CAMBRIDGE TECHNICALS

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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

APPLIED SCIENCE

05847–05849, 05879, 05874

Unit 3 January 2021 series

Version 1

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 OCR.

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Unit 3 series overview

Unit 3 (Scientific analysis and reporting) is a mandatory unit for the Level 3 Cambridge Technical Foundation Diploma, Diploma, and Extended Diploma in Applied Science. All Learning Outcomes within the specification are assessed in every series through a paper worth a maximum of 100 marks and two hours in duration.

This unit assesses:

- the ability to use mathematical techniques to analyse data
- the ability to use graphical techniques to analyse data
- the ability to use keys for analysis
- the ability to analyse and evaluate the quality of data
- the ability to draw justified conclusions from data
- the ability to record, report on, and review scientific analyses
- knowledge of the use of modified, extended, or combined laboratory techniques in analytical procedures.

Problems are presented to candidates using a range of styles, including short answer, calculation, fill-the-blanks, matching pairs, true/false, and a longer 6 mark level-of-response question. Problems are presented in a scientific context, which may be a context with which candidates are unfamiliar.

Centres must provide candidates with extensive opportunities for practising those skills detailed in the unit specification as well as exposure to the required experimental techniques and apparatus – this will allow candidates to answer questions in this paper with greater confidence.

Some of the questions in this paper required candidates to answer precisely, applying their knowledge tightly to the context given, and using the stimulus material to work out the answer, using skills of observation, analysis, and evaluation. Careful reading of the question, and care in answering the question precisely and in depth was important to gain maximum credit.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• understood the conventions to be followed when constructing charts and graphs • took care when performing calculations and carried through calculated values between part questions • answered questions precisely within the context given, demonstrating depth of knowledge • used knowledge gained when carrying out practical activities to answer Question 6(d) • were confident in the use, analysis, and evaluation of data presented in unfamiliar contexts.	• did not appreciate the conventions to be followed when constructing charts and graphs • made mistakes when performing calculations and did not carry through calculated values between part questions • provided vague responses to questions that were not specific to the context given, and did not demonstrate depth of knowledge • were unable to draw on first-hand practical experience to answer Question 6(d) • experienced problems when presented with information and data in unfamiliar contexts.

Question 1 (a) (i)

1 Alex is investigating the dispersal of seeds from a sycamore tree.

Sycamore seeds are wing shaped as shown in **Fig.1.1.**

Their shape causes them to spin away from the tree as they fall through the air.

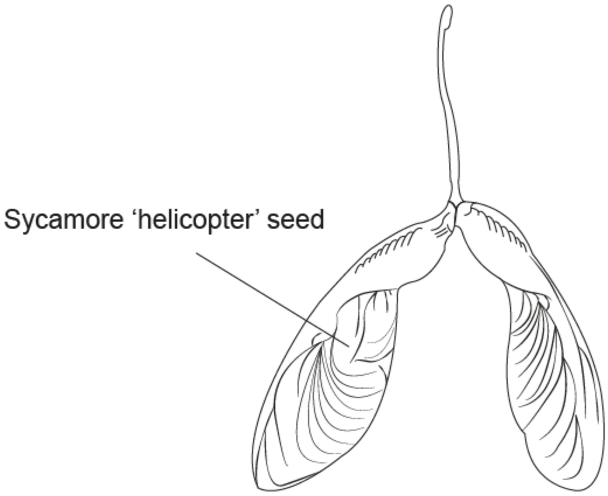

Fig. 1.1

Alex counts the number of seeds in quadrats on one side of a 10 m line transect.

The quadrat used is a wire square-shaped grid (0.5 × 0.5 m) divided into 100 equal sections. The sections make it easier for Alex to count the seeds.

Fig. 1.2 is a diagram of Alex's method.

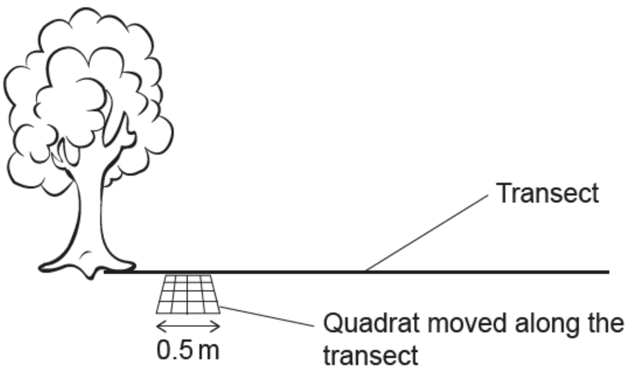

Fig. 1.2

Alex's results are shown in **Table 1.1.**

Distance from tree along the transect line (m)	1	2	3	4	5	6	7	8	9	10
Number of sycamore seeds in each quadrat	39	36	27	18	16	16	10	12	3	0

Table 1.1

(a) Alex uses the scale in **Table 1.2** to convert the number of seeds shown in **Table 1.1** into an abundance rating.

Number of seeds per quadrat	**Abundance rating**
28 or more	5
22 to 28	4
15 to 21	3
8 to 14	2
1 to 7	1

Table 1.2

(i) Complete **Table 1.3** to show the abundance rating of sycamore seeds at each distance from the tree.

Distance from tree (m)	1	2	3	4	5	6	7	8	9	10
Number of seeds	39	36	27	18	16	16	10	12	3	0
Abundance rating										

Table 1.3

[1]

The overwhelming majority of candidates scored the mark for this question. Nearly all candidates who did not score the mark did not do so because they stated the abundance rating at 10 m as being 1.

Question 1 (a) (ii)

(ii) Use your answer in **Table 1.3** to draw a kite diagram on the grid in **Fig. 1.3**.

Your kite diagram should show how the abundance rating of sycamore seeds varies with distance from the tree.

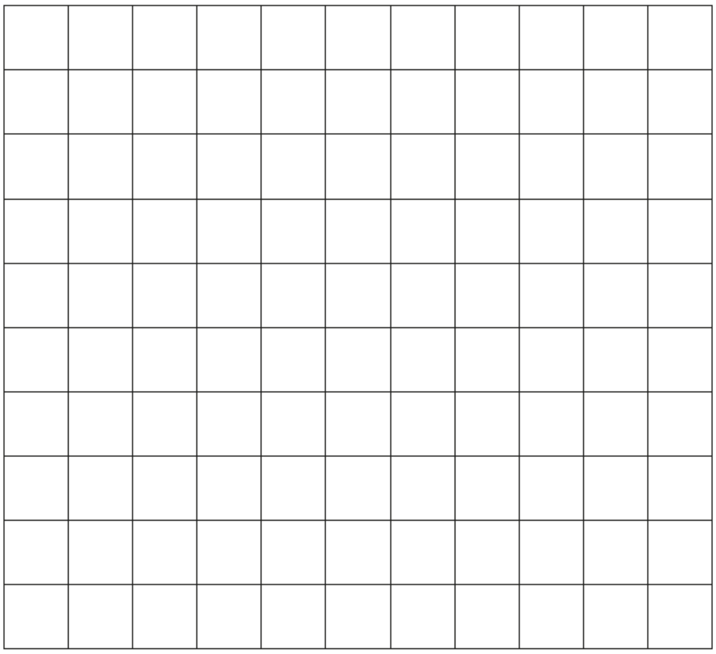

Fig. 1.3

[4]

A number of candidates scored full marks on this question for symmetrical diagrams with ruled axes appropriately labelled. However, many candidates did not appreciate that kite diagrams should be symmetrical about the x-axis. A significant number of candidates lost marks for labelling the y-axis 'abundance' instead of 'abundance rating' and/or omitting units from the x-axis. In many cases where points were plotted correctly the same attention was not given to joining the points – lines were often sketched free-hand and/or thickly-drawn.

Question 1 (b)

(b) Alex repeats his investigation.

He places the transect line in different directions around the tree and counts the number of sycamore seeds in the quadrat along the length of each position of the transect line.

Alex then calculates the number of seeds in each direction as a percentage of the total number of seeds in all directions.

His results are shown in **Table 1.4**.

Direction	Percentage of total number of seeds
north (0°)	5
north-east (45°)	40
east (90°)	25
south-east (135°)	10
south (180°)	5
south-west (225°)	5
west (270°)	5
north-west (315°)	5

Table 1.4

Complete the pie chart in **Fig. 1.4** to show the percentage of seeds in the **north-east**, **east** and **south-east** directions.

Label these three sectors.

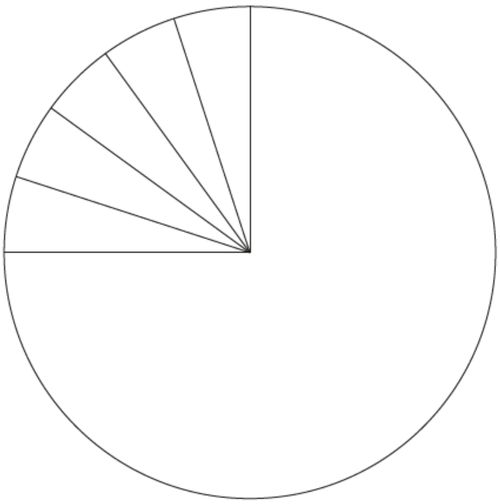

Fig. 1.4

[3]

Nearly all candidates correctly identified the sectors by size, but often the proportions of the sectors were incorrect and/or the sectors ordered incorrectly.

?	**Misconception**	A significant number of candidates were unaware that unless there is an inherent ordering of category levels then the order of sectors within a pie chart should be from largest to smallest, in a clockwise direction.

Question 1 (c) (i)

(c) Alex looks online for an explanation of the seed dispersal.

He finds the chart in **Fig. 1.5** in a journal about UK weather.

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Fig. 1.5

He knows that wind blowing from one direction will blow seeds in the opposite direction.

For example, wind from the south-west will blow seeds in the north-east direction.

(i) Use the data in **Fig. 1.5** to complete the sentence.

In April and ……………………................... there is a ………...………….................. %

chance that the wind will be blowing from either the north-east or the

……………………….................. . **[3]**

Nearly all candidates identified the correct month (mp1) and wind direction (mp3) from the graph, but very few candidates added the maximum and minimum percentage frequencies of wind direction for the relevant time period to score mp2 – the majority of candidates simply quoted a figure of around 30%, not appreciating that it was the range of frequency of winds from both the north-east and south-west which was required.

Question 1 (c) (ii)

(ii) Discuss whether the evidence in **Fig. 1.5** explains the data in **Table 1.4**.

....

....

....

....**[5]**

Stronger responses identified that the largest proportion of seeds were found in the north-east and would have been blown there by winds from the south-west. Few candidates identified, or linked, the information that seeds fall in September-November with the frequency with wind blows from the south-west in this period.

Question 1 (c) (iii)

(iii) Identify which **three** of the following are **most** likely to make a conclusion more secure.

Tick (✓) **three** boxes.

Obtain frequency data for other wind directions. ☐

Repeat the method in **Fig. 1.2** and find the average. ☐

Repeat the measurements in **Table 1.4** using more directions. ☐

Collect seed dispersal data from different tree species. ☐

Collect seed dispersal data from more than one year. ☐

Obtain wind direction frequency data from more than one year. ☐

[3]

This question generated a variety of combinations of responses. A common answer selected was 'repeat the method in Fig.1.2 and find the average', suggesting a vague understanding that more data required collecting but without understanding what the data was nor how to go about collecting it.

Question 1 (d)

(d) Describe the conflicting evidence in **Table 1.4** and **Fig. 1.5**.

....

....

....

....**[2]**

Stronger responses were able to link the low distribution of seeds in the south-west (Table 1.4) with the higher frequency of wind from the north-east (Fig. 1.5). This question proved challenging to the majority of candidates, who made vague references to what data was being displayed – seed dispersal (Table 1.4), wind direction (Fig. 1.5).

Question 2 (a) (i)

2 Mia is an astrophysicist.

She studies the relationship between the size of stars and their temperatures.

(a) To calculate the volume of a star Mia uses the formula: Volume of star = $\frac{4}{3}\pi r^3$

(i) Determine the value of $\frac{4}{3}\pi$ as a decimal.

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

$\frac{4}{3}\pi$ = ... **[2]**

This question was answered correctly by nearly all candidates, who correctly stated the answer to two significant figures.

Question 2 (a) (ii)

(ii) The average radius, r, of the Sun is 7.0×10^{8} m.

Calculate the volume of the Sun.

Give your answer in **standard form**.

Volume of the Sun = …………..…………................ m^3 **[3]**

This question was answered correctly by the majority of candidates, using the value calculated in 2(a)(i). A number of candidates calculated the volume as 4/3πr, despite being given the correct equation in the stem of 2(a)(i).

Question 2 (a) (iii)

(iii) The mass of the Sun is 2.0×10^{30} kg.

Calculate the density of the Sun.

Use your answer to **(a)(ii)** and the equation: mass = volume × density.

Give your answer to **2** significant figures and give the SI unit of density.

Density of the Sun = ………………….................. unit ………………….................. **[3]**

This question was answered correctly by nearly all candidates, using the value calculated in 2(a)(ii), being correctly stated to two significant figures.

Question 2 (b) (i)

(b) Astronomers measure star brightness in terms of luminosity and magnitude.

Luminosity is the amount of light that a star emits from its surface.

Magnitude is a measure of how bright the star appears. The lower the magnitude, the brighter is the star.

The Sun is a main sequence star.

The two charts in **Fig. 2.1** show the relationships between some of the physical properties of main sequence stars.

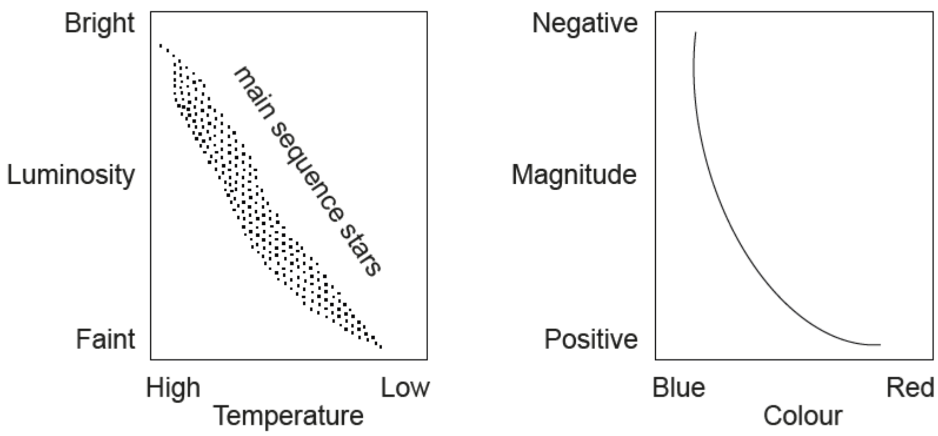

Fig. 2.1

(i) Complete the following sentences to describe the trends in **Fig. 2.1**.

Choose from the following list of words.

You may use each word once, more than once, or not at all.

blue **bright** **colour** **faint** **increases** **magnitude**

negative **neutral** **positive** **red** **temperature**

As the …………………….................. of main sequence stars becomes increasingly

positive, their colour changes from …………………….................

to …………………….................. .

As their …………………….................. increases, their luminosity changes

from …………………….................. to …………………….................. .

[4]

Nearly all candidates were able to use Fig. 2.1 to select the correct words to complete the sentences. The only commonly seen error was not to have realised that on the luminosity v temperature graph the temperature decreases from left to right along the x-axis and so luminosity was incorrectly identified as changing from bright to faint.

Question 2 (b) (ii)

(ii) Mia studies White Dwarf stars. These are the remnants of main sequence stars. White Dwarf stars are in the region below and to the left of the main sequence stars in both charts in **Fig. 2.1**.

Use the information shown in **Fig. 2.1** to describe White Dwarf stars.

....

....

....

....**[2]**

Nearly all candidates were able to correctly read the charts in Fig. 2.1 to identify the features of White Dwarf stars. Where candidates did not score marks was invariably because they stated only one feature from either chart, despite reading each chart correctly.

Question 2 (c) (i)

(c) Only main sequence stars within a certain range of mass become White Dwarfs.

The relationship between the mass of a White Dwarf (compared to the Sun) and its radius (compared to the Sun) is shown in **Fig. 2.2**.

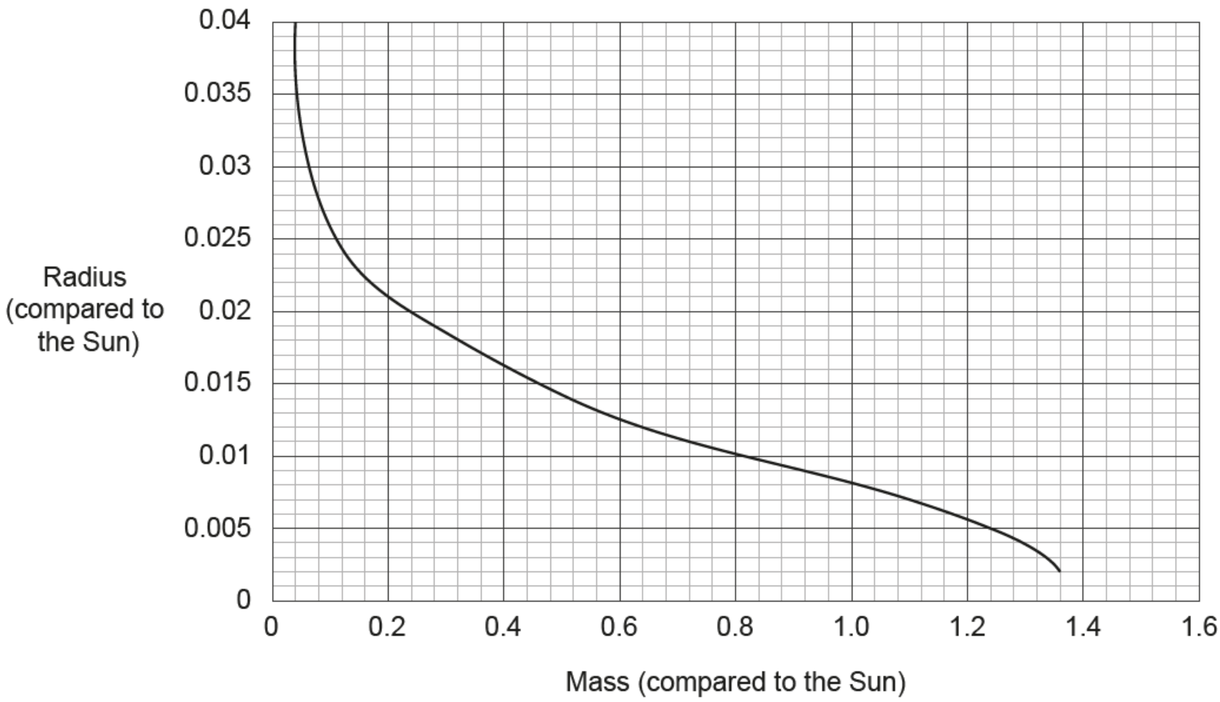

Fig. 2.2

(i) Use **Fig. 2.2** to determine the radius (compared to the Sun) of a White Dwarf formed by a star with a mass of 1.0 (compared to the Sun).

Radius (compared to the Sun) = ………………….……............... **[1]**

The vast majority of candidates were able to use Fig. 2.2 to determine the radius of a White Dwarf star of the stated mass.

Question 2 (c) (ii)

(ii) Calculate the volume of a White Dwarf with the same mass as the Sun as a percentage of the Sun's volume.

Percentage volume = ……………………………................ % **[3]**

This question proved challenging to all candidates. Those candidates that got it incorrect were unable to identify the values with which they needed to work.

Question 2 (c) (iii)

(iii) Describe the trend shown by the graph in **Fig. 2.2**.

....

.... **[1]**

Nearly all candidates identified the relationship/trend shown in Fig. 2.2, but a handful of candidates did not score the mark because they referred to a 'negative correlation' without stating the variables concerned.

	AfL	Where candidates are asked to describe or identify a trend or relationship between two variables they must always identify the variables concerned.

Question 2 (c) (iv)

(iv) Beyond a certain mass, a White Dwarf collapses forming a Black Hole.

Use the graph in **Fig. 2.2** to determine the upper limit to the mass of a White Dwarf.

.... **[1]**

This question proved challenging for nearly all candidates. A relative mass of 1.36 was invariably quoted, this being the point at which the line stopped. Only the very strongest candidates appreciated that the mass beyond which a White Dwarf would collapse would be that at which ceased to exist and, hence, had a radius of 0 and that they were required to extrapolate the line to its intercept with the x-axis.

Question 3 (a)

3 Fungi are classified into different families.

One family is called Agaricaceae.

Fig. 3.1 shows some of the structural features of Agaricaceae fungi.

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Fig. 3.1

The attachment of each gill to the stipe (stem) of a fungus is called the hymenium.

There are different types of hymenium, as shown in **Table 3.1**.

Hymenium		**Description**
	free	gills do not reach the stipe (stem)
	adnexed	gills are narrowly attached to the stipe (stem)
	sinuate	gills curve back down the stipe (stem) before attaching
	adnate	gills are broadly attached to the stipe (stem)
	subdecurrent	gill extends down slightly just as it reaches the stipe (stem)
	decurrent	the whole gill extends down the stipe (stem)

Table 3.1

(a) Use the information in **Table 3.1** to complete the sentences below.

The gills of the fungus shown in **Fig. 3.1** do **not** extend to the base of the stipe (stem).

This means that the hymenium **cannot** be …………………….….................. .

The cap of the fungus in **Fig. 3.1** is the same shape as fungi with a

………………………................... hymenium.

The stipe (stem) of the fungus in **Fig. 3.1** is the same shape as fungi with a

………………………................... hymenium.

[3]

The majority of candidates were able to use the information provided in Table 3.1 to complete the sentences. Some candidates experienced difficulty correctly matching the shape of the cap and/or stipe of the fungus in Fig. 3.1 with the diagrams in Table 3.1 – most commonly the shapes were misidentified as adnexed, rather than adnate.

Question 3 (b)

(b) Suggest **three** reasons why biologists use dichotomous keys.

1 ....

....

2 ....

....

3 ....

....

[3]

Most candidates were able to identify the purpose of dichotomous keys and their advantage. Very few candidates demonstrated an understanding of the basis of dichotomous keys.

Question 3 (c)

(c) **Table 3.2** shows some of the habitats and features of different fungi.

You will need to refer to **Fig. 3.1** and **Table 3.1** to see the different types of stipe (stem) and hymenium.

Fungus name	Habitat	Features		
		Stipe (stem)	Spores	Hymenium
Amanitopsis vaginata	grassland	volva	white	free
Entoloma cetratum	woodland	free	pink	sinuate
Galerina marginata	on wood	ring	brown	adnexed
Lepiota procera	grassland	ring	white	free
Paxillus involutus	woodland	free	brown	decurrent
Pholiota squarosa	woodland	ring	brown	adnate
Pleurotus ostreatus	on wood	free	white	decurrent
Pluteus cervinus	on wood	free	pink	free
Tricholoma gambosum	grassland	free	white	sinuate
Volvariella speciosa	grassland	volva	pink	free

Table 3.2

Use the information in **Table 3.2** to complete the blank spaces in the key in **Fig. 3.2**.

Give the **feature** of the fungus in the blank **grey** rectangles.

Give the **fungus name** in the blank **unshaded** rectangles.

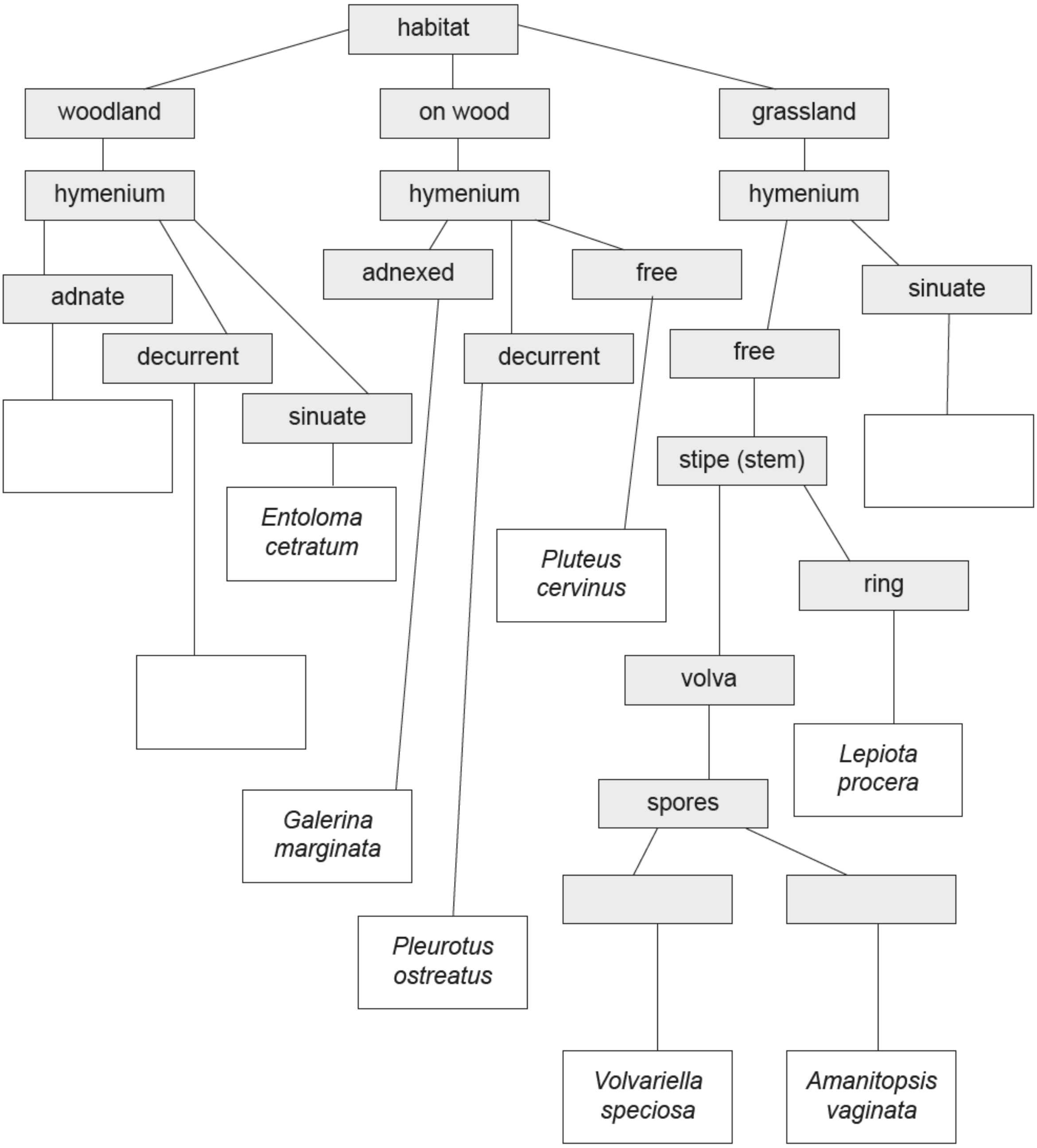


Fig. 3.2

[5]

This question proved straightforward, with most candidates scoring full marks and nearly all candidates scoring at least 3 out of 5. Where candidates lost marks it was invariably for stating an incorrect fungus name (mps 1, 2, 3) rather than spore colour (mps 4, 5).

Question 3 (d) (i)

(d) A fungus described in **Table 3.2** is shown in **Fig. 3.3**.

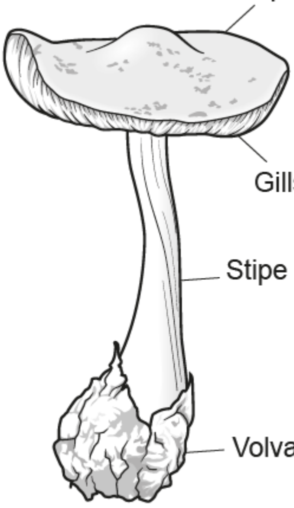


Fig. 3.3

(i) Use **Table 3.2** or the **key in Fig. 3.2** to identify the name of the fungus shown in **Fig. 3.3**.

Tick (✓) **one** box.

Amanitopsis vaginata ☐

Entoloma cetratum ☐

Galerina marginata ☐

Lepiota procera ☐

[1]

Most candidates were able to use Table 3.2 and the key in Fig. 3.2 completed in 3(c) to correctly identify the fungus shown in Fig. 3.3. There was no common error among incorrect responses, with a variety of alternatives being selected.

Question 3 (d) (ii)

(ii) The names of the fungi in **Table 3.2** are based on binomial nomenclature.

Describe the key features of binomial nomenclature and **one** advantage of using this naming system.

Key features ....

....

Advantage ....

....

[2]

Nearly candidates correctly identified one advantage of binomial nomenclature, and most candidates understood the use of genus and species names as a key feature of binomial classification.

Question 4 (a)

4 Eve is investigating reflections in plane mirrors.

She places a coin between two mirrors.

Fig. 4.1 shows the coin and two images of the coin reflected in the mirrors.

Fig. 4.1

Eve adjusts the angle between the mirrors.

She observes that there is a range of angles between which whole images first appear and just before another image begins to appear.

(a) Identify what Eve needs to specify to ensure that her investigation is repeatable.

Tick (✓) **three** boxes.

The range of angles between the mirrors.	☐
The diameter of the coin.	☐
The distance between the coin and the junction between the mirrors.	☐
The position of the observer relative to the mirrors.	☐
The number of images.	☐
The surface area of the mirrors.	☐
The thickness of the coin.	☐

[3]

This question generated a variety of responses from candidates, nearly all candidates scoring at least 1 or 2 marks for identifying that the distance between the coin and the junction between the mirrors and/or the position of the observer relative to the mirrors must be specified to ensure repeatability of the investigation. The most commonly selected distractors were 'the range of angles between the mirrors' and 'the thickness of the coin'.

Question 4 (b) (i)

(b) Eve starts her investigation with the two mirrors at an angle of 180°.

As she reduces the angle between the mirrors from 180° to 166°, Eve observes one image of the coin.

When she reduces the angle to 165°, a second image starts to appear.

She continues to reduce the angle between the mirrors until a third image begins to appear. She measures this angle to be 98°.

(i) Describe the relationship between the variables.

....

....**[2]**

This question presented few problems to candidates, with nearly all candidates scoring both marks for correctly stating that as the angle between the mirrors decreased the number of images increased.

Question 4 (b) (ii)

(ii) Determine the range and interval of angles for the appearance of two images.

Range = ...

Interval = ...
[2]

Only the strongest candidates demonstrated understanding of the concepts of range and interval. The majority of candidates scored zero marks.

	AfL	The concepts of range and interval have proved difficult for candidates in successive series of this examination. This could be addressed through considering and exploring these concepts whenever appropriate investigations are being performed in other units within the qualification.

Question 4 (c) (i)

(c) Eve finds this formula for the number of images n formed between two plane mirrors:

$$n = \frac{360}{\theta} - 1$$

where θ is the angle between the mirrors.

(i) Use the formula to determine the angle of θ that gives two whole images.

θ = ... ° **[1]**

Nearly all candidates were able to correctly substitute and rearrange the equation provided to determine the correct angle.

Question 4 (c) (ii)

(ii) Calculate the number of images which (according to the formula) should be produced when the angle between the mirrors is 165°.

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

Number of images = ... **[1]**

Nearly all candidates were able to correctly substitute the equation to calculate the correct number of images produced, and correctly stated the answer to one decimal place.

Question 4 (c) (iii)

(iii) Calculate the error of the observed angle, 98°, as a percentage of the angle calculated in **(c)(i)**.

Use the equation: Percentage error = $\frac{(O - A)}{A} \times 100$

where A is the calculated angle in **(c)(i)**, and O is the observed angle.

Percentage error of 98° = ……………………................ % **[2]**

Nearly all candidates were able to substitute the angle calculated in 4(c)(i) to calculate the correct percentage error for their calculated value. A number of candidates substituted correctly and performed the calculation correctly but ignored the negative sign when stating their answer.

Question 5 (a) (i)

5 Kai is investigating how the angle θ of a sloping track affects the acceleration a, of a glass ball as it rolls down the track.

The track is shown in **Fig. 5.1**.

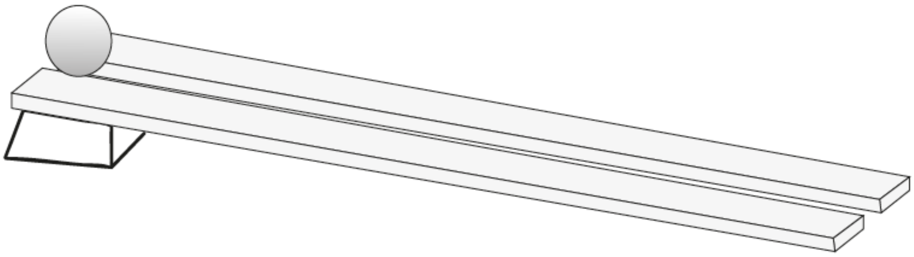


Fig. 5.1

Before he starts the investigation, he uses this equation to calculate some theoretical results:
$a = g \sin \theta$

This equation determines the horizontal component of the acceleration.

Kai uses a value of the acceleration due to gravity, g = 10 m s^{-2}.

He then plots these results on the graph in **Fig. 5.2**.

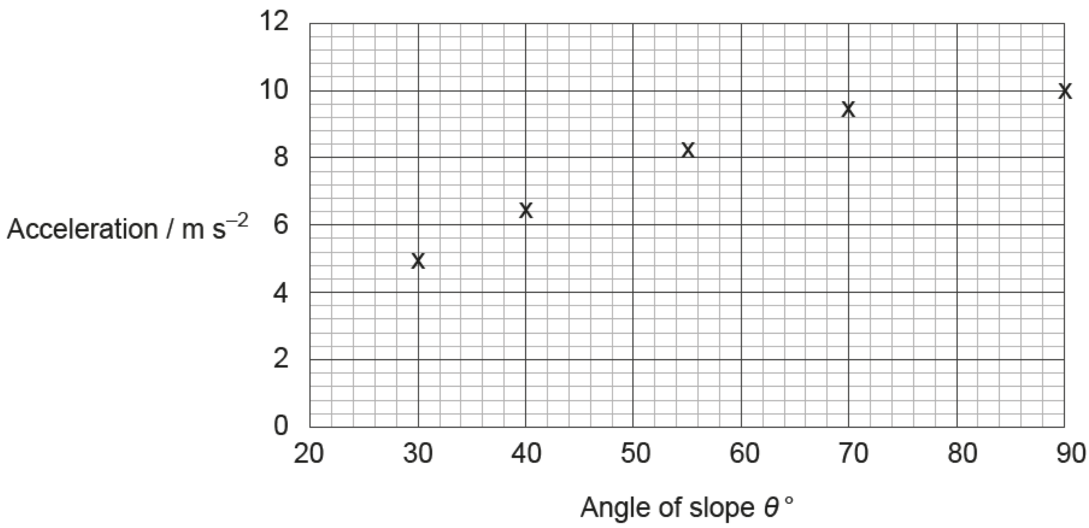


Fig. 5.2

(a) (i) On **Fig. 5.2** draw a curve of best fit.

[1]

All candidates attempted to draw a curve of best fit, but many curves did not pass through all the indicated points and a significant number of candidates attempted to force their drawn curves through (0, 20). Many curves were sketched and/or thickly-drawn and/or extended beyond the limits of the graph.

i	**OCR support**	Guidance on drawing graphs can be found in the OCR *Practical Skills Handbook* for GCE A Level Biology, Chemistry and Physics.

Question 5 (a) (ii)

(ii) Use your curve to determine the acceleration of the ball on a track with an angle of slope $\theta = 20°$.

Acceleration = ………………………………………… m s^{-2} **[1]**

Nearly all candidates were able to use their curve drawn on Fig 5.2 in 5(a)(i) to identify the acceleration on a track of 20° from the intercept on the y-axis. Those candidates who did not score the mark did so because of misreading off the intercept/scale on the y-axis.

Question 5 (a) (iii)

(iii) Calculate the gradient of the curve of best fit when the angle of the slope is 55°.

Show your working on **Fig. 5.2**.

Gradient at 55° = ………………………………………… **[3]**

Only the strongest responses constructed a tangent to the curve drawn in 5(a)(i) and used appropriate coordinates to calculate the gradient of the tangent; many candidates attempted to calculate the gradient without drawing a tangent as though the curve of best fit was linear.

i	**OCR support**	Guidance on determining the gradients of graphs, and other mathematical skills related to the use of graphs, can be found in the OCR Mathematical Skills Handbook for GCE A Level Biology.

Question 5 (b)

(b) Suggest **two** reasons why Kai's theoretical results are **not** accurate.

1 ....

....

2 ....

....

[2]

This question proved difficult for candidates across the ability range; many candidates simply made vague references to the theoretical calculations being incorrect. A common response was reference to human error when conducting the experiment, candidates having misunderstood that the data concerned had been calculated theoretically and not determined by experiment, despite this being clearly stated in the question. Few candidates scored more than one point, either for identifying that g is not exactly 10 ms^{-1} or that the line of best fit may not have been accurately drawn.

Question 5 (c)

(c) Suggest why Kai produces theoretical results to compare with the actual results of his investigation.

....

....**[1]**

Very few candidates provided responses that were specific enough to gain credit, instead referring vaguely to checking the experimental results or improving the accuracy or reliability of the investigation.

Question 6 (a) (i)

6 Jack is a technician working in a food science laboratory.

(a) Jack uses a colorimeter to determine the mass of iron in 100 g of spinach leaves.

He knows that when ammonium thiocyanate is added to a solution containing Fe^{3+} ions, a red complex is formed.

Jack obtains a calibration graph by following four steps:

Step 1 He puts 2 cm^3 of water in a cuvette in the colorimeter and adjusts the absorbance reading to give a value of zero.

Step 2 He prepares 5 solutions of iron(III) chloride of known concentrations as shown in **Table 6.1**.

Step 3 He takes 10 cm^3 of each solution, adds 10 cm^3 of ammonium thiocyanate and mixes thoroughly so that the red colour is evenly distributed.

Step 4 He records the absorbance of 2 cm^3 of each solution as shown in **Table 6.1**.

Concentration of Fe^{3+}/ mg dm^{-3}	Absorbance
2.6	0.19
5.2	0.58
7.8	0.67
10.4	0.89
13.0	1.11

Table 6.1

(i) Plot a graph of concentration of Fe^{3+} (x-axis) against absorbance (y-axis).

[4]

Some candidates produced very good graphs which scored full marks; however, many candidates lost one or more marks for omitting units, drawing incorrect scales (drawing the y-axis to only 1.1 au was a commonly seen error), failing to rule axes, and mistakes when plotting points. A handful of candidates transposed the x- and y-axes.

	OCR support	Guidance on drawing graphs can be found in the OCR *Practical Skills Handbook* for GCE A Level Biology, Chemistry and Physics.

Question 6 (a) (ii)

(ii) Draw a line of best fit on the graph and circle the outlier.

[2]

Nearly all candidates correctly identified the outlier at (5.2, 0.58), but the line of best fit was often incorrectly drawn, being thick and/or extending beyond 0/13 and or being broken/not ruled. A number of candidates did not draw the line of best fit through 0 despite being told in the stem that in step 1 of the investigation the colorimeter was zeroed using distilled water.

Question 6 (b) (i)

(b) Jack then uses his calibration graph to find the amount of iron in spinach leaves.

- He gently heats 3.60 g of spinach leaves until they have all burnt.
- He adds 10 cm^3 of water and filters the mixture to remove the ash.
- He then adds 10 cm^3 of ammonium thiocyanate solution to the 10 cm^3 of spinach extract and measures the absorbance.

He finds that the **absorbance value** is 0.70.

Use the following steps to calculate the mass of iron in 100 g of spinach leaves.

(i) Use the graph to determine the concentration of iron (in mg dm^{-3}) in the spinach extract.

Show your working on the graph.

Concentration of iron = ………………………................... mg dm^{-3} **[1]**

As far as determining the concentration of iron at an absorbance value of 0.70 was concerned this question presented few problems to candidates. However, a significant number of candidates ignored the instruction to show their working on the graph, and so scored zero points. It is important that candidates read and follow the instructions within questions, and where requested show evidence of working – demonstrating an understanding of knowledge of processes involved in scientific reporting is important on this paper.

Question 6 (b) (ii)

(ii) Your answer to **(b)(i)** is the number of mg of iron in 1000 cm^3 of the solution.

Use this value to calculate the mass of iron in **10 cm^3** of the spinach extract.

Mass of iron in 10 cm^3 of the spinach extract = ……………………................ mg **[1]**

Nearly all candidates were able to use the value identified in 6(b)(i) to correctly calculate the mass of iron in 10 cm^3 of spinach extract.

Question 6 (b) (iii)

(iii) Jack uses 3.60 g of spinach leaves in his experiment.

Use your answer to **(b)(ii)** to calculate the mass in mg of iron in **100 g** of spinach leaves.

Mass of iron in 100 g of spinach leaves = ……………………................ mg **[1]**

Nearly all candidates were able to use the answer calculated in 6(b)(ii) to calculate the mass of iron in 100g of spinach leaves.

Question 6 (c)

(c) The recommended dietary allowance (RDA) of iron in an average person's diet is 14 mg.

Calculate what percentage of the RDA of iron an average person will get by eating 100 g of the spinach leaves used in Jack's experiment.

Percentage of the RDA of iron = ……………………................ % **[1]**

This question proved more challenging to candidates than 6(b)(ii) and 6(b)(iii). Many candidates were unaware that the amount of iron consumed daily in 100 g of spinach leaves had been calculated in 6(b)(ii) and instead tried to work with a value of 100 g.

Question 6 (d)

(d) Another technician, Amaya, carries out a titration experiment to compare the vitamin C content of three fruit juices.

One way to determine the amount of vitamin C is to carry out a redox titration using a standard solution of iodine.

When iodine solution is gradually added to a solution containing vitamin C in the presence of starch indicator, iodine is converted to iodide ions.

Once all the vitamin C in the sample has been used up, any further addition of iodine will not react. This excess iodine reacts with starch to form a blue-black complex.

The endpoint of the titration is when the blue-black colour first appears.

Amaya is provided with three different fruit juices, a standard solution of iodine and some starch solution.

She has access to normal glassware apparatus needed for carrying out a titration.

Describe the steps Amaya should follow to find out which fruit juice contains the highest concentration of vitamin C.

In your answer include the names of the apparatus Amaya should use.

....

....

....

....

....

....

....**[6]**

Some candidates produced good responses, demonstrating a knowledge of the glassware and procedure to be followed when conducting a colorimetric titration. However many candidates produced responses that were confused both in terms of the glassware to be used and the procedure to be followed. Some candidates struggled to frame their responses within the context of the question, referring to acid-base titrations and the use of indicators other than iodine.

A significant number of candidates suggested the use of a beaker, rather than a conical flask, for conducting the titration. Many candidates did not refer to using a bulb/graduated pipette to transfer a known volume of sample into the beaker/conical flask.

Invariably candidates suggested that the titration(s) should be repeated a number of times and an average calculated. At this level candidates should be taught and understand that titrations are repeated until concordant results are obtained.

Nearly all candidates simply described the method for conducting a titration to determine the concentration of vitamin C in a fruit juice and overlooked that they had been asked to describe how they could find out which fruit juice contained the highest concentration of vitamin C – this required, as a minimum, a statement that the titration be repeated with all the fruit juices and that the results be compared.

	AfL	Centres should provide candidates with as many opportunities as possible to gain experience with the practical techniques specified in the unit specifications both for this unit and Unit 2 (Laboratory Techniques). Centres should make sure that the correct equipment and processes are followed when conducting investigations, and that candidates understand why particular items of equipment are used and why certain processes are followed.

Question 7 (a)

7 Scientific journal publications contain peer-reviewed articles. Such articles often contain tables of data.

Fig. 7.1 is an example of a table taken from an article which evaluates three different cell counting methods.

The three cell counting methods used were:

- a manual method using a hemocytometer
- a semi-automated method using a Countess cell-counter
- a fully automated method using a Vi-Cell analyser.

Cell counting system	Auto sample	Staining options	Size range (µm)	Sample volume (µL)	Concentration range (cells/mL)	Imaging technology
Hemocytometer [a,b,c]	No	Erythrosin B, Nigrosin, Safranin, Methylene blue and Trypan blue	Undefined	50	2.5×10^5 8.0×10^6	Microscope objective 40x
Countess cell-counter	No	Trypan blue	8-60	20	1×10^4 1×10^7	Camera 2.3x objective and 3.1 Megapixel
Vi-Cell® analyser	Yes	Trypan blue	2-70	500	5×10^4 1×10^7	Auto-focus routine firewire camera 1394x 1040CCD array

[a] Bastidas O. Cell counting with Neubauer chamber. Technical note. Celeromics 1-6

[b] Hsiung F McCollum T, Hefner E and Rubio T. Comparison of count reproducibility, accuracy, and time to results between a hemocytometer and TC20™ Automated cell counter. Technical note: Bio-Rad Laboratories, Inc., 2013.

[c] Maruhashi F, Murakami S, Baba K. Automated monitoring of cell concentration and viability using image analysis system. Cytotechnology 1994; 15: 282-289.

Fig. 7.1

(a) Give **one** reason why a table is a useful way to show this kind of information.

.... **[1]**

Many candidates scored the mark here for a vague identification of clarity or ease or reading; in general, responses demonstrated a lack of depth of understanding of how tables aid clarity or ease of reading.

Question 7 (b)

(b) Suggest why the authors of the research article have included references in the table.

....

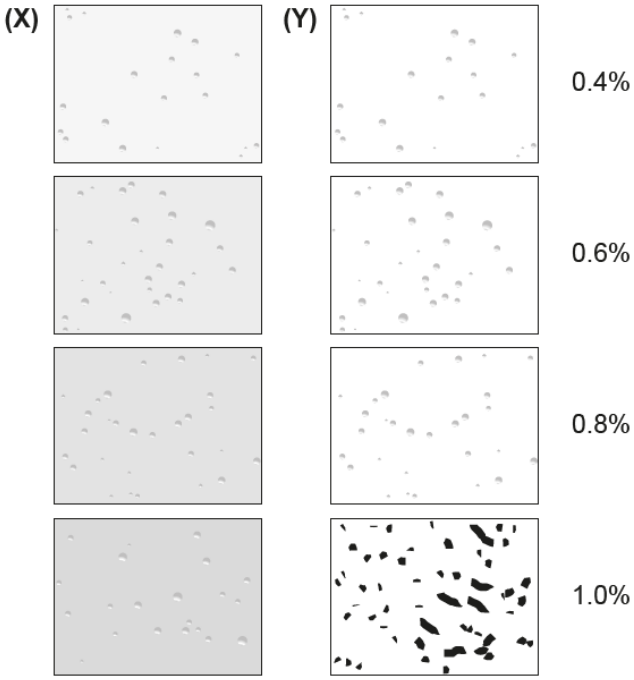
....**[1]**

Nearly all candidates identified that it was important to show from where secondary data had been obtained, but very few candidates demonstrated an understanding that correct referencing of sources is important to allow to follow up on and check information gathered from secondary sources.

Question 7 (c)

(c) The authors presented some of their data in photographic form.

An example of this form of data presentation is shown in **Fig. 7.2**.



Comparison of images produced using the Countess cell-counter with different concentrations of the staining solution.
(X) shows images from the camera, **(Y)** represents images as analysed by computer software

Fig. 7.2

State **two** advantages of presenting data in photographic form in a scientific publication.

1 ....

2 ....
[2]

Many responses to this question were framed around vague ideas of ease of use/clarity; in general candidates had difficulty in identifying when or why the use of photographic data would be advantageous.

Question 7 (d)

(d) Data can also be presented graphically.

One of the graphs included in the research paper is shown in **Fig. 7.3**.

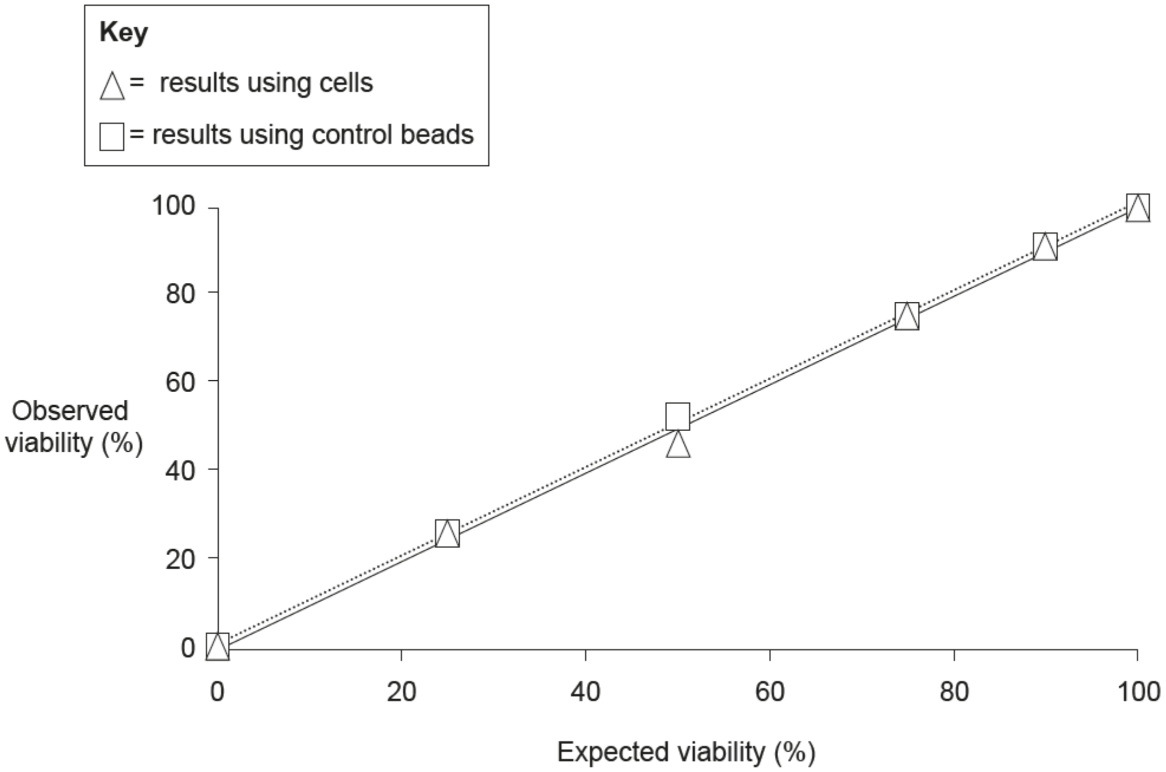


Fig. 7.3

Suggest **two** reasons why the authors chose to show the data in **Fig. 7.3** graphically.

1 ....

2 .... **[2]**

The majority of candidates understood the reasons for/advantages of depicting data graphically and scored both marks, but a significant number of candidates were able only to identify one specific reason/advantage and referred vaguely to ease of use/clarity for the second suggested point.

Question 7 (e)

(e) In addition to tables, photographs and graphs, data can be recorded in other ways.

List **two** other ways that scientific data can be recorded.

1 ....

2 ....
[2]

Where candidates had read and understood the question a variety of credit-worthy suggestions were seen. However, many candidates had not read the question correctly and repeated one of the examples provided in the stem. A small number of candidates misinterpreted the question and suggested places where data can be stored (such as notebooks, USB sticks).

Question 7 (f)

(f) In terms of scientific data, explain the meaning of validity and accuracy.

Validity ....

Accuracy ....
[2]

Nearly all candidates demonstrated an understanding of the term 'accuracy', but there was more confusion over the meaning of the term 'validity' where many responses referred to reliability.

i	**OCR support**	Information on the use of scientific terminology can be found in the OCR publications Language of Measurement in Context which have been produced to support the teaching of GCSE sciences.

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