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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/08 Summer 2024 series

Version 1

ocr.org.uk/science

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 8 series overview

Paper 8 is the final Higher tier paper for candidates for the GCSE (9-1) Combined Science B qualification. It contains questions drawn from all areas of the specification and from all three of the science subjects. In this year's paper, Questions 1 and 2 were the questions that were common to the Foundation tier paper.

With its synoptic nature candidates find this paper more challenging. The ability of a candidate to articulate their responses and the use of technical language is regularly tested. Candidates performed well in the calculations. Candidates found ideas of 'How Science Works' the most challenging. While many seemed to have carried out practical work, there wasn't an understanding of the disciplinary knowledge one might expect from Higher tier candidates. However, it was particularly pleasing to see most candidates engaging well with the extended writing question. Many candidates used the data from the table to give a reasoning for their choice of rope. Some candidates struggled to in their use of appropriate tier 3 vocabulary when describing forces acting on the bungee jumper, as well as constructing a force diagram. This is an area for centres to look to improve upon in future series.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• identified safety precautions when handling radioactive sources • demonstrated an understanding of the relationship between the group number of an element and the number of electrons in the outer shell • completed a Punnet square and described the phenotype produced • described the test for oxygen • showed an understanding of the spring constant and how it relates to the stretchiness of the spring • could extract information from a graph such as gradients in Question 7 (a) (i) and trends in Question 7 (b) (i) • could perform calculations well, including, area of a clear zone in Question 3 (c), percentage difference in area of the clear zone in Question 3 (d), number of moles in Question 4 (b) (ii), and number of molecules in Question 4 (b) (iii), difference in acceleration between two points in Question 6 (b) and rate of photosynthesis in Question 7 (b) (iii).	• found it difficult to complete diagrams with the correct description of the forces involved in Question 8 (c) • could not calculate percentage difference in a clear zone in Question 3 (d), number of moles in Question 4 (b) (ii) when given the equation and values and the difference in acceleration in Question 6 (b) • did not make suitable suggested improvements to a method • could not extract information from graphs effectively in Question 7 (a) (i) and Question 7 (b) (i) • did not demonstrate an understanding of the effect of the spring constant on the ability of a spring to stretch in Question 9 (a) • could not explain why carbon compounds can have a variety of properties in Question 9 (b).

Question 1 (a)

1 Doctors select radioactive isotopes for imaging scans and for treatments very carefully.

The table shows the radiation emitted and half-lives of 6 radioactive samples.

Sample	Radiation Emitted	Half-life
A	Alpha	10 days
B	Alpha	1600 years
C	Beta	8.0 days
D	Beta	2.7 days
E	Gamma	5.3 years
F	Gamma	8 days

(a) Which sample is suitable to be used as a radioactive tracer for an imaging scan?

Explain your answer.

Use data from the table.

Sample ....

Explanation ....

....

....

....

.... **[3]**

Candidates could generally chose either F or D and explain their choice with regards to ionising or penetrating ability, or the ability of the radiation to escape the body and be detected, whilst remaining safe for the patient. Most candidates scored 2 marks

Question 1 (b)

(b) Samples A and B emit alpha radiation.

Suggest **two** precautions that should be taken by hospital staff when handling samples A and B.

1 ....

2 ....
[2]

This question was generally well answered with most candidates being able to describe safety precautions used with radioactive materials.

Question 1 (c)

(c) One of the samples in the table is radium-226.

Determine the number of neutrons in a nucleus of a radium-226 atom.

Use the Data and Equation Sheet.

Number of neutrons = ... **[2]**

Most candidates could successfully calculate the number of neutrons.

Question 1 (d)

(d) How many outer shell electrons does each radium-226 atom have?

Explain your answer.

Use the Data and Equation Sheet.

Number of outer-shell electrons ....

Explanation ....

....

.... **[2]**

Candidates were generally able to relate the group number to the number of outer electrons. Where candidates became confused, was where they tried to determine the number of electrons using ideas of 2,8,8 etc. Some candidates made this more complicated than it was intended to be.

Question 1 (e)

(e) Another of the radioactive isotopes in the table is iodine-131.

Which element will most readily react with iodine-131 to form a salt?

Tick (✓) **one** box.

Copper ☐

Gold ☐

Neon ☐

Sodium ☐

[1]

Most candidates could identify sodium as the element that will react with iodine.

Question 2 (a)

2 Some students are learning about radioactivity and radioactive half-life.

(a) What is the definition for the activity of a radioactive source?

Tick (✓) **one** box.

The current produced by the particles. ☐

The purpose the radioactive sample is used for. ☐

The number of decay events per second. ☐

The type of radiation that the substance emits. ☐

[1]

A large number of candidates could identify the correct definition of activity for a radioactive sample; however a number of candidates selected the last option

Question 2 (b)

(b) What is the definition of half-life?

Tick (✓) **one** box.

Half of the original activity of a sample. ☐

Half the lifetime of a radioactive substance. ☐

The time for half of a decay to happen. ☐

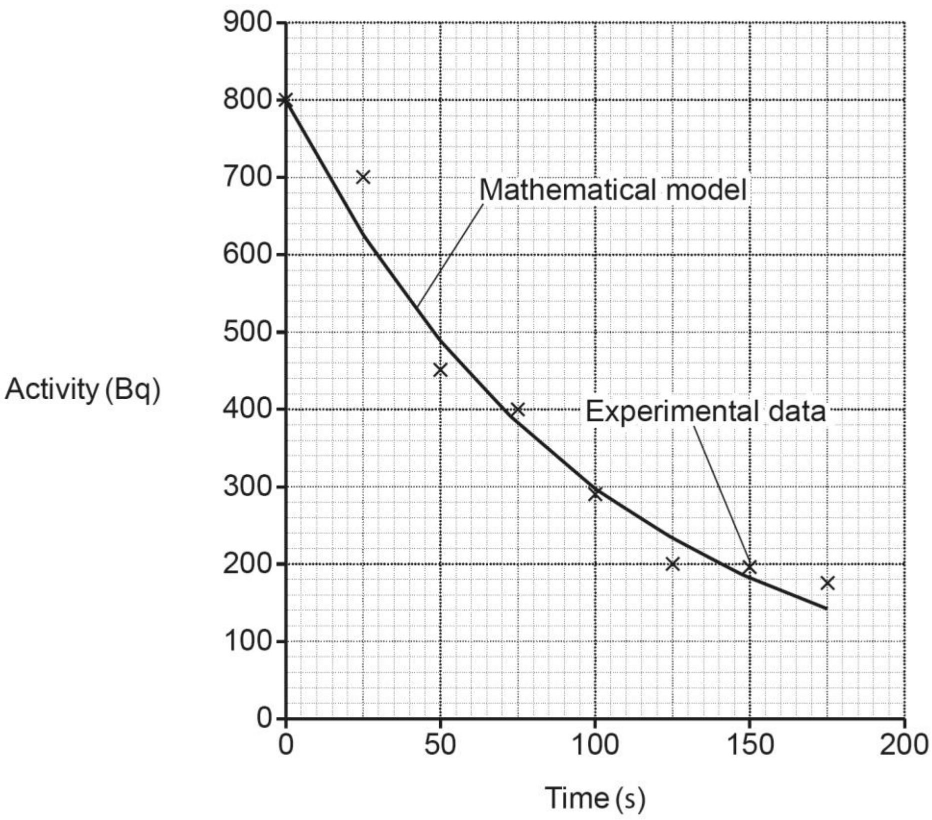
The time for the activity to fall to half. ☐

[1]

Candidates struggled to identify the correct statement, often selecting the statement referring to the time taken for half of the decay to happen rather than the time taken for the activity to halve.

Question 2 (c)

(c) The graph shows experimental data from a radiation detector, and a separate mathematical model of decay.



Complete the sentences about radioactive decay.

Use words from the list.

complete	**match**	**random**	**replace**	**selective**	**trend**

Radioactive decay is a .... process.

Experimental data may not .... the model results due to chance

but the overall .... will be the same.

[3]

Almost all candidates could identify the second and third missing words of 'match' and 'trend'. When candidates were incorrect in their selection for the first gap, they chose the word 'selective' rather than the correct word 'random'.

Question 3 (a)

3 An antibiotic sensitivity test can help researchers to develop new antibiotics.

The test procedure is:

1. Spread bacteria on an agar plate.
2. Soak discs of paper in different antibiotics.
3. Place the discs of paper on an agar plate.
4. Incubate the agar plate so that the bacteria can grow.

There is a clear zone around each disc where no bacteria grow. This shows how effective an antibiotic is against the type of bacteria that is on the agar plate.

The image shows some test results. Some of the paper discs have been labelled **B**, **C** and **D**.

(a) Draw a line to the least effective antibiotic disc and label it **A**. **[1]**

Almost all candidates could identify the least effective antibiotic and label it 'A'.

Question 3 (b)

(b) Measure the diameter of the clear zone for antibiotic disc **B**.

Give your answer in **mm**.

Diameter = ... mm **[1]**

Candidates could generally measure the clear zone correctly. Where candidates were incorrect in their measurements, they were generally too high in their readings.

Question 3 (c)

(c) Calculate the area of the clear zone for antibiotic disc **B**.

Use the equation: area = $3.14 \times r^2$

Area = ... mm^2 **[3]**

Most candidates could use the formula given to calculate an area. Common mistakes included not dividing the diameter by 2 to give the radius before entering the numbers into the equation and additional conversions, such as millimetres to metres or centimetres to millimetres. These conversions are a key part to ensuring candidates have access to all the marks.

Question 3 (d)

(d) The area of the clear zone for disc **C** is 52 mm^2.
The area of the clear zone for disc **D** is 113 mm^2.

Calculate the percentage difference in area of the clear zones for disc **D** compared to disc **C**.

Give your answer to **2** significant figures.

Percentage difference = ... % **[3]**

Candidates found this question challenging with a wide variety of errors seen. Only a small number of candidates scored the full 3 marks on this question. The biggest issue was which number should be the denominator in the calculation. Some candidates added 113 and 52 to give 165 and used this value, some used 113 or 61, showing little understanding of what was being asked by the question. This is an area centres can develop for future series.

Question 4 (a) (i)

4 At school, some students are studying rates of reaction.

(a) They use this method to investigate how temperature affects the rate of reaction:

- Add 50 cm^3 of sulfuric acid to calcium carbonate ($CaCO_3$) powder in a conical flask, at room temperature.
- Measure the change in mass of the reactants every 30 seconds for five minutes.
- Repeat the experiment at 80 °C.

(i) Name **one** piece of equipment the students can use, instead of a Bunsen burner, to heat the reactants and conduct the experiment at 80 °C.

Explain your answer.

Equipment ....

Explanation ....

....

....

[2]

A small number of candidates could identify the equipment used as a water bath. There was a lack of understanding of ensuring there is even heating in the liquid and some suggestions (e.g. use a lighter) would not have been safe.

Question 4 (a) (ii)

(ii) Suggest **two** improvements to this method.
Explain each suggestion.

Suggestion 1 ....

....

Explanation 1 ....

....

Suggestion 2 ....

....

Explanation 2 ....

....
[4]

Candidates found it a challenge not only to suggest a valid improvement, but also to explain why that change would improve the method. Often the response was to 'improve accuracy'. Whilst accuracy is improved with some changes to the method that could be made, it is not the explanation for most of the suggestions made by candidates. Over a third of the candidates were not awarded a mark.

Question 4 (b) (i)

(b) Carbon dioxide gas (CO_2) is produced in the reaction and escapes from the conical flask.

(i) Calculate the relative formula mass of carbon dioxide.

Use the Data and Equation Sheet.

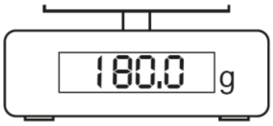
Relative formula mass = ... **[2]**

Most candidates could correctly calculate the relative formula mass.

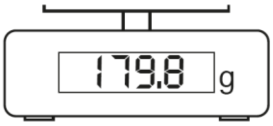
Question 4 (b) (ii)

(ii) The reading on the balance at the start of the experiment and after two minutes is shown.

Start



After two minutes



Calculate the number of moles of carbon dioxide produced in two minutes.

Use the equation: number of moles = $\frac{\text{mass of substance}}{\text{relative formula mass}}$

Number of moles = ... mol **[3]**

Most candidates were awarded 2 or 3 marks in this question. The most common error made was the lack of subtraction of the masses before dividing by the relative formula mass.

Question 4 (b) (iii)

(iii) In another experiment, 0.006 moles of carbon dioxide is produced.

Calculate the number of molecules in 0.006 moles of carbon dioxide.

1 mole of a substance contains 6.0×10^{23} molecules.

Molecules of carbon dioxide = ... **[2]**

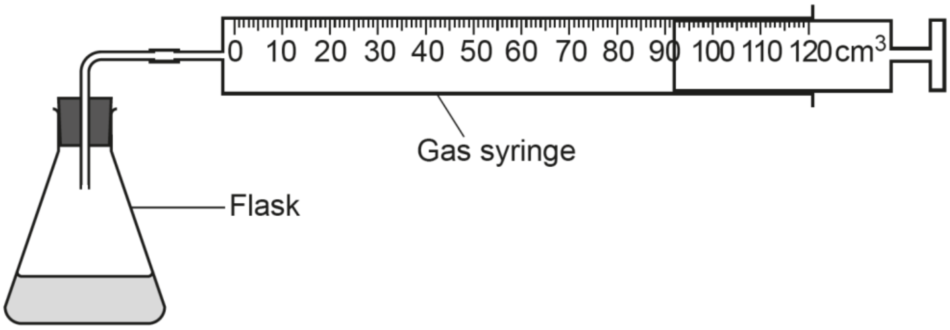
Most candidates were awarded both marks. Some candidates made the error of dividing moles by the Avogadro constant rather than multiplying the two numbers together.

Question 4 (c) (i)

(c) The student repeats the experiment again using a gas syringe to measure the volume of carbon dioxide gas produced.

They measure 92 cm^3 of carbon dioxide which is equal to 0.184 g.

1 cm^3 of carbon dioxide = 0.002 g.



(i) If this 0.184 g of carbon dioxide was weighed on the balance shown in part **(b)(ii)**, what would the balance display?

Tick (✓) **one** box.

0.18 g ☐

0.2 g ☐

0.20 g ☐

0.184 g ☐

[1]

A significant number of candidates chose the value of 0.184g demonstrating a lack of understanding of the resolution of the apparatus.

Question 4 (c) (ii)

(ii) Suggest **one** reason why the gas syringe method will give a more accurate number of moles of carbon dioxide than the balance method.

....

.... **[1]**

A significant number of candidates discussed the advantage of using the gas syringe, often commenting on 'collecting all the gas' or 'no leaking of gas' rather than focusing on the comparison of the resolution of the two pieces of apparatus. Less than 10% of candidates scored a mark on this question.

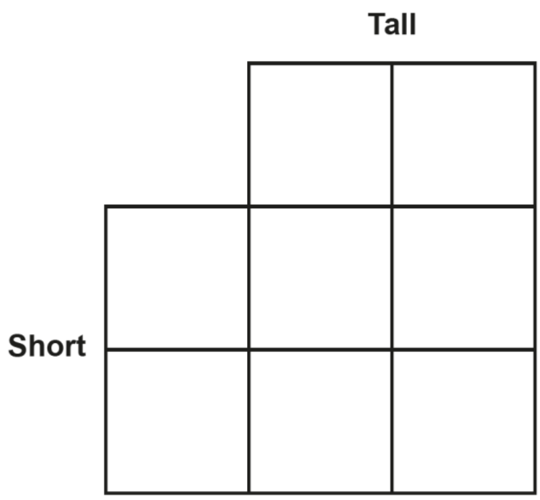
Question 5 (a)

5 In the 1860s Gregor Mendel studied inheritance by crossing together pea plants with different characteristics.

(a) Complete the Punnett square to show the possible genotypes when Mendel crossed **homozygous** tall pea plants with **homozygous** short pea plants.

The dominant allele causes plants to be tall.

Use **T** for the dominant allele.
Use **t** for the recessive allele.



[2]

Most candidates scored at least 1 of the 2 marks available. Where 1 mark was scored it was for correctly entering the offspring alleles from incorrect parent alleles.

Question 5 (b)

(b) A student makes a statement about the genetic cross:

"If 100 pea plants were produced from this cross, then 50 of them should be tall pea plants."

Explain why the student's statement is **incorrect**.

....

....

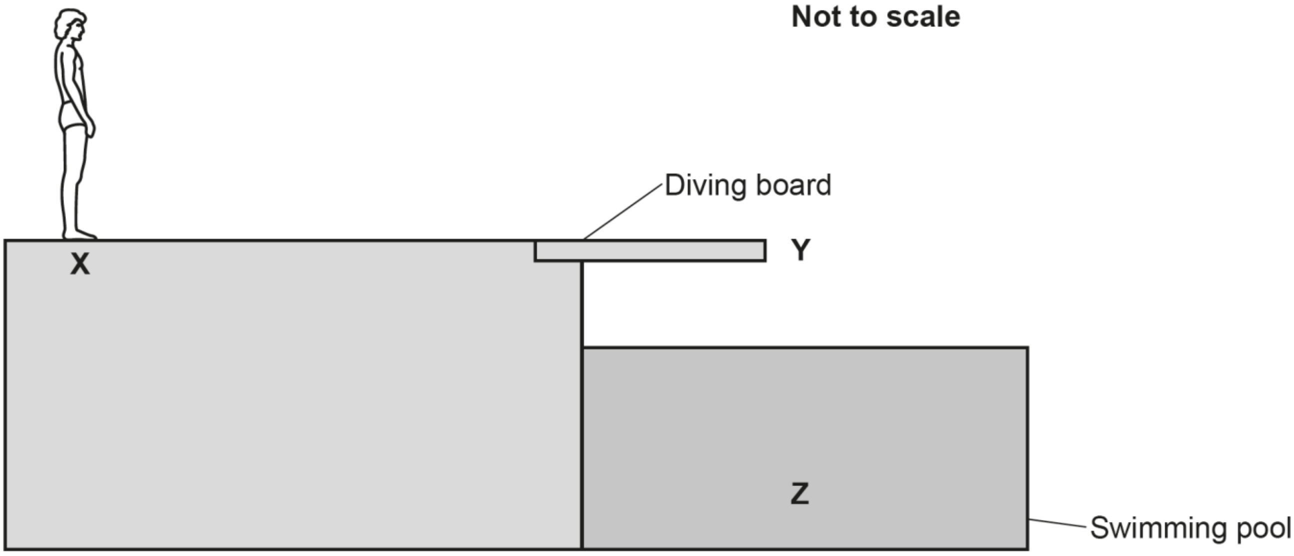
....

.... **[2]**

Error carried forward was given here in a number of instances where the incorrect parent alleles in the previous part of the question had led to a 75% to 25% ratio of tall to short plants. The explanation of why this was eluded many candidates. There needed to be a discussion of the genotype to fully explain the genetic crosses.

Question 6 (a)

6 The diagram shows a diver standing stationary at **point X**, several metres away from the diving board.



(a) The diver takes a run up to the diving board.

The diver's speed when they reach the diving board is 2.7 m/s. It takes 2.5 s for the diver to reach the diving board.

Calculate the acceleration between **point X** and the diving board.

Use the equation: acceleration = $\frac{\text{change in speed}}{\text{time taken}}$

Acceleration = ... m/s^2 **[2]**

Almost all candidates correctly calculated the acceleration given the formula.

Question 6 (b)

(b) At **point Y**, the diver is no longer in contact with the diving board and is in free fall. At **point Z** under water, the diver has reached a constant speed.

Calculate the difference in acceleration between **point Y** and **point Z**.

Difference in acceleration = ... m/s^2 **[1]**

This mark was rarely scored. Most candidates simply repeated the value of 1.08 from the previous part of the question. Very few candidates seemed to appreciate that the diver was in free fall at point Y.

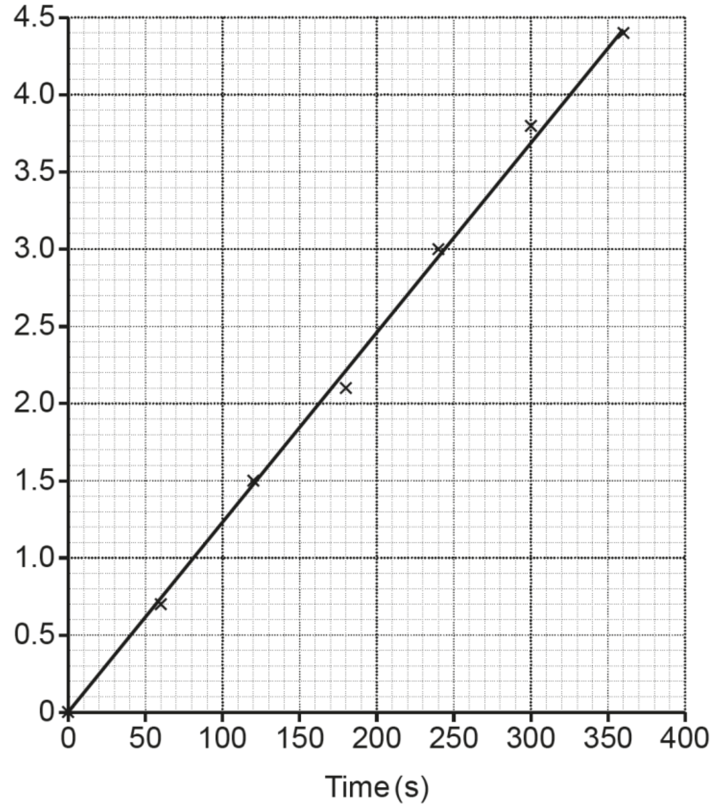
Question 7 (a) (i)

7 Some students are investigating photosynthesis.

(a) They measure the volume of gas produced by pondweed every 60 seconds.

Fig. 7.1 shows their results.

Fig. 7.1



(i) Calculate the rate of reaction.

Rate of reaction = ... cm^3/s **[3]**

Most candidates could read information correctly from the graph. This was a pleasant improvement from previous series. From the correct values there were a number of candidates that went on to correctly calculate the rate of reaction. Common mistakes included dividing the numbers the wrong way around.

Question 7 (a) (ii)

(ii) Describe the chemical test that the students can do to prove that the gas produced is oxygen.

....

....

....

.... **[2]**

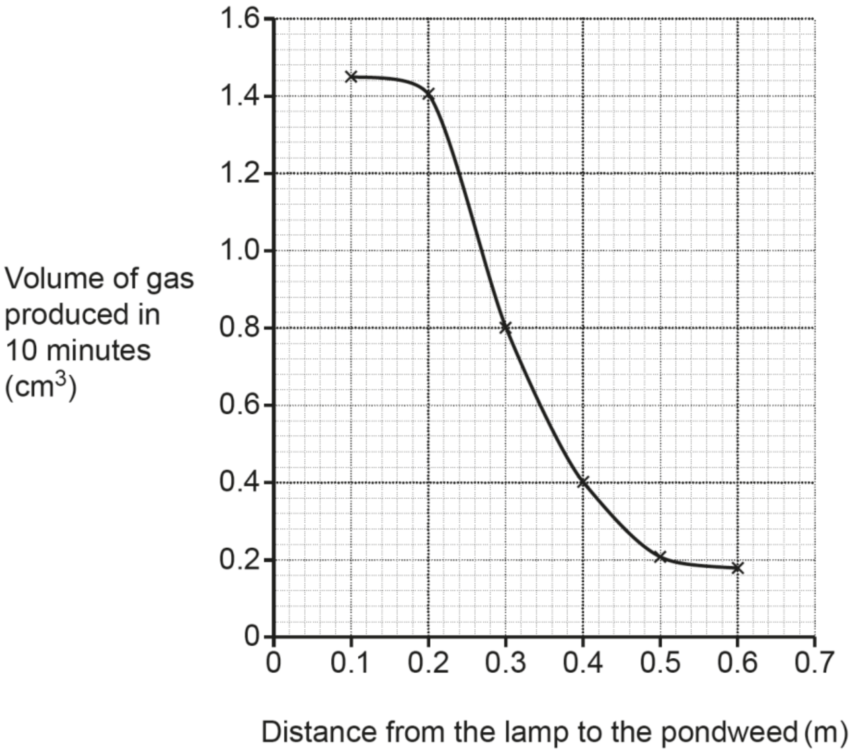
Most candidates could describe the test for oxygen and the positive test result.

Question 7 (b) (i)

(b) The teacher gives the students the data shown in **Fig. 7.2**.

It shows how the intensity of light affects the volume of gas produced by pondweed in 10 minutes. The light intensity is varied by moving the lamp further away from the pondweed.

Fig. 7.2



(i) A student writes:

"The greater the distance of the lamp from the pondweed the slower the rate of photosynthesis."

Evaluate the student's statement.

....

....

....

.... **[2]**

Most candidates found this evaluation challenging. There was a lack of understanding of the rate being indicated by the volume of gas collected in a set time. Very few candidates could articulate their ideas to describe the shape of the graph to help with the evaluation of the student's statement and why it was correct .

Question 7 (b) (ii)

(ii) State **two** factors that need to be controlled in this light intensity experiment.

Factor **1** ....

Factor **2** ....

[2]

Most candidates could identify the lamp as a factor that needed to be controlled. Fewer candidates could identify the temperature or type or size of pondweed as factors to control.

Question 7 (b) (iii)

(iii) Calculate the rate of photosynthesis when the lamp is 0.30 m from the beaker.

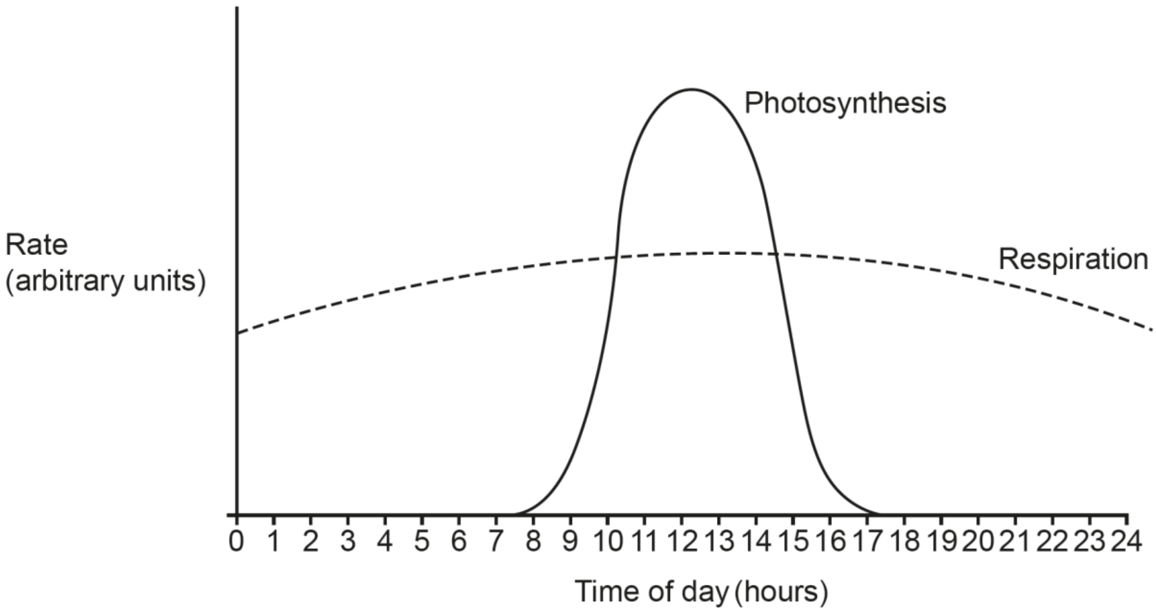
Rate of photosynthesis = ... cm^3 / min **[2]**

A large number of candidates could read the value 0.8 cm^3 from the graph. The calculation following this was more challenging to the candidates.

Question 7 (c) (i)

(c) **Fig. 7.3** shows how the rates of photosynthesis and respiration for a plant vary over a 24 hour period during the **winter**.

Fig. 7.3



(i) At which times of the day are the rate of respiration and the rate of photosynthesis equal in **winter**?

Use **Fig. 7.3**.

.... **[1]**

Most candidates could identify the appropriate times of day.

Question 7 (c) (ii)

(ii) In the summer the hours of daylight are longer and the temperature is warmer.

Sketch a curve on **Fig. 7.3** for the rate of photosynthesis over a 24 hour period in the **summer**. **[2]**

A significant number of candidates scored both marks. Where only 1 mark was scored, this was usually due to drawing a line above the existing line without representing any period of darkness in the 24 hour period.

Question 8 (a)

8 Bungee jumping is an extreme sport that involves jumping off a high platform while attached to an elasticated 'bungee' cord.

(a) A person's weight needs to be measured before a bungee jump so that appropriate equipment can be used.

Describe how weight is measured.

....

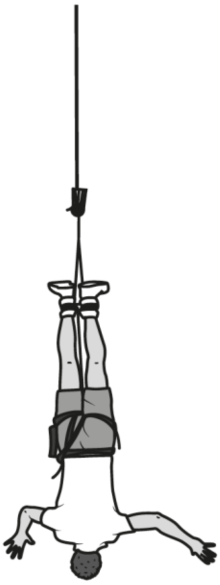
.... **[1]**

Responses that referred to the use of 'scales' and measuring weight in kilograms, were not creditworthy There needed to be a clear recognition that weight is a force and is measured in newtons. This is a simple point that centres can stress with candidates for future exam series.

Question 8 (b)

(b) In **Fig. 8.1**, the bungee cord is stretching.

Fig. 8.1



Describe **two** forces that cause the **cord to stretch**.

....

....

....

.... **[2]**

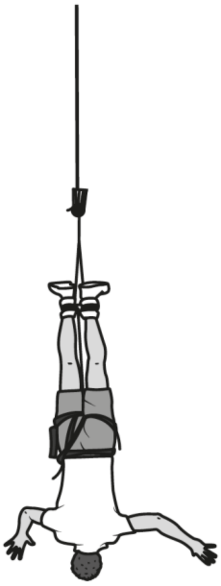
Both the name of the force and the direction are needed for each mark to be awarded. Where the name of the force was given correctly, the direction was often missed. Very few candidates could suggest an upward force.

Question 8 (c)

(c) In **Fig. 8.2**, the bungee jumper is at rest.

Draw **two** labelled arrows on **Fig. 8.2** to represent the interaction pair of forces between the person and the bungee cord.

Fig. 8.2



[2]

The position of the arrows on the diagram were poorly drawn in many cases. The arrows should be drawn from the point of contact and they should be of equal length, pointing in opposite directions. Elasticity was often wrongly quoted as the upward force.

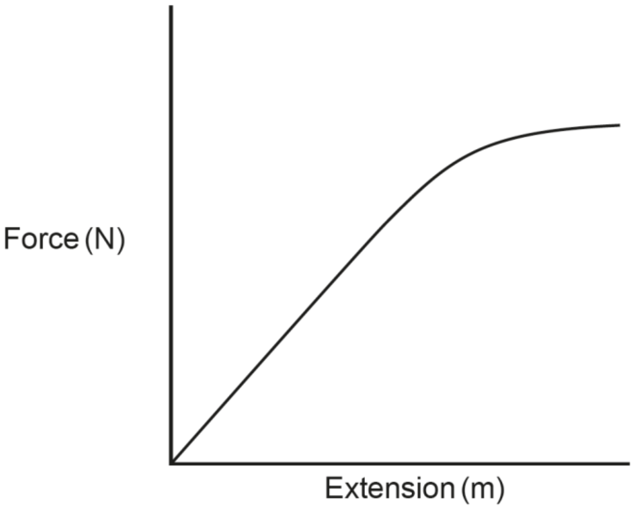
Misconception

? Very few candidates drew arrows correctly representing force pairs. The arrows should be drawn on the diagram rather than to the side of the diagram. They should also be equal length and pointing in opposite directions when an object is at rest.

Question 8 (d)

(d) **Fig. 8.3** shows the force-extension graph for a bungee cord at forces up to and beyond the forces experienced during a bungee jump.

Fig. 8.3



Describe the relationship between force and extension in **Fig. 8.3**.

....

....

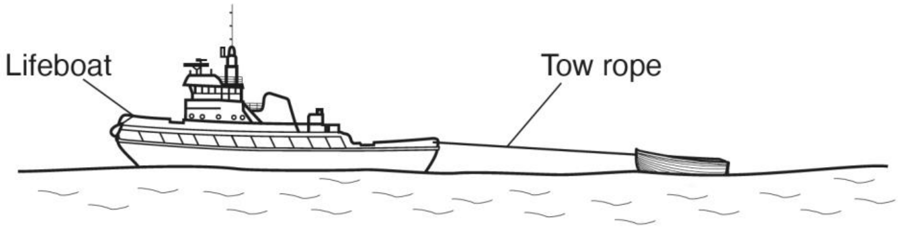
....

.... **[2]**

Most candidates could describe the relationship between force and extension below the limit of proportionality. Fewer candidates could describe the relationship of force and extension beyond this limit of proportionality, often becoming confused.

Question 9 (a)*

9 Lifeboats sometimes use tow ropes during rescues.



(a)* A lifeboat organisation wants to buy a new tow rope.

The tow rope must:

- have a breaking force greater than 88 MN
- stretch easily to store energy as the boats go over waves
- sink in sea water.

The table shows some properties of three polymer ropes which all have the same dimensions.

The density of sea water is 1.02 g / cm^3.

Polymer	Breaking force (MN)	Spring constant (MN / m)	Density (g / cm^3)
Aramid	560	21.5	1.44
Nylon	170	0.8	1.14
Polypropylene	110	0.4	0.91

Explain which polymer is the most suitable to use for the tow rope.

Include in your answer:

- why you have **not** chosen the other polymers
- any other factors that may be considered when choosing the most suitable polymer.

....

....

....

....

....

.... **[6]**

Level 3 was rarely seen, as the candidates were asked to explain other factors that would need to be considered when purchasing a rope. Very few candidates added their own knowledge to the information in the question. The spring constant value was misinterpreted by candidates. Some candidates referred to the higher spring constant being 'more stretchy', which is incorrect. Other than this misconception, candidates generally responded well to this question, evaluating the information given.

Exemplar 1

• I choose Nylon as the polymer, since its breaking force is greater than the required 88MN (Nylon's is 170MN).
• It has a spring constant of 0.8MN/m which means it can stretch easily
• Nylon is able to sink in water as its density is 1.14g/cm³
• I did not choos Aramid since its spring constant is 21.5 MN/m so it is not that stretchy, it may also be too heavy as its density is much greater than Nylon and polypropylene.
• I did not choose polyprophylene since it is unable to sink in water 0.91g/cm³ < 1.02g/cm³. [6]
• The cost of the polymer must also be considered when choosing.

This example shows a Level 3 response. The candidate has made a clear choice of Nylon. They have commented on the breaking force, the spring constant, and the density from the table of information given. They have said why they have not chosen the other materials. Finally they have discussed another factor to be considered. In this case 'cost' was discussed. This candidate has answers all parts of the question.

Question 9 (b)

(b) Explain why carbon atoms can form a large variety of polymer ropes.

Use ideas about bonding.

....

....

....

....

....

.... **[3]**

There were many opportunities to score marks on this question. Most candidates tried to give complicated responses that didn't answer the question. Almost half of candidates scored 1 or more marks for describing the bonding of carbon atoms.

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