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Oxides of nitrogen are produced when fuels are burnt.

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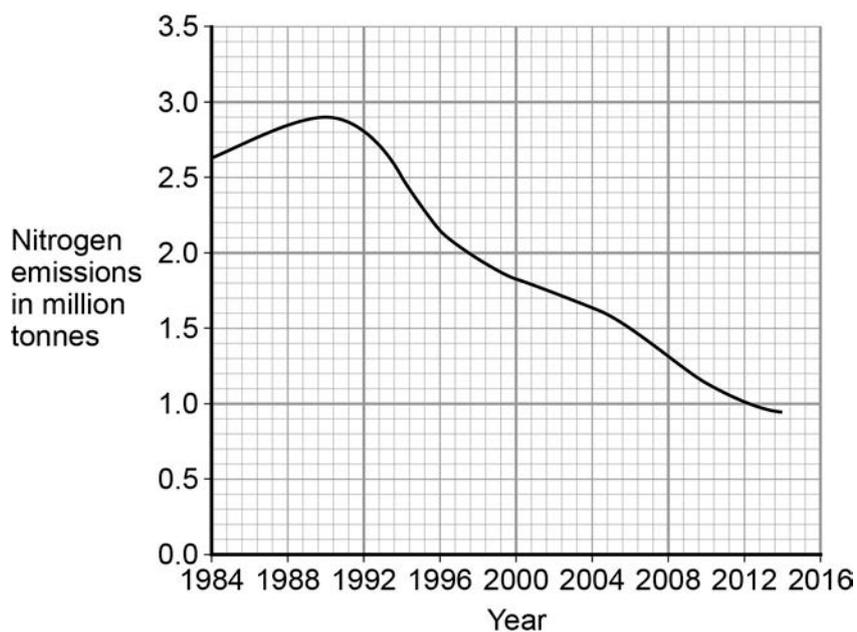
Write a balanced symbol equation for the production of nitrogen dioxide (NO<sub>2</sub>) from nitrogen and oxygen.

**[2 marks]**

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**0 1 . 2** Figure 1 gives information about emissions of oxides of nitrogen in the UK.

Figure 1



Calculate the percentage decrease in emissions of oxides of nitrogen from 1990 to 2014.

Give your answer to three significant figures.

[3 marks]

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Percentage decrease = \_\_\_\_\_ %

**0 1 . 3** Give **one** advantage of reducing the emissions of oxides of nitrogen.

[1 mark]

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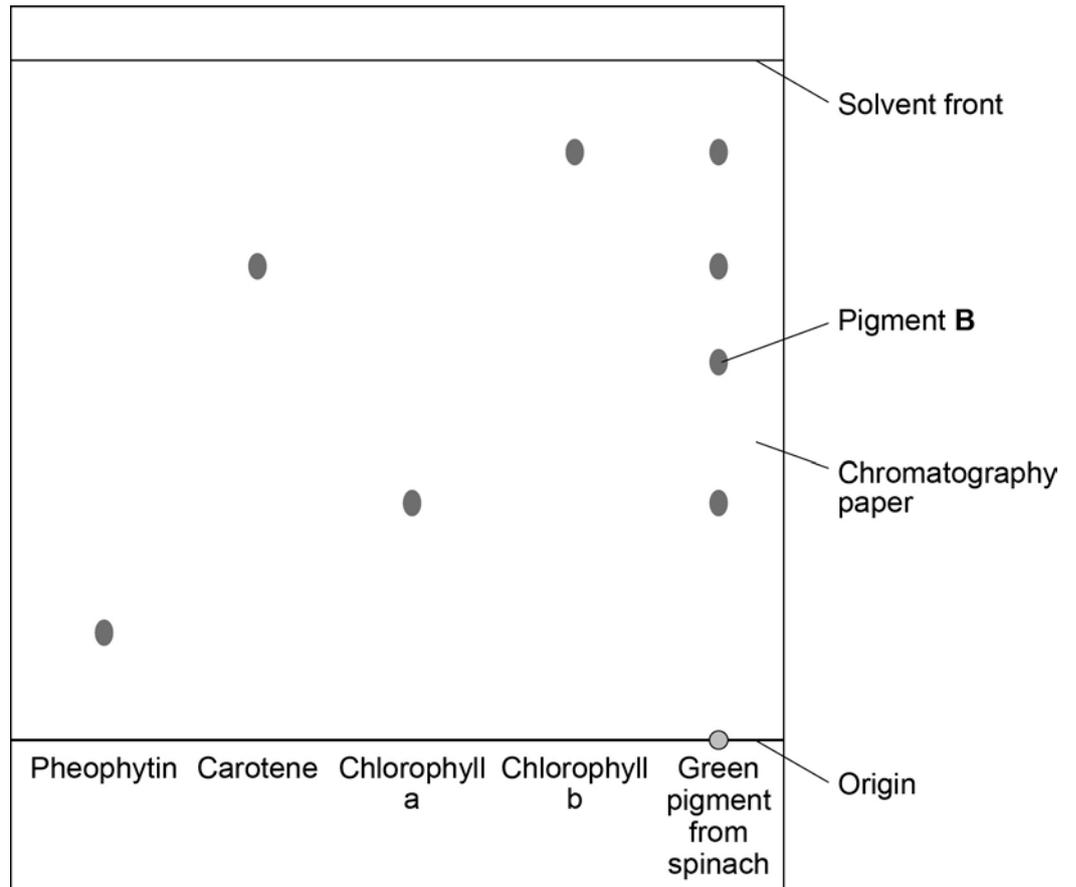
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0 2

A student used chromatography to identify the pigments in spinach leaves.  
She used propanone as a solvent.

Figure 2 shows the student's results.

Figure 2



0 2

. 1

Name the mobile phase and the stationary phase in the student's experiment.

[2 marks]

Mobile phase \_\_\_\_\_

Stationary phase \_\_\_\_\_

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**0 2** . **2** What does **Figure 2** tell you about the green pigment from spinach?

**[3 marks]**

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**0 2** . **3** Write the equation that links distance moved by solvent, distance moved by solute and  $R_f$  value.

**[1 mark]**

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**0 2** . **4** Use **Figure 2** to calculate the  $R_f$  value for pigment **B**.

**[3 marks]**

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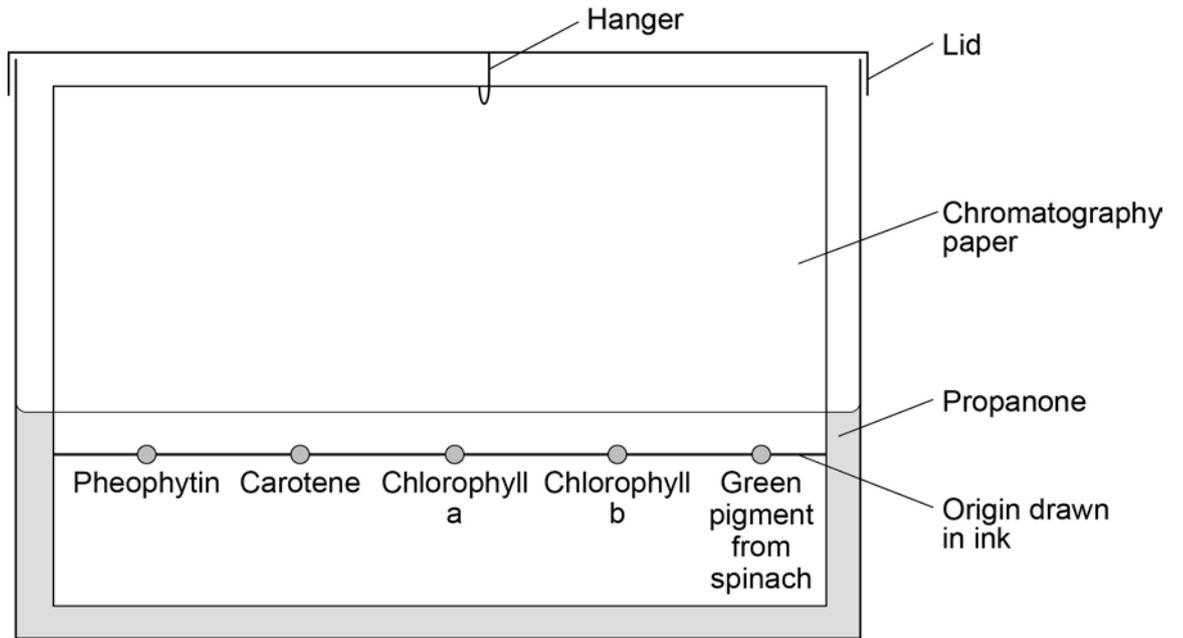
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$R_f$  value = \_\_\_\_\_

**Question 2 continues on the next page**

**0 2 . 5** Another student set up the apparatus shown in **Figure 3**.

**Figure 3**



This student did not set up the apparatus correctly.

Identify the errors the student made.

Explain how the errors she made would affect her results.

**[4 marks]**

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**Turn over for the next question**



Table 1 shows the student's results.

Table 1

Metal	Mass of material in kg	Time in minutes	Temperature change in °C	Change in thermal energy in J	Calculated specific heat capacity of material in J/kg °C
Aluminium	1	10	2	4 780	2 390
Brass	1	10	4	4 660	1 165
Copper	1	10		4 600	657
Steel	1	10	5	4 690	938

0 3 . 2 Use data from Table 1 to calculate the temperature change for copper.

Use the correct equation from the Physics Equation Sheet.

[3 marks]

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Temperature change = \_\_\_\_\_ °C

0 3 . 3 What is the independent variable in the student's investigation?

[1 mark]

Tick **one** box.

Mass of material

Power used

Time in minutes

Type of material

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**0 3** . **4** The student calculated the specific heat capacity of aluminium to be 2 390 J/kg °C.

The 'true' specific heat capacity of aluminium is 900 J/kg °C.

Suggest why the student's result for aluminium is different from the 'true' value.

**[2 marks]**

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**0 3** . **5** The teacher suggested that putting bubble wrap round the metal block would change the results.

How would using bubble wrap change the results?

Give a reason for your answer.

**[2 marks]**

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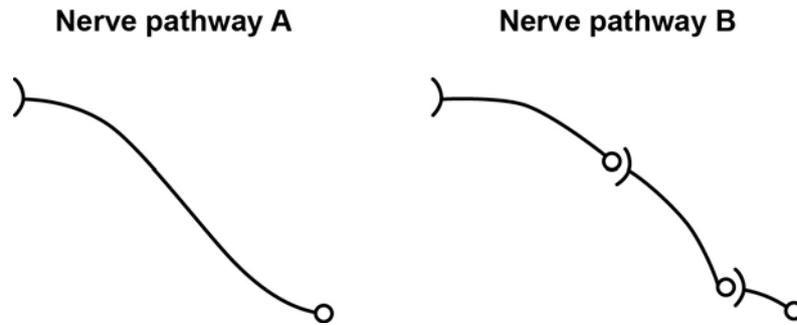
**Turn over for the next question**

**0 4**

The nervous system allows humans to respond to their surroundings.

**Figure 4** shows two nerve pathways.

**Figure 4**

**0 4****. 1**

Nerve pathway **A** is 92 cm long.

A nerve impulse travels along pathway **A** at 76.2 m/s.

Calculate how long it takes for the nerve impulse to travel the length of the pathway.

Use the equation:

$$\text{distance} = \text{speed} \times \text{time}$$

**[3 marks]**

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Time = \_\_\_\_\_ s

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**0 4** . **2** Nerve pathways **A** and **B** are the same length.

The nerve impulse takes longer to travel along pathway **A** than along pathway **B**.

Use **Figure 4** to explain why.

**[3 marks]**

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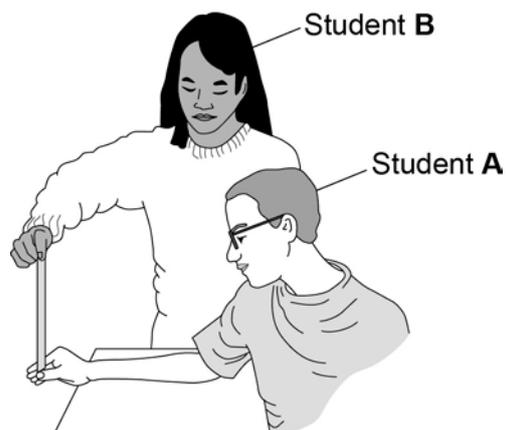
**Question 4 continues on the next page**

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Two students compare their reactions using a ruler.

This is the method used.

1. Student **A** sits with his elbow on a table top.
2. Student **B** holds the ruler so the bottom of the ruler is level with the top of student **A**'s thumb.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler.
5. Record the drop distance.
6. Repeat steps 1 to 5 four more times.
7. Repeat the whole experiment with student **A** dropping the ruler and student **B** catching it.



Both students are right-handed.

Student **A** uses his right hand to catch the ruler.

Student **B** uses her left hand to catch the ruler.

**Table 2** shows the students' results.

**Table 2**

Student	Drop distance in mm				
	Test 1	Test 2	Test 3	Test 4	Test 5
Student <b>A</b> – right hand	203	167	140	156	163
Student <b>B</b> – left hand	230	211	279	215	264

**0 4** . **3** What is the range of student **A**'s results?

[1 mark]

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**0 4** . **4** The students are testing the hypothesis:

**The drop distance of the ruler is smaller when a right-handed person uses their right hand to catch the ruler.**

The students' results in **Table 2** are not a good test of the hypothesis.

Suggest what the students should have done to test the hypothesis.

[3 marks]

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**0 4** . **5** Student **A**'s mean reaction time was 0.19 s.

Mean reaction time can be calculated using the equation:

$$\text{Mean reaction time} = \sqrt{\frac{2 \times \text{mean drop distance in m}}{9.8 \text{ m/s}^2}}$$

Calculate the mean reaction time for Student **B**.

Give your answer to two significant figures.

Student **B**'s results are repeated here to help you answer the question.

	Drop distance in mm				
	Test 1	Test 2	Test 3	Test 4	Test 5
Student <b>B</b> – left hand	230	211	279	215	264

[4 marks]

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Mean reaction time = \_\_\_\_\_ s

**Turn over for the next question**

0 5

Humans can use different methods to produce animals and plants with desired characteristics.

Figure 5 shows some different breeds of horse.

Figure 5



0 5

. 1

All breeds of horse are of the same species.

Suggest what you could do to show this.

[2 marks]

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**0 5** . **2** Horse racing is an ancient sport.

Selective breeding has been used for centuries to produce racehorses.

Describe the steps involved in selective breeding to produce a racehorse.

**[3 marks]**

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**Question 5 continues on the next page**

Another way of producing organisms with desired characteristics is genetic engineering.

Bt cotton is a variety of cotton that has been genetically engineered to produce a poison.

The poison kills several different species of insect that feed on cotton plants.

The poison is naturally produced by a soil bacterium called *Bacillus thuringiensis*.

**0 5** . **3**

Describe how cotton plants can be genetically engineered to produce the Bt poison.

**[3 marks]**

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**0 5** . **4** Describe the advantages and disadvantages of growing Bt cotton.

**[4 marks]**

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**Turn over for the next question**

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Huntington's disease is an inherited disorder that affects the nervous system.

It is caused by a dominant allele.

A man is heterozygous for Huntington's disease.

His partner is healthy and does not have the allele that causes Huntington's disease.

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What are the genotypes of the man and the woman?

Use:

- **H** for the allele that causes Huntington's disease
- **h** for the healthy allele.

**[1 mark]**

Man's genotype

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Woman's genotype

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**0 6** . **2** The couple want to have a child.

Use a Punnett square to determine the probability of the child having Huntington's disease.

Circle the genotypes of any children that will have Huntington's disease.

**[4 marks]**

Probability of child having Huntington's disease = \_\_\_\_\_

**Question 6 continues on the next page**

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**0 6** . **3** The couple visit a genetic counsellor, who gives them the following options.

1. Adopt a child.
2. Gamete donation – uses sperm from another man to fertilise the woman’s eggs by in vitro fertilisation (IVF).
3. Conceive naturally.
4. Use pre-implantation genetic diagnosis (PGD).
  - Many embryos are produced by IVF using gametes from the man and woman.
  - Embryos are tested for Huntington’s disease and a healthy embryo is implanted into the woman’s uterus.
  - The risk of implanting an embryo with the allele for Huntington’s disease is 0.2%.
  - Costs the NHS about £11 000.
5. Conceive naturally and use prenatal diagnosis (PND) once the woman becomes pregnant.
  - A sample of the placenta is taken at 10 weeks of pregnancy or a sample of fluid is taken from around the developing baby at 16 weeks of pregnancy.
  - The sample is tested for the Huntington’s allele.
  - A 0.5–1.0% risk of miscarriage.
  - About 1% of samples collected are unsuitable for testing.
  - Costs the NHS about £600.

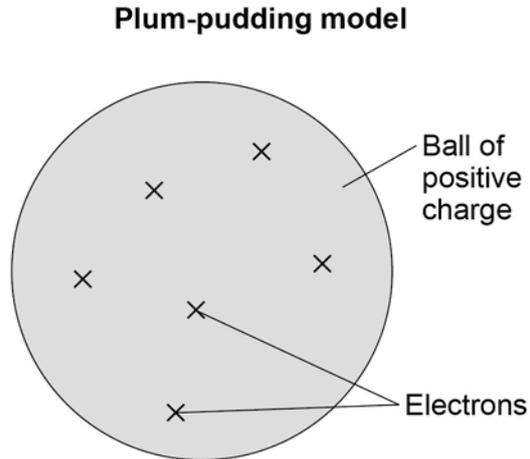


**0 7**

**Figure 6** shows the plum pudding model of the atom.

This model was used by some scientists after the discovery of electrons in 1897.

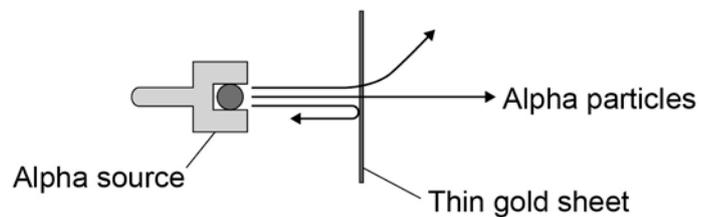
**Figure 6**



In 1911 the scientists Geiger and Marsden investigated the effect of firing alpha particles at very thin sheets of gold foil.

Their experiment is shown in **Figure 7**. The arrows show the paths taken by alpha particles in the experiment.

**Figure 7**



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- 0 7** . **1** Explain why scientists replaced the plum pudding model of the atom with the nuclear model of the atom as a result of the experiment.

**[4 marks]**

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- 0 7** . **2** According to modern measurements:

- the radius of an atom is about  $1 \times 10^{-10}\text{m}$
- the radius of an atomic nucleus is about  $1 \times 10^{-14}\text{m}$

Show that these values fit with the nuclear model of the atom.

**[2 marks]**

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**Question 7 continues on the next page**

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**0 7 . 3** In 1931 a scientist discovered that there are hydrogen atoms with mass number 2 as well as hydrogen atoms with mass number 1.

A year later, another scientist discovered neutrons.

Explain why the discovery of neutrons could explain the presence of hydrogen atoms with different mass numbers.

**[3 marks]**

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**0 7 . 4** How would the results of the experiment shown in **Figure 7** change if neutrons were used instead of alpha particles to bombard a thin sheet of gold?

**[2 marks]**

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A student investigated the effect of light intensity on the rate of photosynthesis in pondweed.

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The formula for glucose is  $C_6H_{12}O_6$

Use the formula for glucose to write the balanced symbol equation for photosynthesis.

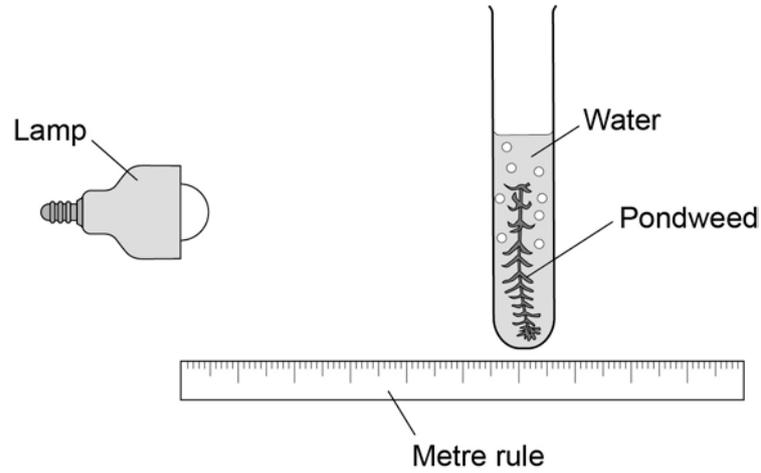
**[2 marks]**

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**Question 8 continues on the next page**

Figure 8 shows the apparatus the student used.

Figure 8



The student altered the distance of the lamp from the pondweed and counted the number of bubbles produced in 30 seconds for each distance.

Table 5 shows the student's results.

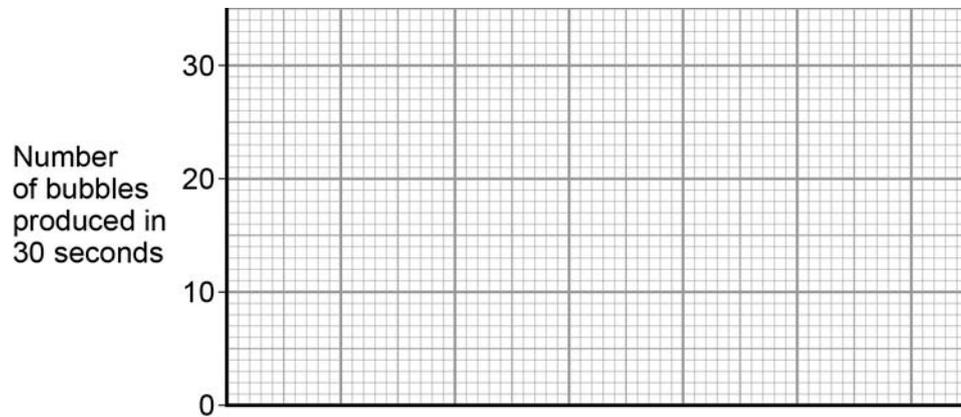
Table 5

Distance in cm	Number of bubbles produced in 30 seconds
10	27
20	23
30	16
40	7
50	2

**0 8** . **2** Use the data in **Table 5** to complete the graph on **Figure 19**.

[3 marks]

**Figure 9**



**0 8** . **3** The student concluded that the rate of photosynthesis is inversely proportional to the distance of the lamp from the pondweed.

Does the student's data support this conclusion?

Use data from **Figure 9** to justify your answer.

[3 marks]

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**Question 8 continues on the next page**

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**0 8** . **4** The volume of one bubble can be calculated using the equation:

$$V = \frac{4}{3} \pi r^3$$

The radius of one bubble is 0.1 cm.

The value for  $\pi$  is 3.14

Use data from **Table 5** and the information above to calculate the rate of gas production at a distance of 40 cm.

Give your answer in standard form to three significant figures.

**[5 marks]**

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Rate of reaction = \_\_\_\_\_  $\text{cm}^3$  per minute



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