



**Surname** \_\_\_\_\_

**Forename(s)** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**I declare this is my own work.**

**A-level**

**BIOLOGY**

**Paper 3**

**7402/3**

**Wednesday 19 June 2024**

**Morning**

**Time allowed: 2 hours**

**[Turn over]**



**On the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.**

## **MATERIALS**

**For this paper you must have:**

- **a ruler with millimetre measurements**
- **a scientific calculator.**

## **INSTRUCTIONS**

- **Use black ink or black ball-point pen.**
- **Answer ALL questions in SECTION A.**
- **Answer ONE question from SECTION B.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**



- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Show all your working.**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**

## **INFORMATION**

- **The marks for the questions are shown in brackets.**
- **The maximum mark for this paper is 78.**

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



**SECTION A**

**Answer ALL questions in this section.**

**You are advised to spend no more than 1 hour and 15 minutes on this section.**

**0 1 . 1**

**In the following passage, each numbered space can be filled with a biological term.**

**Each type of cell has specific molecules on its \_\_\_\_\_ (1) that identify it. An antibody is a \_\_\_\_\_ (2) with two \_\_\_\_\_ (3) binding sites. Antibodies are made and released by \_\_\_\_\_ (4) cells.**

**Vaccines can provide protection for individuals and populations against disease. The response to a vaccine**



**5**

is an example of     (5)     immunity.

    (6)     immunity occurs when a large proportion of a population becomes immune to a disease.

**Write the correct biological term beside each number below that matches the space in the passage. [3 marks]**

**1** \_\_\_\_\_

**2** \_\_\_\_\_

**3** \_\_\_\_\_

**4** \_\_\_\_\_

**5** \_\_\_\_\_

**6** \_\_\_\_\_

**[Turn over]**



01.2

**There is currently no effective vaccine available for HIV.**

**Suggest ONE reason why. [1 mark]**

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**[Turn over]**

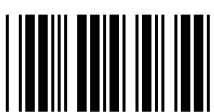


**01.3**

**TABLE 1 shows the action of two antibiotics.**

**TABLE 1**

<b>ANTIBIOTIC</b>	<b>ACTION OF ANTIBIOTIC</b>
<b>Ciprofloxacin</b>	<b>Causes double-stranded DNA to break apart</b>
<b>Penicillin</b>	<b>Prevents formation of crosslinks between murein chains</b>



**Using the information in TABLE 1, explain why each antibiotic is NOT effective against HIV. [2 marks]**

**Ciprofloxacin** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Penicillin** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**[Turn over]**

<hr/>
<b>6</b>



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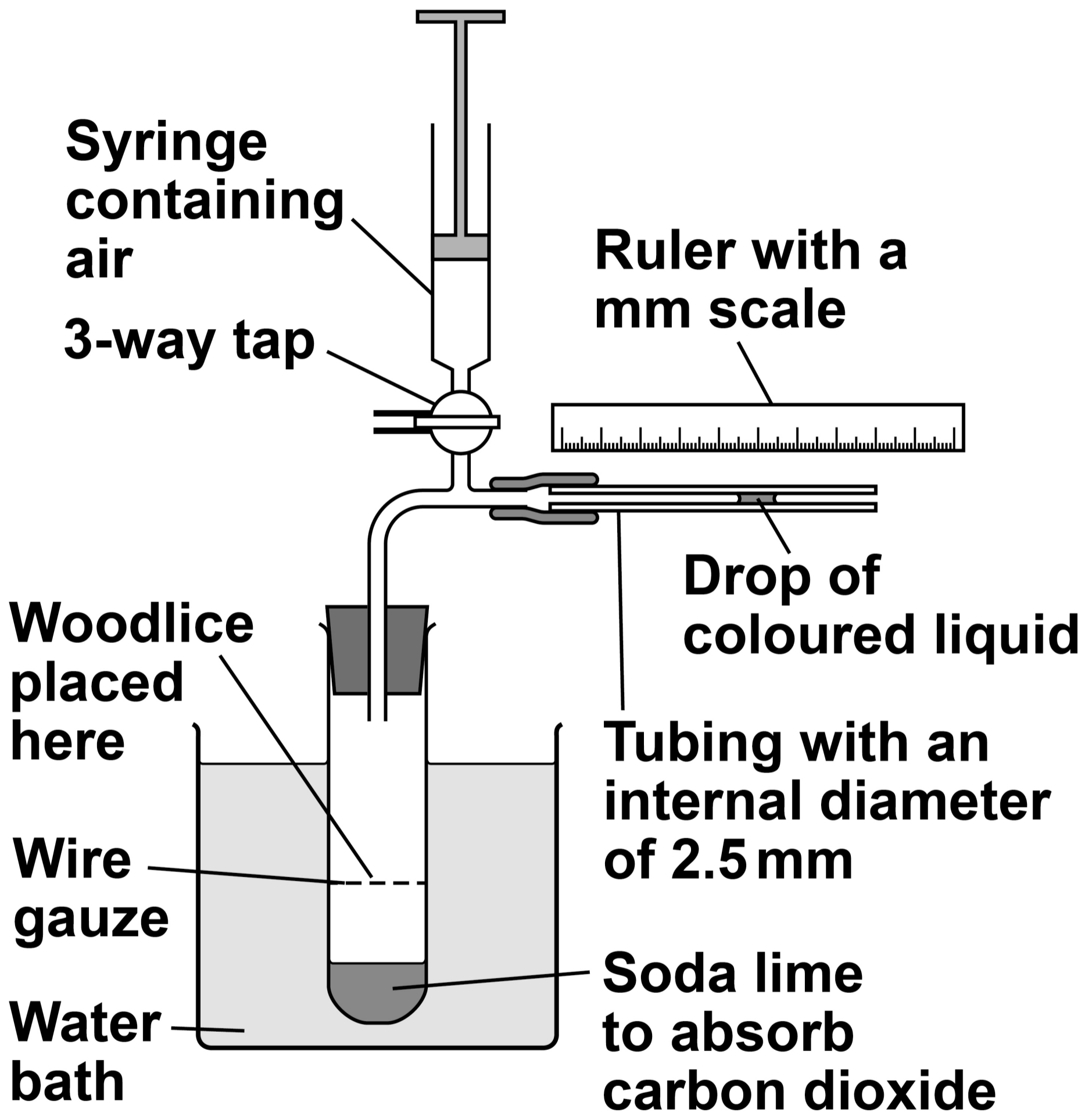
**A student investigated the effect of temperature on the rate of aerobic respiration in woodlice.**

**FIGURE 1, on the opposite page, shows the apparatus they used.**

**The student altered the temperature of the water bath and measured how far the drop of coloured liquid moved every minute for 5 minutes.**



FIGURE 1



[Turn over]



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0 2 . 1

**Other than those stated, suggest TWO variables the student should have kept constant in this investigation. [1 mark]**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

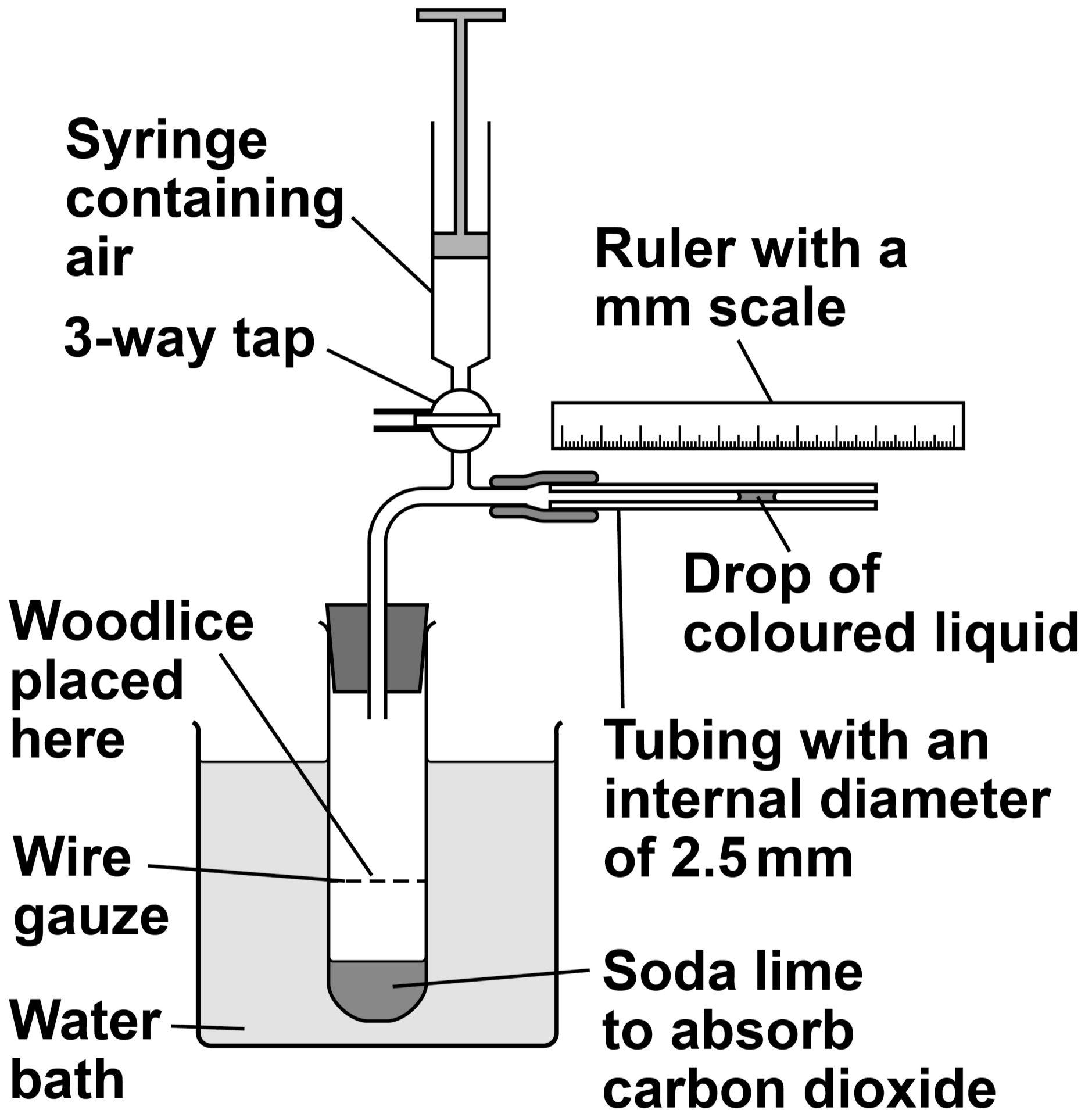
**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**[Turn over]**

## REPEAT OF FIGURE 1



02.2

**Describe how the student used the apparatus in FIGURE 1 to reset the drop of coloured liquid back to the RIGHT-HAND end of the tubing.**

**[2 marks]**

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**[Turn over]**

0 2 . 3

**The student also set up a control experiment.**

**Suggest a suitable control experiment AND explain why it was necessary.**

**[2 marks]**

**Control experiment** \_\_\_\_\_

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**Explanation** \_\_\_\_\_

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**[Turn over]**



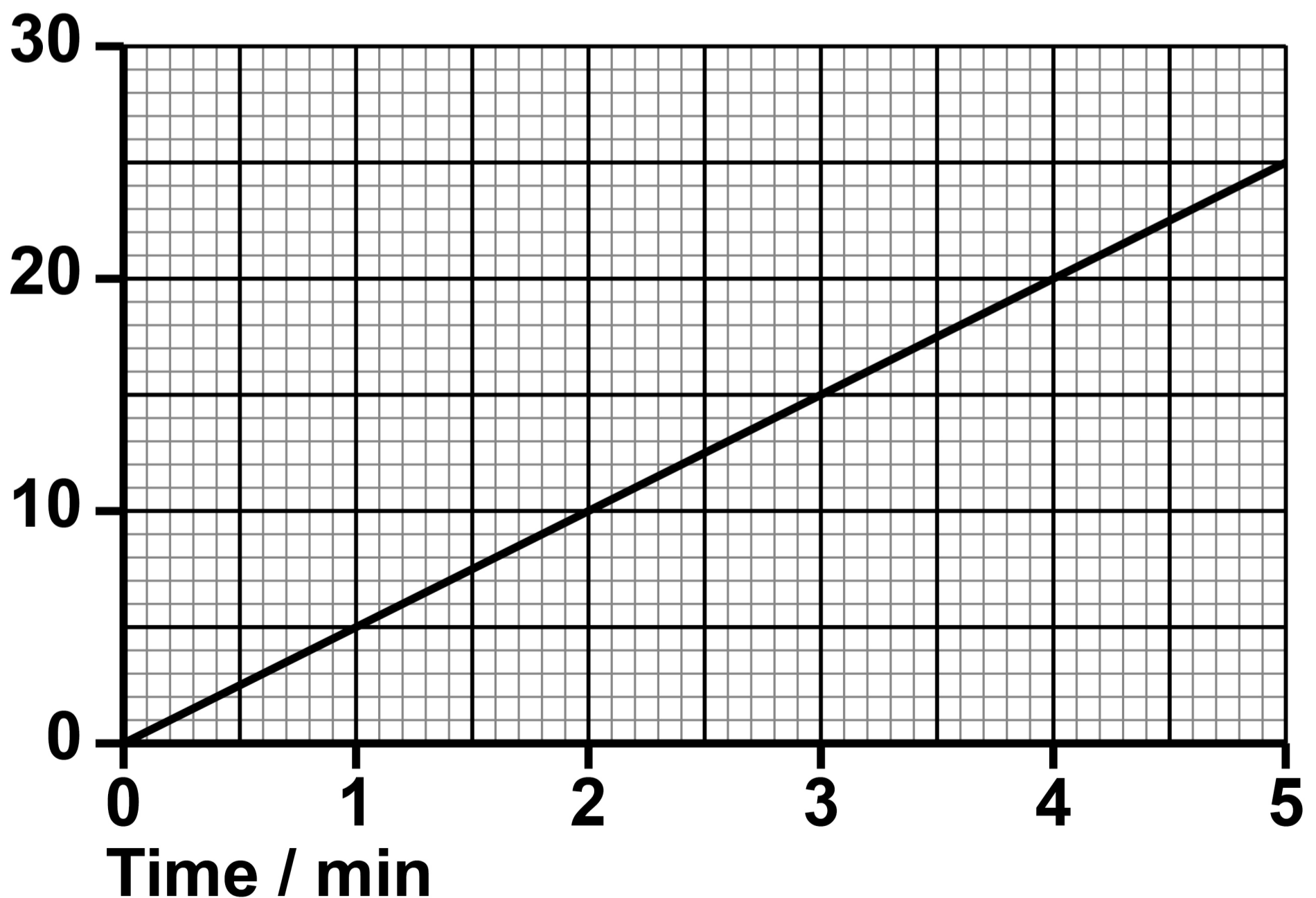
0 2 . 4

**FIGURE 2** shows the student's results at 25 °C

The mass of the woodlice in the tube was 3.78 g

**FIGURE 2**

Distance moved by the drop of coloured liquid / mm



Use FIGURE 1 (on page 14) and FIGURE 2 to calculate the mean rate of oxygen uptake by the woodlice in  $\text{mm}^3 \text{s}^{-1} \text{g}^{-1}$

The formula for the volume of the capillary tubing is  $\pi r^2 l$ .

Use  $\pi = 3.14$  in your calculation.

Show your working AND give your answer to 2 decimal places. [3 marks]

Answer \_\_\_\_\_  $\text{mm}^3 \text{s}^{-1} \text{g}^{-1}$

[Turn over]



0 3 . 1

**Describe AND explain the relationship between surface area to volume ratio of the human body and metabolic rate.**

**[3 marks]**

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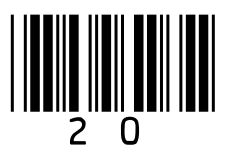
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**[Turn over]**



**TABLE 2 shows the height and mass of two adults.**

**TABLE 2**

<b>PERSON</b>	<b>HEIGHT / cm</b>	<b>MASS / kg</b>
<b>A</b>	<b>181</b>	<b>90.90</b>
<b>B</b>	<b>149</b>	<b>62.62</b>

**The surface area of a person is estimated using the following formula:**

**Surface area in m<sup>2</sup> =**

$$\sqrt{\frac{\text{height in cm} \times \text{mass in kg}}{3600}}$$

**The volume of a person is estimated using the following formula:**

$$\text{Volume in m}^3 = \frac{\text{mass in kg}}{1010}$$



**03.2**

**Using suitable calculations, deduce which person has the smaller surface area to volume ratio.**

**Show your working AND complete the sentence below.**

**Give your answer to 3 significant figures.  
[3 marks]**

**Person \_\_\_\_\_**

**has the smaller surface area to volume ratio which = \_\_\_\_\_**

**[Turn over]**



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**Which is NOT a possible explanation for the difference in surface area to volume ratio between person A and person B?  
[1 mark]**

**Tick (✓) ONE box.**

**Person A and person B have different body shapes.**

**Person A has a higher mass than person B.**

**Person A is taller than person B.**



03.4

**Name TWO structural features of the gills of a fish that increase their surface area.  
[1 mark]**

1 \_\_\_\_\_

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\_\_\_\_\_

2 \_\_\_\_\_

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**[Turn over]**

8



**04**

**Osteoarthritis (OA) is a disease resulting in joint damage which causes stiffness.**

**Scientists investigated the use of a drug called pralnacasan to treat OA in 80 mice.**

**The scientists:**

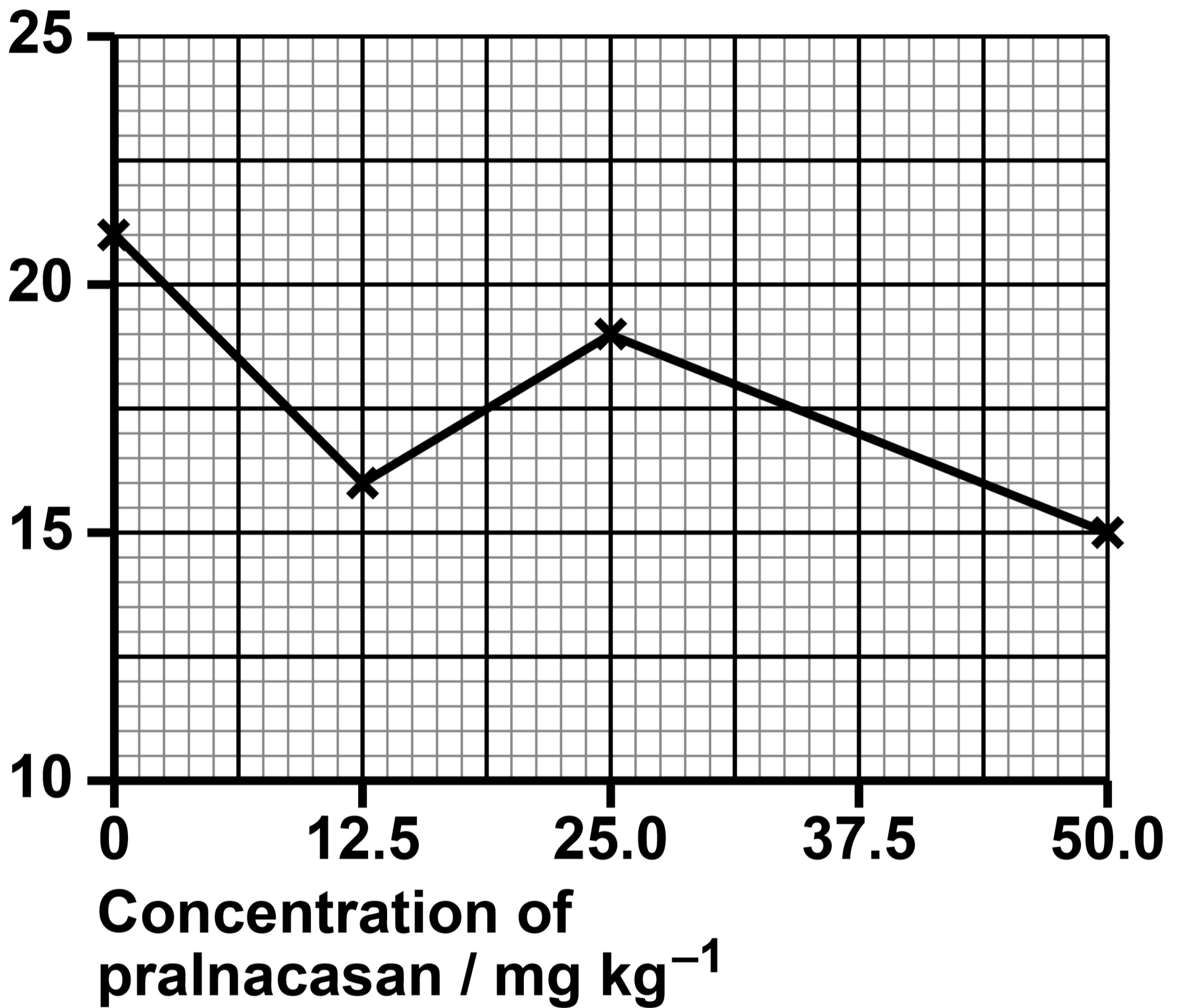
- **injected the knee joints of mice with an enzyme to cause joint damage**
- **split the mice randomly into 4 equal groups**
- **fed each group with food containing a different concentration of pralnacasan**
- **after 6 weeks, assessed the stiffness of the knee joints of the mice and scored them using an arbitrary scale.**

**FIGURE 3, on the opposite page, shows their results.**



**FIGURE 3**

**Median stiffness  
score / arbitrary units**



**[Turn over]**



04.1

**Describe how the scientists determined the median of the stiffness scores.**

**[1 mark]**

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04.2

**Using all the information, evaluate the use of pralnacasan as an effective treatment for OA in humans. [5 marks]**

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**Leigh syndrome (LS) is a rare, recessive, inherited condition.**

**LS is caused by a mutation in any one of more than 75 different genes coding for proteins involved in oxidative phosphorylation.**

**In 80% of people with LS, these mutations occur in nuclear DNA. In 20% of people with LS, these mutations occur in mitochondrial DNA (mtDNA).**

**15% of the nuclear DNA mutations that cause LS occur in the *SURF1* gene. A mutated *SURF1* gene codes for a shorter polypeptide than a non-mutated *SURF1* gene.**



05.1

Name ONE type of *SURF1* gene mutation and explain how this mutation could lead to production of a shorter polypeptide.

[2 marks]

Type of mutation \_\_\_\_\_

Explanation \_\_\_\_\_

[Turn over]



**Globally, the frequency of LS is 1 in 40 000**

**In the Faroe Islands, which are 18 isolated islands, the frequency of LS is 1 in 1700**

**0 5 . 2**

**The population of the Faroe Islands is 49 053**

**Estimate the number of people in the Faroe Islands with LS caused by a mutation in the *SURF1* gene.**

**Use information in this question and the information on page 30.**



**Give your answer to the nearest whole number.**

**Show your working. [3 marks]**

**Answer** \_\_\_\_\_ **people**

**[Turn over]**



**0 5 . 3**

**The frequency of LS is higher in the Faroe Islands than globally.**

**Suggest and explain ONE reason why.  
[2 marks]**

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**LS usually causes death within the first three years of life.**

**Using all the information in this question, evaluate whether all people should be genetically screened for LS. [3 marks]**

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**[Turn over]**



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**0 6 . 1**

**Define the biological term POPULATION.  
[2 marks]**

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**[Turn over]**



**Ecologists monitored the biodiversity of birds in a protected woodland.**

**They recorded the number of bird species breeding in the woodland on the same day, every year for a 30-year period.**

**FIGURE 4, on the opposite page, shows their results.**

**FIGURE 4**

**FIGURE 4 not reproduced here due to third-party copyright restrictions.**

**The figure is taken from the following website:**

**Figure 1a. Anne E. Magurran, Stephen R. Baillie, Stephen T. Buckland, Jan McP. Dick, David A. Elston, E. Marian Scott, Rognvald I. Smith, Paul J. Somerfield, Allan D. Watt, Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time, Trends in Ecology & Evolution, Volume 25, Issue 10, 2010, Pages 574-582, ISSN 0169-5347, <https://doi.org/10.1016/j.tree.2010.06.016>.**

**[Turn over]**



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**06.2**

**Which statement correctly represents the species richness of the woodland?  
[1 mark]**

**Tick (✓) ONE box.**

**The number of all species present in the woodland**

**The number of all species present in the woodland and their habitats**

**The number of animal and plant species present in the woodland**

**The number of bird species present in the woodland**

**[Turn over]**



**0 6 . 3**

**A student studying the information in this question concluded that all woodlands should be protected to increase the biodiversity of birds.**

**Evaluate the student's conclusion.  
[4 marks]**

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**[Turn over]**



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**It is NOT possible to extrapolate the data for the number of bird species recorded breeding each year beyond 1979.**

**Explain why. [1 mark]**

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**In this woodland, the ecologists measured the similarity in the bird community by comparing each year to 1949 using an index of similarity.**

**This index ranges from 1.0 for total similarity to 0.0 for total dissimilarity.**

**FIGURE 5, on page 46, shows their results.**

**[Turn over]**



**FIGURE 5**

**FIGURE 5 not reproduced here due to third-party copyright restrictions.**

**The figure is taken from the following website:**

**Figure 1b, Anne E. Magurran,  
Stephen R. Baillie, Stephen T. Buckland,  
Jan McP. Dick, David A. Elston,  
E. Marian Scott, Rognvald I. Smith,  
Paul J. Somerfield, Allan D. Watt,  
Long-term datasets in biodiversity  
research and monitoring: assessing  
change in ecological communities  
through time,  
Trends in Ecology & Evolution,  
Volume 25, Issue 10, 2010,  
Pages 574-582, ISSN 0169-5347,  
<https://doi.org/10.1016/j.tree.2010.06.016>.**



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**Suggest how the changes in the index of similarity in the bird community provide evidence for the process of succession.  
[2 marks]**

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**[Turn over]**



**06.6**

**In FIGURE 5, on page 46, the index of similarity for the last 10 years remains fairly constant.**

**Name the stage of a succession this represents.**

**Suggest ONE reason why the index of similarity is NOT absolutely constant.**

**[2 marks]**

**Stage of succession** \_\_\_\_\_

**Reason why the index of similarity is not absolutely constant** \_\_\_\_\_

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**[Turn over]**



**The Living Planet Index (LPI) is an index designed to monitor the state of the world's biodiversity.**

**The LPI is arbitrarily scaled to be 1.0 in 1970, the baseline year.**

**FIGURE 6, on the opposite page, shows the LPI from the Living Planet Report, 2008. The dotted lines represent  $\pm 2$  standard deviations from the mean, which includes over 95% of the data.**

**FIGURE 7, on page 52, shows an alternative version of FIGURE 6 published on a news website.**



**FIGURES 6 and 7 not reproduced here due to third-party copyright restrictions.**

**The figures are taken from the following website:**

**Figure 2a and 2b, Anne E. Magurran, Stephen R. Baillie, Stephen T. Buckland, Jan McP. Dick, David A. Elston, E. Marian Scott, Rognvald I. Smith, Paul J. Somerfield, Allan D. Watt, Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time, Trends in Ecology & Evolution, Volume 25, Issue 10, 2010, Pages 574-582, ISSN 0169-5347, <https://doi.org/10.1016/j.tree.2010.06.016>.**

**[Turn over]**



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06.7

The news website published the headline:

The LPI shows human activities cause significant decrease in biodiversity.

Suggest THREE reasons why this headline is NOT valid.

Use all the information provided.  
[3 marks]

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**[Turn over]**



**SECTION B**

**Answer ONE question.**

**You are advised to spend no more than 45 minutes on this section.**

**07**

**Write an essay on ONE of the topics below.**

**EITHER**

**07.1**

**Phosphorus-containing substances and their importance in biological systems.  
[25 marks]**



OR

**07.2**

**The mechanisms and importance of transport within organisms. [25 marks]**

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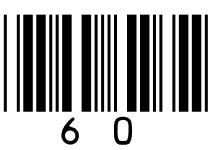
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**Additional page, if required.**

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For Examiner's Use	
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**WP/M/CD/Jun24/7402/3/G4006/V4**



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