

## Wednesday 5 June 2024 – Morning

## Level 3 Cambridge Technical in Applied Science

## 05874 Unit 23: Scientific research techniques

**Time allowed: 2 hours**

**C344/2406**

**You must have:**

- your copy of the Pre-release

**You can use:**

- a scientific or graphical calculator



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

Date of birth

D	D	M	M	Y	Y	Y	Y
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## INSTRUCTIONS

- Use black ink.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- At the end of the exam, hand in your pre-release notes with your exam paper.
- Use the pre-release to answer Questions **4** and **5**.

## INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [ ].
- This document has **16** pages.

## ADVICE

- Read each question carefully before you start your answer.

- 1 According to a recent business report, the global market for water purification technologies is expected to exceed \$50 billion by 2029.

The research and development of these technologies is reported in a variety of secondary sources.

**Table 1.1** shows different types of sources.

**Table 1.1**

Source types	Letter
Media	A
Government	B
Published scientific research	C
Trade website	D
Journal (scientific)	E
Scientific research institution	F

Use **Table 1.1** to identify which type of source has been used for each piece of information.

Write **one** letter **A, B, C, D, E** or **F** in each row of **Table 1.2**.

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

**Table 1.2**

	Information	Source type
1	The water you drink from the tap has been drunk up to 10 times by people before, because wastewater is continually passed through one of two different cycles before making a full circle back to your sink's tap.	.....
2	Get your free PDF copy of Kemira's Water Handbook – 'The ABC of water treatment' now! We have updated and republished our esteemed and much used guide to include the latest developments and research in water treatment applications and technologies.	.....
3	The Drinking Water Inspectorate (DWI) does not decide which products the water industry uses, but our role, as operator of the approval process under regulation 31 of The Water Supply (Water Quality) Regulations 2016 (as amended) in England and Wales, is to ensure that the requirements of the legislation are met.	.....

[3]

- 2 In humans, the gene 'AMY1' codes for production of the protein amylase, which is secreted in saliva. Amylase acts as a biological catalyst (enzyme) in the breakdown of starch.

A group of scientists investigated 'AMY1' in different populations of humans.

Their research paper included the following abstract.

### Abstract

Starch consumption is a prominent characteristic of agricultural societies and hunter-gatherers in arid (dry) environments. In contrast, rainforest and circum-arctic hunter-gatherers and some nomadic animal herders consume much less starch. This behavioural variation raises the possibility that different selective pressures have acted on amylase, the enzyme responsible for starch hydrolysis. We found that salivary amylase gene ('AMY1') copy number is correlated positively with salivary amylase enzyme levels, and that individuals from populations with high-starch diets have on average more 'AMY1' copies than those with traditionally low-starch diets. This example of positive selection on a copy number-variable gene is one of the first in the human genome. Higher 'AMY1' copy numbers and salivary amylase levels are likely to improve the digestion of starchy foods, and may buffer against the fitness-reducing effects of intestinal disease.

<https://www.nature.com/articles/ng2123>

(a)

- (i) The scientists identified different types of human populations for their research.

State **three** factors from the abstract that vary between these population types.

- 1 .....
- 2 .....
- 3 .....

[3]

- (ii) Suggest **two** hypotheses that the scientists were testing in their investigation.

- 1 .....  
.....
- 2 .....  
.....

[2]

- (b) Explain why the researchers needed to consider **sample size** in their investigation.

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

- 3** Various procedures require small volumes of liquid to be accurately dispensed using a pipette.

A laboratory technician checks the calibration of a  $1.000\text{ cm}^3$  one mark pipette using the following procedure.

- 1 Fill a clean beaker with distilled water\*.
- 2 Place a small beaker on an electronic balance.
- 3 Zero the balance.
- 4 Rinse the pipette with distilled water, then use it to extract  $1.000\text{ cm}^3$  of distilled water from the beaker.
- 5 Transfer the  $1.000\text{ cm}^3$  of distilled water into the small beaker on the balance.
- 6 Record the mass in a table.
- 7 Repeat steps 2–6 five more times.

\* distilled water has a density of  $0.998\text{ g cm}^{-3}$  at standard room temperature and pressure.

- (a)** State **three** reasons why the technician does **not** use ordinary tap water to rinse and fill the pipette.

- 1 .....
- .....
- 2 .....
- .....
- 3 .....
- .....

**[3]**

- (b)** Before starting this procedure, the technician must choose a balance to use.

- (i)** State **one** piece of information that the technician must check about the balance chosen.

..... **[1]**

- (ii)** The technician checks to confirm that the balance has recently been calibrated.

Explain why calibration is important.

..... **[1]**

- (c) There are variations between the masses of the six water samples weighed by the technician.  
The six readings are used to calculate a mean.

- (i) State **two** other types of calculations that can be done, using the readings, to determine whether the range of values is statistically significant.

1 .....

2 ..... [2]

- (ii) The technician uses mass and volume measurements in a calculation.

How does the technician use the result of this calculation to determine if the pipette is accurate?

.....

..... [1]

- (d) During the procedure, the technician holds the pipette in their hand and works slowly.

Suggest **two** ways that this method could cause uncertainties in the measurements.

1 .....

.....

2 .....

.....

[2]

Questions **4** and **5** relate to the pre-release material you have studied and your secondary research.

**4 Sources A and B** refer to crops grown to provide bioenergy.

(a) With reference to **Source A** the research team demonstrated a successful innovation.

(i) Describe the innovation.

.....

.....

..... [2]

(ii) Describe the supporting evidence that allowed the researchers to be confident that the innovation was successful.

.....

.....

..... [2]

(b) With reference to **Source B**:

(i) From 2015 to 2020, the area of land used for maize increased by 41 000 hectares (ha).

Describe three **other** trends in the data, stating the year the trend started and the size of the change.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(ii) The 'key messages for 2020' contain some raw data and some data that has been processed using a statistical method.

What type of statistical method has been used?

..... [1]

- (iii) Calculate, using this statistical method, values for the agricultural land used to grow miscanthus in 2015 and in 2016.

Show your working.

2015 .....

2016 ..... [2]

- (iv) Explain why using this statistical method provides a fairer analysis of the data.

Use the raw data and your answers to (b)(iii) to support your answer.

..... [1]

- (c) In the next stage of the research outlined in **Source A**, the CABBI researchers want to apply their innovation further.

- They identify a new hypothesis and identify a required outcome
- They also write a plan for the analysis of the results

- (i) Using **Source A**, deduce a hypothesis for this next stage of research and identify the required outcome.

..... [4]

- (ii) In the plan for the analysis of the results, the researchers must consider time frames.

Suggest **two** reasons why a time frame of at least one year may be necessary.

1 .....

2 ..... [2]

- (iii) The researchers must also consider a risk assessment before completing their plan.

State the name of the regulations the researchers should consult for guidance on the safety of the materials they use.

.....  
..... [1]

- (iv) Suggest **two** risks that may arise from the innovation described in **Source A**.

Risk 1 .....  
.....  
.....  
Risk 2 .....  
.....  
..... [2]



**5** Write a report on your own research related to the pre-release material, including the following:

- the area of focus you have chosen
- the findings from your research
- evaluation of your research with reference to:
  - method(s) chosen
  - evidence generated
  - source material(s) used.
- conclusions and implications of your findings
- areas where further research may be required.

**[20]**

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**EXTRA ANSWER SPACE**

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

A series of horizontal dotted lines for writing answers, with a solid vertical line on the left margin.







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