

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.**

**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)**

**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 mmol per dm<sup>3</sup>.**

**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)**

**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**

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

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

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**Turn over**



**1(c) continued.**

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

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**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**

**(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)**

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

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**2(b)(i) continued.**

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- (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.**

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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.**

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

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**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)**

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

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

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- 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.**

**(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)**

**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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- (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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**3(c) continued.**

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

**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)**

**4(a) continued.**

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

**Explain how gases move from the alveolus to the capillary.**

**(3 marks)**

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

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

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**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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**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**

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

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

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**5(a)(ii) continued.**

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

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**(continued on the next page)**

**5(a) continued.**

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

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**Turn over**

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

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

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**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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- (ii) The image has been magnified 150 $\times$ .**

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

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

**\_\_\_\_\_ mm**

**6 continued.**

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

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**6 continued.**

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

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**6(c) continued.**

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**6(c) continued.**

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

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