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Examiners' report

APPLIED SCIENCE

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Unit 3 January 2025 series

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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. 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 Teach Cambridge.

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Unit 3 series overview

Many candidates performed well with this paper. They had a good understanding of the Learning Outcomes (LOs), and exemplification statements outlined on the specification for Unit 3. They were also able to adhere to the rubric of the paper and were familiar with the format of both the objective and free-response items. A number of candidates were successful when answering the Level of Response (LoR) question [Question 6 (b) (ii)] and performed at Level 2 or 3.

It appears that candidates had time to complete the paper within the 2 hours allocated. Some used the additional pages to add to or replace their responses written within the paper. In such instances, the candidates usually made clear links between the part-questions included on the additional pages and the relevant item on the paper. Some of the questions were not attempted by a number of candidates, including the variance/standard deviation calculation at Question 1 (a) (ii). There was no clear pattern between this particular nil response and other calculation-based questions in the paper. In most cases however, candidates engaged with all questions and provided a response.

The use of graphical techniques (Learning Outcome 2) was effective for many candidates and most candidates were confident when using the classification key (Learning Outcome 3). Some were challenged by the evaluation and analysis of data (Learning Outcome 4) but the application of knowledge and understanding for microscopy (Learning Outcome 6) was accessible for many candidates.

A number of calculations were included in this paper for Unit 3. It is recommended that candidates show their working when completing such calculations. Many candidates were awarded marks for different steps completed before writing the final answer, even if the final answer was incorrect. The application of 'error carried forward' (ecf) marks for a number of calculation questions enabled some candidates to obtain further marks. Such marks were accessible only for those candidates who showed the calculation steps in the space provided.

Candidates who did well on this paper generally:	**Candidates who did less well on this paper generally:**
• were able to successfully use the data provided for Question 1 (a) (ii) and complete the correct values for variance and standard deviation • recalled the types of error (e.g. systematic/instrumental) presented when considering the % uncertainty of data [Question 3 (d) (iii)] • estimated the gradient of a line shown for pH change with or without an emulsifier [Question 4 (d) (i)] • determined the % of living cells in a haemocytometer field of view [Question 6 (a) (iii)] • used the opportunity to provide a drawing to explain the use of a video camera to record a ball-bouncing experiment [Question 7 (b)].	• struggled to explain the quality and appropriateness of the line in a graph [Question 3 (b)] • miscalculated the % uncertainty in a given value [Question 3 (d) (ii)] • misinterpreted the relationship between pH change and the impact of an emulsifier [Question 4 (a) (ii)] • faced challenges when recalling the protocol for colorimetry [Question 5 (b) (i)] • did not articulate an effective description for the use of a PowerPoint to present results and observations [Question 7 (d)].

Question 1 (a) (i)

1 There are many brands of apple juice on the market.

Different brands contain different amounts of sugars and are made from different types of apple. Fructose is one of the main sugars in apple juice.

The table shows how the fructose concentration, in $g\,dm^{-3}$, varies in eight different brands of apple juice.

Brand	Fructose concentration ($g\,dm^{-3}$)
1	40
2	42
3	50
4	66
5	68
6	72
7	78
8	80

(a)
(i) Use the data in the table to determine the mean, median and range of the fructose concentrations in these eight brands of apple juice.

- mean ....
- median ....
- range ....

[3]

Most candidates completed the correct values for mean, median and range. Candidates were not challenged by this question. However, in some cases candidates gave a value of 66 instead of 67 for the median.

Question 1 (a) (ii)

(ii) Calculate the variance s^2 and standard deviation s of the fructose concentrations shown in the table.

Use the equation:

$$(n-1) \times s^2 = \sum (X - \overline{X})^2$$

where n is the number of samples, X is the concentration of each sample and $\overline{X}$ is the mean fructose concentration calculated in **(a)(i)**.

Show your working.

s^2 = ...

s = ...

[4]

Although the more successful candidates determined the correct values for both variance and standard deviation, some did not engage with this question, resulting in a nil response (NR). No clear error was identified for the calculations involved but some candidates were able to obtain 1 mark as an error carried forward (ecf) for calculating the square root of variance for ($\sqrt{\ }$) standard deviation, based on an incorrect value for variance.

Question 1 (b) (i)

(b) A group of students carries out a survey at their school to find out which concentration of fructose people prefer.

They ask 30 students in their year-group to taste samples of the eight brands shown in the table in **(a)** and ask them which brand tastes the best.

They find that most participants prefer the apple juice with a concentration of $50\,g\,dm^{-3}$.

(i) Which brand of apple juice did most participants prefer?

brand number .... **[1]**

Almost all candidates identified that the brand number for the most-preferred apple juice was 3, using the data presented in the table. No clear pattern of alternative responses was observed.

Question 1 (b) (ii)

(ii) They conclude that most people in the school prefer the brand which has a concentration of 50 g dm^{-3}.

Suggest **two** ways they could modify their survey design to make their conclusion more secure.

1 ....

....

2 ....

....

[2]

Many candidates appreciated that the conclusion would be more secure if the survey contained more samples/students. They also referred to using students from different year groups, or even teachers in some cases. No clear pattern of alternative responses was observed but some candidates did incorrectly refer to the quality/type of apple juice involved.

Question 1 (b) (iii)

(iii) The students predict that if they dilute a sample of Brand 8, more people would prefer it to the original concentration. They take 1 dm^3 of Brand 8, add 0.6 dm^3 water and mix thoroughly.

Calculate the concentration of fructose in this diluted sample and explain why their prediction is reasonable.

- Calculation

- Explanation ....

....

[3]

This question was accessible to the most successful candidates because they were able to complete the calculation correctly. Many candidates, however, did successfully relate the value for the changed concentration of apple juice to sample 3/50 dm^{-3}. This enabled them to obtain 1 out of the 3 marks available.

Question 1 (b) (iv)

(iv) Suggest an assumption the students made when making their prediction.

....

.... **[1]**

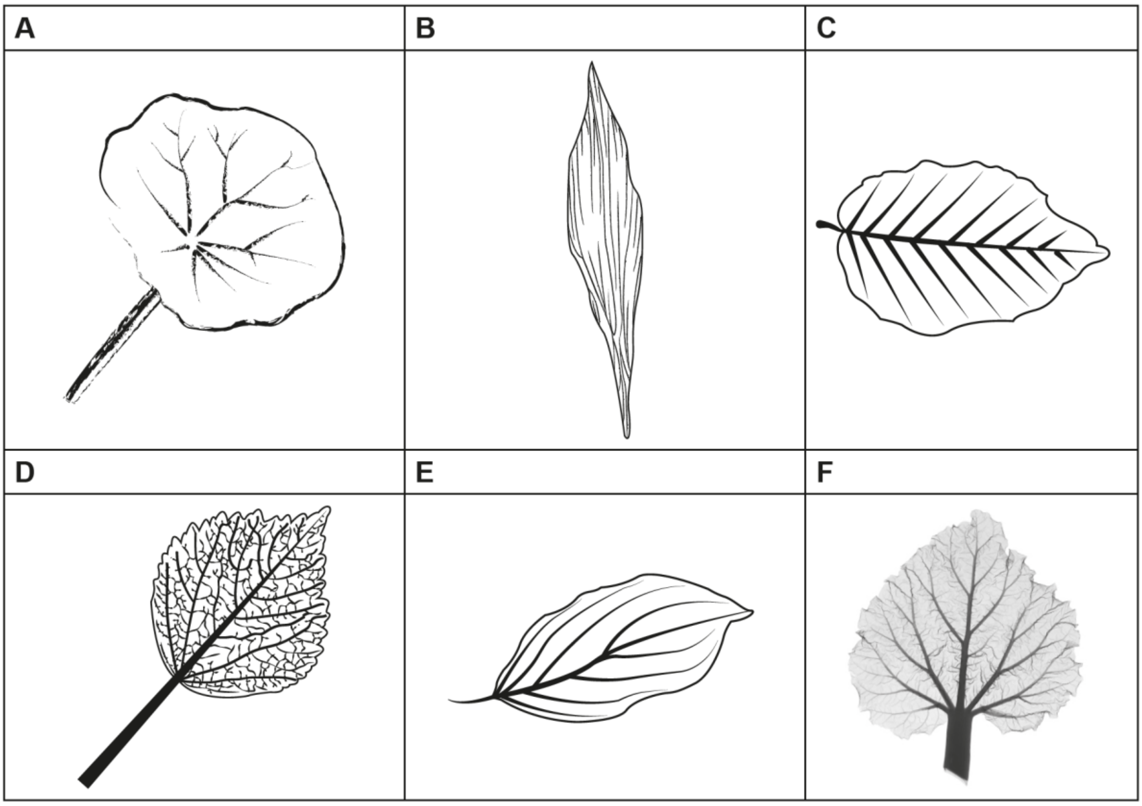
Most candidates seemed to be challenged by this question. There were very few who considered that the fructose concentration is the only factor determining the preferences of participants. No clear pattern of alternative responses was seen.

Question 2 (a)

2 Leaf veins provide support for the leaf. They also transport water and nutrients through the leaf and on to the rest of the plant. The patterns formed by the veins (venation) can be used to identify the plants on which they grow.

Fig. 2.1 shows leaves from six plants with different patterns of venation.

Fig. 2.1



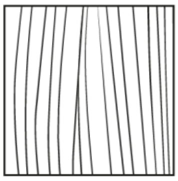
The key in **Fig. 2.2** can be used to identify the leaves in **Fig. 2.1**.

Fig. 2.2 Key

1	Secondary veins are paired opposite to each other and do not divide further.	YES – go to 2 NO – go to 3
2	**European Beech**	
3	Veins radiate from a point in the centre of the leaf.	YES – go to 4 NO – go to 5
4	**Nasturtium**	
5	Veins are arranged alongside each other without showing any connections.	YES – go to 6 NO – go to 7
6	**Tulip**	
7	Smaller veins form a finely branched network.	YES – go to 8 NO – go to 9
8	**Rose**	
9	Several primary veins diverge from a point on one side of the leaf.	YES – go to 10 NO – go to 11
10	**Rhubarb**	
11	Secondary veins bend towards the apex or tip of the leaf.	YES – go to 12
12	**Dogwood**	

The diagrams in **Fig. 2.3** can be used to identify the pattern of venation in each leaf.

Fig. 2.3 Patterns of venation

		
Arcuate	Cross-venulate	Dichotomous
		
Longitudinal	Palmate	Parallel
		
Pinnate	Reticulate	Rotate

(a) Use **Fig. 2.2** to identify the type of plant using leaves **A** to **F** and use **Fig. 2.3** to identify the pattern of venation in each leaf.

	Type of plant	**Pattern of venation**
A	....	....
B	....	....
C	....	....
D	....	....
E	....	....
F	....	....

[12]

For many candidates, the link between the appearance of the plant leaves (venation) and the classification/type of plant was clear. In some cases, they were able to obtain full marks. It is clear that they were familiar with the exemplification column of the specification at **Learning Outcome 3.1**.

Misconception

Some candidates, however, were less successful and introduced longitudinal or dichotomous venation patterns. These patterns were not described in the identification key at **Fig. 2.2**.

Question 2 (b)

(b) European Beech is classified as *Fagus sylvatica*.

Explain the nomenclature used to classify plants and animals.

....

....

.... **[3]**

This question was accessible to many candidates. They often referred to the binomial nature of the nomenclature, the two-naming characteristic and to genus/species. Many candidates also considered the use of Latin for the names and/or noted that this was internationally recognised. No clear pattern of alternative responses was observed.

Question 3 (a)

3 An electromagnet is produced when a current is passed through a coil of wire.

A student is investigating how the distance of an electromagnet from a permanent magnet affects the strength of the magnetic field.

Method

- Place a magnet on a two decimal place balance and set the reading to 0.00 g.
- Place a coil of wire connected to a power supply at a distance *d* mm from the magnet.
- Switch on the power and measure the reading on the balance.
- Repeat the experiment for different values of *d*, keeping the current in the wire constant.

The current in the wire, I = 1.2 A and the length of wire in the coil, L = 0.3 m.

The strength of the magnetic field *B* for each value of *d* can be calculated using the equation:

$$B = \frac{m \times g}{1000 \times I \times L}$$

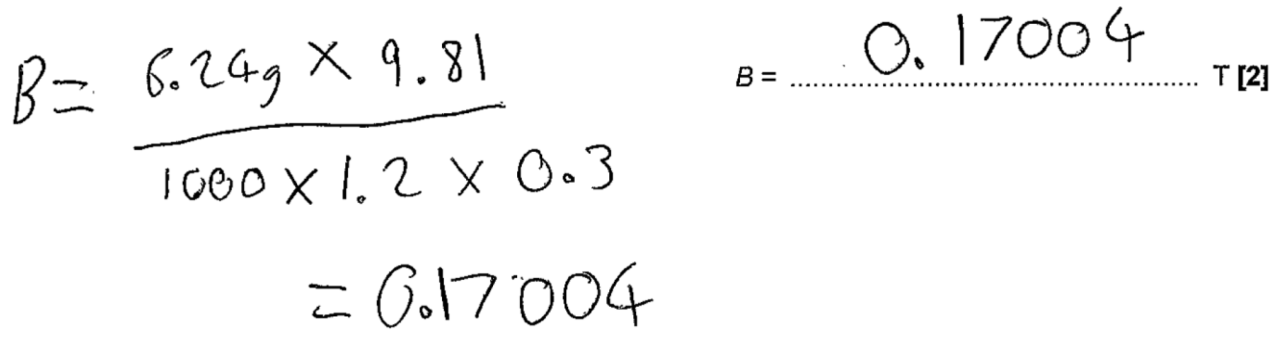
where g = 9.81 N kg^{-1}, m is the balance reading in g and B is the magnetic field strength in Teslas (T).

(a) Use the equation to calculate the value of *B* when m = 6.24 g.

B = ... T **[2]**

Many candidates successfully calculated the value of *B* and showed their working in the space provided (as demonstrated in the **exemplar** below). For those showing the incorrect value for *B*, there was an opportunity to obtain 1 mark for using the appropriate equation (populated with numbers presented in the stem of the question). This reinforces the need for candidates to show their working. No clear pattern of alternative values was observed for this calculation.

Exemplar 1

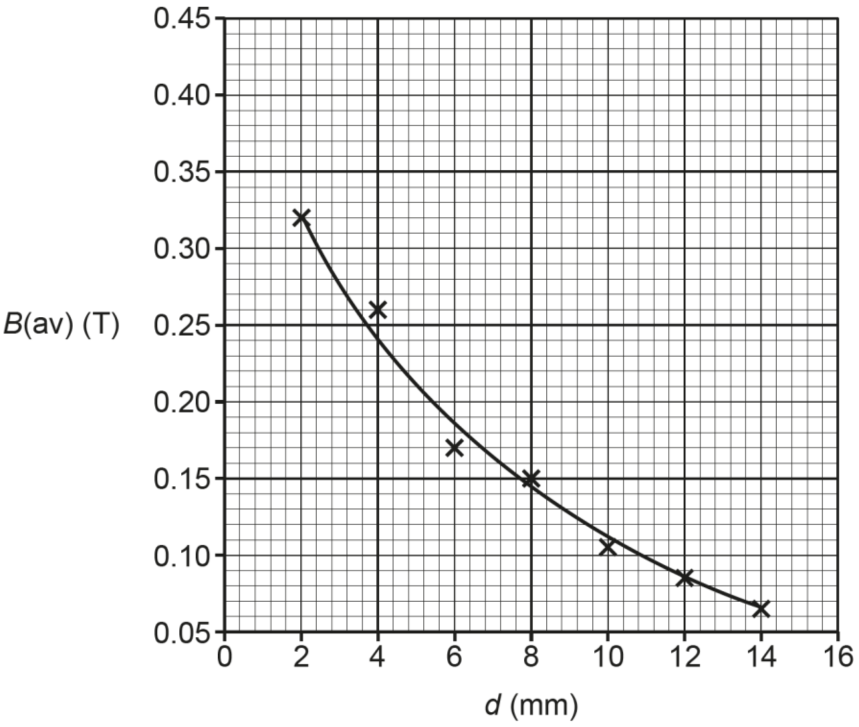


This answer correctly calculated the value of *B* and gained full marks.

Question 3 (b)

(b) For each value of *d*, the student measures two values of *m*. These values are used to calculate two values of *B* and the average strength of the magnetic field, *B*(av).

The student plots a graph of *B*(av) against *d* as shown below.



The student draws a line of best fit on the graph.

Give **two** reasons why the line in the graph above is of good quality and appropriate for this data.

Good quality ....

....

Appropriate ....

....

[2]

Candidates who did less well with this paper tended to struggle to explain the quality and appropriateness of the line in the graph. Relatively few candidates described the curve as smooth, but some did consider the balance of points above and below the line. Others provided a general statement with regards to the line 'passing through many of the points.' This was not creditworthy. Very few referred to the line representing continuous data.

OCR support

It is suggested that candidates are aware of the differences between continuous and discontinuous data and their representation via line graphs, as outlined in the specification at **Learning Outcome 2.2**.

Question 3 (c) (i)

(c) Use the graph opposite to determine:

(i) the distance *d* when *B*(av) = 0.2 T

.... **[1]**

This question did not seem to present a significant challenge for many candidates. A number of candidates correctly determined the distance as 5.4(mm). No pattern of alternative responses was noted.

Question 3 (c) (ii)

(ii) the value of *B*(av) when *d* = 5 mm

.... **[1]**

Again, this calculation was seen to be straightforward for most candidates. They were able to determine the value of *B*(av) as 0.21(T). Almost all candidates obtained this value.

Question 3 (c) (iii)

(iii) an estimated value of *B*(av) when *d* = 1 mm

.... **[1]**

This was another calculation that was accessible to many candidates. Candidates often correctly estimated the value of *B*(av) when d = 1mm, as 0.37. This demonstrated the graphical skill of extrapolating a curve and reading a value from the y axis (in this case).

Misconception

Some candidates misread the graph and gave a value out of the acceptable range, e.g. > 0.38.

Question 3 (d) (i)

(d) The table shows a pair of readings of *m* when *d* = 8 mm. The student determines two values of *B* and calculates the average, *B*(av).

m_1 (g)	m_2 (g)	B_1 (T)	B_2 (T)	B(av) (T)
5.58	5.43	0.152	0.148	0.150

(i) Calculate the absolute uncertainty in the value of *B*(av).

Use the equation: Uncertainty = $\frac{B_1 - B_2}{2}$.

absolute uncertainty = ± .... T **[1]**

Many candidates correctly used the equation provided and inserted the correct values from the table of data. This enabled them to calculate the absolute uncertainty as +/- 0.002. A value of 2 x 10^{-3} was equally correct. Some candidates made an error via the equation, and this resulted in answers including 200 and 0.0002.

Question 3 (d) (ii)

(ii) Calculate the percentage uncertainty in the value of *B*(av).

percentage uncertainty = ... % **[1]**

Those candidates who performed less well with this paper sometimes miscalculated the percentage uncertainty and presented values other than 1.33(%).

Assessment for learning

It is recommended that candidates are given the opportunity to rehearse the skill of calculating percentage uncertainty across a range of data and scenarios.

Question 3 (d) (iii)

(iii) Suggest **three** sources of error which could result in the % uncertainty in the values of *B*(av).

1 ....

....

2 ....

....

3 ....

....

[3]

Some candidates had a confident understanding of this topic and correctly identified errors such as measurement, systematic and instrumental/equipment. Others were somewhat challenged and struggled to suggest an appropriate error resulting in the % uncertainty in the *B*(av) values. No clear pattern of alternative responses was observed.

OCR support

It is suggested that candidates could clarify the differences between various categories of error across a wide range of experimental results, as listed in the specification at **Learning Outcome 4.2**, including the examples shown in the exemplification column.

Question 4 (a) (i)

4 Lipase is an enzyme which causes fats to break down into fatty acids and glycerol.

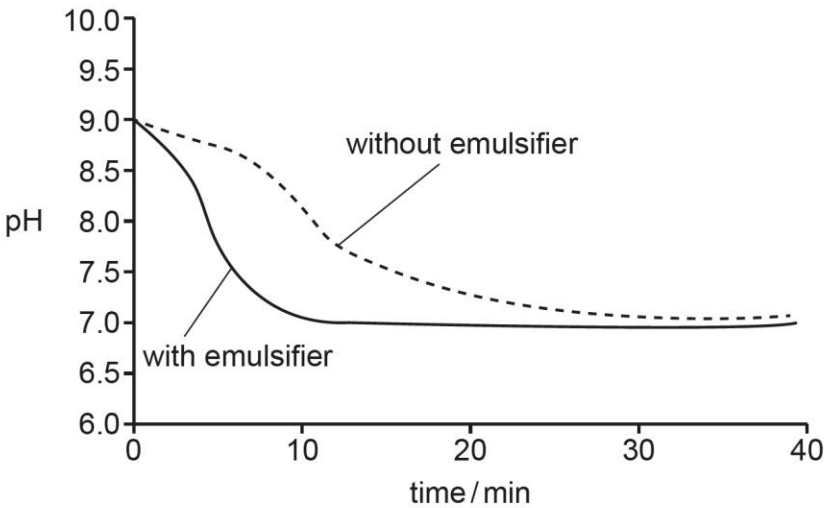
An emulsifier is a food additive which helps to prevent oil and water separating.

A food scientist is investigating how the pH of milk changes with and without the addition of an emulsifier.

Method

- Place 5.0 cm^3 of high-fat milk in a boiling tube in a water bath.
- Use a sensor attached to a datalogger to measure the pH of the milk.
- Add drops of sodium carbonate solution to the milk until the pH of the mixture is pH 9.
- Add 5.0 cm^3 of lipase solution to the milk mixture in the boiling tube and record the pH, using the datalogger, for 40 minutes.
- Repeat the procedure using a fresh sample of high-fat milk with a few drops of an emulsifier added to the mixture.

The graph shows the graphical output from the datalogger.



(a)
(i) Suggest why the graphical output from the datalogger is suitable for this data.

....

....

....

.... **[2]**

This was a challenging topic for most candidates. Very few were able to suggest the suitability of a datalogger for the scenario in this question. The generation of a line graph to represent continuous data was not considered by many candidates. Features of the graph, including the extent of the axes and the area of the graph utilised, were also not seen.

OCR support

It is suggested that the relevance of a datalogger could be considered in more detail to enable candidates to appreciate the above features. This is possible via a simple model of a datalogger and to analyse a variety of graphs generated (using **Learning Outcome 2** as a guide).

Question 4 (a) (ii)

(ii) Describe the trends in the data in the graph opposite.

....

....

....

.... **[3]**

Those candidates who performed well overall for this paper were capable of referring to pH decrease over time, the constancy of plots when pH 7 was reached and the faster nature of the reaction in the presence of the emulsifier. This enabled them to obtain 2 or 3 marks. Some candidates who performed less well were more likely to refer only to the drop in pH over time. No clear pattern of alternative responses was observed.

Question 4 (a) (iii)

(iii) Suggest explanations for the trends in the graph opposite.

....

....

....

....

.... **[3]**

Few candidates 'explained' the trends in the graph. This was an application of knowledge and understanding question, resulting in limited references to the creation of a lower pH due to the release of fatty acids (and glycerol) following the breakdown of the lipids in the milk. Many candidates obtained 1 mark for a 'description' of the trend i.e. lower pH.

Question 4 (b)

(b) The procedure followed by the food scientist does not have enough information for it to be repeatable.

What information should be included in the procedure so that it is repeatable?

1 ....

2 ....

3 ....
[3]

Many candidates performed well with this question and listed information including amount of fat in the milk (as a %), temperature and type and amount of emulsifier.

Misconception

There was a tendency for some candidates to suggest concentration of sodium bicarbonate, but this was not considered to be relevant for this study. Some candidates also repeated the stem of the question without qualification.

Question 4 (c)

(c) Suggest how the technician would know whether the procedure is reproducible.

....

....

....

....

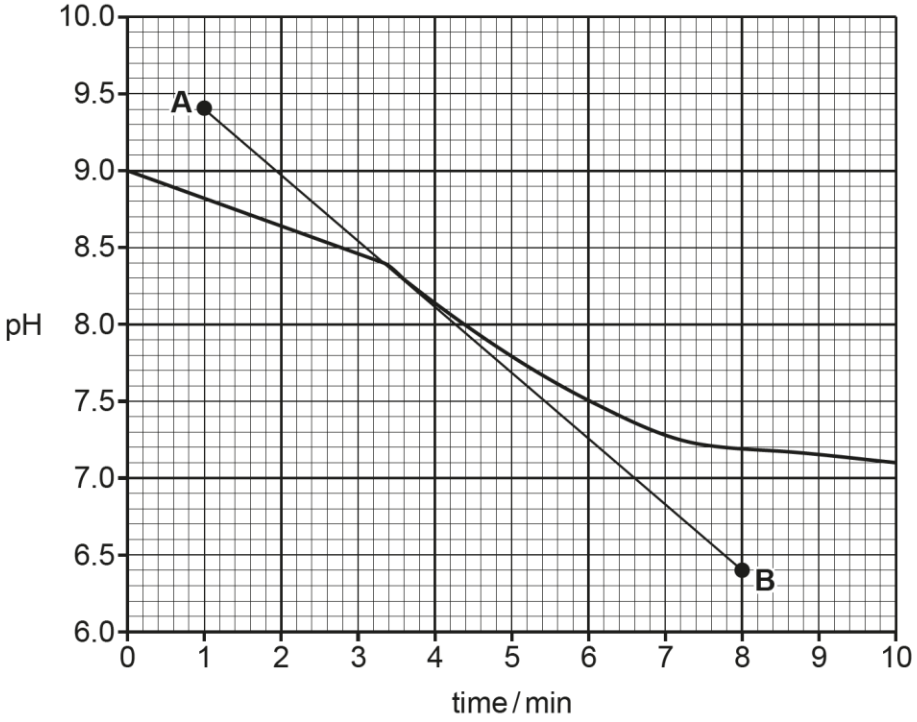
.... **[3]**

Although some candidates found it difficult to suggest features of the procedure to promote reproducibility, others were much more confident and referred to the involvement of another person (food scientist/technician) carrying out the procedure with different equipment and using a different method. No common misconceptions were observed for this question. Most candidates were limited to a maximum of 2 marks.

Question 4 (d) (i)

(d) The technician decides to calculate the fastest rate of change of pH without the emulsifier.

The graph shows a print-out of a small section of the graph.



The technician draws a tangent to the curve at the steepest part of the curve and determines the coordinates of points **A** and **B** on the tangent.

(i) Calculate the gradient *G* of the tangent.

Show your working on the graph and record your answer to **2** significant figures.

G = ... **[3]**

The most successful candidates in the paper overall were not challenged by this question. It was clear that they had a good understanding of how to use a graph to determine the gradient G of the tangent. Some candidates showed clear working on the graph but were unable to apply this to correctly calculate the gradient. Such candidates had the potential to obtain 1 mark for this working on the graph.

Assessment for learning

It is proposed that this reinforces the need for candidates to be given the opportunity to practice the skill of calculating gradients of tangents, using a range of graphs with different tangents. The candidates could be shown a number of graphs to apply this skill.

Question 4 (d) (ii)

(ii) Explain why this method gives an accurate value for *G* at this point on the curve.

....

.... **[1]**

Few candidates were able to give a clear explanation for this question. The large values of Δy and Δx could have been considered to reduce the error in G. It may have also been possible to suggest that the gradient of the curve was equal to the gradient of the tangent drawn at that point. This second option was successfully achieved by some candidates, using alternative wording.

Question 5 (a) (i)

5

(a) Millions of tonnes of plastic waste are buried in the ground (landfill) each year.

Uncollected plastic waste can enter rivers and oceans and cause environmental damage.
One study concluded that 8 million tonnes of plastic enter the oceans every year in the form of thousands of billions of small pieces called microplastics.

Some processes that remove plastic waste from the environment are described in the table:

Process	**Description**
Incineration	Plastic is burned in the air, producing carbon dioxide and other gases, heat and ash. The heat can be used to convert water to steam for electricity generation.
Gasification	Plastic is reacted with a gasifying agent (e.g. steam) at temperatures in the range from 500 °C to 1300 °C. This produces energy-rich gases such as hydrogen and methane. These can be burned for electricity generation or converted into diesel, ethanol or other chemicals.
Pyrolysis	Plastic is heated at temperatures in the range 300 °C to 650 °C in the absence of oxygen. This produces energy-rich oils with similar properties to diesel.

(i) Some countries have decided that incineration is the best option, rather than gasification or pyrolysis.

Which reasons might be put forward to support this decision?

Tick (✓) **three** boxes.

A Ash is buried in landfill. ☐

B Diesel is inexpensive in their country. ☐

C Gasification does not produce CO_2. ☐

D Incineration releases CO_2 into the atmosphere. ☐

E Incineration would decrease the need to burn coal. ☐

F The cost of waste collection is high. ☐

G Waste hot water can be used to heat local schools and offices. ☐

[3]

Most candidates appreciated that E and G were suitable reasons to put forward in support of using the incineration option. This enabled most to obtain at least 2 out of the 3 marks.

Misconception

A number of candidates selected A, instead of B. This incorrect choice may have been steered by the reference to ash for incineration in the table. However, the key reason is the lack of diesel production observed with gasification. No clear pattern of alternative responses was noted, most candidates focused on A or B with E and G.

Question 5 (a) (ii)

(ii) Suggest **two** reasons why pyrolysis may be chosen instead of gasification.

1 ....

....

2 ....

....

[2]

This question appeared to be challenging for many candidates. However, many correctly observed that pyrolysis requires less energy/heat (300-650°C) when compared to gasification (500-1300°C). Some candidates enhanced their response when suggesting that fewer steps are involved in the process for pyrolysis. The more able candidates often demonstrated an effective analytical skill when constructing their responses.

Question 5 (a) (iii)

(iii) Recycling is another option for waste plastic.

Suggest **three further** pieces of evidence needed to show that the processes described in the table are better options than recycling.

1 ....

....

2 ....

....

3 ....

....
[3]

Some candidates seemed to be confused when responding to this question. There was a tendency to focus on the disposal of unwanted plastics via landfill or the generation of micro plastics. References to landfill were appropriate when justified, e.g. linked to the impact on the environment/pollution. A number of candidates successfully considered the cost of recycling. In some cases, it was unclear whether the candidate was referring to the options in the table or to recycling.

Question 5 (b) (i)

(b) Water pollution is also an environmental issue.

(i) Potassium thiocyanate is often used to test for the presence of Fe^{3+} ions in water samples.

What colour is seen when potassium thiocyanate is added to a solution containing Fe^{3+} ions?

Tick (✓) the correct box.

Blue ☐

Green ☐

Purple ☐

Red ☐

[1]

Many candidates were unsuccessful when identifying the colour seen when potassium thiocyanate is added to a solution containing Fe^{3+} ions. Some selected purple instead of red.

OCR support

An account of this reaction (and the resulting intense red colour) is outlined in the exemplification column in the specification at **Learning Outcome 6.4**.

Question 5 (b) (ii)

(ii) A technician prepares solutions of known concentrations of Fe^{3+} ions and adds an equal volume of potassium thiocyanate to each solution.

Outline how colorimetry can be used to determine the concentration of Fe^{3+} ions in a sample of water.

....

....

....

....

....

.... **[4]**

Candidates who did less well with this paper were challenged by this question. They were unable to describe the steps for colorimetry. The more successful candidates often provided a detailed, step-by-step, description including references to % absorption, establishing a calibration graph and comparing results for the test solution (following the addition of potassium thiocyanate).

Misconception

? Some candidates described colour changes visible to the naked eye (seen via a test tube or filter paper) and others incorrectly focused on the steps for titration.

Question 6 (a) (i)

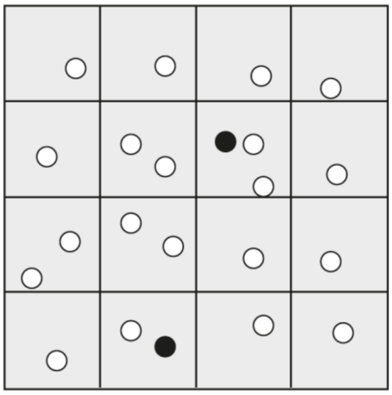
6 Methylene blue is a stain that can be used in light microscopy. It stains dead cells blue, but the stain is decolourised within living cells.

(a) Methylene blue can be used to determine the percentage of living cells in an animal cell culture.

The following method is used.

- Mix $1.00\,cm^3$ of cell culture with $1.00\,cm^3$ of methylene blue solution.
- Place a $1\,mm^3$ portion in a haemocytometer and view down a light microscope.
- Count the total number of cells in a 4 by 4 grid and count the number of cells not stained blue.

The volume of this 4 by 4 grid is $0.1\,mm^3$.



(i) Count the number of living cells in the grid.

.... **[1]**

This was a straightforward and accessible task for candidates. Almost all candidates counted the number of living cells in the grid as 20.

Question 6 (a) (ii)

(ii) Calculate the number of living cells per cm^3 of the cell culture.

number of living cells per cm^3 .... **[3]**

Not all candidates were able to use the conversion of mm^3 to cm^3 when determining the number of living cells per cm^3. Some candidates made an error in the calculation and resulted in the incorrect value of 200,000 or 200. Other candidates obtained 1 mark for an error carried forward (ecf) in their calculation.

Question 6 (a) (iii)

(iii) Calculate the percentage of cells that are alive in the cell culture.

percentage = ... % **[2]**

Many candidates successfully calculated the percentage of cells that are alive in the cell culture. They were able to consider the two additional dead cells and incorporate these into their % calculation. No clear pattern of alternative responses was observed.

Question 6 (b) (i)

(b) **Fig. 6.1** shows a temporary microscope slide of onion cells.

Fig. 6.2 shows a permanent slide of animal cells stained with methylene blue.

Fig. 6.1

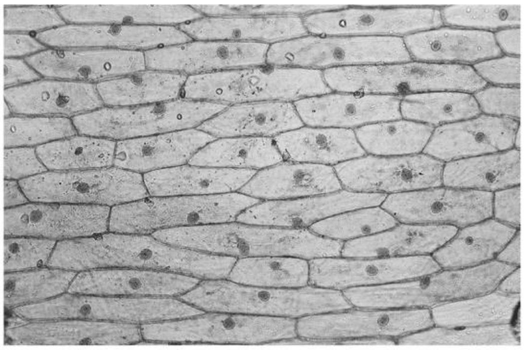


Fig. 6.2

The image of a photomicrograph of methylene blue stained neurones has been removed due to copyright reasons.

(i) Name **one** stain that binds to and shows up starch molecules in plant cells.

.... **[1]**

Not all candidates correctly identified the stain for starch as iodine.

Misconception

Some candidates incorrectly referred to other stains listed in the specification at **Learning Outcome 6.5**, used for gram staining of bacteria i.e. crystal violet or safranin.

Question 6 (b) (ii)

(ii) Outline the steps involved in producing a permanent, stained microscope slide and explain the purpose of each step.

Suggest some advantages and disadvantages of preparing a permanent slide compared to a temporary slide.

....

....

....

....

....

.... **[6]**

Many candidates found this topic of microscopy to be accessible and performed at Level 2 or 3 for this Level of Response (LoR) question. They were able to outline the steps involved in the preparation of a permanent microscope slide (with common references to fixing, clearing, staining, mounting and labelling) and were often very confident when comparing this type of slide with temporary slides. Some candidates struggled with the description of the preparation of the permanent slide but gained marks solely for a clear account of advantages and disadvantages. No clear misconception was observed.

Exemplar 2

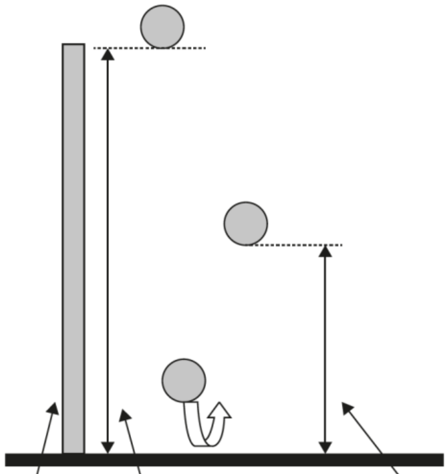
Take a microscope slide ~~and add iodine~~ and add the sample. Put a few drops of iodine over the sample to stain it and put a plastic cover over the top. You can then observe the slide under a microscope.
A permanent slide can get damaged and might need to be kept in certain conditions. The sample in the slide might not keep very well (for example it could dry out) so using temporary slides might be a better option.

The response shown in exemplar 2 shows how a candidate engages with this Level of Response (LoR) question at Level 1, as outlined in the answer column of the mark scheme. More than two of the valid points listed in the guidance column of the mark scheme are included i.e. the use of a microscope slide, the addition of a stain (in this case, iodine) and viewing the specimen using a microscope. This is, however, a limited response to the scaffolding provided in the stem of the question. It does not effectively include an explanation for each step and a consideration of advantages vs disadvantages (for permanent and temporary slides) is incomplete.

Question 7 (a) (i)

7 Two students are investigating how the height a tennis ball is dropped from (the 'drop height') affects the height the ball bounces (the 'bounce height').

They set up the experiment as shown below.



- One student drops the ball from a known height and the other student estimates the bounce height.
- For each drop height, the students measure the bounce height three times (h_1, h_2 and h_3).

(a) The students record their results and calculate an average bounce height, as shown in their table.

Drop height	Bounce height			Average bounce height
	h_1	h_2	h_3	
1.0	0.80	0.81	0.78	0.796667
1.2	0.95	0.97	0.98	0.966667
1.4	1.1	1.05	1.11	1.086667
1.6	1.25	1.14	1.26	1.246667
1.8	1.4	1.43	1.41	1.413333
2.0	1.55	1.54	1.53	1.54

(i) State **two** improvements the students need to make to the presentation of their results.

1 ....

2 ....

[2]

Although some candidates incorrectly identified changes to the method (such as drop height) or the calculation of the mean with outliers removed, many candidates successfully referred to the need for units for the height values and the use of a common number of significant points in the data. In general, this question was answered well.

Question 7 (a) (ii)

(ii) Put a ring around the outlier in the table of results. **[1]**

Many candidates correctly circled the 1.14 value as the outlier for the range of bounce heights when the drop height was 1.6 (arbitrary units).

Misconception

Some candidates were tempted to select the 1.05 value in the box above. It seemed that other candidates chose 1.54 in the average bounce height column, presumably because it showed only 2 decimal points.

Question 7 (b)

(b) The students could have used a video camera to measure bounce height.

Explain how a video camera could be used to improve the quality of the data collected.
You may draw a diagram to help your explanation.

....

....

....

....

....

.... **[3]**

Some candidates did well with this question and described the capacity to pause/replay the images and to record the highest bounce height within the field of view (as shown in the **exemplar below**). For those candidates who struggled with this question, there was a tendency to repeat the wording provided in the stem.

Exemplar 3

A video camera would be able to capture the exact moment the ball reaches it's highest bounce height ~~this would make~~ as the students would be able to slow down and pause the video. This would **[3]** improve the ~~acc~~ accuracy of results.

This response described the capacity to record the highest bounce height within the field of view.

Question 7 (c) (i)

(c) The students present their data in a scatter graph.

(i) State what variables they should plot on the axes.

- *y*-axis ....
- *x*-axis ....

[1]

This was an opportunity for candidates to recall the positioning of the y and x axes on a graph. Most successfully identified bounce height for the y-axis and drop height for the x-axis. Some placed the wrong axis label for each of y and x.

Question 7 (c) (ii)

(ii) The graph they plot is a straight line starting from 0,0.

What can they conclude from this?

.... **[1]**

Only some candidates correctly referred to the proportional relationship between the bounce and drop heights. A few included the term 'proportional' in their response, but the term was unqualified. This was not acceptable for the marking point.

Question 7 (c) (iii)

(iii) The students include range bars on their graph.

Explain how range bars can be used to evaluate the quality of their conclusion.

....

....

.... **[2]**

Relatively few candidates were able to explain the use of range bars for this type of graph. Some correctly referred to the maximum and minimum value displayed by these bars. However, the value of range bars to determine the uncertainty of data was rarely seen in candidate responses. No clear pattern of alternative suggestions was observed.

Assessment for learning

It is recommended that candidates are presented with sets of data to plot a line graph and to draw range bars using a variety of scenarios.

Question 7 (d)

(d) PowerPoint is a computer slide show which projects text and images onto a screen. It enables the presenter(s) to communicate to a live audience.

The students decide to use PowerPoint to present their results to their peers.

Suggest **three** reasons why PowerPoint is suitable for their presentation.

1 ....

....

2 ....

....

3 ....

....
[3]

Those candidates who generally did less well with this paper tended not to articulate an effective description for the use of a PowerPoint to present results and observations. They often referred to a named example of images/figures, e.g. video or table of results but struggled to add further reasons in a clear manner. The more successful candidates included the potential to adapt or change the presentation, the appealing nature of the medium or the ability to present findings online to a wider audience.

Question 7 (e)

(e) The teacher suggests that the students should do further investigations using different types of sports balls.

Suggest **two other** variables that the students could investigate that might be of interest to a sports equipment manufacturer.

1 ....

....

2 ....

....
[2]

Most candidates found this question to be accessible. They often referred to the type of surface (when bouncing a ball), the size of the ball and temperature of the ball or surrounding air. Some progressed further with suggestions ranging from the pressure inside the ball to the material the ball is made from. Candidates often showed a sound grasp of this topic.

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Question 2 (a): Fig. 2.1f Rhubarb leaf, Credit: Ted Kinsman/Science Photo Library Question 6 (b) (i): Fig. 6.1 Photomicrograph of onion cells, Credit: Photographer: J M Barres

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