T-LEVELS | Institute for Apprenticeships & Technical Education

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

Core knowledge and understanding (Paper B Elements 11–12)

Paper number: **P002397** Time allowed: **2 hours 30 minutes**
Assessment date: **Wednesday 13 December 2023** Time: **9:00am – 11:30am**

Student instructions

- Use black 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 **7, 13, 18** and **19**, you will be assessed on the quality of your written communication (QWC). Specifically, your ability to:
  - use good English
  - express and organise ideas clearly and logically
  - use appropriate technical terms.
- In questions **1(d), 3(b), 9 and 10** you will be assessed on your mathematical ability.
- You may use a calculator.

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

Please complete / check your details below

Student Name:

Provider Name:

Student Number: Provider Number:

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) **Figure 1:** a diagram of a prokaryotic microorganism

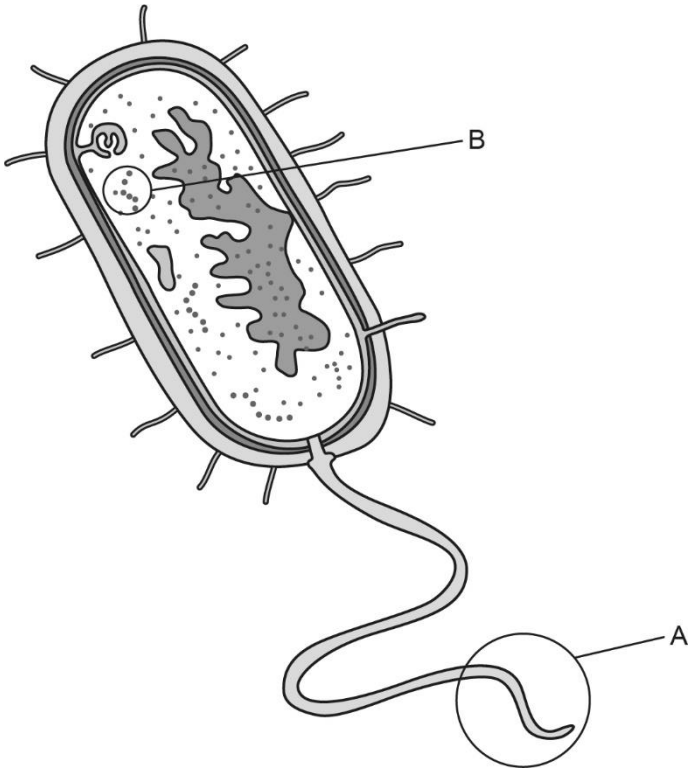


Figure 1 is a diagram drawn from a photograph taken with an electron microscope and shows some of the features of a prokaryotic microorganism. The organism is capable of carrying out photosynthesis.

(i) Give the name of the organelle found in plant cells that carries out photosynthesis.

[1 mark]

Structure A is a flagellum, it is used to enable the cell to move.

(ii) Explain how **Structure A** may help this microorganism to photosynthesise.

[2 marks]

(b) Identify **one** feature from **Figure 1** that proves that this microorganism is a bacterium rather than a virus.

[1 mark]

(c) State the name of the structures labelled **B** and give their function.

[2 marks]

Question 1 continues on the next page.

Please turn over.

1(d) The actual length of the microorganism is 2 µm, the length on the photograph was 75 mm. Calculate the magnification used.

$$\text{magnification} = \frac{\text{size of image}}{\text{size of object}}$$

1mm=1000 µm

You must show your working.

[4 marks]

2(a) An accident victim has a chest wound which has pierced the pleural membranes. The lungs have not been pierced.

(i) Outline how the intercostal muscles bring about inspiration.

[4 marks]

(ii) Explain why this type of chest wound is likely to make inspiration more difficult.

[2 marks]

(b) Name the **other** component in the respiratory system which helps bring about inspiration.

[1 mark]

Please turn over for the next question.

3 A glucose meter shows that a patient's blood sugar level, before eating a meal with a high starch content, is 5 mmol/L. This rises to 7.5 mmol/L after the meal.

(a) Give the name of the digestive enzyme responsible for breaking down starch.

[1 mark]

(b) Calculate the percentage rise in blood sugar level after the meal.

You must show your working.

[2 marks]

4 A student suggests that in order to provide better targeted healthcare all newborn babies should undergo genome mapping and gene screening.

To what extent do you agree with the student's suggestion?

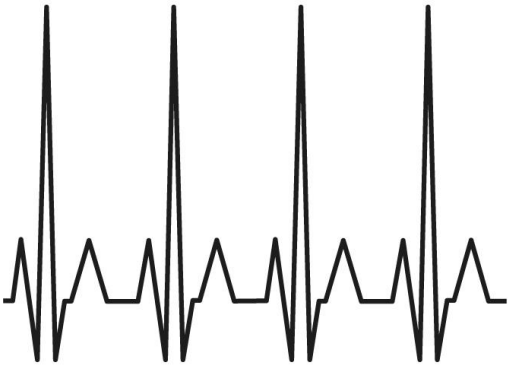
Your response must include reasoned judgements and conclusions.

[6 marks]

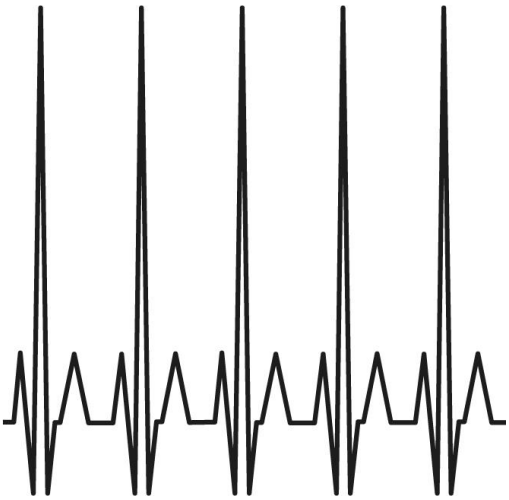
Please turn over for the next question.

5(a) **Figure 2:** ECG traces from the same person at different times

Trace A



Trace B



(i) Give the letters associated with the trace shown in **Figure 2.**

[1 mark]

(ii) Explain **one** piece of evidence from **Figure 2** that shows the person's physical activity has increased in **Trace B**.

[2 marks]

The **two** traces allow a comparison of heart rate.

(b) Identify **one additional** piece of information which should be added to the traces to enable the individual's actual heart rate to be determined.

[1 mark]

Please turn over for next the question.

6 A lecturer states that the endocrine function of the ovaries in reproduction is as important as the egg production function of the ovaries.

To what extent do you agree with the lecturer's statement?

Your response must include reasoned judgements and conclusions.

[6 marks]

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Please turn over for the next question.

7 A student studying the immune system stated that the T and B cell responses were more important in preventing and responding to infection than the physical and chemical barriers and phagocytosis.

Discuss the validity of the student's statement.

Your response should include reasoned judgements and conclusions.

[9 marks, plus 3 marks for QWC]

This is the end of Section A.
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.

8(a) Outline the process that occurs in an unstable nucleus to emit a beta particle.

[2 marks]

(b) State the range of a beta particle in air.

[1 mark]

9 A student constructs a circuit with a 10 volt battery and two bulbs. The circuit has a total resistance of 2 Ohms.

Calculate the current in amps. Use the following equation to help you.

$$I = \frac{V}{R}$$

[2 marks]

10 Microwave therapy can be used alongside other radiotherapy techniques to kill cancer cells.

A microwave has a wavelength of 1×10^{-3} m.

Microwaves travel at a speed of 3×10^{8} m/s.

Using the equation $v = f\lambda$, calculate the frequency of the wave.

You must show your working and provide appropriate units.

[4 marks]

Please turn over for the next question.

11(a) Electromagnets are often used in locking mechanisms for healthcare science laboratories' access doors. This is to ensure security and give access only to authorised people.

A team of scientists is investigating the use of electromagnets for this purpose.

They begin by investigating the relationship between voltage and magnetic field strength. Their results are shown in Table 1.

Table 1: Results from scientists' initial experiment

Voltage (V)	Magnetic field strength (T)
0	0.00
2	0.02
4	0.04
6	0.05
8	0.06
10	0.07

(T) – Tesler, the unit of measurement for the strength of magnetic fields.

Describe the trend shown in the data in Table 1.

[2 marks]

(b) The same team of scientists then perform a similar experiment using two different metals in the electromagnet and measure how fast each one loses its magnetic field after the current is switched off.

They measure the magnetic field strength every two seconds for ten seconds after the current is switched off. Results are shown in Table 2.

Table 2: Results from scientists' experiments

	Magnetic field strength (T)	
Time elapsed (s)	**Metal 1**	**Metal 2**
0	0.09	0.11
2	0.05	0.09
4	0.02	0.07
6	0.00	0.05
8	0.00	0.03
10	0.00	0.02

One of the scientists suggests using metal 2 as this metal has a stronger magnetic field than metal 1 and therefore is more secure.

Using the data provided in Table 2, assess this suggestion.

[3 marks]

Please turn over for the next question.

12 A consultant needs to image the digestive system of a patient. To achieve this the consultant is going to use a radioactive tracer, a pill that can be swallowed and gives off a small amount of radiation. The radiation will then be measured using a detector that surrounds the patient, producing an image.

The consultant says:

'The isotope we will use needs to have a suitable level of radioactivity and be able to pass through the soft tissues of the patient to reach the detector.'

Table 3 shows the details of some radioactive isotopes.

Table 3: Radioactive isotopes

Isotope	**Half-life**	**Radiation**
Americium-241	432 years	Alpha
Technetium-99	6 hours	Gamma

Analyse the suitability of the radioactive isotopes for the procedure.

[3 marks]

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13 Scientists are investigating the use of a preservative spray as an alternative to using gamma radiation for the preservation of a dietary supplement.

They take 4 samples, place each one in an identical environment and give each treatment once per day, as shown in Table 4. Over six days they observe the number of bacterial colonies that develop on the surface of the samples. Their results are displayed in Table 4.

Table 4: Scientists' observations after six days of experimentation

Treatment given (once per day)	**Bacterial colonies observed**			
	Day 0	Day 2	Day 4	Day 6
No treatment (control)	0	1	3	4
preservative Spray	0	0	1	2
Gamma radiation	0	0	0	0

A scientist suggests that one option for further research could be to use the preservative spray twice per day as this may prevent bacterial colonies from forming on the sample and also avoid using gamma radiation.

Using your knowledge of gamma radiation and food preservation, evaluate the scientist's suggestion.

Your answer should include reasoned judgements and conclusions.

[9 marks, plus 3 marks for QWC]

This is the end of Section B.
Please turn over for the next section.

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.

14 Name **one** type of sub-atomic particle located in the nucleus of an atom.

[1 mark]

15 State **one** property of an acid.

[1 mark]

16 Scientists are interested in developing a new type of lightweight and durable container for a detergent. They are considering two types of material: a polymer named high density polyethene and a ceramic named silicon carbide.

You are provided with some basic data comparing these materials in Table 5.

Table 5: Data comparing both materials to be investigated.

Material	**High density polyethene**	**Silicon carbide**
Melting point (°C)	131	2830
Density (g/cm^3)	0.94	3.22

(a) Explain why high density polyethene might be more appropriate to use as a container.

[2 marks]

(b) Suggest **one other** property of polymers that would make them a good choice for a container.

[1 mark]

Please turn over for the next question.

17 Scientists are producing aspirin. The method that is currently used is slow, but they have developed a new method which is faster.

They carried out their new method at different temperatures to find out if they could make it even faster and still produce at least 55% aspirin. They measure the rates of reaction and percentage of aspirin produced and record their results in Table 6.

Table 6: Initial results from scientist's experiment

Temperature (°C)	Rate of Reaction (mg/s^1)	Percentage of the final product that is aspirin (%)
20	5.23	60
30	6.67	56
40	8.96	53
50	10.04	50

One of the scientists predicts that temperatures higher than 50°C will produce larger percentages of aspirin as well as an increased rate of reaction.

Using your knowledge of collision theory, evaluate the scientist's prediction.

[3 marks]

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18 A healthcare scientist is assisting with a chemotherapy drug trial. Their laboratory has been sent a urine sample from a cancer patient taking part in the trial. The first round of analysis of this sample shows four unknown products.

The composition of the urine sample is shown in Table 7.

Table 7: Composition data of sample taken from patient.

Component	% by weight
Water	90.1
Sugars	5.6
Product A	1.2
Product B	0.3
Product C	1.4
Product D	1.4

The laboratory manager would like the healthcare scientist to find out what the unknown products (products A, B, C and D) are.

The healthcare assistant decides to use mass spectrometry.

Evaluate the use of mass spectrometry in this situation, comparing and contrasting it to other separation techniques.

Your answer should include reasoned judgements and conclusions.

[9 marks, plus 3 marks for QWC]

This is the end of Section C.
Please turn over for the next section.

Section D: Biology, Chemistry and Physics
This section is worth **12** marks, plus **3** marks for quality of written communication (QWC) and use of specialist terminology.
Answer **all** questions in the spaces provided.

19 A new clinic is being set up to deal with sports injuries, and they are considering purchasing X-ray machines and MRI machines.

One of the healthcare scientists states:

'More X-ray machines should be provided as most injuries will be to the musculoskeletal system, and X-ray is sufficient for the diagnosis of these injuries, MRI machines are too expensive and slow.'

Using your knowledge of the musculoskeletal system, X-ray and MRI scans, evaluate the validity of this statement.

Your response should include reasoned judgements and conclusions.

[12 marks, plus 3 marks for QWC]

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Document information

Owner: Head of Assessment Design

To be completed by the examiner			
Question	Mark	Question	Mark
1(a)(i)		8(a)	
1(a)(ii)		8(b)	
1(b)		9	
1(c)		10	
1(d)		11(a)	
2(a)(i)		11(b)	
2(a)(ii)		12	
2(b)		13	
3(a)		14	
3(b)		15	
4		16(a)	
5(a)(i)		16(b)	
5(a)(ii)		17	
5(b)		18	
6		19	
7			
		TOTAL MARK	