

Combined Science  
PAPER 4  
Higher Tier

Total Marks
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Friday 9 June 2023 – Afternoon

Time: 1 hour 10 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

**YOU MUST HAVE**

**Ruler, calculator**

**YOU WILL BE GIVEN**

**Diagram Booklet**

**INSTRUCTIONS**

**Answer ALL questions.**

**Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.**

**INFORMATION**

**The total mark for this paper is 60.**

**The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.**

**(continued on the next page)**

**Turn over**

**INFORMATION continued.**

**In questions marked with an ASTERISK (\*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.**

**There may be spare copies of some diagrams.**

**ADVICE**

**Read each question carefully before you start to answer it.**

**Try to answer every question.**

**Check your answers if you have time at the end.**

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**Answer ALL questions. Write your answers in the spaces provided.**

**Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.**

- 1 People with diabetes cannot always control the concentration of glucose in their blood.**

**(a) Two people eat identical meals.**

**One person has diabetes, the other person does not have diabetes.**

**Look at FIGURE 1 for Question 1(a) in the Diagram Booklet. It shows the concentration of glucose in the blood of these two people after eating the meals.**

**(continued on the next page)**

**Turn over**

**1(a) continued.**

- (i) Calculate the maximum increase in the concentration of glucose in the blood of the person with diabetes.  
(1 mark)**

\_\_\_\_\_ mmol per dm<sup>3</sup>

**(continued on the next page)**

**1(a) continued.**

- (ii) Water moved out of the red blood cells of the person with diabetes when the concentration of glucose in the blood was above  $15 \text{ mmol per dm}^3$ .**

**Explain why water moved out of the red blood cells of the person with diabetes.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**1 continued.**

**(b) The pancreas produces a hormone that causes the concentration of glucose in the blood to decrease.**

**(i) Name this hormone.  
(1 mark)**

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**(ii) State how this hormone is transported from the pancreas to its target organs.  
(1 mark)**

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**(continued on the next page)**

**1(b) continued.**

**(iii) Which is the target organ for the hormone that controls the concentration of glucose in the blood?  
(1 mark)**

- ☐ **A kidney**
- ☐ **B pancreas**
- ☐ **C liver**
- ☐ **D lung**

**(continued on the next page)**



**1 continued.**

**(c) Explain how type 2 diabetes can be controlled.  
(3 marks)**

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**(Total for Question 1 = 9 marks)**

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**Turn over**

**2 Respiration occurs in cells.**

**(a) Why do cells respire?  
(1 mark)**

- ☐ **A to produce nitrogen**
- ☐ **B to release oxygen**
- ☐ **C to produce glucose**
- ☐ **D to release energy**

**(continued on the next page)**

**2 continued.**

**(b) An athlete runs every day as part of their training.**

**(i) Explain why the breathing rate of the athlete increases when running.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**2(b) continued.**

- (ii) When the athlete is running, their muscle cells use both aerobic respiration and anaerobic respiration.**

**State TWO differences between aerobic respiration and anaerobic respiration.  
(2 marks)**

**Answer space continues on the next page.**

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

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**2(b)(ii) continued.**

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

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**(continued on the next page)**

**2 continued.**

**(c) Bromothymol blue (BTB) solution is an indicator of pH.**

**Look at FIGURE 2 for Question 2(c) in the Diagram Booklet. It shows the colour of BTB at different pH levels.**

**When air is passed through green BTB, for one minute, the solution stays green.**

**When a person breathes out through a straw into BTB for one minute the solution turns yellow.**

**(continued on the next page)**

**Turn over**

**2(c) continued.**

- (i) Explain why the air breathed out turns the BTB solution yellow.  
(2 marks)**

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**(continued on the next page)**

**2(c) continued.**

- (ii) A scientist placed pondweed into two sealed test tubes containing green BTB solution.**

**Test tube A was kept in the dark.  
Test tube B was kept in the light.  
All other conditions were kept the same.**

**Look at FIGURE 3 for  
Question 2(c)(ii) in the Diagram  
Booklet. It shows these test tubes  
at the start of the investigation.**

**Look at FIGURE 4 for  
Question 2(c)(ii) in the Diagram  
Booklet. It shows the colour of  
the BTB solution after 5 hours.**

**Explain the results for tube A and  
tube B shown in Figure 4.  
(2 marks)**

**Answer space continues on the next page.**

**Turn over**



**2(c)(ii) continued.**

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**(Total for Question 2 = 9 marks)**

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**Turn over**

- 3 A student investigated the effect of light intensity on the photosynthesis of pondweed.**

**A light source was placed at different distances from the pondweed.**

**The bubbles produced were counted for 2 minutes.**

**Look at FIGURE 5 for Question 3 in the Diagram Booklet. It shows the apparatus that was used.**

- (a) (i) State why the student included a water bath in the apparatus.  
(1 mark)**

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**(continued on the next page)**

**3(a) continued.**

**(ii) State TWO variables that should be controlled when completing this investigation.  
(2 marks)**

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

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

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**(continued on the next page)**

**3 continued.**

**(b) Look at FIGURE 6 for Question 3(b) in the Diagram Booklet. It shows the results of this investigation.**

**(continued on the next page)**

**3(b) continued.**

- (i) The light intensity was calculated using the inverse square law for photosynthesis.**

**Calculate the light intensity at a distance of 25 cm from the lamp.**

**Include the equation for the inverse square law in your answer.  
(3 marks)**

**\_\_\_\_\_ arbitrary units**

**(continued on the next page)**

**Turn over**

**3(b) continued.**

- (ii) Explain how the student could improve this investigation to get a more accurate measurement of the gas produced.  
(2 marks)**

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**(continued on the next page)**

**3 continued.**

**(c) Devise a plan to show that temperature is a limiting factor in photosynthesis.**

**Use the apparatus shown in Figure 5.  
(3 marks)**

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**Turn over**

**3(c) continued.**

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**(Total for Question 3 = 11 marks)**

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- 4 Gas exchange happens in the alveoli in the lungs.**

**Look at FIGURE 7 for Question 4 in the Diagram Booklet. It shows an alveolus and a capillary.**

- (a) (i) Name the gas used in respiration that moves from the alveolus into the capillary.  
(1 mark)**

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- (ii) Name the gas produced by respiration that moves from the capillary into the alveolus.  
(1 mark)**

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**(continued on the next page)**

**Turn over**

**4(a) continued.**

**(iii) The capillary wall is only one cell thick.**

**Explain how gases move from the alveolus to the capillary.  
(3 marks)**

**Answer space continues on the next page.**

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**Turn over**

**4(a)(iii) continued.**

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**4(a) continued.**

**(iv) Explain the advantages of red blood cells passing one at a time through this narrow capillary.  
(3 marks)**

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**(continued on the next page)**

**Turn over**

**4 continued.**

**(b) The average number of alveoli in each human lung is 280 million.**

**The surface area of 1 million alveoli is  $0.25\text{m}^2$ .**

**Calculate the total surface area of a human lung.  
(2 marks)**

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**(Total for Question 4 = 10 marks)**

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**Turn over**

**5 Look at FIGURE 8 for Question 5 in the Diagram Booklet. It shows the changes in the levels of the hormones of the menstrual cycle.**

**(a) (i) The maximum concentration of oestrogen is just before ovulation.**

**Which is the maximum concentration of oestrogen?  
(1 mark)**

- ☐ **A 8 ng / ml**
- ☐ **B 210 pg / ml**
- ☐ **C 320 pg / ml**
- ☐ **D 900 ng / ml**

**(continued on the next page)**

**Turn over**

**5(a) continued.**

**(ii) Explain how TWO of the hormones shown in Figure 8 cause ovulation.  
(3 marks)**

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**(continued on the next page)**

**Turn over**

**5(a) continued.**

**(iii) State the number of days for the first menstruation shown in Figure 8.  
(1 mark)**

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**(iv) Explain how the levels of each hormone in the woman shown in Figure 8 would be different, if she was pregnant.  
(4 marks)**

**Answer space continues on the next page.**

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**Turn over**



**5(a)(iv) continued.**

[illegible]

**(Total for Question 5 = 9 marks)**

**Turn over**

**6 Look at FIGURE 9 for Question 6 in the Diagram Booklet. It shows a photomicrograph of two stomata in a leaf.**

**(a) (i) The length of one guard cell in this image is 6 mm.**

**Convert the length of this guard cell into micrometres ( $\mu\text{m}$ ).  
(1 mark)**

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**(continued on the next page)**

**6(a) continued.**

**(ii) The image has been magnified 150×.**

**Calculate the actual size of the guard cell.**

**Give your answer in standard form in mm.  
(3 marks)**

\_\_\_\_\_mm

**(continued on the next page)**

**Turn over**

**6 continued.**

**(b) Explain the role of denitrifying bacteria in the nitrogen cycle.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**6 continued.**

**\*(c) Describe how carbon is cycled through the biotic and abiotic components of an ecosystem. (6 marks)**

**Answer space continues on the next 2 pages.**

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**Turn over**

**6(c) continued.**

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**Turn over**

**6(c) continued.**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

**(Total for Question 6 = 12 marks)**

**TOTAL FOR PAPER = 60 MARKS**  
**END OF PAPER**