SPECIMEN MATERIAL

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher Tier Paper 2H

Specimen 2018 Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a calculator
- the periodic table (enclosed)
- the Physics equation sheet (enclosed).

Instructions
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions 03.1, 06.3 and 09 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

Advice
- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

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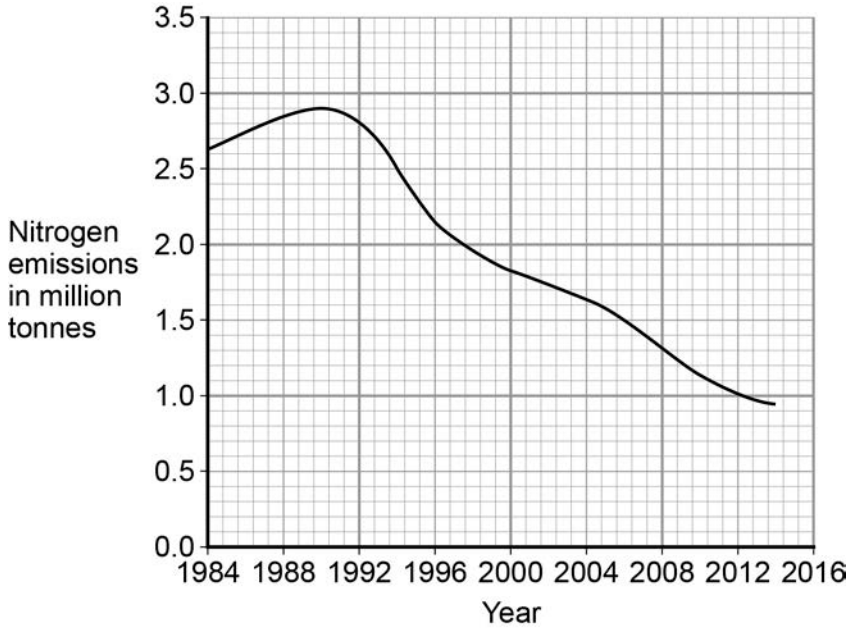
0 1 Oxides of nitrogen are produced when fuels are burnt.

0 1 . 1 Write a balanced symbol equation for the production of nitrogen dioxide (NO_2) from nitrogen and oxygen.

[2 marks]

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]

Percentage decrease = _____ %

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

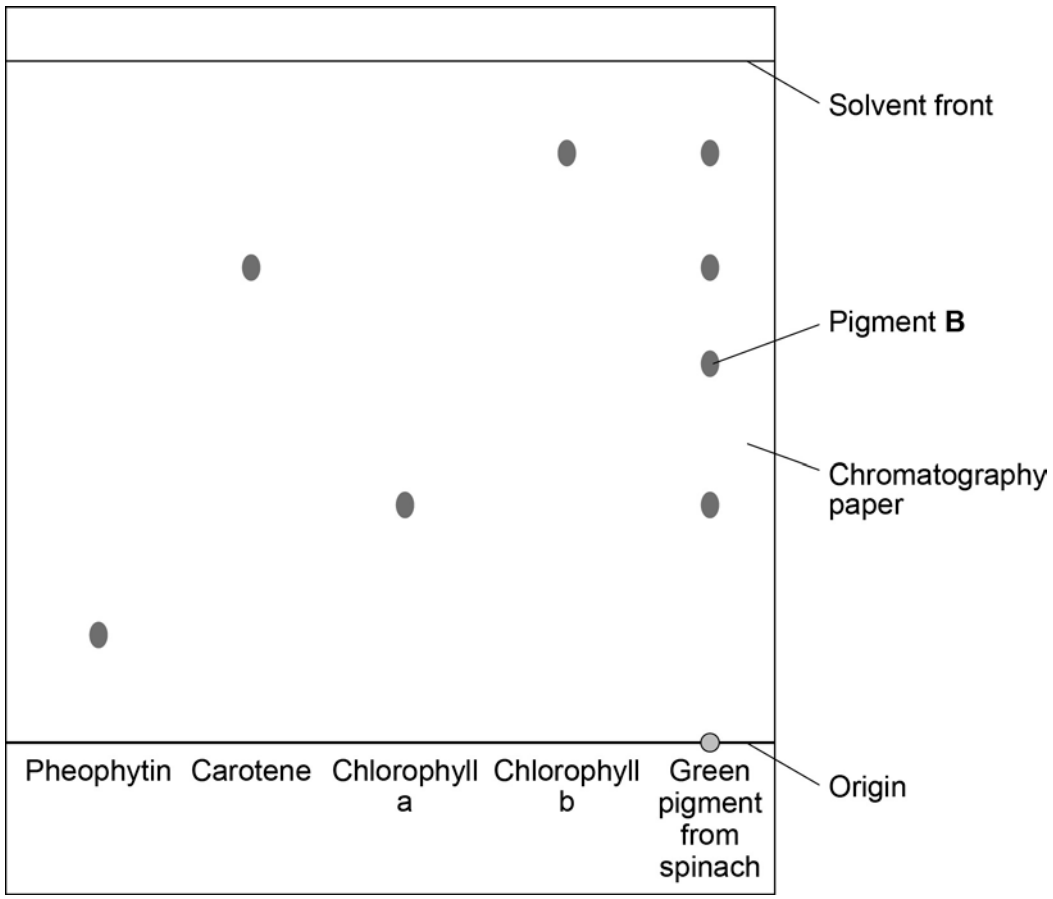
[1 mark]

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 _____

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

[3 marks]

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

[1 mark]

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

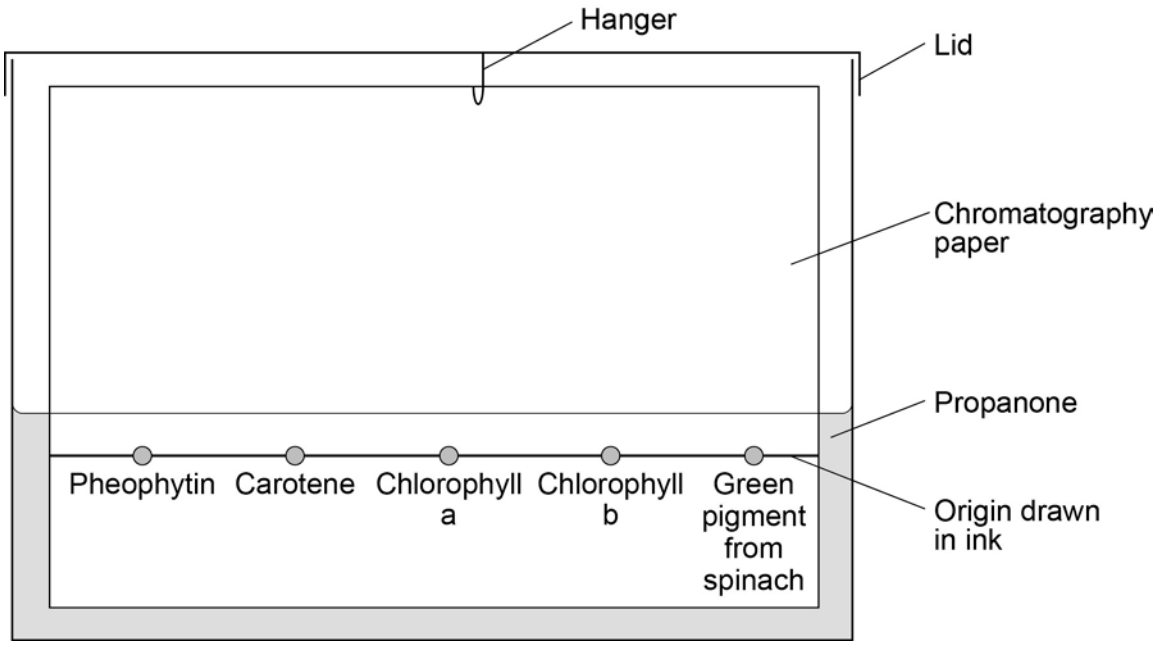
[3 marks]

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]

Turn over for the next question

0 3 A student investigated the specific heat capacity of metals.

0 3 . 1 Describe an experiment the student could do to measure the specific heat capacity of a metal.

[6 marks]

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]

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 ☐

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]

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.

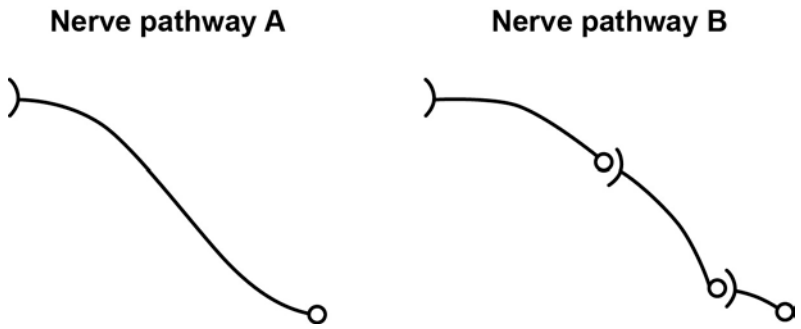
[2 marks]

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:

distance = speed × time

[3 marks]

Time = _____ s

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.

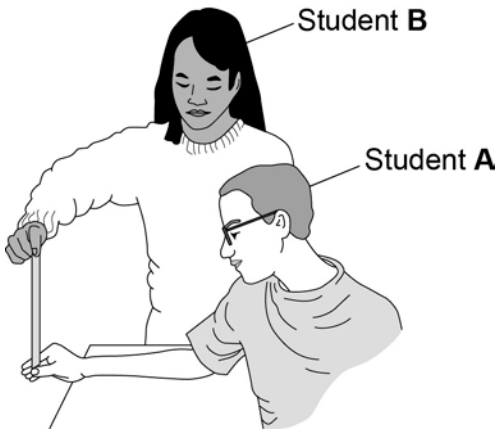
[3 marks]

Question 4 continues on the next page

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 **A** – right hand	203	167	140	156	163
Student **B** – left hand	230	211	279	215	264

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

[1 mark]

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]

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** – left hand	230	211	279	215	264

[4 marks]

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]

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]

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]

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

[4 marks]

Turn over for the next question

0 6 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.

0 6 . 1 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 _____

Woman's genotype _____

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

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.

The couple decide they want to have a healthy baby that is their own biological offspring.

Evaluate the options.

Suggest which option would be best for the couple.

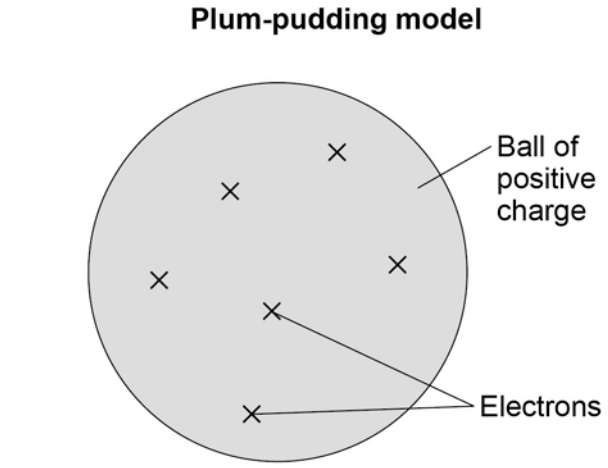
[6 marks]

Turn over for the next question

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.

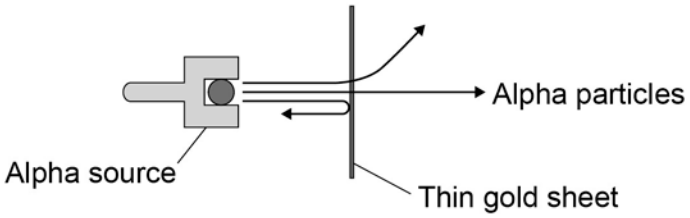
Figure 6



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



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]

0 7 . 2 According to modern measurements:

- the radius of an atom is about 1×10^{-10}m
- the radius of an atomic nucleus is about 1×10^{-14}m

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

[2 marks]

Question 7 continues on the next page

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]

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]

0 8 A student investigated the effect of light intensity on the rate of photosynthesis in pondweed.

0 8 . 1 The formula for glucose is $C_6H_{12}O_6$

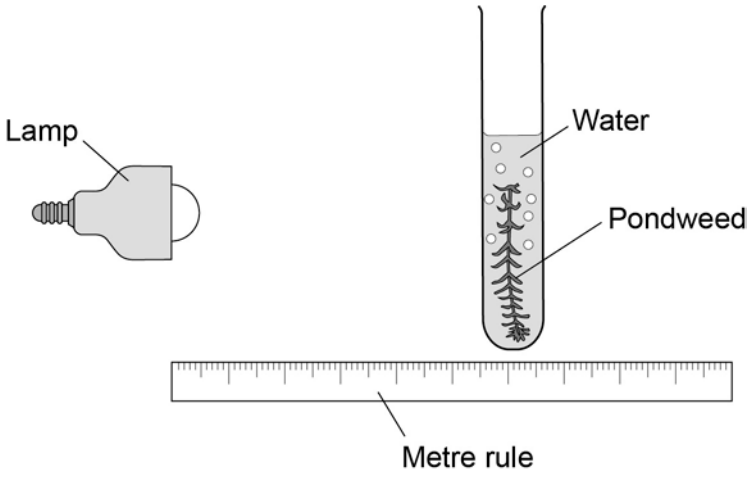
Use the formula for glucose to write the balanced symbol equation for photosynthesis.

[2 marks]

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.

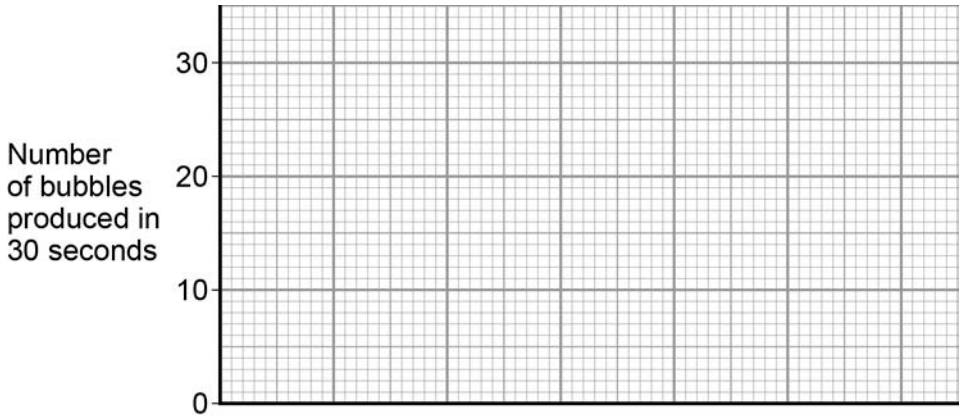
Table 5

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]

Question 8 continues on the next page

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

$$V = 4/3\ \pi\ r^3$$

The radius of one bubble is 0.1 cm.

The value for π 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]

Rate of reaction = _____ cm^3 per minute

0 9 In the last 200 years the concentration of carbon dioxide in the Earth's atmosphere has risen.

Explain how a rise in carbon dioxide concentration in the atmosphere can decrease biodiversity.

[6 marks]

END OF QUESTIONS

There are no questions printed on this page

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