

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

## Core knowledge and understanding

Paper B Elements 11–12

Paper number: Sample

Specimen 2021

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 **10**, **14**, **17** and **18**, you will be assessed on your quality of written communication (QWC) and use of specialist terminology.
- In questions **3(a)**, **3(b)**, **11**, **12(a)**, **12(b)**, **12(c)** and **16(b)**, 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

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

To be completed by the Examiner			
Question	Mark	Question	Mark
1		10	
2a		11	
2b		12a	
3a		12b	
3b		12c	
3c		13a	
4a		13b	
4b		14	
5a		15a	
5b		15b	
5c		15c	
6		16a	
7		16b	
8		17	
9		18	
			TOTAL MARK

**Section A: Biology**

This section is worth 45 marks, plus 3 marks for QWC and use of specialist terminology.

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

---

**1** Cells can be broadly classified as eukaryotic (eukaryotes) or prokaryotic (prokaryotes).

Give **one** difference between eukaryotic and prokaryotic cells.

[1 mark]

---

---

**2 (a)** State the number of different types of amino acids commonly found in proteins.

[1 mark]

---

---

**2 (b)** Briefly describe the process by which dipeptides are formed.

[1 mark]

---

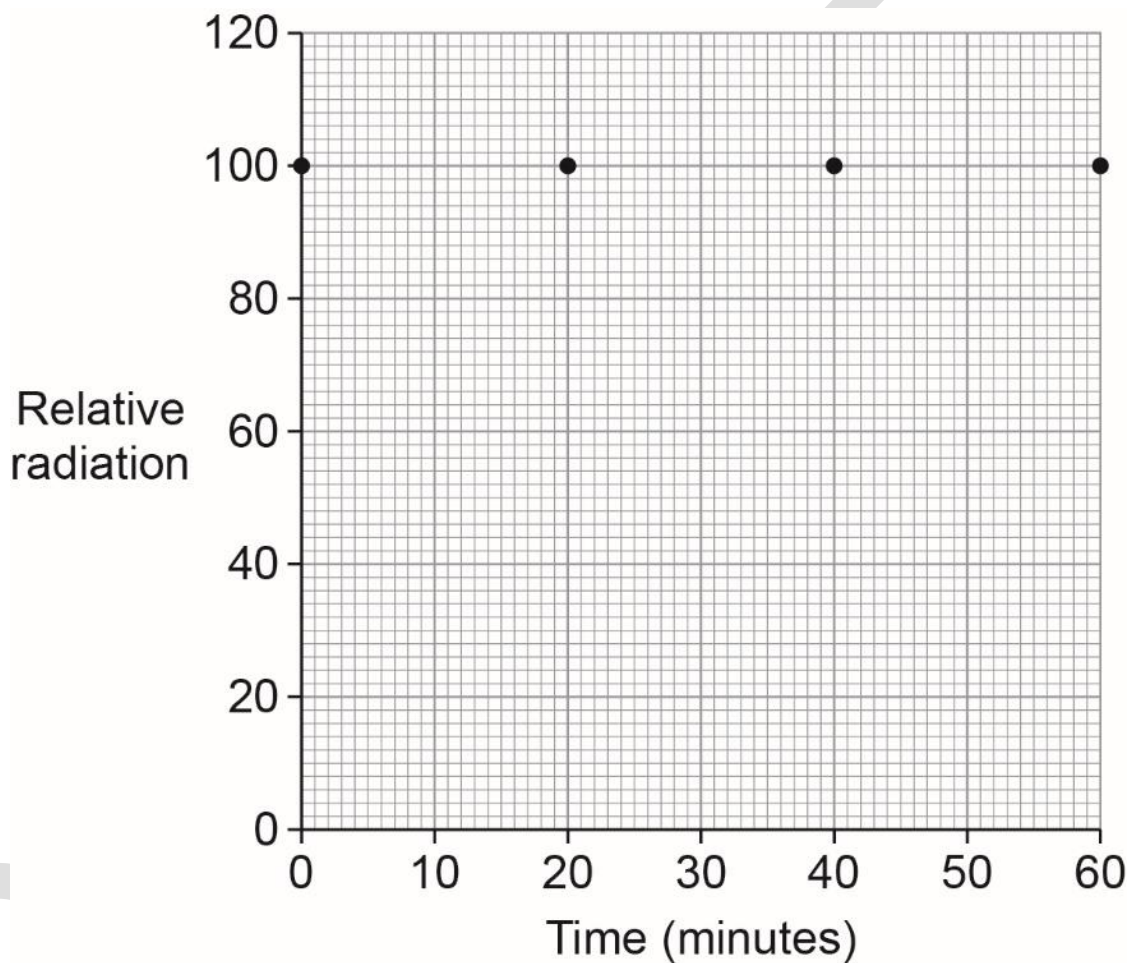
---

**3 (a)** Radionucleotides emit radiation but behave as normal nucleotides. When cells are grown with radionucleotides, the new DNA synthesised is radioactively labelled.

A bacterium which divides every 20 minutes is added to a media containing radionucleotides. Samples of cells are removed at 0, 20, 40 and 60 minutes, and the radioactivity levels recorded.

As a control, bacteria are also cultured in a media containing radionucleotides for 24 hours. This means that all their DNA consists of radionucleotides. The experiment is repeated for them.

Using the graph below, plot how the detected radioactivity will change over time. No radioactivity is present at  $t=0$ , and the control is shown in black.



[3 marks]

**3 (b)**

Individual cells are isolated, and the composition of their DNA is determined.

At 20 minutes, a single cell from the culture is selected at random.

What percentage of its DNA is expected to be radioactively labelled?

**[1 mark]**

---



---

**3 (c)**

A student concluded that however many divisions occur, the total bacterial DNA can never become 100% radioactively labelled.

Evaluate the accuracy of the student's conclusion.

Your response should demonstrate reasoned conclusions.

**[2 marks]**

---



---



---



---



---



---



---



---



---



---



---

SAMPLE

**4 (a)**

State **two** ways in which light microscopy and staining can be used to identify the precise causative agent of a disease.

**[2 marks]**

---

---

---

---

SAMPLE

**4 (b)** Give **one** reason why light microscopy and staining would be unlikely to work if an infection is caused by a virus. **[1 mark]**

---

---

**5 (a)** A 64 year old male has been experiencing increasing shortness of breath and tiredness over the last 6 months.

He has a persistent cough that is producing thick, green sputum.

He was previously active but has recently been struggling to walk without becoming breathless.

He has smoked 20 cigarettes a day since he was 16 and has a BMI of 36.

Name **one** disease likely to cause his shortness of breath. **[1 mark]**

---

---

**5 (b)** Suggest **one** routine test that can be used to identify the cause of the symptoms. Describe the potential outcome of this test. **[2 marks]**

---

---

---

---

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

**5 (c)**

A consultant stated that 'if the patient stopped smoking this would have a significant positive effect on their symptoms'.

Evaluate the accuracy of the consultant's statement.

**[4 marks]**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**6**

A 34 year old female is admitted to accident and emergency with a blood pressure of 84/52 mmHg following a motorcycle accident.

Suggest the most likely cause of the abnormal blood pressure measurements and an appropriate intervention to correct the blood pressure.

**[2 marks]**

---

---

---

---

7 Infection with HIV may progress to acquired immune deficiency syndrome (AIDS) where the patient's CD4+ T helper cells are destroyed.

HIV is a blood-borne virus (BBV) and is normally transmitted through the exchange of bodily fluid.

The CD4+ cells and viral load of HIV patients are regularly monitored.

One patient's results are shown below:

	6 months ago	Today
<b>Viral load</b>	Undetectable	100 000 copies/ml
<b>CD4+ count</b>	795 cells/mm <sup>3</sup>	50 cells/mm <sup>3</sup>

Describe **two** suitable procedures to care for the patient whilst in hospital.

Justify your choices taking into account risks to the patient and others.

[4 marks]

1.

---

---

---

---

2.

---

---

---

---

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



- 8 A scientist investigating the passage of drugs into cells through the cell surface membrane, removed **four** identical squares of the small intestine of a rat and placed these in **four** separate beakers: A, B, C and D.

The scientist then added **two** different drugs and a respiratory inhibitor as shown in the table.

After 20 minutes, they measured the amount of the drug absorbed in each, in  $\mu\text{g}$  per minute.

	Beaker A	Beaker B	Beaker C	Beaker D
Type of drug added	Drug X	Drug X	Drug Y	Drug Y
Respiratory inhibitor added	No	Yes	No	Yes
Amount of drug absorbed $\mu\text{g}$ per minute	21	21	47	5

The scientist made the following conclusions:

- drug X was transported passively by diffusion
- drug Y was mainly transported actively
- drug Y was also transported to a lesser extent passively by diffusion
- drug Y may be a significantly larger molecule than drug X.

Use the results from the table above to evaluate the accuracy of the scientist's conclusions.

[5 marks]

---



---



---



---



---



---



---



---



---



---



---



---

---

---

---

---

---

---

---

---

---

---

---

---

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

SAMPLE

The table below provides information regarding outbreaks of infectious diseases:

	Disease X	Disease Y
<b>Pathogen airborne</b>	Yes	Yes
<b>Transmissibility – <math>R_0^*</math></b>	3.0	2.4
<b>Incubation period – days</b>	4–12	2–7
<b>Interval between symptom onset and maximum infectivity – days</b>	0	5–7
<b>Proportion with only mild symptoms or asymptomatic infection</b>	High	Low
<b>Proportion of patients requiring hospitalisation</b>	Few (20%)	Most (>70%)
<b>Proportion of patients requiring intensive care</b>	1/16 000	40%
<b>Proportion of deaths in people younger than 65 years out of all deaths</b>	0.6–2.8%	Unknown
<b>Total cases</b>	14.7 million (confirmed)	8096 (confirmed)
<b>Total deaths</b>	610 000	774
<b>Risk factors for severe illness</b>	Age, pre-existing health conditions	Age, pre-existing health conditions

Evaluate how the features of disease X and disease Y have contributed to the severity of each epidemic.

Use the data in the table.

Your response should include:

- discussion of the differences between disease X and disease Y
- reasoned judgements of the consequences of failing to limit the spread of infection.

**[6 marks]**

---



---



---



---



---



---



---



---



---



---

10

Sarah is a healthy 48 year old and is 14 weeks pregnant with non-identical twins. This is her first pregnancy. Prenatal screening tests show that her pregnancy is at 30% risk of at least **one** child having Down's syndrome.

Sarah and her partner are requesting further genetic testing to check for any health problems their children may face. Carrying out this testing may be invasive and pose a risk to the pregnancy.

Evaluate the associated risks and benefits to both parents and children.

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

SAMPLE

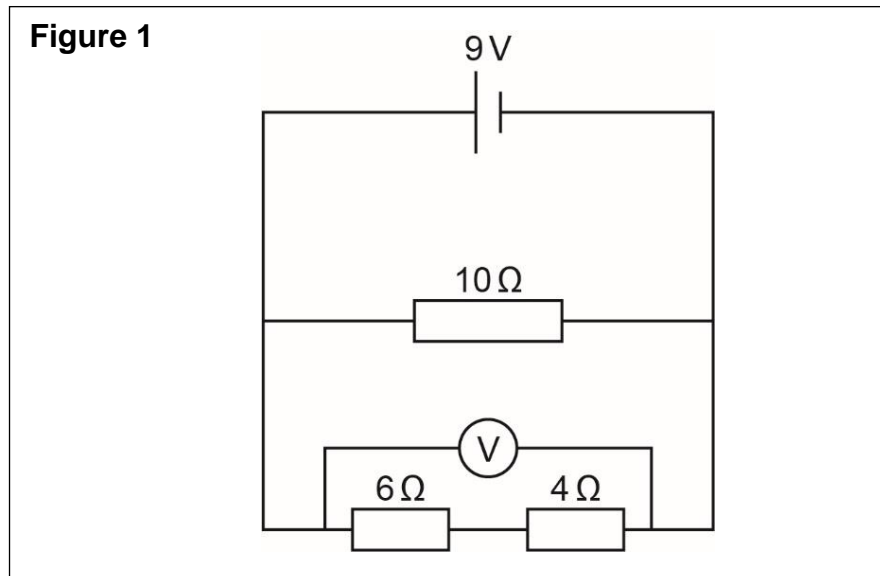
**Please turn over for the next section.**

**Section B: Physics**

This section is worth 26 marks, plus 3 marks for QWC and use of specialist terminology.

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

- 11 **Figure 1** shows an electronic circuit. The battery has negligible internal resistance.



Calculate the total resistance of the circuit.

[4 marks]

---

---

---

---

---

---

---

---

- 12 (a)** The most common form of colour vision deficiency results in a difficulty in distinguishing between red, yellow and green. These colours appear much duller and reds are often confused with blacks. This is known as red green colour deficiency.

A student states:

'The effect of red green colour vision deficiency in SCUBA divers is reduced as the diver travels deeper into the water'.

The chart below shows how far different wavelengths of light can penetrate water.

Colour	Red	Orange	Yellow	Green	Blue	Violet
Wavelength nm	620-750	590-620	570-590	495-570	450-495	380-450
How deep the light penetrates in metres	10	20	35	45	100	80

Use the information above to evaluate the student's statement.

**[3 marks]**

---



---



---



---



---



---

- 12 (b)** An ultrasound probe uses sound waves at a frequency of 6 MHz.

The speed of sound in human tissue is approximately  $1500 \text{ ms}^{-1}$ .

Calculate the wavelength of the sound waves in human tissue in mm.

**[2 marks]**

---



---



---



---

**12 (c)** A patient undergoing an ultrasound scan has a small cyst at an unknown depth in their tissue.

A sound wave is sent and the signal from the cyst is received 0.03ms later, this means that the time taken for the sound wave to reach the cyst itself is 0.015ms.

Calculate the depth of the cyst in cm.

**[2 marks]**

---

---

---

---

**13 (a)** Describe how an image is formed when carrying out an X-ray on the human body.

**[3 marks]**

---

---

---

---

---

---

SAMPLE



**13 (b)** A patient requires a scan of a suspected soft tissue lesion on their liver.

The patient has an artificial knee implant made of titanium.

The patient's consultant states:

'Although magnetic resonance imaging (MRI) produces strong magnetic fields, it is medically more appropriate than using X-ray in this situation'.

Evaluate the consultant's statement.

**[3 marks]**

---

---

---

---

---

---

---

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

SAMPLE

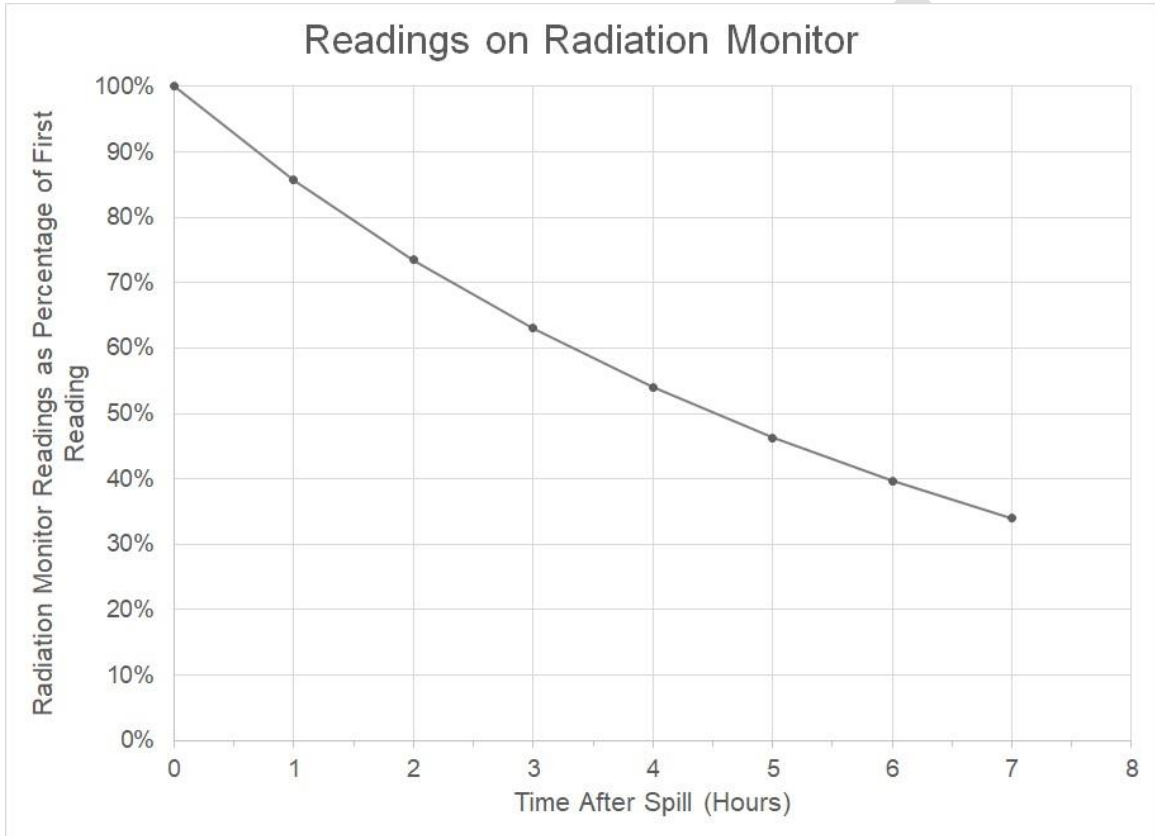
14

A workbench has become contaminated by a radioactive material which is emitting both gamma and alpha radiation. Monitor readings were taken throughout the day. The results are shown on the graph below:

The lab is closed at weekends, so the manager is considering **two** options to deal with the spill:

- have staff manually decontaminate the workbench now
- temporarily seal the lab and resume work on Monday.

Using your knowledge of radiation and half-life, evaluate the best option.



[9 marks, plus 3 marks for QWC]

SH

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

SAMPLE

Please turn over for the next section.

**Section C: Chemistry**

This section is worth 17 marks, plus 3 marks for QWC and use of specialist terminology.

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

---

**15 (a)** State what the following **two** types of chromatography are used for:

- column chromatography
- gas chromatography.

**[2 marks]**

---

---

---

---

**15 (b)** A solution containing a mixture of **three** amino acids (X) is analysed by thin layer chromatography (TLC). The procedure includes the following two points:

- plastic gloves must be worn when drawing a pencil line 2cm from the bottom of the TLC plate
- when solvent is added to the developing tank, that the TLC plate is placed into, it must **not** be more than 1.5cm deep.

Explain why each of the highlighted aspects of the procedure are essential.

**[2 marks]**

---

---

---

---

- 15 (c)** **Two** students follow the procedure carefully. One student's TLC shows **three** amino acids and the other student's TLC shows **two** amino acids.

Explain why there is a difference in the student's results.

[1 mark]

---

---

- 16 (a)** Which unit of the International System of Units is used to measure an amount of substance?

[1 mark]

---

---

- 16 (b)** The equation for the reaction between ethanoic acid and sodium hydroxide is  $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$ .

25.00cm<sup>3</sup> of ethanoic acid was placed in a conical flask. This was neutralised by titrating 24.60cm<sup>3</sup> of sodium hydroxide, with a concentration of 0.100mol dm<sup>-3</sup>.

The equation to calculate concentration is 'conc = mol / vol'. Use the information above to calculate the concentration of the ethanoic acid, in mol dm<sup>-3</sup>.

You do not need to show your working.

[2 marks]

---

---

---

---

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

**17** A student is investigating the reaction rate between **two** equal amounts of gas A and B at different temperatures.

The student repeated the experiment **three** times.

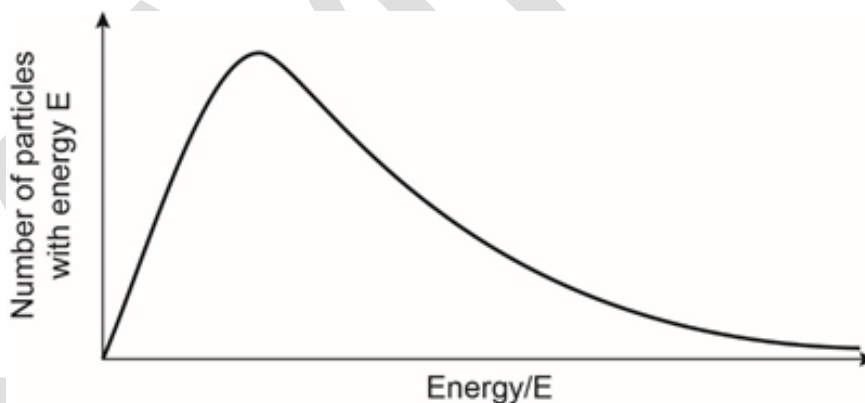
The table below shows the results and their calculated average reaction rates:

Temperature/K	Run 1 rate	Run 2 rate	Run 3 rate	Average rate
275	0	0	0	0
285	0	0	0	0
295	2	3	2	2
305	4	4	5	4
315	8	7	10	8
325	15	16	14	15
335	30	31	32	31
345	62	60	98	73
355	126	132	128	129
365	256	252	260	256
375	200	200	202	200

The student studied the results shown in the table and a copy of the distribution graph in **Figure 2** to form the following conclusions:

- the higher the temperature, the faster the reaction because the number of collisions increases (conclusion 1)
- for every 10 K rise in temperature, the reaction rate doubles due to the number of collisions doubling (conclusion 2)

**Figure 2**



Evaluate the accuracy of the student's conclusions using the information in the table and the graph in **Figure 2** to support your answer.

Your response should include reasoned judgements and conclusions.

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

---



---



---



---

SAMPLE

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





SAMPLE

**This is the end of Paper B.**

**SAMPLE**

**This page is left intentionally blank.**

**This page is left intentionally blank.**

SAMPLE

## Document information

The T Level Technical Qualification is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.

Copyright in this document belongs to, and is used under licence from, the Institute for Apprenticeships and Technical Education, © 2021–2023.

‘T-LEVELS’ is a registered trade mark of the Department for Education.

‘T Level’ is a registered trade mark of the Institute for Apprenticeships and Technical Education.

‘Institute for Apprenticeships & Technical Education’ and logo are registered trade marks of the Institute for Apprenticeships and Technical Education.

Owner: Head of Assessment Design

## Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Post approval, updated for publication.		January 2021
v1.1	NCFE rebrand.		September 2021
v1.2	Amends to Q16b. ODSR_070		September 2022
v1.3	Sample added as a watermark	November 2023	20 November 2023