

# T Level Technical Qualification in Healthcare Science (603/7083/X)

## Core knowledge and understanding

### Paper B Elements 11–12

June 2022 Morning/Afternoon

Time allowed: 2 hours 30 minutes

#### Student instructions

- Use black or blue ink.
- Fill in the boxes at the bottom of this page.
- Answer **all** questions.
- Read each question carefully.
- You **must** write your responses in the spaces provided. There may be more space than you need.
- You may do rough work in this answer book. Cross through any work you do not wish to be marked.

#### Student information

- The marks available for each question are shown in brackets. This is to help you decide how long to spend on each question.
- The maximum mark for this paper is 112.
- In questions **8**, **15** and **18** you will be assessed on your quality of written communication (QWC) and use of specialist terminology.
- In questions **3 (a)**, **10 (a)**, **13** and **17 (a)**, you will be assessed on your mathematical ability.
- You may use a calculator.

Please complete the details below clearly and in BLOCK CAPITALS.

Student name \_\_\_\_\_

Provider name \_\_\_\_\_

Student number

Provider  
number

To be completed by the examiner			
Question	Mark	Question	Mark
1 (a)		9	
1 (b)		10 (a)	
1 (c)		10 (b)	
2		11	
3 (a)		12	
3 (b)		13	
4 (a)		14	
4 (b)		15	
4 (c)		16 (a)	
5		16 (b)	
6		16 (c)	
7 (a)		16 (d)	
7 (b)		17	
8		18	
		<b>TOTAL MARK</b>	

**Do not turn over until the invigilator tells you to do so.**

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SAMPLE

**Section A: Biology**

This section is worth 45 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

Answer **all** questions in the spaces provided.

**1 (a)** A student wishes to examine the internal structures of a sample of cells.

State **one** advantage of using a transmission electron microscope over a light microscope for this examination.

[1 mark]

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**1 (b)** The student decides to use a transmission electron microscope for the examination.

Identify **two** features the student could observe in this examination that would indicate that these cells were prokaryotic.

[2 marks]

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**1 (c)** Prokaryotic ribosomes are smaller than eukaryotic ribosomes.

Explain how the student could use the size of the ribosomes in the sample of cells, to determine whether these cells were prokaryotic or eukaryotic.

[2 marks]

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**Please turn over for the next question.**

- 2 **Figure 1** gives information about cells taken from two different types of human tissue.

**Figure 1**

	Average number of mitochondria per cell	Relative surface area to volume
<b>Tissue A</b>	100,000	Smaller surface area compared to volume
<b>Tissue B</b>	500,000	Larger surface area compared to volume

The duodenum is involved with the transport of nutrients into the blood, including glucose, which is transported actively.

State why tissue B is more likely to be from the duodenum of the digestive system than tissue A and explain why you have made this conclusion.

**[3 marks]**

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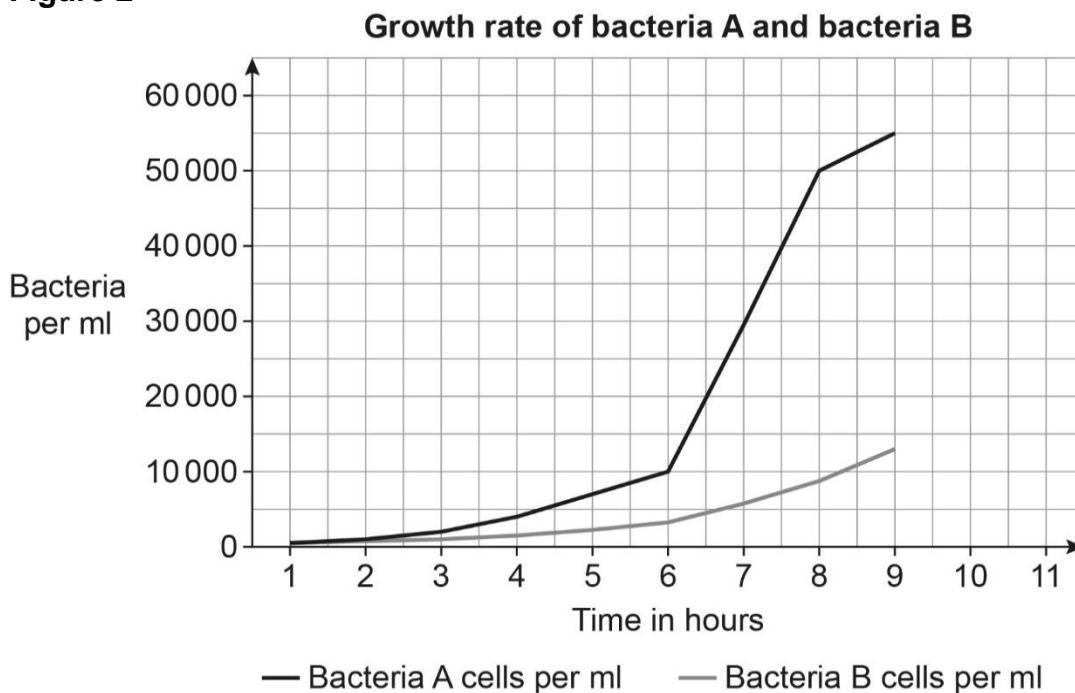
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3 Two different pathogenic bacteria, A and B, were grown in laboratory conditions and their rate of growth was measured.

Both bacteria can cause diseases of the respiratory system. The results are represented in **Figure 2**.

**Figure 2**



3 (a) Calculate the rate of growth of bacteria A in cells produced per minute, between 6 hours and 8 hours.

Show your working and express your answer to the nearest whole number.

**[2 marks]**

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Please turn over for the next question.

**3 (b)** A student stated that bacteria A was more dangerous than bacteria B as it has a faster growth rate in laboratory conditions.

Evaluate the student's statement.

**[3 marks]**

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**4 (a)** Emphysema is a lung condition that causes:

- the bronchioles to collapse, preventing ventilation of the alveoli
- the individual air sacs of the alveoli to rupture. This creates larger spaces instead of many smaller ones.

Explain the effect of emphysema on the available alveolar surface area.

**[2 marks]**

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**4 (b)** Give **four** functions of the respiratory process.

**[4 marks]**

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4 (c)

Polio is a virus that infects and weakens muscles. This disease can weaken or paralyse the diaphragm and intercostal muscles.

Give **three** reasons why the polio virus can make breathing difficult.

**[3 marks]**

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Please turn over for the next question.

5

A 57-year-old woman visits her GP stating that she has recently developed the following symptoms:

- dark urine
- recent weight loss
- loss of appetite
- constant tiredness.

Discussion with the woman reveals she has a history of alcoholism and has frequent migraines, for which she has taken paracetamol for many years.

The GP makes an initial diagnosis of liver damage caused by alcohol consumption.

To what extent can this diagnosis be justified?

Your response should include reasoned judgements and / or conclusions

**[4 marks]**

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6 The human genome makes up our genes, approximately 2% of the human genome includes the coding genes. Some genetic disorders result from changes in the base sequence within these coding regions.

The remaining 98% of the genome is non-coding deoxyribonucleic acid (DNA), this contains many regions which control the expression of our genes.

Other genetic disorders can be caused by a change in the base sequence of a region of non-coding DNA which controls the expression of a particular gene.

i) Explain how **either** a change in the base sequence of the DNA in a gene **or** a change in the base sequence in a region of non-coding DNA, could lead to a genetic disorder.

ii) A genomics lecturer states that an understanding of epigenetics is as important as an understanding of functional genomics, in understanding genetic conditions.

Evaluate this statement.

[5 marks]

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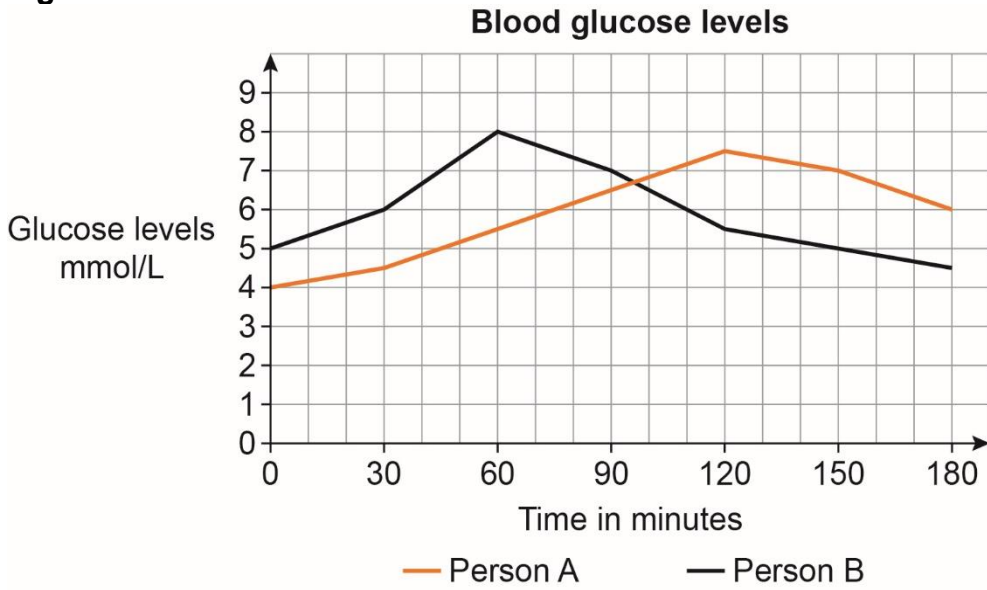
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7 **Figure 3** shows the blood glucose levels over a 3-hour period for two different people.

**Figure 3**



Both people had fasted for 6 hours before eating a snack at time 0 on the graph.

One of the people ate a starch-rich snack at time 0.

One of the people ate a glucose-rich snack at time 0.

7 (a) Suggest which person ate the glucose-rich snack **and** explain your choice. **[2 marks]**

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**7 (b)**

A clinician examining the graph states that it is unlikely either person has diabetes.

Evaluate their statement.

Your response should include a reasoned judgement and / or conclusion.

**[3 marks]**

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SAMPLE

8

Tanzania is a country in the equatorial area of East Africa.

In 2011, 20 people died and thousands were left homeless in Tanzania after excessive rainfall led to severe flooding. Many of the homeless were housed in temporary camps, which were overcrowded and with minimal facilities. After the incident, the mortality rate from disease rose significantly in the area.

A student studying epidemiology suggested that:

- the increase in mortality may be due to increased cases of malaria
- poorer people are likely to be affected more than the wealthy.

Evaluate the epidemiology student’s suggestions.

Your response should demonstrate:

- an understanding of transmission routes for disease-causing organisms
- an understanding of how health promotion can affect disease transmission
- reasoned judgements and / or conclusions.

**[9 marks plus 3 marks for QWC]**

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SAMPLE

**Please turn over for the next section.**

## Section B: Physics

This section is worth 26 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

Answer all questions in the spaces provided.

9 Define a longitudinal wave.

[1 mark]

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10 **Figure 4** Shows radiation activity recordings from samples for carbon dating per day above background level.

**Figure 4**

	Sample	Control
Activity (counts per day)	42	168

The use of radioactivity when dating deceased organisms is used to estimate the age of organic material. The technique works by detecting levels of the radioisotope Carbon-14 ( $^{14}\text{C}$ ), which is found in trace amounts in organic compounds and emits radiation via beta decay.

$^{14}\text{C}$  has a half-life of 5730 years.

Archaeologists are excavating an ancient burial site and identify human remains. They analyse a piece of tissue and use radiocarbon dating to age the organic material. Levels of radioactive activity from  $^{14}\text{C}$  in the specimen are compared to a control sample of fresh tissue.

10 (a) The results of these measurements are shown in **Figure 4**.

Using this information and your knowledge of the use of radioactivity when dating deceased organisms, calculate the estimated age of the sample.

[3 marks]

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**10 (b)** A team of forensic scientists is investigating a death known to have occurred within the last year.

The team has decided to use radiocarbon dating to determine the exact date of death. They plan to take a tissue sample from the body and determine levels of  $^{14}\text{C}$ . These results will be compared to those from a similar sample taken from a living donor.

Evaluate the team's plan and the suitability of radioactivity when dating deceased organisms to determine the date of death.

**[3 marks]**

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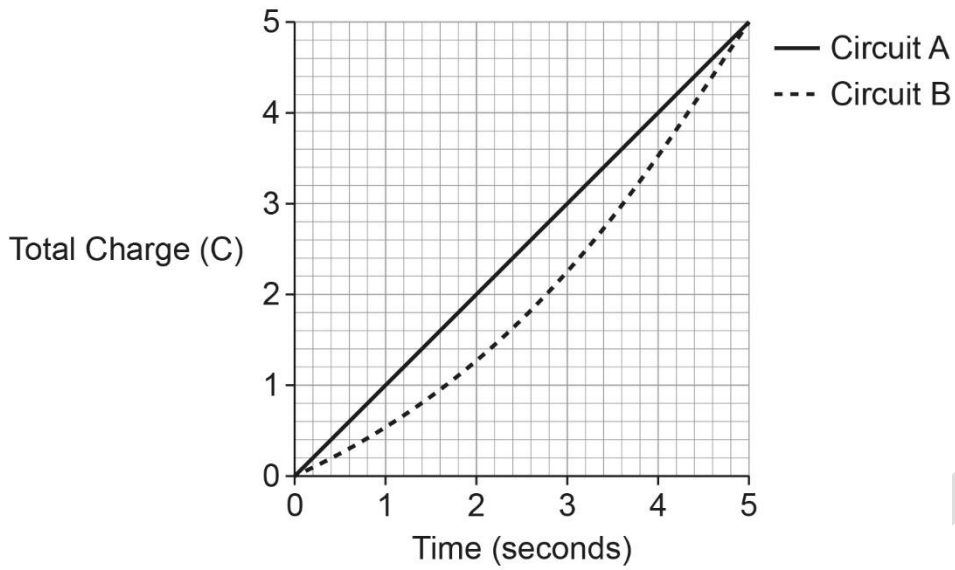
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11

**Figure 5** Plots of cumulative charge transfer in both circuits (A and B)



An electrician is measuring the charge that passes through circuit A and circuit B. The total charge that is transferred is measured in each circuit and recorded once every second for 5 seconds.

The measurements are plotted in a graph that is shown in **Figure 5**.

The electrician concludes that, as the total charge transferred over 5 seconds is 10 C for each circuit, the current is the same at the 5 second time point.

Evaluate this conclusion.

**[3 marks]**

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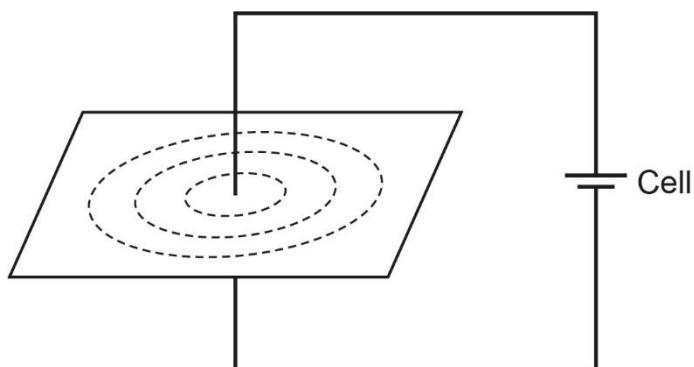


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12

**Figure 6** Electrical circuit passing through a piece of card holding iron filings. The dotted line indicates the alignment of iron filings on the piece of card.



A wire is passed through a sheet of card and connected to a cell, as shown in **Figure 6**.

Iron filings are placed on the card and are observed to form circles around the wire.

Explain what will happen if the positive and negative terminals of the cell are reversed.

**[3 marks]**

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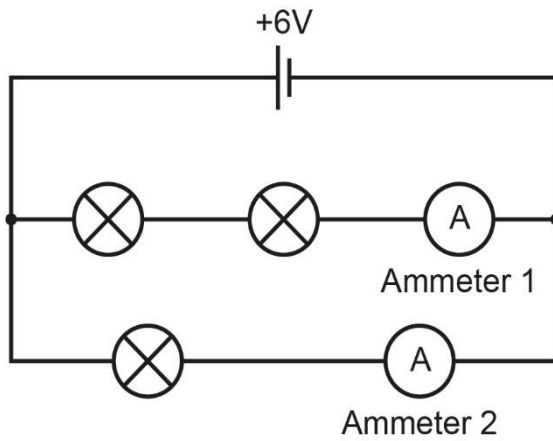


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**Please turn over for the next question.**

13

**Figure 7** Circuit diagram showing bulbs in parallel



The circuit in **Figure 7** is constructed.

Each bulb has a resistance of  $4\Omega$ .

Calculate the reading on each ammeter. Show your working.

[3 marks]

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14

A wavemeter is a device that can measure the wavelength of light.

Give the other measurement that is needed to calculate the speed of light.

[1 mark]

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SAMPLE

15

External beam radiotherapy is often used to kill or reduce malignant tumours in patients suffering from cancer.

A research scientist is developing a new method of administering radiotherapy, by injecting a radioisotope that emits alpha radiation close to the tumour site.

**Figure 8** A comparison of properties of alpha and gamma radiation

	<b>Alpha radiation</b>	<b>Gamma radiation</b>
<b>Percentage of radiation that penetrates 10 cm of tissue</b>	0.01%	99.8%
<b>Relative ionising strength of radiation</b>	20	1

Using the information in **Figure 8**, evaluate the use of injecting alpha-emitting radioisotopes over external beam radiotherapy in the treatment of cancer. Your response should include reasoned judgements and / or conclusions.

**[9 marks plus 3 for QWC]**

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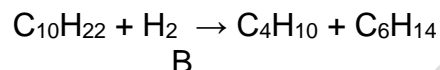


**Section C: Chemistry**

This section is worth 17 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

Answer **all** questions in the spaces provided.

- 16 (a)** A team of chemists is conducting experiments in the laboratory to generate hydrocarbons. They are producing butane ( $C_4H_{10}$ ) from decane ( $C_{10}H_{22}$ ). The process is represented by the following chemical reaction:



Identify the role of reagent B.

[1 mark]

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- 16 (b)** With reference to the process depicted in question 16 (a), explain how reagent B affects the rate of this reaction.

[2 marks]

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- 16 (c)** The chemists are curious how changes in temperature affect the chemical reaction used to produce butane. They carry out the experiment at a range of different temperatures without reagent B.

The starting quantity of decane ( $C_{10}H_{22}$ ) for each experiment is 5 kilograms (kg). All reactions proceed for 2 hours, after which the quantity of Butane ( $C_4H_{10}$ ) is measured.

The results are shown in **Figure 9**.

**Figure 9** Results from initial experiment

Reaction conditions (K)	Mass of $C_{10}H_{22}$ (after 2 hours) (kg)	Reaction rate ( $gs^{-1}$ )	% yield of $C_4H_{10}$
100 K	4.5	0.069	60
200 K	4.25	0.104	50
300 K	3.98		46

- $gs^{-1}$  = grams per second
- 1kg = 1000g.

Calculate the rate of reaction for 300 K. Show your working and give your final calculation to **three** decimal places. Ensure to include units.

**[3 marks]**

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Please turn over for the next question.

**16 (d)** The chemists repeat the experiment at 100 K but this time include reagent B. They record the following results:

- rate of reaction (after 2 hours):  $0.157 \text{ gs}^{-1}$
- percentage yield of butane ( $\text{C}_4\text{H}_{10}$ ): 72%.

Analyse the effect that the change in temperature and the addition of reagent B has on the production of butane ( $\text{C}_4\text{H}_{10}$ ).

[2 marks]

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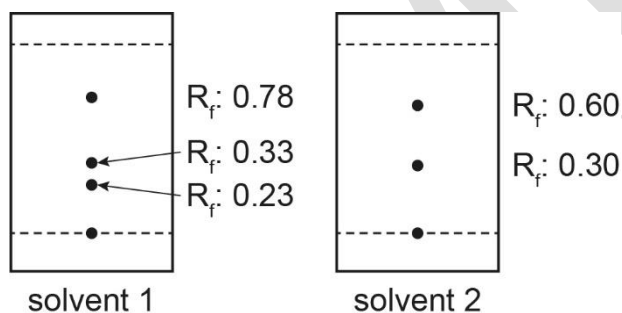
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**17** A research scientist has synthesised a compound in the laboratory. The compound now requires purification from a mixture. The scientist conducts a thin layer chromatography (TLC) analysis of the mixture in two different solvents and obtains the following results as shown in **Figure 10**.

**Figure 10** TLC analysis plates of the mixture



The scientist now plans to perform column chromatography on this mixture.

Using your knowledge of purification techniques, evaluate the suitability of the scientist's next steps.

Your answer should include reasoned judgements and / or conclusions.

[9 marks plus 3 marks for QWC]

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Owner: Head of Assessment Design

## Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Additional specimen assessment materials		November 2022
v1.1	Sample added as a watermark	November 2023	20 November 2023