CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

APPLIED SCIENCE

Unit 3 January 2019 series

Version 1

Contents

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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 can be downloaded from OCR.

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Unit 3 series overview

This is the third series for the Unit 3 (Scientific Analysis and Reporting) paper, and the second published examiners' report for the unit.

To do well on this paper, candidates need to be confident responding to questions on a wide range of scientific topics. Those candidates who had been prepared well for the examination responded well to the combination of objective questions and open-response questions. Nearly all candidates were able to attempt all questions in the time available, and there were very few questions that were not attempted. Few candidates required the use of additional pages.

Candidates who performed well on this paper were able to carry out calculations correctly without introducing arithmetic errors, and were able to analyse relevant data correctly.

Generally, candidates did not seem to have the knowledge required to be able to rearrange equations (question 1(d)), the skills necessary to draw lines/curves of best fit with a suitable level of competence (questions 2(b)(i) and 6(b)(i)), nor the understanding of how to calculate the gradient of a curve at a given point (question 6(b)(i)) and how to derive the correct units for the gradient.

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Question 1(a)

1 The formation and decay of strong magnetic fields in the solar atmosphere causes sunspots on the Sun's surface.

Table 1.1 shows the number of sunspots each year from 1999 and 2011.

Year	Number of sunspots
1999	93
2000	120
2001	111
2002	104
2003	64
2004	40
2005	30
2006	15
2007	8
2008	3
2009	3
2010	17
2011	56

Table 1.1

(a) Calculate the median number of sunspots in **Table 1.1**.

median = ...

[1]

Nearly all candidates were able to calculate the median of the data provided.

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Question 1(b)

(b) Calculate the mean number of sunspots in **Table 1.1**.

Show your working.

mean = ...

[2]

Nearly all candidates were able to calculate the mean number from the data provided, but many candidates reported the mean as a decimal fraction, failing to appreciate that the number of sunspots must be rounded to a whole number.

Question 1(c)

(c) The formula below can be used to calculate the standard deviation for the data in **Table 1.1**.

standard deviation $s = \sqrt{\frac{1}{N-1}\Sigma_{i=1}^{N}\left(x_i - \overline{x}\right)^2}$

N = 13, the number of years from 1999 to 2011

x_i is the number of sunspots in a particular year

$\overline{x}$ is the mean calculated in **(b)**

Use the formula above to calculate the standard deviation for the data in **Table 1.1**.

Give your answer to **1** decimal place.

Show your working.

standard deviation = ...

[6]

The majority of candidates were able to calculate the standard deviation and report it to one decimal place. Some candidates were unable to utilise the equation provided and were unable to complete the first two or three steps correctly, but did gain some marks for subsequent division by twelve and/or taking the square root. Unfortunately a number of candidates lost marks through arithmetic errors, such as: missing out a year or including a year more than once, incorrect transcription of figures, or recoding the answer to more than one decimal place.

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Question 1(d)

(d) The relative sunspot number is a quantity that measures the number of sunspots and groups of sunspots present on the surface of the Sun.

The relative sunspot number is calculated using the formula: $R = k(10g + s)$

s is the number of individual spots

g is the number of sunspot groups

k is a factor that varies with location and instrumentation

Rearrange the relative sunspot number formula to make g the subject.

g = ...
[2]

The majority of candidates had difficulty rearranging the equation as required, but most gained 1 mark for a correct element being present.

Question 1(e)(i)

(e) **(i)** The solar constant G_{SC} is the radiation received by the Earth when it is at the mean distance from the Sun.

$G_{SC} = 1.361 \text{ kW m}^{-2}$

The radius (r) of the Earth is 6371×10^3 m.

Calculate the total radiation received, per second, by the Earth.

Use the formula: Area = πr^2

$\pi = 3.14$

total radiation = ...kJ s^{-1}
[3]

A range of answers was accepted depending on the value of π used (even though a value of 3.14 was stated in the stem of the question) and the rounding of values in the calculation. Common errors made by candidates were: calculating $(\pi r)^2$, failing to multiply by G_{sc} , or dividing by G_{sc} .

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Question 1(e)(ii)

(ii) The Earth's orbit is elliptical.

The distance between the Sun and the Earth varies by 1.7%.

Calculate the difference between the maximum and the minimum radiation received per second by Earth. Use your answer from **(e)(i)**.

Show your working.

energy difference = ...kJ **[3]**

A significant number of candidates did not attempt this question. A common error made by candidates was the failure to calculate the total variation in the distance between the Sun and the Earth; other candidates multiplied the total radiation, calculated in 1(e)(i) by the percentage variation without first converting the latter to a decimal fraction.

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Question 2(a)(i)

2 Mia is investigating the distribution of plants in a field.

She uses quadrats to survey four plant species growing in a field surrounding a tree.

She counts the number of each plant species on both sides of a 10 m line transect.

A quadrat is shown in **Fig 2.1**.

Image removed due to copyright restrictions

Fig. 2.1

Her results are shown in **Table 2.1**.

	Distance from tree (m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Number of each plant species	**A. Stinging nettle**	1	4								
	B. Rough hawkbit			1	1		1				
	C. Common chickweed				2	8					
	D. White clover						10	9	9	4	

Table 2.1

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(a) Mia decides to present the data from **Table 2.1** in another table to show the species total and the percentage of each species.

(i) Complete **Table 2.2** for species **B**, **C** and **D**. Species A has already been calculated.

Distance from tree (m)	**Species total**	**Percentage of total number of plants (%)**
A. Stinging nettle	5	10
B. Rough hawkbit		
C. Common chickweed		
D. White clover		
Total	50	100

Table 2.2

[3]

Nearly all candidates were able to correctly complete Table 2.2; no pattern of alternative responses could be identified.

Question 2(a)(ii)

(ii) Complete the pie chart in **Fig. 2.2** using the data from **Table 2.2**.

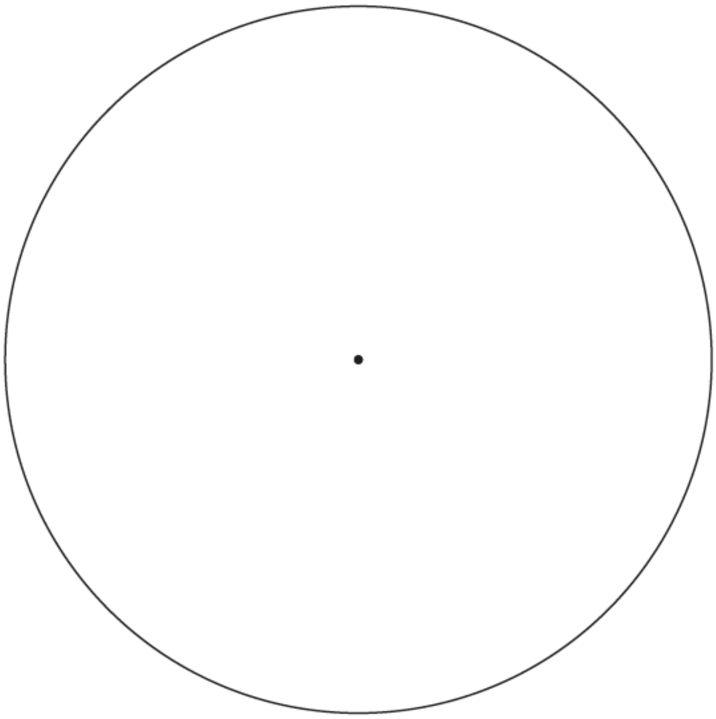

Fig. 2.2

[2]

Nearly all candidates were able to correctly complete the pie chart in Fig. 2.2 with reasonable accuracy. Where the areas of the segments were out of proportion, they were almost invariably in the correct order of proportions and a mark was gained for labelling. Only a very small number of candidates were unable to attempt this question.

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Question 2(b)(i)

(b) Mia also plots the graph in **Fig. 2.3** to show how light intensity varies with distance from the tree along the 10 m line transect.

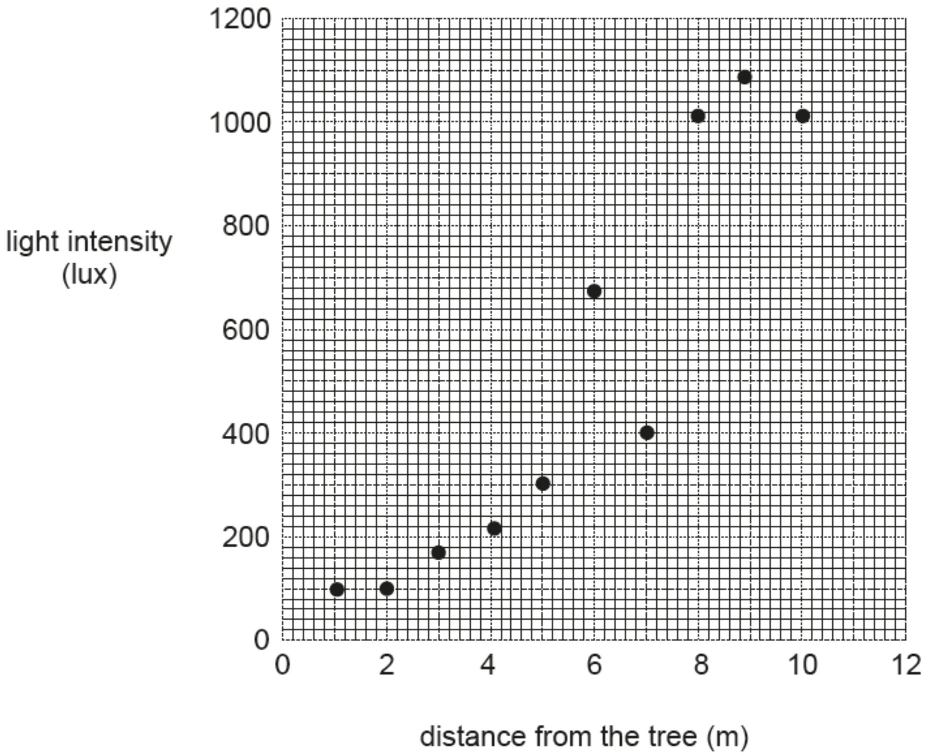

Fig. 2.3

(i) On the graph in **Fig. 2.3** draw a curve of best fit.

[1]

Nearly all candidates incorrectly drew a smooth curve with increasing gradient up to c1000 lux through the point at 7 m. Many of the curves were 'wobbly', drawn with thick lines, sketched, or extended into the margins of the graph, and so would not have gained credit even if the curve had been drawn in the correct position.

Question 2(b)(ii)

(ii) Draw a circle around the outlier in the graph in **Fig. 2.3**.

[1]

Where the correct curve had been drawn in 2(b)(i) candidates identified the correct outlier at 7 m. However, nearly all candidates drew an incorrect curve through the point at 7 m and consequently incorrectly identified the point at 6 m as being the outlier – no consequential error carried forward mark was credited.

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Question 2(b)(iii)

(iii) Use the graph in **Fig. 2.3** to identify the value of light intensity that Mia should expect to find at the outlier.

expected value = ...lux
[1]

The majority of candidates incorrectly read the value of light intensity directly off the y-axis for the outlier identified in 2(a)(iii), only a very small number of candidates read the value of light intensity from the curve drawn in 2(b)(i) – a consequential error carried forward from the curve drawn in 2(a)(iii) and/or the outlier identified in 2(a)(ii) was allowed here, but because of the error in reading the graph few candidates benefitted.

Question 2(b)(iv)

(iv) Calculate the gradient of the graph in **Fig. 2.3** at a distance of 4.0 m from the tree.

Give the units.

Show your working.

gradient = ... units ....
[4]

Only a very small number of candidates attempted to use the equation y = mx + c. Nearly all candidates attempted to calculate the gradient of the curve by measuring the change in vertical distance and the change in horizontal difference from the graph. However, the majority of candidates had little understanding of the correct approach. Few candidates drew a tangent to the curve, instead simply calculating the change in vertical distance and horizontal difference between two different points on the curve. The tangents that were drawn were often inappropriate, being to one or the other side of 4m rather than at 4m. Tangents were frequently inaccurately drawn, and/or drawn with thick lines, and/or far too small to be read accurately. Few candidates seemed to understand the derivation of the correct units when calculating the gradient of a graph.

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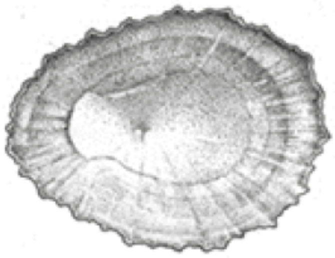
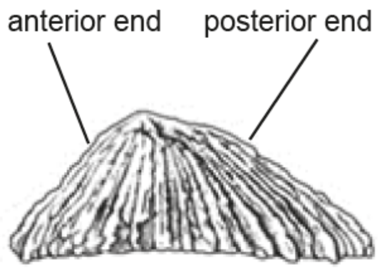
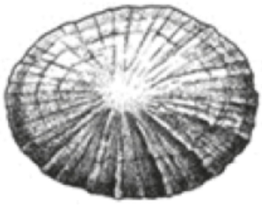
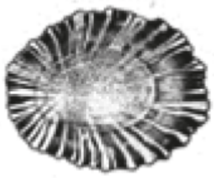
Question 3(a)(i)

3 Layla is on a field trip to a seashore.

She is investigating the features of three species of limpet, **A**, **B** and **C**.

Her teacher has given her some drawings of the empty shells of adult sized limpets of the three species as shown in **Table 3.1**.

Limpet	Top view	Internal view	Side view
A			
B			
C			

2 cm

Table 3.1

(a) The three species of limpet in **Table 3.1** are *Patella depressa*, *Patella ulyssiponensis* and *Patella vulgata*.

(i) What is indicated by the term '*Patella*'?

.... **[1]**

A significant number of candidates offered 'genus', but a variety of other responses was also seen.

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Question 3(a)(ii)

(ii) Give **one** advantage of binomial nomenclature.

....**[1]**

The majority of candidates offered ideas relating to ease of identification, ease of classification, or identification of similarities. Few candidates understood that binomial nomenclature is a universal system recognised everywhere and avoids the complications from the same species being known by different common names in different places, or different species being known by the same common name in different places.

Question 3(a)(iii)

(iii) An internet source describes:

- *Patella ulyssiponensis* as a limpet with a low cone with an apex noticeably anterior to centre
- *Patella vulgata* as a limpet with an anterior end which is noticeably narrower than the posterior end.

Use **Table 3.1** to identify *P. ulyssiponensis* and *P. vulgata*.

Choose **A**, **B** or **C**.

Justify your choice.

P. ulyssiponensis is .... because ....

....

P. vulgata is .... because ....

....
[4]

A significant number of candidates were unable to use the information provided in the stem of the question and Table 3.1 to correctly identify *P.ulyssiponensis* and/or *P.vulgata*.

Many justifications of correct identifications were simply copied from the stem of the question and consequently lacked the comparative element required. A number of justifications of correct identifications of *P.ulyssiponiensus* lacked reference to one or other of the features of cone morphology referred to in the stem of the question.

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Question 3(b)

(b) Layla designs an identification key for the limpets in **Table 3.1** using the format as shown in **Fig. 3.1**.

1a	go to 2
1b	go to 3
2a	(answer)
2b	(answer)

Fig. 3.1

Give the name of the identification key shown in **Fig. 3.1**.

....**[1]**

A significant number of candidates offered 'dichotomous/dichotomy', but a number of other responses were offered. No pattern of alternative responses could be identified.

Question 3(c)(i)

(c) (i) What type of data is shown in **Table 3.1**?

....**[1]**

A significant number of candidates offered 'secondary', but a number of other responses were offered. No pattern of alternative responses could be identified.

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Question 3(c)(ii)

(ii) Give **one advantage** and **one disadvantage** of using the data shown in **Table 3.1** to identify limpets.

advantage ....

....

disadvantage ....

.... **[2]**

Only a very small number of candidates correctly identified that Table 3.1 provides a visual representation of the differences between the species; the majority of candidates referred to ideas around clarity, ease of use, that it could be used by anybody, or that it was fast to use.

Similarly, only a very small number of candidates correctly identified that the representations in Table 3.1 are of adult specimens, and that juveniles may have a different appearance to adults; the majority of candidates referred to ideas around subjective interpretations by observers, the possibility of inaccurate representations, that different individuals within the same species might have varying appearances (without qualification by reference to age), or the effects of mutation on appearance.

Question 3(d)

(d) Limpets attach themselves to rocks with a strong muscular foot. During the field trip Layla was told **not** to detach any limpets from the rocks.

Explain why **not** detaching any limpets may be a disadvantage when trying to identify the limpet species.

....

....

....**[2]**

The majority of candidates understood that detaching limpets from rocks would allow closer inspection of limpets but many referred to easier inspection from the side rather than the underside. Only a very small number of those candidates who referred to inspection of the underside specifically identified that the muscular foot might be different in each species, the majority simply referring vaguely to 'easier identification'. Some candidates misread the question and explained why detaching limpets would have been a disadvantage.

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Question 3(e)

(e) Layla also has a description of the seashore as shown in **Fig. 3.2**.

High tide zone: Shoreline. Covered with seawater only during high tides.

Middle tide zone: Two times a day seaweeds and animals are covered and uncovered by seawater, allowing exposure to air.

Low tide zone: Seaweeds and animals are almost always covered with seawater and exposed to air only at the lowest of tides.

Fig. 3.2

Explain how the information in **Fig. 3.2** may be used to identify species of limpet and why Layla should only count the limpets that are attached to the rocks.

....

....

....

....

....**[3]**

The majority of candidates identified that limpets that had become detached from rocks might have been washed along the seashore into a different tide zone. Unfortunately, in many cases this idea was not developed into or linked to the ideas of different habitats being occupied by different species. Where the idea of different species occupying different habitats was referred to, there was often a lack of clarity of expression that prevented credit being given for other than the idea that limpet species are specific to each zone. The term ‘habitat' was used only rarely by candidates.

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Question 4(a)(i)

4 Alex is an oceanographer.

He calculates the depth of the ocean floor using an instrument that emits a pulse of sound. He measures the time taken for the pulse of sound to return.

He needs to estimate the speed of sound through seawater to complete his calculation.

(a) Alex uses the data in **Table 4.1** to calculate the maximum and minimum values for the speed of sound through water.

Temperature *T* (°C)	Salinity S (ppt)	Depth *D* (m)	Speed of sound in seawater *c* (ms^{-1})
20.5	36.75	0	1525.2
19.5	33.25	0	1517.7
14.0	36.75	500	1514.0
12.0	33.25	500	1502.7
4.0	36.75	1000	1485.3
2.0	33.25	1000	1472.1

Table 4.1

(i) Determine the **three** intervals of the temperature measurements in **Table 4.1**.

....

....

....

....**[3]**

This question was not answered well by candidates. Candidates seemed to have little idea of what the term 'interval' meant, how to identify an interval or how to correctly express an interval.

Question 4(a)(ii)

(ii) Determine the interval of salinity measurements in **Table 4.1**.

....

....**[1]**

As with question 4(a)(i), this question was again not answered well by candidates. Candidates seemed to have little idea of what the term 'interval' meant, how to identify an interval, or how to correctly express an interval.

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Question 4(a)(iii)

(iii) Describe the relationships between *T* and *D*, *T* and *c*, and *S* and *c*.

T and *D* ....

....

T and *c* ....

....

S and *c* ....

....**[3]**

Nearly all candidates were able to correctly describe the relationships between T and D, and T and c. However, the majority of candidates did not identify that at each depth the speed of sound in seawater (c) increases with salinity (S). Often candidates' expression of the relationships described was poor, particularly in relation to depth (D). References to 'as the depth goes down' rather than 'as the depth increases' or 'as depth decreases' were common.

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Question 4(b)(i)

(b) Alex uses a salinometer to measure the salinity (amount of dissolved salt) of the seawater.

The salinometer contains a probe which is inserted into a sample of seawater.

Alex calibrates the salinometer using a standard sample of salinity 20.0 ppt. After the first test he adjusts the salinometer and repeats the test.

Table 4.2 shows the results of the two tests.

	Repeat				
	1	2	3	4	5
Test A	21.6	21.5	21.4	21.5	21.4
Test B	20.1	20.0	19.9	20.0	19.9

Table 4.2

(i) What type of error is shown in **Test A**?

Tick (✓) **one** box.

Measurement error ☐

Random error ☐

Systematic error ☐

[1]

A significant number of candidates selected measurement error or random error rather than the correct answer systematic error.

Question 4(b)(ii)

(ii) Suggest a possible cause of the error identified in **(b)(i)**.

....

....**[1]**

Irrespective of the error selected in 4(b)(i) the vast majority of candidates suggested inaccurate calibration as the cause of the error, only a small number of candidates correctly suggested a contaminated probe. A number of other responses were offered but no pattern of alternative responses could be identified.

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Question 4(b)(iii)

(iii) What type of error is shown in **Test B**?

Tick (✓) **one** box.

Measurement error ☐

Random error ☐

Systematic error ☐

[1]

A significant number of candidates selected measurement error or systematic error rather than the correct answer random error.

Question 4(b)(iv)

(iv) Suggest how the error identified in **(b)(iii)** can be minimised.

....

....**[1]**

Irrespective of the error selected in 4(b)(iii) a significant number of candidates suggested recalibration of the instrument as an appropriate action. Others suggested repeating measurements and calculating a mean when they had made an incorrect selection in 4(b)(iii) for which this would not be an appropriate response. Many candidates referred to repeating measurements without specifically stating the need to calculate a mean.

Question 4(b)(v)

(v) Describe what Alex must do to ensure that there is **no** instrument error.

....

....

....**[2]**

This question was answered very poorly, very few candidates appeared to understand the concept of instrument error or how to minimise its effect. The majority of candidates suggested recalibration of the instrument.

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Question 4(c)(i)

(c) The instrument used by Alex to emit a pulse of sound down to the seabed is called a fathometer. The fathometer has a range of timer options.

Alex uses the data in **Table 4.2** to calculate an average speed of sound as 1504.3 m s^{-1}.

He uses the time measurement and the average speed to calculate the depth of the seabed.

(i) Complete **Table 4.3**.

Use the equation: depth = 0.5 × speed × time

	Time (s)	Average speed (m s^{-1})	Depth (m)
Timer (option 1)	2.60	1504.3	
Timer (option 2)	2.64	1504.3	
Timer (option 3)	2.644	1504.3	

Table 4.3

[3]

Nearly all candidates were able to calculate the depths with each timer option, although some candidates lost marks for incorrect rounding up of the calculated value at one or more depths.

Question 4(c)(ii)

(ii) The more sensitive the timer, the higher the cost of the fathometer.

Explain why a very high sensitivity is **not** necessary.

....

....**[1]**

This question was answered very poorly, very few candidates identified that the greater sensitivity of timer 3 offered little improvement in accuracy over that for timer 2 (for a greater cost) in the context of overall depth.

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Question 5(a)(i)

5 James is a crop nutritionist. He works with farmers to increase their crop yields.

He visits five fields and carries out some soil tests to estimate the amount of nitrogen, N, available in the soil.

The results of the soil tests are shown in **Table 5.1**.

	Field				
	1	**2**	**3**	**4**	**5**
Estimate of soil nitrogen content (kg N/ha)	110	140	210	120	100

Table 5.1

The farmers are planning to grow wheat crops in each of the fields.

James uses the internet to check the recommended amount of nitrogen fertiliser to add to the soil.

He finds the following information:

- Less than 120 kg N/ha soil content – apply 200 kg N/ha fertiliser
- At or over 120 kg N/ha soil content – apply only 40 kg N/ha fertiliser

(a) **(i)** What recommendations should James make for each field?

Field 1 ....

Field 2 ....

Field 3 ....

Field 4 ....

Field 5 ....

[2]

This question was answered well, nearly all candidates correctly identified that 200 kg N/ha fertiliser should be applied to fields 1 and 5, and that 40 kg N/ha fertiliser should be applied to fields 2, 3, and 4.

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Question 5(a)(ii)

(ii) James checks the values shown in **Table 5.1** and considers that one of the values is an anomaly.

Identify the anomaly in **Table 5.1** and explain why you have chosen this value.

The anomaly is in field ....

Explanation ....

....

....

....**[3]**

Nearly all candidates correctly identified that the anomaly was in field 3.

Nearly all candidates correctly identified that the soil nitrogen content for field 3 was much higher than for the other fields. However, comparatively few candidates referred to the range for the other fields/the maximum difference between the other fields, or the difference between field 3 and the maximum value of the other fields.

Question 5(a)(iii)

(iii) James must present his findings to all five farmers. He cannot simply delete the conflicting anomaly because he needs a value for each field.

Suggest what James should do to overcome this problem.

....

....

....

....**[2]**

The majority of candidates referred, in some way, to repeating soil testing. Although, in many cases it was unclear as to whether this was solely for field 3 or for all fields. Where repeat testing for field 3 was concerned some candidates incorrectly stated that a mean value including the original test value would be calculated. Very few candidates who specifically referred to repeating soil tests on the other fields qualified their answers with an explanation that this would be to ensure the original test values were correct.

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Question 5(b)

(b) James reads a fertiliser manual to find out about the economic rates of nitrogen fertilisers. The economic rate is the cost of fertiliser nitrogen as £/kg N divided by the value of grain as £/kg.

He reads the statement in **Fig. 5.1**.

Research has shown that the main causes of yield variation in wheat crops between fields (soil type, rotational position, sowing date or variety) may not be associated with variations in the economic rate of nitrogen (N) fertiliser.

Fig. 5.1

What further evidence could James collect so he can make a conclusion about the effect of nitrogen fertiliser on the yield of wheat crops?

....

....

....

....

....

....**[4]**

This question proved to be challenging for candidates. A significant number of candidates referred vaguely to repeating testing to confirm results. The majority of creditworthy responses considered field investigations, but the nature of the investigations to be conducted was often ill-defined. Few responses considered the need to conduct field investigations of different nitrogen fertilisers under controlled conditions or the possibility of conducting investigations into the effects of other conditions. Very few candidates referred to the economic rate of nitrogen fertilisers.

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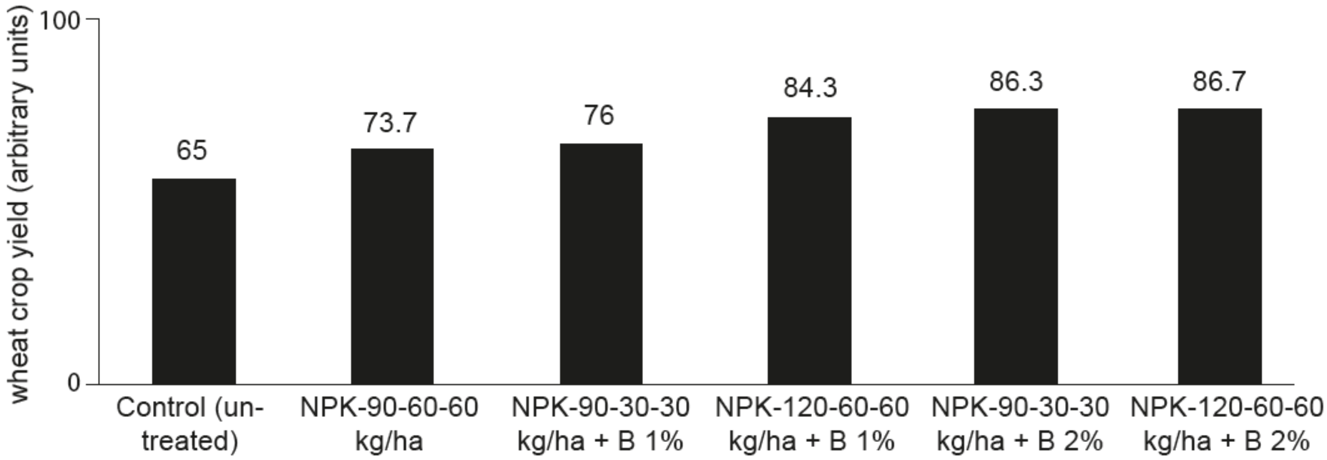
Question 5(c)

(c) Nitrogen is often applied as part of a combined fertiliser known as NPK (nitrogen (N), phosphorous (P) and potassium (K)).

A team of crop scientists investigate the effect of different concentrations of N, P and K plus the addition of boron (B) on the yield of wheat crops.

The results of their investigation are shown in **Fig. 5.2**.



(**Key:** NPK is applied as kg/ha and B is applied as a %percentage value.)

Fig. 5.2

Identify the **two** correct conclusions based on the data shown in **Fig. 5.2**.

Tick (✓) **two** boxes.

The addition of B to NPK fertiliser at 90-30-30 does not affect the yield of wheat.	☐
The application of twice as much N within NPK fertiliser has the greatest impact on wheat yield.	☐
The application of NPK fertiliser increases wheat yield in relation to the control (untreated).	☐
Changing the nitrogen content of NPK does not have an effect on wheat yield.	☐
The application of B at 2% causes a greater increase in wheat yield than the application of B at 1%.	☐

[2]

This question proved to be challenging for candidates. A variety of combinations of options was selected.

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Question 6(a)

6 Sam is a microbiologist working at a brewery. She monitors the condition of the yeast cells during beer fermentation.

Sam uses the stain methylene blue to estimate numbers of living yeast cells in the yeast culture used to brew the beer.

Methylene blue is decolorised by living yeast cells. She counts numbers of blue and colourless cells using a counting chamber.

The results of one of her yeast cell counts is shown in **Table 6.1**.

Number of cells stained blue	Number of colourless cells
54	823

Table 6.1

(a) Calculate the viability of the culture using the equation:

$$\text{viability} = \frac{\text{number of colourless cells}}{\text{total number of cells}} \times 100$$

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

viability =......................................%
[3]

Nearly all candidates were able to substitute the correct figures from Table 6.1 into the equation provided in the stem of the question to correctly calculate the viability of the culture. But a significant number of candidates clearly did not understand the meaning of '2 significant figures' as they recorded their answers to 2 decimal places.

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Question 6(bi)

Adapted data from Isolation of microplastics in biota-rich seawater samples and marine organisms, Scientific Reports 4, Article number: 4528 (2014) www.nature.com, Nature Publishing Group. Reproduced under the terms of the Creative

(b) The graph shown in **Fig. 6.1** shows how the viability of yeast cells in a culture changes over a period of time.

viability (%)

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time (days)

Fig. 6.1

(i) Draw an appropriate line of best fit on the graph in **Fig. 6.1**. **[1]**

Although, all candidates had used a ruler to draw a suitable line of best fit, many were drawn with thick lines, were not continuous, or extended into the margins of the graph.

Question 6(b)(ii)

(ii) To start a fermentation satisfactorily, the viability of the culture must be over 92 %.

Using your line of best fit for **Fig. 6.1**, state the maximum age of a culture that would be able to start a fermentation.

maximum age = ...days **[1]**

Nearly all candidates correctly read the time from the line of best fit drawn in 6(b)(i). For a very small number of candidates, the line of best fit drawn in 6(b)(i) led to a reading outside the +/- 0.5 day tolerance that was allowed.

Question 6(c)(i)

(c) Sam tests for microbiological contaminants in beer, which include yeasts found naturally in the environment ('wild yeasts'), and bacteria.

The tests she uses are shown in **Table 6.2**

(i) Name the test in **Table 6.2** that can be used to identify an organism as a **fungus**.

Tick (✓) **one** box.

Lin's Cupric Sulfate Medium (LCSM) ☐

Acid production ☐

Catalase production ☐

Oxidase production ☐

Lactophenol blue stain ☐

[1]

Contaminant organism	Type of organism	Result of test				
		Growth on Lin's Cupric Sulfate Medium (LCSM)	Acid production	Catalase production	Oxidase production	Lactophenol blue stain
Acetobacter sp.	Bacterium	✗	✓	✓	✗	✗
Brettanomyces spp. – wild yeasts	Fungus	✓	✓	✓	✗	✓
Lactobacillus spp.	Bacterium	✗	✓	✗	✗	✗
Saccharomyces cerevisiae – brewer's yeast	Fungus	✗	✗	✓	✗	✓

Table. 6.2

This question proved to be challenging for candidates. A significant number of candidates had difficulty in analysing the pattern of results in Table 6.2 to identify the correct test.

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Question 6(c)(ii)

(ii) Name the test in **Table 6.2** that would identify 'wild yeasts'.

Tick (✓) **one** box.

Lin's Cupric Sulfate Medium (LCSM)	☐
Acid production	☐
Catalase production	☐
Oxidase production	☐
Lactophenol blue stain	☐

[1]

This question proved to be challenging for candidates. A significant number of candidates had difficulty in analysing the pattern of results in Table 6.2 to identify the correct test.

Question 6(c)(iii)

(iii) Name the test in **Table 6.2** that can be used to distinguish a species of *Lactobacillus* from the two types of bacteria.

Tick (✓) **one** box.

Lin's Cupric Sulfate Medium (LCSM)	☐
Acid production	☐
Catalase production	☐
Oxidase production	☐
Lactophenol blue stain	☐

[1]

This question proved to be challenging for candidates. A significant number of candidates had difficulty in analysing the pattern of results in Table 6.2 to identify the correct test.

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Question 6(d)

(d) At regular intervals, Sam prepares some permanent slides of the yeast culture used by the brewery.

She carries out the following steps for each microscope slide. They are in the **incorrect** order.

A	clear in xylene
B	stain using lactophenol blue
C	mount using Canada Balsam
D	fix using acetic acid alcohol
E	dehydrate (in increasing concentrations of alcohol)
F	add a drop of albumin to stick the yeast cells to the surface of the slide

Put the steps in the correct order. One has been done for you.

Complete the table below.

F					

[4]

This question proved to be challenging for candidates; very few candidates were able to list all steps in the correct order. However, nearly all candidates gained some marks for providing one or more steps in the correct order and/or providing one or more pairs of steps correctly sequenced in an incorrect order.

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Question 6(e)

(e) An optimum calcium ion concentration in water is essential when used for brewing.

From time to time, chemists at the brewery monitor the calcium ion concentration of water from the brewery well.

Describe a titration technique that could be used to determine the calcium ion concentration.

....

....

....

....

....

....**[4]**

This question proved challenging for candidates and was not answered well. Knowledge of both a suitable technique and the ability to describe a titration in generic terms was lacking. Very few candidates gained any marks. Where a mark was gained, it was invariably for reference to use of an indicator. One-or-two candidates referred to titrating until the end-point or repeating until concordant results were achieved.

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Question 7(a)(i)

7 Plastics are made from polymers.

(a) Plastics become an environmental hazard when they are discarded into the sea.

A study on plastics at different locations in the sea around the UK identified different types of plastic litter.

Plastic litter varies in shape, size, colour and polymer type.

The results of the study are shown in **Table 7.1**.

Type of plastic litter	Percentage of total litter sampled (%)
Beads	3
Fibres	58
Fragments from larger plastic pieces	34
Macroplastics (> 5 mm)	5

Table 7.1

(i) Suggest **two** methods of recording the different types of plastic litter found in the sea around the UK.

1 ....

....

2 ....

.... **[2]**

Candidates produced a variety of responses to this question. The correct answers related to the means of recording the evidence gathered or storing he evidence gathered. A significant number of responses related to the nature of the evidence to be gathered (size, volume, weight, type, colour) or the means by which the evidence could be sampled (nets, random sampling).

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Question 7(a)(ii)

(ii) Describe how data showing the location of plastic litter can be captured, stored and displayed.

....**[1]**

A significant number of candidates suggested maps as being a suitable approach, overlooking the facts that maps themselves do not allow for the capture or storage as opposed to the display of data.

Question 7(a)(iii)

(iii) Suggest how the data in **Table 7.1** could be presented to the wider public.

....**[1]**

Nearly all candidates suggested either a means of distribution via suitable media or a suitable means of visualising/displaying the data that would be accessible to the wider public. A small number of candidates overlooked the significance of the term 'wider public' and suggested that 'scientific reports' would be appropriate. In a handful of responses the reference to scientific reports negated otherwise creditworthy references to means of visualising/displaying the data.

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Question 7(b)

(b) Plastic litter can also be found as very small particles (<5mm) called microplastics.

A team of scientists reviewed two recent investigations into the types of microplastic, including their use and amount released into the environment and the microplastics found in marine fish.

The results from the investigation into the types of microplastic are shown in **Table 7.2**.

Type of microplastic	Use of microplastic	Amount released to environment ($t\ yr^{-1}$)
Primary microplastic (produced intentionally)	Plastic pellets used as a raw material	400
	Laundry products	40
Secondary microplastic (formed when larger pieces of plastic break down)	Released from plastic football pitches	3000
	Released from the abrasion of tyres	77 000

Table 7.2

The results from the second investigation into the microplastics found in marine fish are shown in **Table 7.3**.

Fish	Marine habitat	Size of microplastic particles found	Percentage of fish containing microplastic particles (%)
Cod	lives on sea floor	> 500 μm	1.2
Herring	coastal water	none	0.0
Mackerel	coastal water	> 500 μm	13.0

Table 7.3

Use the information in **Table 7.2** and **Table 7.3** to write a report on the two investigations.

It should be written to inform the public about the results and possible conclusions of the investigations on microplastic waste.

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....

....

....

....**[6]**

This question proved challenging for candidates. Very few candidates were able to access Level 3 as the majority of answers lacked sufficient analysis of the data, particularly in relation to the differing feeding habits of the fish studied. Responses that simply repeated data quoted from the Tables 7.2 and 7.3 without manipulation/comparison were not creditworthy. The majority of candidates scored within Level 2 for manipulating data from both Tables 7.2 and 7.3, this was invariably for comparing the amounts of plastics released into the environment and for comparing the percentage of fish affected by microplastics. Very few responses were framed in the context of being structured as a report for public consumption.

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