

# Discussion 4: Stretch and challenge

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## Specimen high demand questions

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- What are the characteristics of your current Year 11 A and A\* pupils?
- How will this be different for the new specifications?
- Will the teaching and learning approach need to be different?
- Does practice make perfect?
- What skills/techniques do students need to develop from Year 7 onwards?
- What do the current A and A\* students currently struggle with?
- How can you use these high demand questions?

The questions are taken from the first set of specimen assessment materials.

| B2H  | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type                    |
|------|---------------|---------------|---------------|----|-------------------------|
| 09.1 |               | 4             |               | 1  | Knowledge in isolation. |
| 09.2 |               | 2             | 2             | 1  |                         |
| 09.3 |               | 1             | 2             | 2  | Maths.                  |
| 09.4 |               |               | 1             | 3  |                         |
| 09.5 |               |               | 1             | 2  |                         |
| 09.6 |               | 2             |               | 3  | Interpreting graphs.    |

**0 | 9**

Homeostasis controls the internal conditions of the body.

**0 | 9**

**. | 1**

Explain how blood glucose levels are controlled in the body of someone who does **not** have diabetes.

**[4 marks]**

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**0 | 9**

**. | 2**

Compare how each type of diabetes is caused.

Suggest how each type of diabetes can be treated.

**[4 marks]**

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**0 9 . 3** Look at **Table 5**.

**Table 5**

|                                                             |                    |
|-------------------------------------------------------------|--------------------|
| <b>Population of UK in 2015</b>                             | $6.5 \times 10^7$  |
| <b>Number of people diagnosed with diabetes</b>             | $3.45 \times 10^6$ |
| <b>Estimated number of people with undiagnosed diabetes</b> | $5.49 \times 10^5$ |

Calculate the percentage (%) of the UK population estimated to have diabetes.

You should include both diagnosed and undiagnosed people in your calculation.

Give your answer to two significant figures.

**[3 marks]**

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Estimated percentage of population with diabetes = \_\_\_\_\_ %

**0 9 . 4** A urine test can be used to check for the presence of glucose in the urine.

Diabetes can also be diagnosed with a blood test to measure the concentration of blood glucose.

Suggest *why* a blood test is more reliable than a urine test.

**[1 mark]**

**0 9 . 5** A blood test called the glucose tolerance test checks how well the body processes glucose.

Concentrations of glucose in the blood are measured before and after drinking a glucose drink.

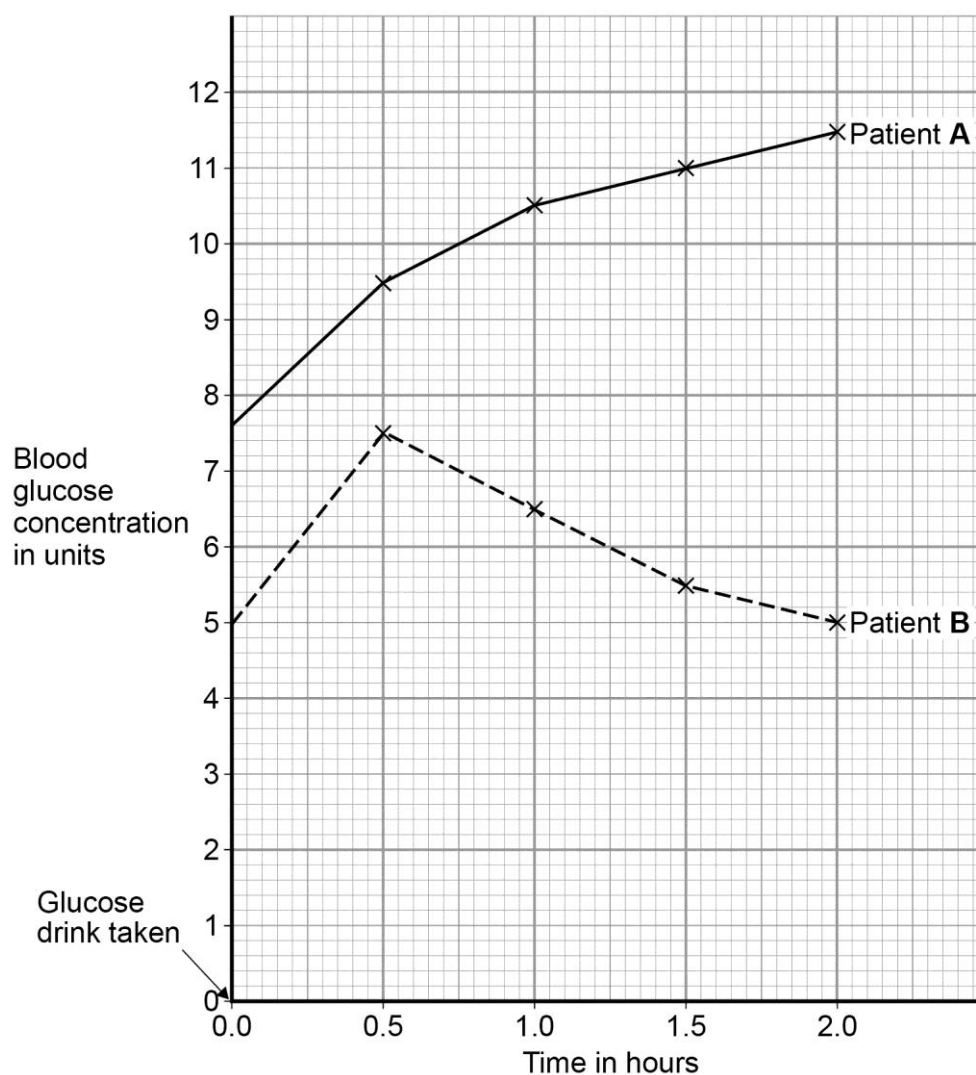
Patients are not allowed to eat food for 8 hours before the glucose tolerance test.

Suggest *why* patients are **not** allowed to eat for 8 hours before the test.

**[1 mark]**

**09 . 6** **Figure 11** shows the results of a glucose tolerance test for two patients, **A** and **B**.

**Figure 11**



Which patient has diabetes?

Justify your answer.

**[2 marks]**

Patient \_\_\_\_\_

Justification \_\_\_\_\_

| B2H  | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO  | Type                                      |
|------|---------------|---------------|---------------|-----|-------------------------------------------|
| 10.1 |               |               | 3             | 1   |                                           |
| 10.2 |               |               | 2             | 1   |                                           |
| 10.3 |               |               | 4             | 2 3 | Applying knowledge to unfamiliar context. |

**1 0** Endocrine glands produce hormones.

**1 0** . **1** Hyperthyroidism is caused by an overactive thyroid gland.

Suggest what would happen in the body of a person with hyperthyroidism.

**[3 marks]**

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**1 0** . **2** Describe the roles of FSH and LH in the menstrual cycle.

**[2 marks]**

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**1 0** . **3** The combined pill is a contraceptive that contains progesterone **and** oestrogen.

The 'mini-pill':

- is a contraceptive that **only contains** the progesterone hormone
- has to be taken at the same time each day to prevent pregnancy.

The success rate of the mini-pill in preventing pregnancy is lower than that of the combined pill.

Explain why missing a dose of the mini-pill would reduce the success rate of the mini-pill.

**[4 marks]**

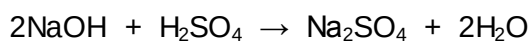
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| C1H | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type                          |
|-----|---------------|---------------|---------------|----|-------------------------------|
| 8.1 |               | 2             |               | 1  | Knowledge in isolation.       |
| 8.2 |               | 2             |               | 1  | Knowledge in isolation.       |
| 8.3 | 2             | 2             |               | 1  | Required practical.           |
| 8.4 | 2             |               |               | 2  | Maths.<br>Required practical. |
| 8.5 |               | 2             | 2             | 2  | Maths.<br>Required practical. |
| 8.6 |               | 2             |               | 2  | Maths.<br>Required practical. |

**0 8**

Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:



**0 8**

**. 1**

Sulfuric acid is a strong acid.

What is meant by a strong acid?

**[2 marks]**

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**0 8**

**. 2**

Write the ionic equation for this neutralisation reaction. Include state symbols.

**[2 marks]**

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**0 8 . 3**

A student used a pipette to add  $25.0 \text{ cm}^3$  of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of  $0.100 \text{ mol/dm}^3$  sulfuric acid needed to neutralise the sodium hydroxide.

Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

**[4 marks]**

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The student carried out five titrations. Her results are shown in **Table 5**.

**Table 5**

|                                                                      | Titration<br>1 | Titration<br>2 | Titration<br>3 | Titration<br>4 | Titration<br>5 |
|----------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Volume of $0.100 \text{ mol/dm}^3$<br>sulfuric acid in $\text{cm}^3$ | 27.40          | 28.15          | 27.05          | 27.15          | 27.15          |

**0 8 . 4**

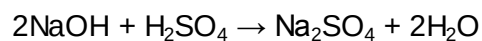
Concordant results are within  $0.10 \text{ cm}^3$  of each other.

Use the student's concordant results to work out the mean volume of  $0.100 \text{ mol/dm}^3$  sulfuric acid added.

**[2 marks]**

Mean volume = \_\_\_\_\_  $\text{cm}^3$

**0 8 . 5** The equation for the reaction is:



Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

**[4 marks]**

Concentration = \_\_\_\_\_ mol/dm<sup>3</sup>

**0 8 . 6** The student did another experiment using 20 cm<sup>3</sup> of sodium hydroxide solution with a concentration of 0.18 mol/dm<sup>3</sup>.

Relative formula mass ( $M_r$ ) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm<sup>3</sup> of this solution.

**[2 marks]**

Mass = \_\_\_\_\_ g

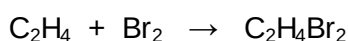


| C1H | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO  | Type               |
|-----|---------------|---------------|---------------|-----|--------------------|
| 9.1 |               | 3             |               | 1   | Scientific ideas.  |
| 9.2 |               | 2             |               | 1   | Scientific ideas.  |
| 9.3 |               |               | 3             | 2   | Maths.             |
| 9.4 |               | 2             | 4             | 2 3 | Extended response. |

**0 9**

This question is about the reaction of ethene and bromine .

The equation for the reaction is:



**0 9**

**. 1**

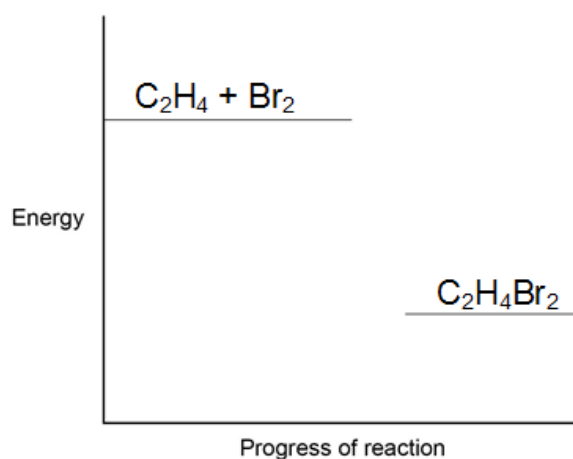
Complete the reaction profile in **Figure 6**.

Draw labelled arrows to show:

- the energy given out ( $\Delta H$ )
- the activation energy.

**[3 marks]**

**Figure 6**



09 . 2

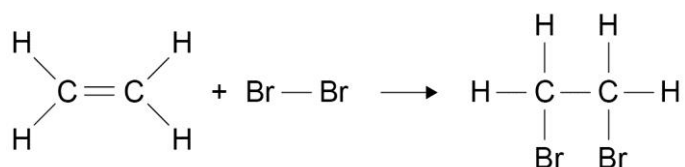
When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

[2 marks]

Figure 7 shows the displayed formulae for the reaction of ethene with bromine.

Figure 7



The bond enthalpies and the overall energy change are shown in Table 6.

Table 6

|                   | C=C | C-H | C-C | C-Br | Overall energy change |
|-------------------|-----|-----|-----|------|-----------------------|
| Energy in kJ/mole | 612 | 412 | 348 | 276  | -95                   |

09 . 3

Use the information in Table 6 and Figure 7 to calculate the bond energy for the Br-Br bond.

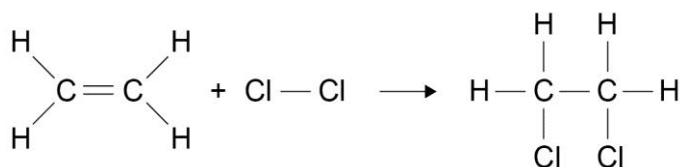
[3 marks]

Bond energy \_\_\_\_\_ kJ/mole

09 . 4

**Figure 8** shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

**Figure 8**



“The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms.”

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

**[6 marks]**

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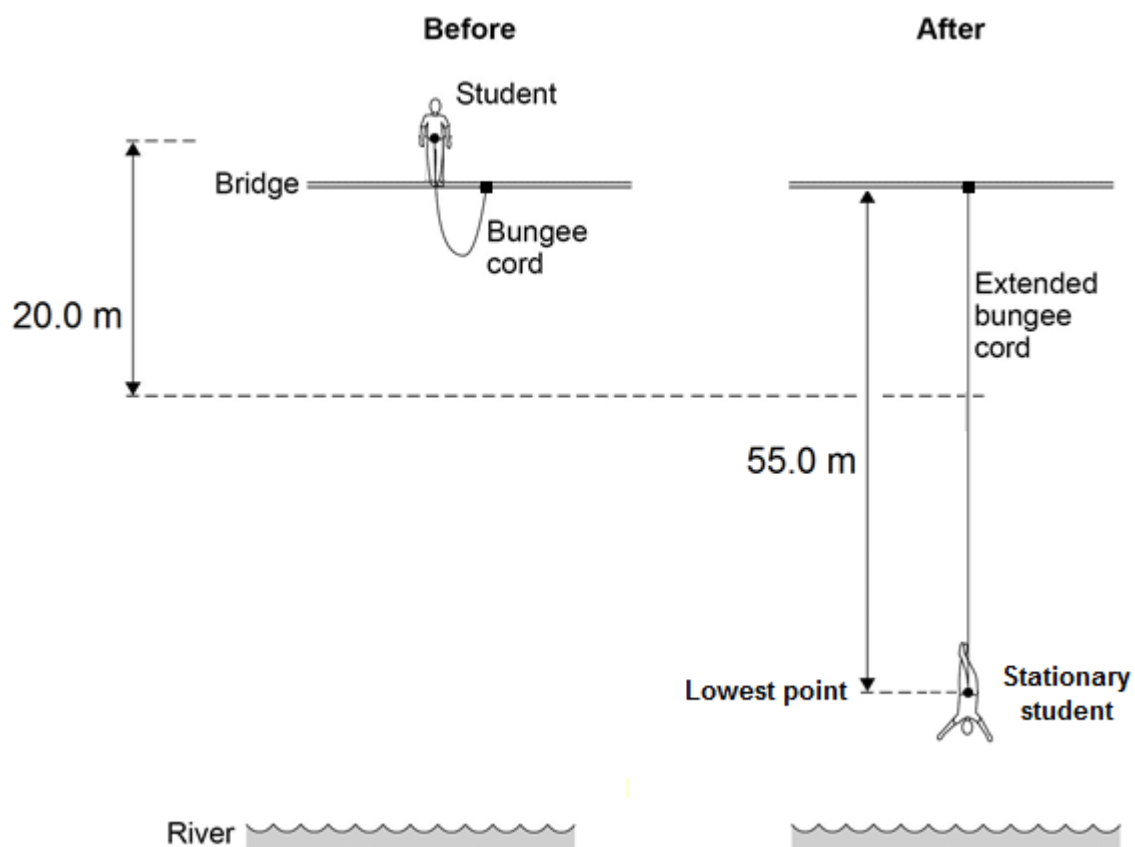
| P1H  | Grades 4–5 | Grades 6–7 | Grades 8–9 | AO | Type                                             |
|------|------------|------------|------------|----|--------------------------------------------------|
| 11.1 | 1          |            |            | 1  | Recall of equations.                             |
| 11.2 | 2          |            |            | 2  | Apply equation, show working.                    |
| 11.3 |            | 1          |            | 2  | Calculation.                                     |
| 11.4 |            | 1          | 3          | 2  | Calculations.<br>Rearranging with a square root. |
| 11.5 |            | 3          |            | 2  | Calculation.                                     |

**1 | 1**

**Figure 17** shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.

**Figure 17**



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N/kg.

**1 1 . 1**

Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

**[1 mark]**

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**1 1 . 2**

Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

**[2 marks]**

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Change in gravitational potential energy = \_\_\_\_\_ J

**1 1 . 3**

80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

**[1 mark]**

Kinetic energy gained = \_\_\_\_\_ J

**1 1 . 4** Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

**[4 marks]**

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Speed = \_\_\_\_\_ m/s

**1 1 . 5** At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

**[3 marks]**

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Spring constant = \_\_\_\_\_ N / m

| P2H  | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type                          |
|------|---------------|---------------|---------------|----|-------------------------------|
| 11.1 | 2             |               |               | 1  |                               |
| 11.2 |               | 1             |               | 1  |                               |
| 11.3 |               |               | 6             | 1  | Extended response.<br>Linked. |

**1 1**

Waves may be either longitudinal or transverse.

**1 1**

**. 1**

Describe the difference between a longitudinal and a transverse wave.

[2 marks]

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**1 1**

**. 2**

Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.

[1 mark]

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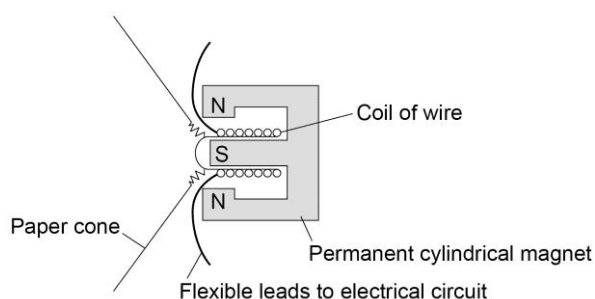
**1 1**

**. 3**

**Figure 19** shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.

**Figure 19**



Explain how the loudspeaker converts current in an electrical circuit to a sound wave.

[6 marks]

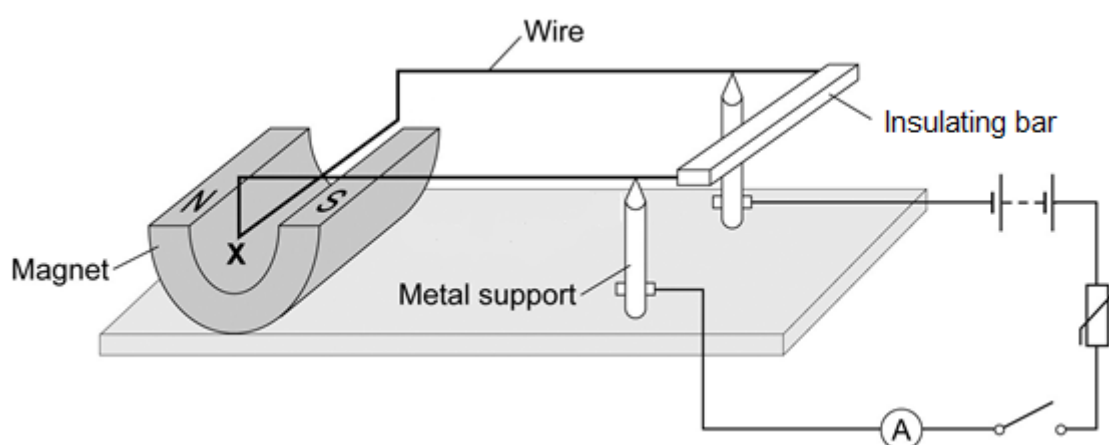
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| P2H  | Grades 4–5 | Grades 6–7 | Grades 8–9 | AO  | Type                               |
|------|------------|------------|------------|-----|------------------------------------|
| 12.1 |            | 1          |            | 1   |                                    |
| 12.2 |            | 1          |            | 2   |                                    |
| 12.3 |            | 1          | 5          | 1 2 | Multi step calculation.<br>Linked. |

**1 2**

**Figure 20** shows a piece of apparatus called a current balance.

**Figure 20**



When the switch is closed, the part of the wire labelled **X** experiences a force and moves downwards.

**1 2**

**1**

What is the name of the effect that causes the wire **X** to move downwards?

**[1 mark]**

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**1 2**

**2**

Suggest one change you could make to the apparatus in **Figure 20** that would increase the size of the force that wire **X** experiences.

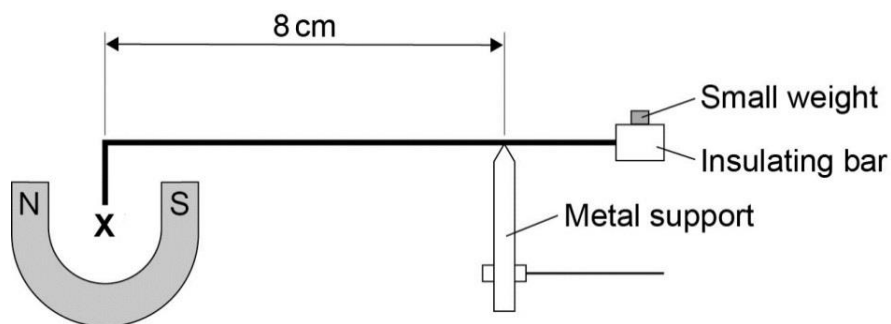
**[1 mark]**

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**Figure 21** shows how a small weight placed on the insulating bar makes the wire **X** go back and balance in its original position.

**Figure 21**



**1** **2** . **3** The wire **X** is 5 cm long and carries a current of 1.5 A.

The small weight causes a clockwise moment of  $4.8 \times 10^{-4}$  Nm.

Calculate the magnetic flux density where the wire **X** is positioned

Give the unit.

**[1 mark]**

Magnetic flux density = \_\_\_\_\_ Unit \_\_\_\_\_

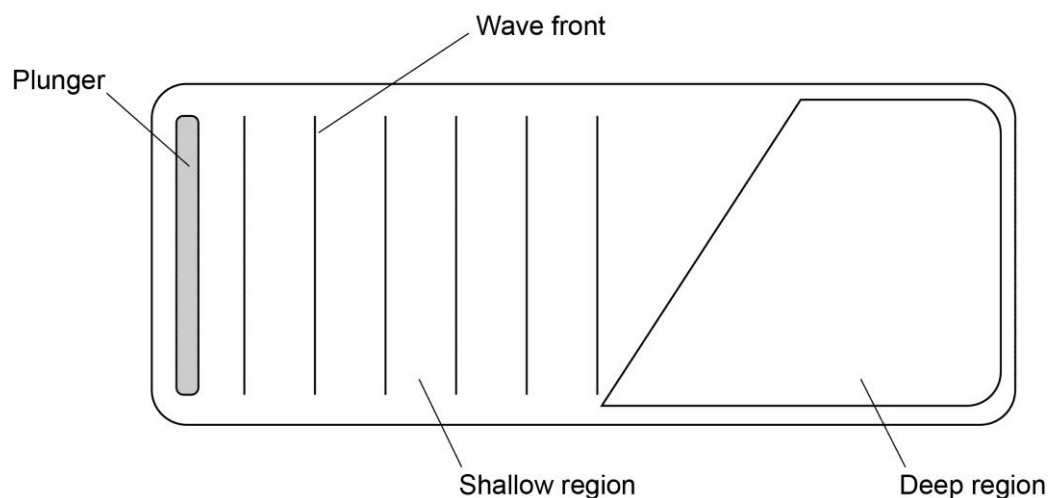
| Synergy 1H | Grades 4–5 | Grades 6–7 | Grades 8–9 | AO | Type |
|------------|------------|------------|------------|----|------|
| 9.1        |            |            | 1          |    |      |
| 9.2        |            |            | 2          |    |      |
| 9.3        |            | 3          |            |    |      |
| 9.4        |            |            | 2          |    |      |
| 9.5        |            | 5          |            |    |      |

09

Some students did an investigation to study the behaviour of waves.

**Figure 9** shows a ripple tank that they used to model the behaviour of waves.

**Figure 9**



09

. 1

Complete the wave fronts on **Figure 9**.

Show how the wave is refracted as it passes from the shallow region into the deep region

[1 mark]

09

. 2

Explain what happens to the waves as they pass into the deep region.

[2 marks]

**0 9 . 3** The waves generated on the surface of the water are transverse waves.

Describe the differences between longitudinal waves and transverse waves.

You may include labelled diagrams to help your answer.

**[3 marks]**

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**0 9 . 4** Some students investigate the properties of the waves generated in **Figure 9**.

Student **A** says 'the waves move water from one end of the tank to the other'.

Student **B** says 'that's wrong. Only the waves move, not the water'.

Suggest what the students could do to decide which of them is correct.

**[2 marks]**

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**0 9 . 5** Another student uses a ripple tank where all the water is the same depth.

She measures the wavelength of each wave as 0.34 m.

The period of each wave is 0.42 s.

Calculate the speed of the wave.

Use the correct equation from the Physics Equation Sheet.

Give the unit.

Give your answer to three significant figures.

**[5 marks]**

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Speed = \_\_\_\_\_

Unit = \_\_\_\_\_

| Synergy 1H | Grades 4–5 | Grades 6–7 | Grades 8–9 | AO | Type                          |
|------------|------------|------------|------------|----|-------------------------------|
| 8.1        |            | 2          |            | 1  |                               |
| 8.2        |            | 3          |            | 2  | Required practical.<br>Maths. |
| 8.3        |            | 3          |            | 3  | Required practical.<br>Maths. |
| 8.4        |            |            | 5          | 2  | Required practical.<br>Maths. |

**0 8**

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

**0 8**

**. 1**

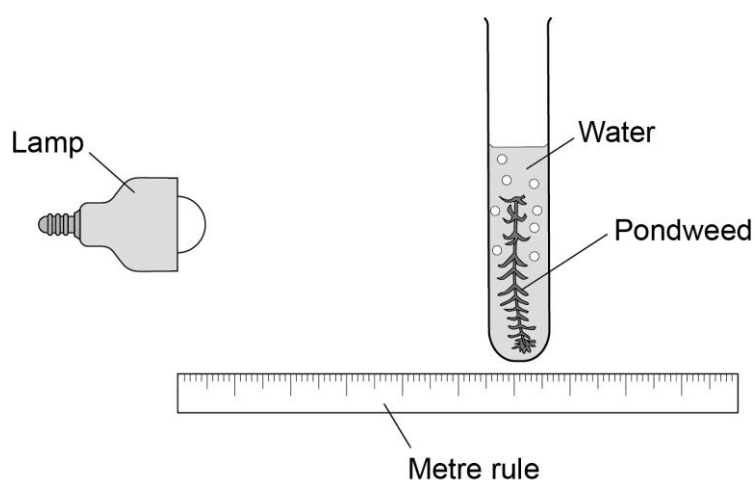
The formula for glucose is  $C_6H_{12}O_6$

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

**[2 marks]**

**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.

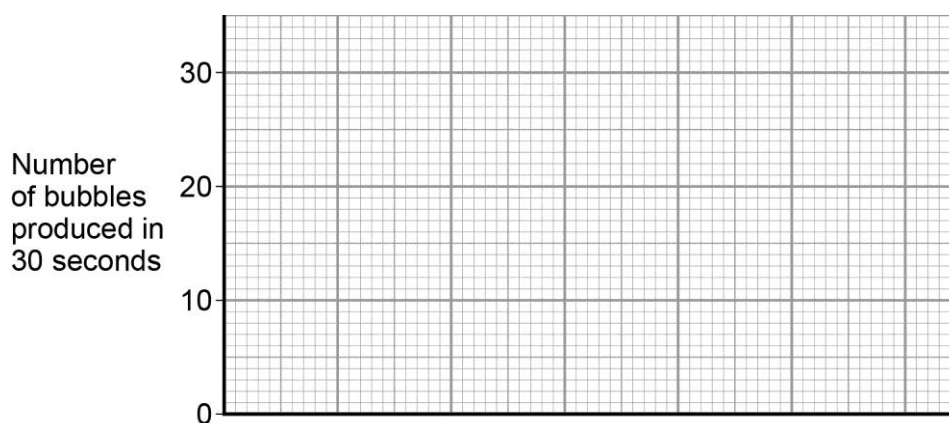
**Table 5**

| 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 9**.

**[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]**

**08** . **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 = \_\_\_\_\_ cm<sup>3</sup> per minute

| Synergy<br>2H | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type          |
|---------------|---------------|---------------|---------------|----|---------------|
| 9             |               | 6             |               | 1  | Linked ideas. |

**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]**

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| Synergy<br>3H | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type                    |
|---------------|---------------|---------------|---------------|----|-------------------------|
| 6.1           | 2             |               |               | 2  | Maths.                  |
| 6.2           |               | 3             |               | 2  | Maths.                  |
| 6.3           |               | 3             |               | 1  |                         |
| 6.4           |               | 5             |               | 2  | Maths.<br>Linked ideas. |
| 6.5           |               | 3             |               | 2  | Maths.                  |

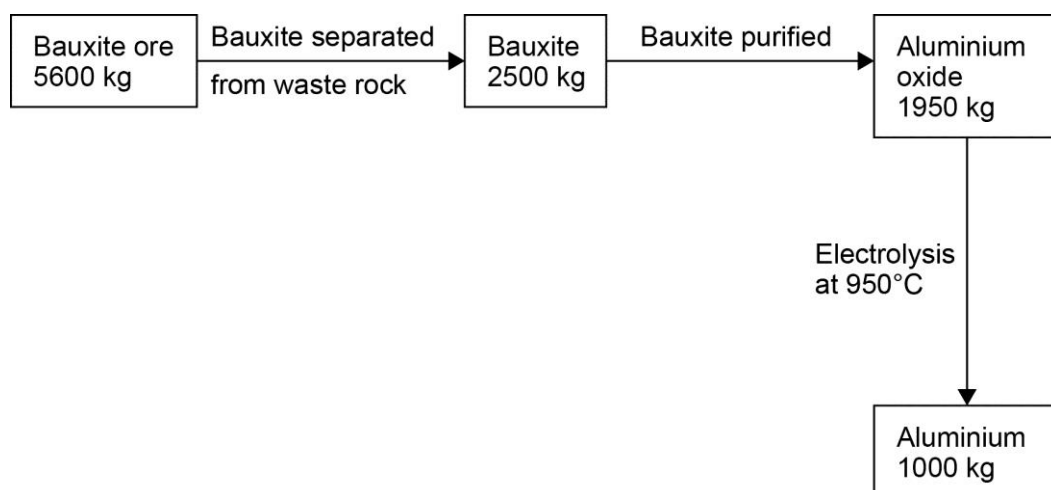
**0 6**

Aluminium is produced from an ore called bauxite.

Bauxite contains aluminium oxide.

Look at **Figure 7**.

**Figure 7**



**0 6**

**1**

Calculate the percentage of bauxite that is converted into aluminium oxide.

**[2 marks]**

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Percentage = \_\_\_\_\_



- 0 6 . 2** Show by calculation that the mass of aluminium produced is less than that expected from 1 950 kg aluminium oxide ( $\text{Al}_2\text{O}_3$ ).

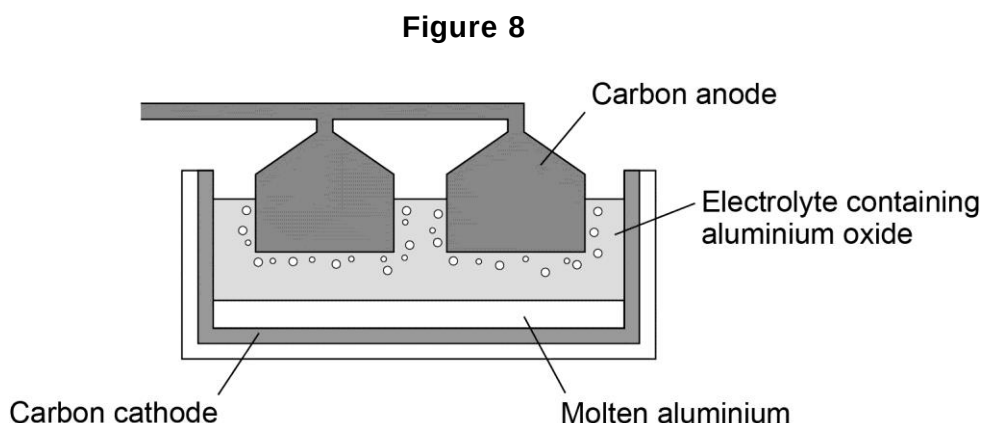
You should state the difference in the mass of aluminium expected and the mass of aluminium produced to three significant figures.

Relative atomic masses ( $A_r$ ): O = 16; Al = 27

[3 marks]

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**Figure 8** shows an electrolysis cell used to extract aluminium.



- 0 6 . 3** Why does the carbon anode used in the electrolysis cell need to be continually replaced?

[3 marks]

- 
- 0 6 . 4** In an electrolysis cell the current is  $1.5 \times 10^5$  A, at a potential difference of 4V.

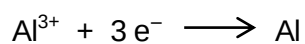
Calculate the energy transferred by the electrolysis cell in 24 hours.

[5 marks]

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Energy transferred = \_\_\_\_\_ J

**06 . 5** The half equation at the cathode is:



Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

Relative atomic mass ( $A_r$ ): Al = 27

**[3 marks]**

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Answer = \_\_\_\_\_ moles

| Synergy<br>4H | Grades<br>4–5 | Grades<br>6–7 | Grades<br>8–9 | AO | Type                                |
|---------------|---------------|---------------|---------------|----|-------------------------------------|
| 10            |               | 6             |               | 3  | Extended response.<br>Linked ideas. |

**1 0**

Read the information about production of copper.

- World demand for copper in 2014 was about 22 million tonnes.
- World reserves of copper are about 700 million tonnes.
- Most of the copper today is obtained from copper ores. The ores are mined.
- Copper ore is heated in a furnace to produce copper sulfide. The furnace is heated by burning fossil fuels. Air is blown through the hot copper sulfide to produce copper and sulfur dioxide.
- Some copper is extracted from low-grade ores by phytomining. Phytomining uses plants to absorb copper compounds. The plants are burned and copper is extracted from the ashes.

A scientist stated:

‘more copper should be extracted by phytomining.’

Use the information to justify the scientist’s statement.

**[6 marks]**