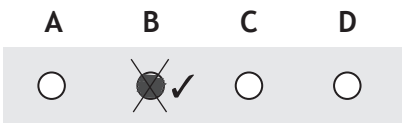
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:



or



SECTION 1 — Answer Grid

OBJ20AD1

	A	B	C	D
1	○	○	○	○
2	○	○	○	○
3	○	○	○	○
4	○	○	○	○
5	○	○	○	○
6	○	○	○	○
7	○	○	○	○
8	○	○	○	○
9	○	○	○	○
10	○	○	○	○
11	○	○	○	○
12	○	○	○	○
13	○	○	○	○
14	○	○	○	○
15	○	○	○	○
16	○	○	○	○
17	○	○	○	○
18	○	○	○	○
19	○	○	○	○
20	○	○	○	○

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DO NOT WRITE ON THIS PAGE

[Turn over for Question 1 on *Page six*

DO NOT WRITE ON THIS PAGE

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2—60 marks

Attempt ALL questions

1. Ethyne is the first member of the alkyne family.

It can be produced by the reaction of calcium carbide with water.

The equation for this reaction is

$$CaC_2(s) + 2H_2O(\ell) \longrightarrow C_2H_2(g) + Ca(OH)_2(aq)$$

(a) The table shows the results obtained in an experiment carried out to measure the volume of ethyne gas produced.

Time (s)	0	30	60	90	120	150	180	210
Volume of ethyne (cm^3)	0	60	96	120	140	148	152	152

Calculate the average rate of reaction between 60 and 90 seconds.

Your answer must include the appropriate unit. **3**

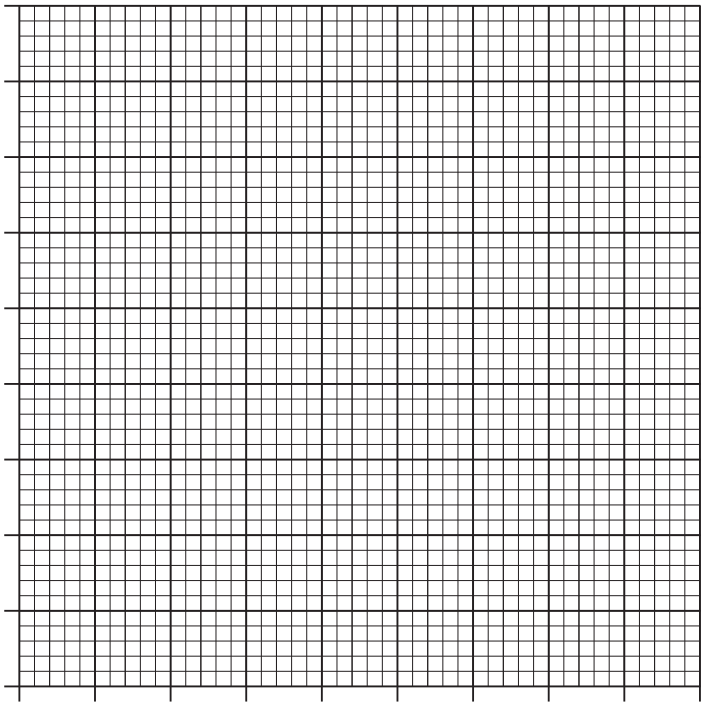
Show your working clearly.

1. (continued)

(b) Draw a line graph of the results.

Use appropriate scales to fill most of the graph paper. **3**

(Additional graph paper, if required, will be found on *Page twenty-seven*.)



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MARKS | DO NOT WRITE IN THIS MARGIN

2. Americium-241, a radioisotope used in smoke detectors, has a half-life of 432 years.

(a) The equation for the decay of americium-241 is

$$^{241}_{95}\text{Am} \longrightarrow {}^{4}_{2}\text{He} + \mathbf{X}$$

Name element **X**. **1**

(b) Name the **type** of radiation emitted by the americium-241 radioisotope. **1**

(c) Another radioisotope of americium exists which has an atomic mass of 242.

Americium-242 has a half-life of 16 hours.

(i) A sample of americium-242 has a mass of 8 g.

Calculate the mass, in grams, of americium-242 that would be left after 48 hours. **2**

Show your working clearly.

(ii) Suggest why americium-241, and not americium-242, is the radioisotope used in smoke detectors. **1**

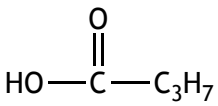
3. Butter contains different triglyceride molecules.

(a) A triglyceride molecule is made when the alcohol glycerol reacts with carboxylic acids.

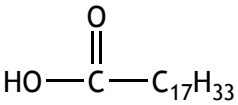
(i) Name the functional group present in glycerol. **1**

(ii) Name the family to which triglycerides belong. **1**

(b) When butter goes off, a triglyceride molecule is broken down, producing compounds **X** and **Y**.



X



Y

(i) Name compound **X**. **1**

(ii) Describe the chemical test, including the result, to show that compound **Y** is unsaturated. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

4. Some sources of methane gas contain hydrogen sulfide, H_2S.

(a) Draw a diagram, showing all outer electrons, to represent a molecule of hydrogen sulfide, H_2S. **1**

(b) If hydrogen sulfide is not removed before methane gas is burned, sulfur dioxide is formed.

When sulfur dioxide dissolves in water in the atmosphere, acid rain is produced.

(Circle) the correct words to complete the sentence.

Acid rain contains more { hydrogen / hydroxide } ions than { hydrogen / hydroxide } ions. **1**

(c) In industry, calcium oxide is reacted with sulfur dioxide to reduce the volume of sulfur dioxide released into the atmosphere.

Explain why calcium oxide is able to reduce the volume of sulfur dioxide gas released. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

5. A researcher investigated the conditions for producing ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Name the catalyst used in the production of ammonia. **1**

(b) In her first experiment she measured how the percentage yield of ammonia varied with pressure at a constant temperature of 500 °C.

Pressure (atmospheres)	100	200	300	400	500
Percentage yield (%)	10	18	26	32	40

Predict the percentage yield of ammonia at 700 atmospheres. **1**

(c) In a second experiment the researcher kept the pressure constant, at 200 atmospheres, and changed the temperature as shown.

Temperature (°C)	200	300	400	500
Percentage yield (%)	89	67	39	18

Describe how the percentage yield varies with temperature. **1**

(d) **Using the information in both tables**, suggest the combination of temperature and pressure that would produce the highest percentage yield of ammonia. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

6. Read the passage below and answer the questions that follow.

Clean coal technology comes a step closer

It is claimed a process called Coal-Direct Chemical Looping (CDCL) is able to release energy from coal while capturing 99% of the carbon dioxide emitted. CDCL works by extracting the energy from coal using a reaction other than combustion.

A mixture of powdered coal and beads of iron(III) oxide is heated inside a metal cylinder. Carbon in the coal and oxygen from the beads react to form carbon dioxide which can be captured for recycling or stored.

This reaction gives off heat energy that could be used to heat water in order to drive electricity-producing steam turbines.

Adapted from *Focus: Science and Technology*, April 2013

(a) The CDCL process produced 300 tonnes of carbon dioxide.

Calculate the mass, in tonnes, of carbon dioxide released into the atmosphere. **1**

(b) Write the ionic formula for the iron compound used in CDCL. **1**

(c) State the term used to describe all chemical reactions that release heat energy. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

7. A student was asked to carry out an experiment to determine the concentration of a copper(II) sulfate solution.

Part of the work card used is shown.

> Determination of the Concentration of Copper(II) Sulfate Solution
>
> 1. Weigh an empty crucible
> 2. Add 100 cm^3 copper(II) sulfate solution
> 3. Evaporate the solution to dryness
> 4. Weigh the crucible containing dry copper(II) sulfate

(a) Suggest how the student could have evaporated the solution to dryness. **1**

(b) The student found that the 100 cm^3 solution contained 3·19 g of copper(II) sulfate, $CuSO_4$.

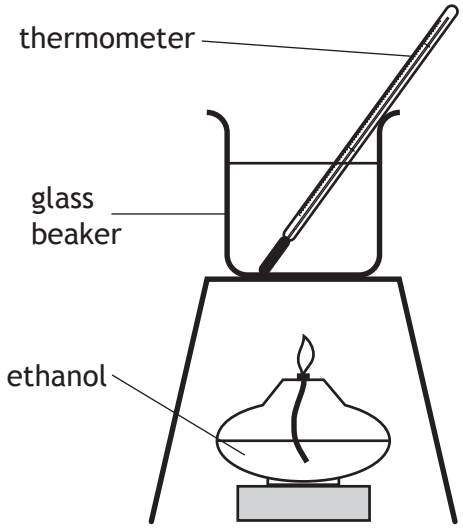
Calculate the concentration of the solution in mol l^{-1}. **2**

Show your working clearly.

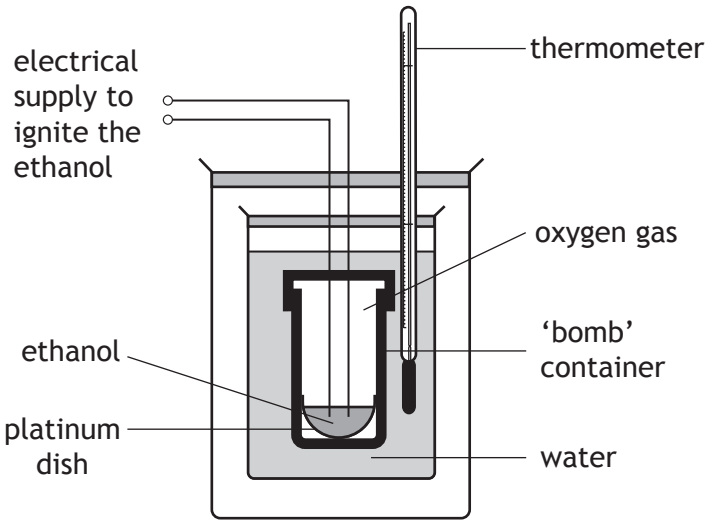
[Turn over

8. A student calculated the energy absorbed by water when ethanol is burned using two different methods.

Method A



Method B



The student recorded the following data.

	Method	
	A	**B**
Mass of ethanol burned (g)	0·5	0·5
Mass of water heated (g)	100	100
Initial temperature of water (°C)	24	24
Final temperature of water (°C)	32	58

(a) The final temperature of water in method **B** is higher than in method **A**.
Suggest why there is a difference in the energy absorbed by the water. **1**

8. (continued)

(b) Calculate the energy, in kJ, absorbed by the water in method **B**. **3**

You may wish to use the data booklet to help you.

Show your working clearly.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. Aluminium can be extracted from naturally occurring metal compounds such as bauxite.

(a) State the term used to describe naturally occurring metal compounds such as bauxite. **1**

(b) Bauxite is refined to produce aluminium oxide.

Electrolysis of molten aluminium oxide produces aluminium and oxygen gas.

The ion-electron equations taking place during the electrolysis of aluminium oxide are

$$Al^{3+} + 3e^- \longrightarrow Al$$

$$2O^{2-} \longrightarrow O_2 + 4e^-$$

(i) Write the redox equation for the overall reaction. **1**

(ii) State why ionic compounds, like aluminium oxide, conduct electricity when molten. **1**

9. (continued)

(c) Bauxite contains impurities such as silicon dioxide.

Silicon can be extracted from silicon dioxide as shown.

$$SiO_2 + 2Mg \longrightarrow Si + 2MgO$$

Identify the reducing agent in this reaction. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

10. A group of students were given strips of aluminium, iron, tin and zinc.

Using your knowledge of chemistry, suggest how the students could identify each of the four metals. **3**

11. Electrons can be removed from all atoms.

The energy required to do this is called the ionisation energy.

The first ionisation energy for an element is defined as the energy required to remove one mole of electrons from one mole of atoms, in the gaseous state.

The equation for the first ionisation energy of chlorine is

$$Cl(g) \longrightarrow Cl^{+}(g) + e^{-}$$

(a) State the electron arrangement for the Cl^{+} ion. **1**

You may wish to use the data booklet to help you.

(b) Write the equation for the first ionisation energy of magnesium. **1**

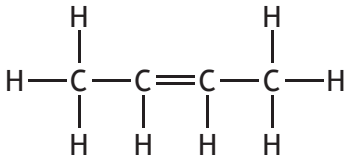
(c) Information on the first ionisation energy of some elements is given in the table.

Element	*First ionisation energy* ($kJ\,mol^{-1}$)
lithium	526
fluorine	1690
sodium	502
chlorine	1260
potassium	425
bromine	1150

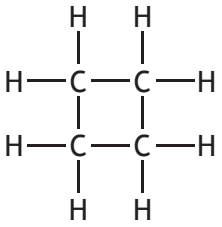
Describe the trend in the first ionisation energy going down a group in the Periodic Table. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

12. The structural formulae of two hydrocarbons are shown.



A



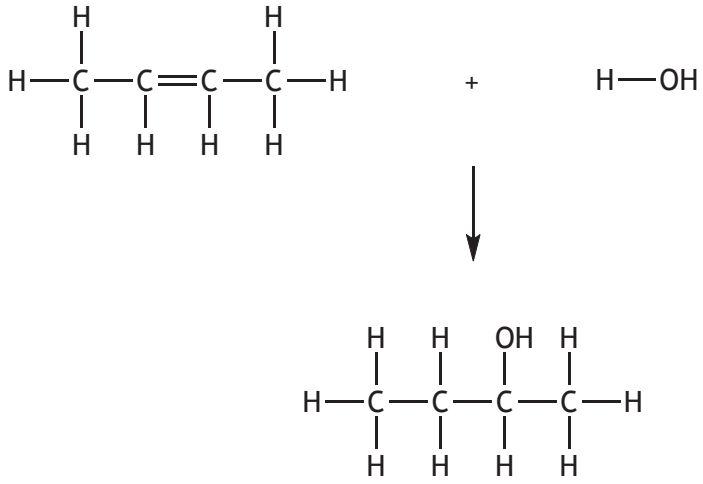
B

(a) Name hydrocarbon **A**. **1**

(b) Hydrocarbons **A** and **B** can be described as isomers.
State what is meant by the term isomer. **1**

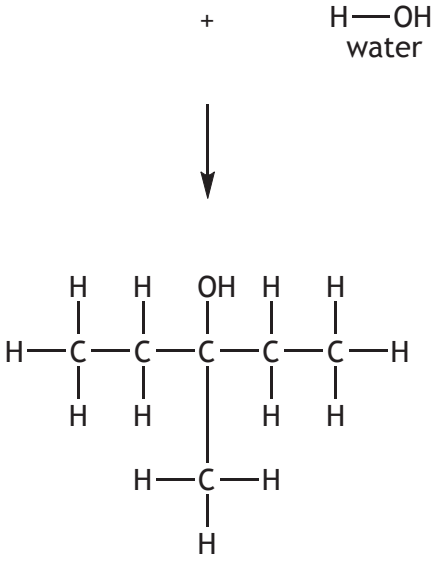
12. (continued)

(c) Hydrocarbon **A** can undergo an addition reaction with water to form butan-2-ol as shown.



A similar reaction can be used to produce 3-methylpentan-3-ol.

Draw a structural formula for the hydrocarbon used to form this molecule. **1**

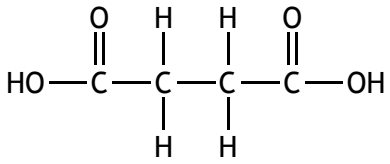


3-methylpentan-3-ol

MARKS | DO NOT WRITE IN THIS MARGIN

13. Succinic acid is a natural antibiotic.

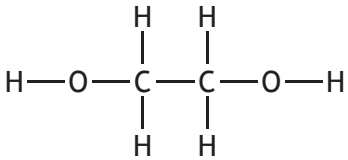
The structure of succinic acid is shown.



(a) Name the functional group present in succinic acid. **1**

(b) Succinic acid can form a polymer with ethane-1,2-diol.

The structure of ethane-1,2-diol is shown.



(i) Name the type of polymerisation which would take place between succinic acid and ethane-1,2-diol. **1**

(ii) Draw the repeating unit of the polymer formed between succinic acid and ethane-1,2-diol. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

14. Titanium is the tenth most commonly occurring element in the Earth's crust.

(a) The first step in the extraction of titanium from impure titanium oxide involves the conversion of titanium oxide into titanium(IV) chloride.

$$TiO_2 + 2Cl_2 + 2C \longrightarrow TiCl_4 + 2X$$

(i) Identify **X**. **1**

(ii) Titanium(IV) chloride is a liquid at room temperature and does not conduct electricity.

Suggest the type of bonding that is present in titanium(IV) chloride. **1**

(b) The next step involves separating pure titanium(IV) chloride from other liquid impurities that are also produced during the first step.

Suggest a name for this process. **1**

(c) The equation for the final step in the extraction of titanium is

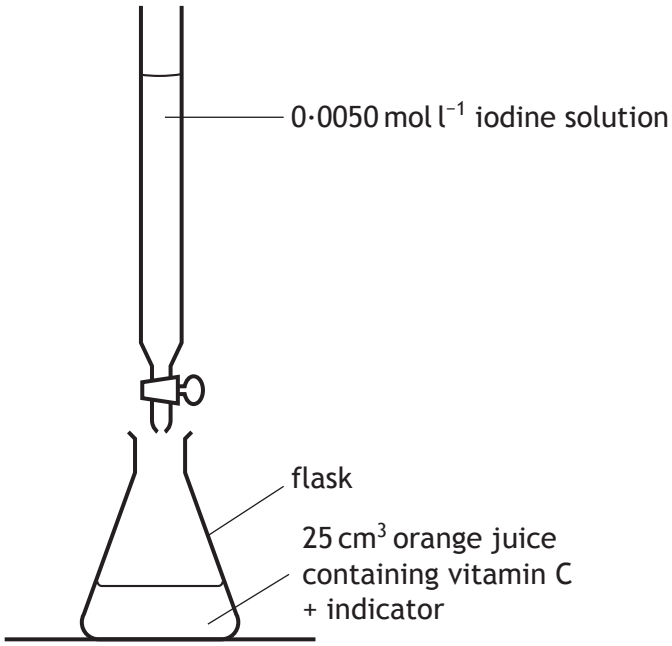
$$TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$$

The sodium chloride produced can be electrolysed.

Suggest how this could make the extraction of titanium from titanium oxide more economical. **1**

15. Vitamin C is found in fruits and vegetables.

Using iodine solution, a student carried out titrations to determine the concentration of vitamin C in orange juice.



The results of the titration are given in the table.

Titration	*Initial burette reading* (cm^3)	*Final burette reading* (cm^3)	*Titre* (cm^3)
1	1·2	18·0	16·8
2	18·0	33·9	15·9
3	0·5	16·6	16·1

(a) Calculate the average volume, in cm^3, that should be used in calculating the concentration of vitamin C. **1**

15. (continued)

(b) The equation for the reaction is

$$\underset{\text{vitamin C}}{C_6H_8O_6(aq)} + I_2(aq) \longrightarrow C_6H_6O_6(aq) + 2HI(aq)$$

Calculate the concentration, in mol l^{-1}, of vitamin C in the orange juice. **3**
Show your working clearly.

[Turn over for Question 16 on *Page twenty-six*

MARKS | DO NOT WRITE IN THIS MARGIN

16. A student is given three different compounds each containing carbon.

Using your knowledge of chemistry, describe how the student could identify the compounds. **3**

[END OF QUESTION PAPER]

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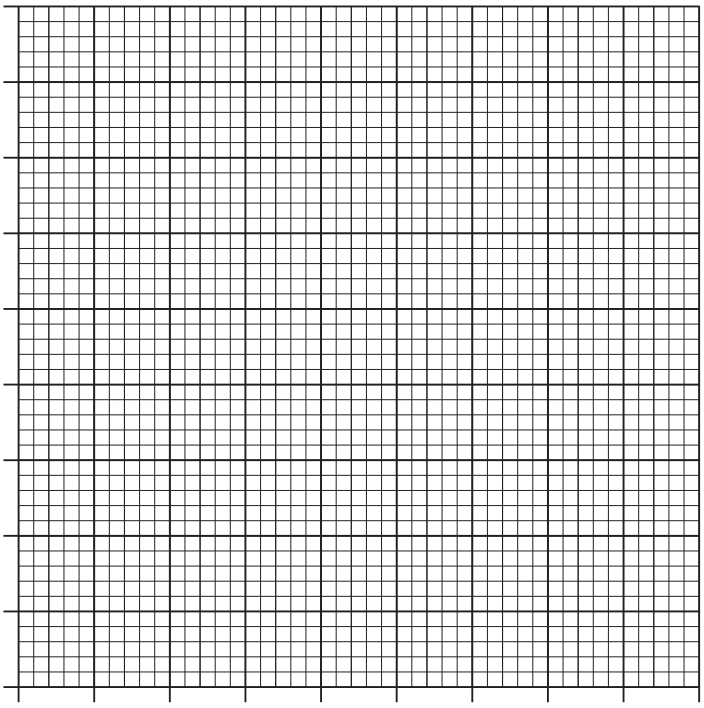
ADDITIONAL SPACE FOR ANSWERS

Question 1(b)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ACKNOWLEDGEMENT

Question 6 – Text is adapted from original article by **Russell Deeks** published in BBC Focus Magazine © Immediate Media Company Bristol Ltd.