

## Friday 16 June 2023 – Afternoon

### Level 3 Cambridge Technical in Applied Science

05874 Unit 23: Scientific research techniques

Time allowed: 2 hours

C344/2306



**You must have:**

- your copy of the Pre-release

**You can use:**

- a scientific or graphical calculator
- an HB pencil



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

Centre number

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

Candidate number

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

First name(s)

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Last name

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Date of birth

|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| D | D | M | M | Y | Y | Y | Y |
|---|---|---|---|---|---|---|---|

#### INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- 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

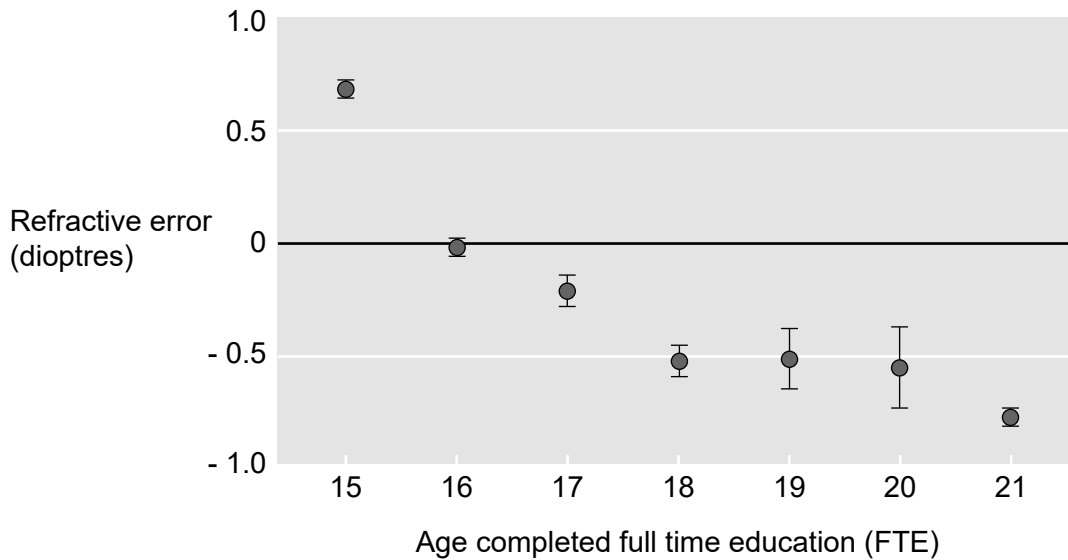
- Read each question carefully before you start your answer.

**1** Myopia, or short-sightedness, is one of the leading causes of visual disability.

Myopia is a refractive error. It is measured in dioptres. A negative dioptre indicates myopia.

A 2018 study of 67,798 men and women from England, Scotland and Wales reported in the British Medical Journal (BMJ), contains the graph shown in **Fig. 1.1**.

**Fig. 1.1**



**(a)** Put a tick (✓) in the table against the **two** hypotheses tested in the 2018 study (**Fig. 1.1**).

**(i)**

| Hypotheses   | Tick |
|--|------|
| Myopia is more prevalent in people leaving FTE aged 21 than in the general population                            |      |
| There is a link between myopia and the number of years that students use computer screens during FTE             |      |
| Myopia increases as the age of completing FTE increases  |      |
| To avoid visual disabilities the optimum age to leave FTE is 16  |      |
| There is little difference in the incidence of myopia for subjects who completed FTE when aged between 18 and 20 |      |

**[2]**

(ii) Suggest **three** further pieces of information that would increase confidence in these hypotheses.

1 .....

.....

2 .....

.....

3 .....

.....

**[3]**

(b) Error bars are shown for the data values plotted in **Fig. 1.1**.

Use the error bars to compare the significance of the data between:

- people who were 17 years old when completing FTE and those who were 19 years old
- people who were 18 years old when completing FTE and those who were 19 years old.

Between 17 and 19 years old

.....

.....

Between 18 and 19 years old

.....

.....

**[2]**

- 2 A biohazard is a biological material that poses potential harm to the health of other living organisms.

In law, authorised officers are allowed to take samples of food, or samples from food preparation surfaces, in premises where food is processed. This is to identify any risks from biohazards.

Jamal is an assistant manager in a laboratory that processes many of these samples each day. At the end of each day the laboratory is disinfected.

Jamal wants to find out more about a technique using ultraviolet radiation (UV-C) to disinfect the laboratory. He reads some different pieces of information in a range of secondary source types.

**Table 2.1** shows different types of sources.

**Table 2.1**

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

Use **Table 2.1.** to identify which type of source has been used for each piece of information given in **Table 2.2.**

Write **one** source-type letter **A, B, C, D, E, F,** or **G** in each row of **Table 2.2.**

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

**Table 2.2**

| Information   | Source type |
|---|-------------|
| ‘.....provision for securing that food is fit for human consumption and meets such microbiological standards (whether going to the fitness of the food or otherwise) as may be specified by or under the regulations...’  | .....       |
| As a pioneer in the microbiology outsourcing industry for more than 25 years, we offer a comprehensive range of microbiology services with strict adherence to cGMP requirements to support all aspects of microbiology testing. We believe that our prices are competitive.  | .....       |
| Our organisation provides solutions to accommodate offices and workspaces, manufacturing environments, clinical theatres, retail and the hospitality sectors. We also provide sanitisation solutions to sports grounds, stadiums and changing facilities. We can visit your premises at any time to give advice, free of charge.  | .....       |
| In the constant battle against the spread of infectious diseases, scientists are continually on the hunt for new weapons that specifically target pathogenic microbes. Now, investigators from the Center for Radiological Research at Columbia University Irving Medical Center (CUIMC) believe they may have found an effective solution to eradicating airborne viruses in indoor public spaces.   | .....       |
| Abstract:<br>We have compared the efficacy of continuous ultraviolet (UV-C) (254 nm) and pulsed UV light in reducing the viability of <i>Salmonella Enteritidis</i> , <i>Listeria monocytogenes</i> , <i>Staphylococcus aureus</i> , enterohemorrhagic <i>Escherichia coli</i> , <i>pseudomonas</i> spp., <i>Brochothrix thermospacta</i> , <i>Carnobacterium divergens</i> , and extended-spectrum $\beta$ -lactamase producing <i>E. coli</i> inoculated on chicken fillet surface. | .....       |
| The Quadram Institute is at the forefront of a new era of food and health research, working at the interface between food science, gut biology and health. It develops solutions to worldwide challenges in food-related disease and human health.  | .....       |
| Why you should think twice before buying that UV-C disinfection gadget. Many home UV-C devices aren’t worth buying, don’t do what they claim to, or could potentially be dangerous.   | .....       |

[7]

3 Ling is an ecologist. He uses a range of tests to assess the quality of the water in a river.

One test is for nitrates. Excess nitrates in the water can lead to conditions that make it difficult for insects and fish to survive.

Ling has a choice of techniques available to him to measure the level of nitrates dissolved in the river water.

Two of the techniques are outlined below.

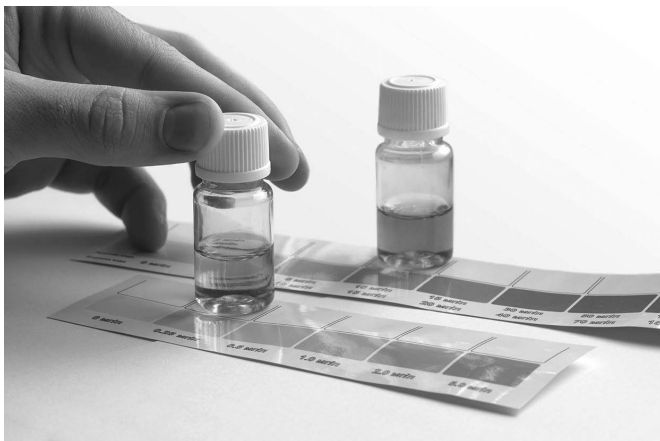
- Technique 1 – an electronic sensor is calibrated, using a buffer solution, to read nitrate levels between 30 parts per million (ppm) and 300 ppm. The sensor is dipped in the river (Fig. 3.1) and the reading appears on a digital display when the measurement is complete.

**Fig. 3.1**



- Technique 2 – a fixed volume of river water is mixed with a fixed mass of reagent. A colour change occurs and this can be matched to a chart (Fig. 3.2). The reading is judged by eye to the nearest  $0.2 \text{ mg/dm}^3$ .

**Fig. 3.2**



(a) (i) Ling evaluates the two nitrate measuring techniques shown in **Fig. 3.1** and **Fig. 3.2**.

He compares them using **three** factors:

- complexity
- reliability
- repeatability.

Compare the two techniques using these **three** factors.

Complexity .....

.....

.....

Reliability .....

.....

.....

Repeatability .....

.....

.....

[3]

(ii) State **one** health and safety risk that Ling must consider when evaluating **each** technique. You must state a different risk for each technique.

Technique 1 .....

.....

Technique 2 .....

.....

[2]

(b) Ling writes a risk assessment for his chosen technique.

Other ecologists who work with Ling will be required to adhere to the risk assessment.

Suggest how Ling can be sure that they are aware of the risks.

.....

.....

..... [1]

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

4 (a) Sources A and B share similar scientific perspectives.

For example, the two sources agree that kelp are habitat-forming.

Suggest **three** other similar scientific points of view shared by **sources A** and **B**.

1 .....

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2 .....

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3 .....

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[3]

(b) Suggest how the methods for mapping and monitoring wild kelp resources described in **Source B** are relevant to the bylaw described in **Source A**.

.....

.....

.....

.....

.....

[2]



(c) **Source B** describes mapping and monitoring methods which will help to protect kelp.

Why are these methods needed?

Put a tick (✓) in the **three** correct boxes.

|   |  |
|---|--|
| Backscatter information is a crucial component of the predictive model  |  |
| Harvesting of wild kelp is increasing                                   |  |
| It is difficult to access kelp in the shallow, rocky sublittoral fringe |  |
| Kelp are critical to ecosystem functioning and commercial fisheries     |  |
| Monitoring is needed to ensure sustainability                           |  |
| Remote sensing technologies can now be used to monitor the kelp         |  |
| The sublittoral fringe is shallow and rocky                             |  |

[3]

(d) **Sources A** and **B** both refer to climate change.

Identify the link between kelp and climate change in each source.

**Source A** .....

.....

**Source B** .....

.....

[2]

(e) **Source B** concludes:

‘We found the high resolution acoustic data very effective for mapping kelp distribution.’

Describe **three** pieces of information that the researchers should also provide to support this conclusion.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(f) **Source B** describes how cameras were used to record underwater footage of a field sampling technique used in ground-truthing.

(i) State the name of this field sampling technique.

..... [1]

(ii) Describe **two** reasons for replacing the technique used in ground-truthing with acoustic measurement.

1 .....

2 ..... [2]

(g) One method of determining the quality of data is to evaluate reproducibility.

Comment on the reproducibility of the data produced by the high resolution acoustic techniques described in **Source B**.

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

(h) **Sources A** and **B** both refer to baseline data.

Explain how baseline data should be used to draw conclusions.

.....  
.....  
.....  
.....  
.....  
..... [3]





A series of 25 horizontal dotted lines for writing.



**ADDITIONAL ANSWER SPACE**

If additional answer space is required, you should use the following lined pages. The question numbers must be clearly shown in the margins – for example, 2 or 4(g).

A vertical line on the left side of the page is followed by 25 horizontal dotted lines, providing a ruled area for writing answers.



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