AQA GCSE Biology | 8461

SPECIFICATION POINT 4.4.2.3

Metabolism

Past-paper questions

Tier	**Foundation**
Question groups	**12**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

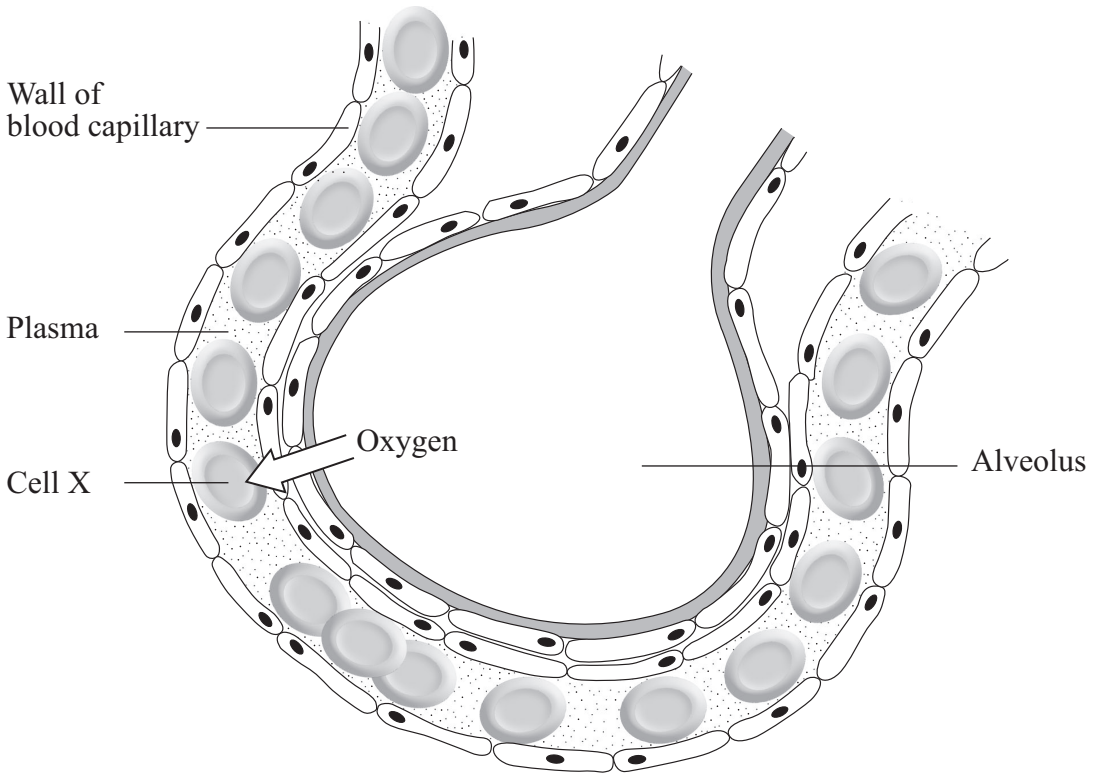
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.2.3 Metabolism

Question 01

June 2008 | BLY3F | Original Q4 | Legacy

4 The diagram shows a small part of a lung.



4 (a) The arrow on the diagram shows the movement of oxygen from the air in the alveolus to cell **X**.

Complete the sentences by drawing a ring around the correct answer.

4 (a) (i) Cell **X** is a platelet / red cell / white cell .

(1 mark)

4 (a) (ii) Oxygen moves from the air in the alveolus into cell **X** by diffusion / filtration / respiration .

(1 mark)

4 (a) (iii) The substance in cell **X** that combines with oxygen is called glycogen / haemoglobin / lactic acid .

(1 mark)

4.4.2.3 Metabolism

Question 01 · continued

for mark

4 (a) (iv) Cell **X** does **not** have

a cell membrane
cytoplasm
a nucleus

.

(1 mark)

4 (b) **On the diagram**, draw an arrow to show the movement of carbon dioxide during gas exchange. *(1 mark)*

5

4.4.2.3 Metabolism

Question 02

January 2009 | BLY2F | Original Q4 | Legacy

4 Waste products, such as carbon dioxide and urea, have to be removed from the body.

Draw a ring around the correct answer to complete each sentence.

4 (a) Carbon dioxide is produced by [breathing / diffusion / respiration].

(1 mark)

4 (b) Most carbon dioxide leaves the body through the [kidneys / lungs / skin].

(1 mark)

4 (c) Urea is produced in the [kidneys / liver / lungs].

(1 mark)

4 (d) Urea is produced from the breakdown of [amino acids / glucose / urine].

(1 mark)

4

4.4.2.3 Metabolism

Question 03

June 2011 | BLY3F | Original Q4 | Legacy

4 Muscles need energy during exercise.

Draw a ring around the correct answer in parts (a) and (b) to complete each sentence.

4 (a) (i) The substance stored in the muscles and used during exercise is

glycogen.

lactic acid.

protein.

(1 mark)

4 (a) (ii) The process that releases energy in muscles is

digestion.

respiration.

transpiration.

(1 mark)

4.4.2.3 Metabolism

Question 03 · continued

4 (b) The table shows how much energy is used by two men of different masses when swimming at different speeds.

Speed of swimming in metres per minute	Energy used in kJ per hour	
	34 kg man	70 kg man
25	651	1155
50	1134	2103

4 (b) (i) When the 34 kg man swims at 50 metres per minute instead of at 25 metres per minute, the extra energy he uses each hour is

36 kJ.
483 kJ.
948 kJ.

(1 mark)

4 (b) (ii) When swimming at 50 metres per minute, each man's heart rate is faster than when swimming at 25 metres per minute.

A faster heart rate helps to supply the muscles with more

carbon dioxide.
glycogen.
oxygen.

(1 mark)

4 (b) (iii) During the exercise the arteries supplying the muscles would

constrict.
dilate.
pump harder.

(1 mark)

4 (c) When a person starts to swim, the breathing rate increases.

Give **one** way in which this increase helps the swimmer.

.....

.....

(1 mark)

6

4.4.2.3 Metabolism

Question 04

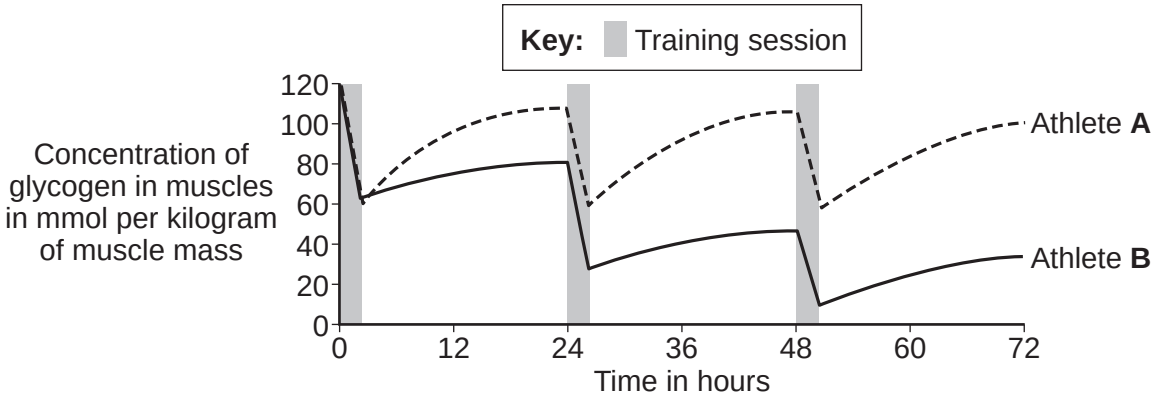
June 2012 | BL2FP | Original Q9 | Legacy

9 Glycogen is stored in the muscles.

Scientists investigated changes in the amount of glycogen stored in the muscles of two 20 year-old male athletes, **A** and **B**.
Athlete **A** ate a high-carbohydrate diet. Athlete **B** ate a low-carbohydrate diet.

Each athlete did one 2-hour training session each day.

The graph shows the results for the first 3 days.



9 (a) (i) Give **three** variables that the scientists controlled in this investigation.

.....

.....

.....

.....

.....

.....

(3 marks)

9 (a) (ii) Suggest **two** variables that would be difficult to control in this investigation.

.....

.....

.....

.....

(2 marks)

4.4.2.3 Metabolism

Question 04 · continued

9 (a) (iii) Describe **one** way in which the results of Athlete **B** were different from the results of Athlete **A**.

.....

.....

(1 mark)

9 (b) Both athletes were training to run a marathon.

Which athlete, **A** or **B**, would be more likely to complete the marathon?

Use information from the graph to explain your answer.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

10

4.4.2.3 Metabolism

Question 05

6 Scientists investigated how exercise affects blood flow to different organs in the body.

The scientists made measurements of blood flow to different organs of:

- a person resting in a room at 20 °C
- the same person, in the same room, doing vigorous exercise at constant speed on an exercise cycle.

The table shows the scientists' results.

Organ	Blood flow in cm^3 per minute whilst …	
	resting	doing vigorous exercise
Brain	750	750
Heart	250	1000
Muscles	1200	22 000
Skin	500	600
Other	3100	650

6 (a) In this investigation, it was better to do the exercise indoors on an exercise cycle than to go cycling outdoors on the road.

Suggest **two** reasons why.

Do **not** include safety reasons.

1 .....

.....

.....

2 .....

.....

.....

(2 marks)

6 (b) Blood flow to **one** organ did **not** change between resting and vigorous exercise.

Which organ? .....

(1 mark)

4.4.2.3 Metabolism

Question 05 · continued

6 (c) (i) How much more blood flowed to the muscles during vigorous exercise than when resting?

.....

.....

Answer = ... cm^3 per minute

(2 marks)

6 (c) (ii) Name **two** substances needed in larger amounts by the muscles during vigorous exercise than when resting.

1 .....

2 .....

(2 marks)

6 (c) (iii) Tick (✓) **one** box to complete the sentence.

The substances you named in part **(c)(ii)** helped the muscles to

make more lactic acid. ☐

respire aerobically. ☐

make more glycogen. ☐

(1 mark)

Question 6 continues on the next page

4.4.2.3 Metabolism

Question 05 · continued

6 (c) (iv) The higher rate of blood flow to the muscles during exercise removed larger amounts of waste products made by the muscles.

Which **two** substances need to be removed from the muscles in larger amounts during vigorous exercise?

Tick (✓) **two** boxes.

Amino acids ☐

Carbon dioxide ☐

Glycogen ☐

Lactic acid ☐

(2 marks)

6 (d) The total blood flow was much higher during exercise than when resting.

One way to increase the total blood flow is for the heart to pump out a larger volume of blood each beat.

Give **one** other way to increase the blood flow.

.....

.....

(1 mark)

11

4.4.2.3 Metabolism

Question 06

7 Lipase is an enzyme that digests fat.

7 (a) (i) Complete the equation to show the digestion of fat.

Use the correct answer from the box.

[1 mark]

glucose	**glycerol**	**glycogen**

fat $\xrightarrow{\text{lipase}}$ fatty acids + ...

7 (a) (ii) Name **one** organ that makes lipase.

[1 mark]

.....

7 (b) Some students investigated the effect of bile on the digestion of fat by lipase.

The students:
1 mixed milk and bile in a beaker
2 put the pH sensor of a pH meter into the beaker
3 added lipase solution
4 recorded the pH at 2-minute intervals
5 repeated steps 1 to 4, but used water instead of bile.

Suggest **two** variables that the students should have controlled in this investigation.

[2 marks]

1 .....

.....

2 .....

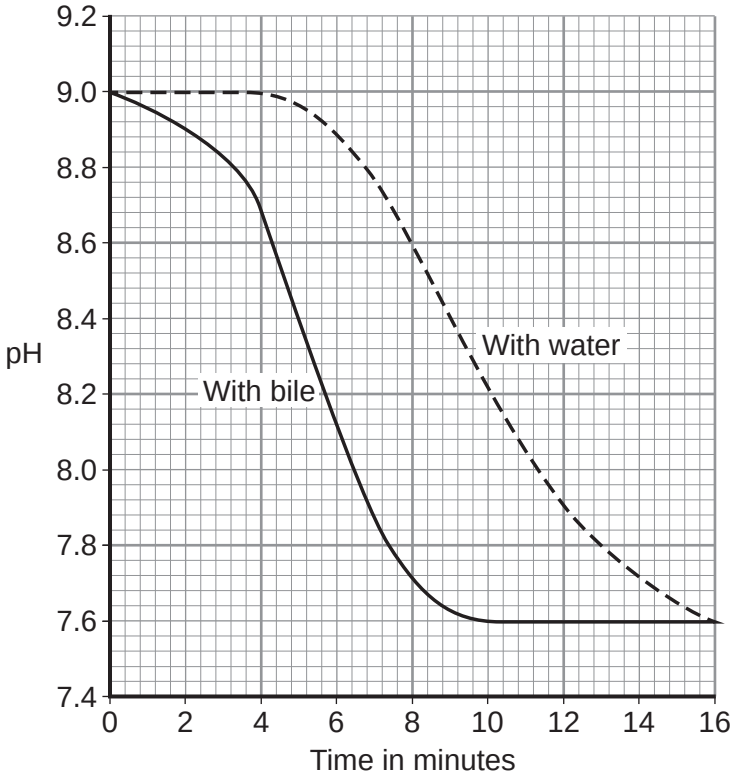
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4.4.2.3 Metabolism

Question 06 · continued

7 (c) **Figure 7** shows the students' results.

Figure 7



7 (c) (i) Why did the pH decrease in both investigations?

[1 mark]

.....

.....

7 (c) (ii) Bile helps lipase to digest fat.

What evidence is there in **Figure 7** to support this conclusion?

[1 mark]

.....

.....

7 (c) (iii) Suggest **one** reason why the contents of both beakers had the same pH at the end of the investigations.

[1 mark]

.....

.....

7

4.4.2.3 Metabolism

Question 07

June 2018 | 8461/1F | Original Q8

0 8 Metabolism is the sum of all the chemical reactions in the cells of the body.

One metabolic reaction is the formation of lipids.

0 8 . 1 Give **one** other metabolic reaction in cells.

[1 mark]

Table 5 shows the mean metabolic rate of humans of different ages.

Table 5

Age in years	Mean metabolic rate in kJ/m^2/hour	
	Males	Females
5	53	53
15	45	42
25	39	35
35	37	35
45	36	35

0 8 . 2 What **two** conclusions can be made from the data in **Table 5**?

[2 marks]

Tick **two** boxes.

- As age increases, mean metabolic rate of males and females increases. ☐
- Males have a higher metabolic rate than females after five years of age. ☐
- The mean metabolic rate of females decreases faster than males up to 25 years of age. ☐
- The mean metabolic rate of males and females decreases more quickly after the age of 35. ☐
- There is no relationship between age and mean metabolic rate. ☐

4.4.2.3 Metabolism

Question 07 · continued

0 8 . 3 Calculate the percentage decrease in the mean metabolic rate of males between 5 years and 45 years of age.

Use the equation:

$$\text{percentage decrease} = \frac{\text{decrease in metabolic rate}}{\text{original metabolic rate}} \times 100$$

Give your answer to 3 significant figures.

[3 marks]

Percentage decrease= _____

Question 8 continues on the next page

Question 07 · continued

Regular exercise can increase metabolic rate.

Two people did five minutes of gentle exercise from rest.

Table 6 shows the effect of the exercise on their heart rates.

Table 6

Time in minutes	Heart rate in beats per minute	
	Person R	Person S
0 (at rest)	60	78
1	76	100
2	85	110
3	91	119
4	99	129
5	99	132

0 8 . 4 Describe **two** differences in the response of person **R** and person **S** to the exercise.

Use information from **Table 6**.

[2 marks]

1 _____

_____

2 _____

_____

0 8 . 5 Complete the line graph in **Figure 12** for person **S**.

You should:

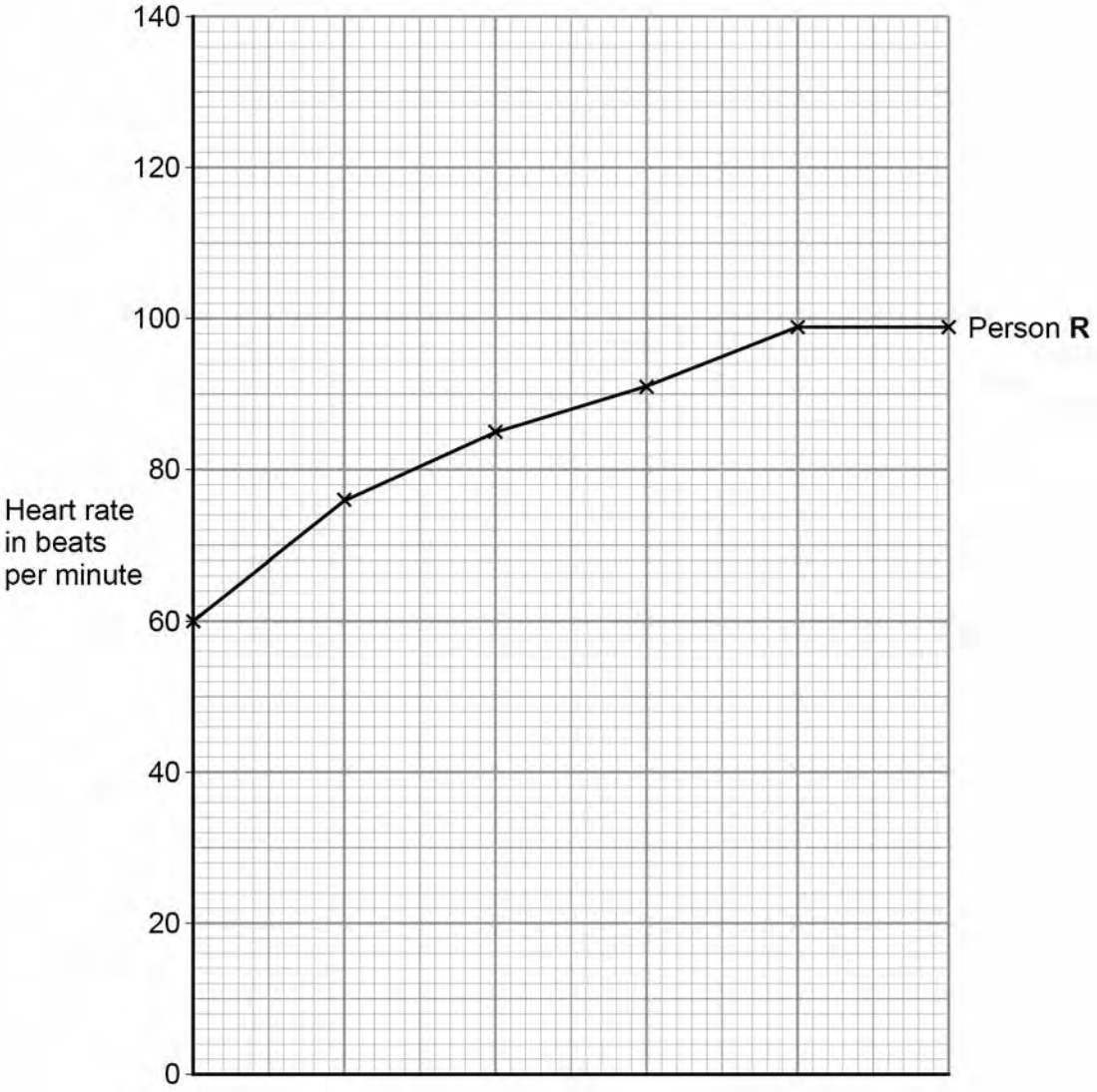
- add the scale to the x axis
- label the x axis.

[4 marks]

4.4.2.3 Metabolism

Question 07 · continued

Figure 12



0 8 . 6 After five minutes of exercise, the heart rate of person **S** was 132 beats per minute. When person **S** rested, his heart rate decreased steadily at a rate of 12 beats every minute.

Calculate how much time it would take the heart rate of person **S** to return to its resting rate.

[2 marks]

Time = _____ minutes

Question 8 continues on the next page

4.4.2.3 Metabolism

Question 07 · continued

0 8 . 7 A student made the following hypothesis about the heart rate of smokers and non-smokers during exercise.

"During exercise, the heart rate of smokers increases more than the heart rate of non-smokers."

Design an investigation that would allow you to test this hypothesis.

[6 marks]

20

4.4.2.3 Metabolism

Question 08

June 2018 | 8461/2F | Original Q5

0 5 A person with Type 1 diabetes cannot make enough insulin.

0 5 . 1 Which organ makes insulin?

[1 mark]

Tick **one** box.

- Adrenal gland ☐
- Pancreas ☐
- Pituitary gland ☐
- Thyroid ☐

0 5 . 2 A person with Type 1 diabetes can control the concentration of glucose in the blood by injecting insulin.

Complete the sentences.

[2 marks]

Choose answers from the box.

DNA	**glycogen**	**kidney**
liver	**protein**	**skin**

Insulin acts on an organ called the _____.

This organ then takes in excess glucose from the blood and changes the glucose into _____.

0 5 . 3 Insulin cannot be taken as a tablet. This is because insulin is a type of protein.

What would happen to the insulin in the tablet if it reached the stomach?

[1 mark]

_____

_____

Question 08 · continued

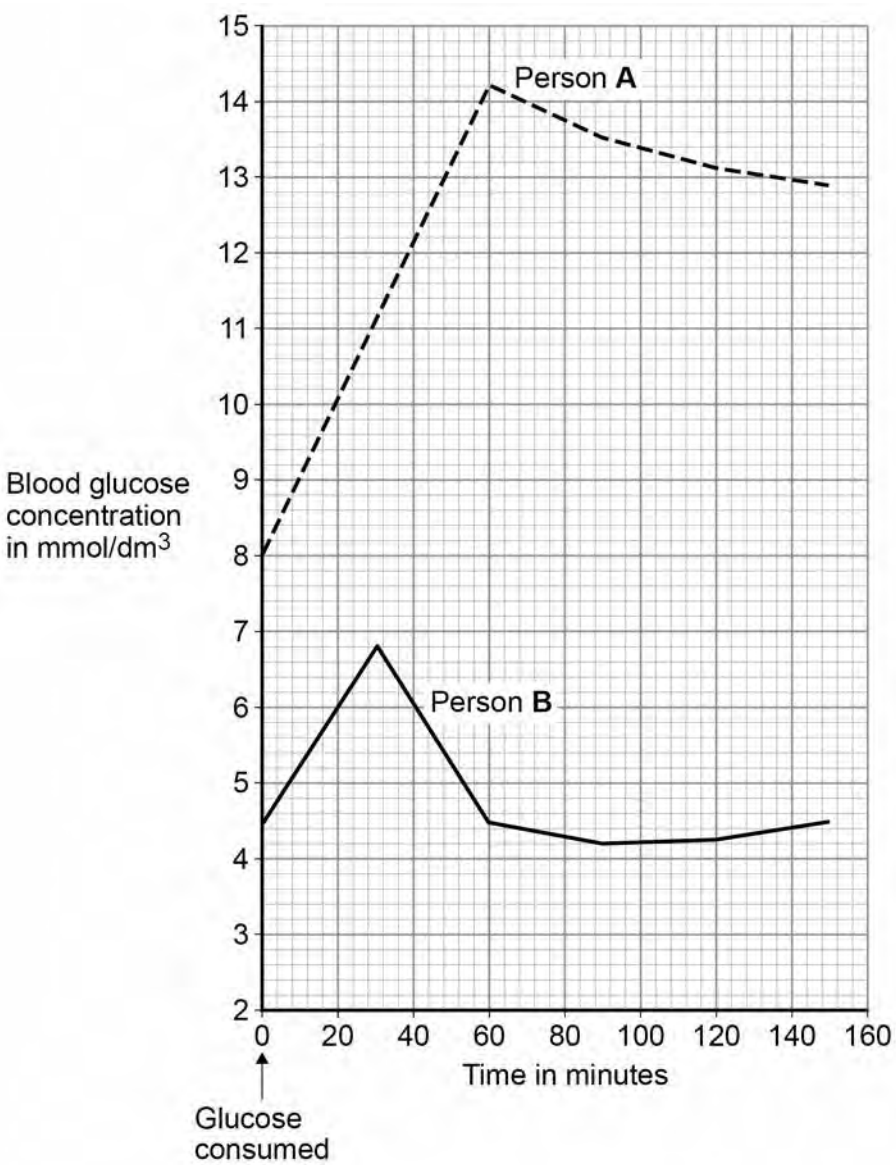
Two people each drank the same volume of a glucose drink.

Person **A** has Type 1 diabetes.

Person **B** does **not** have diabetes.

Figure 6 shows how the concentration of glucose in their blood changed.

Figure 6



4.4.2.3 Metabolism

Question 08 · continued

0 5 . 4 How much higher was the **highest** concentration of glucose in the blood of person **A** than the **highest** concentration in person **B**?

Use information from **Figure 6**.

[2 marks]

Answer = _____ mmol/dm^3

0 5 . 5 Describe **one** other way that the results for person **A** were different from the results for person **B**.

Use information from **Figure 6**.

[1 mark]

Question 5 continues on the next page

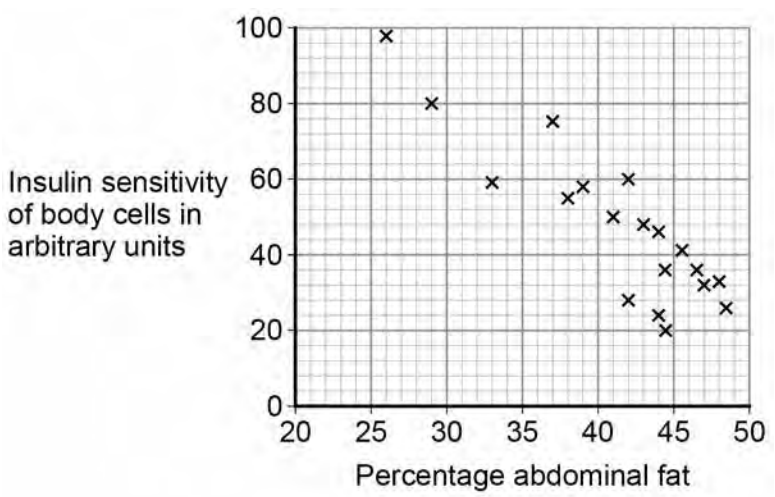
Question 08 · continued

Type 2 diabetes is another form of diabetes. Type 2 diabetes is common in obese people.

People with Type 2 diabetes make enough insulin, but still cannot control their blood glucose concentration. This is because the body cells are not sensitive to the insulin.

Figure 7 shows information about abdominal fat and insulin sensitivity in body cells.

Figure 7



0 5 . 6 What type of relationship is shown in **Figure 7**?

[1 mark]

Tick **one** box.

A negative correlation ☐

No correlation ☐

A positive correlation ☐

0 5 . 7 A person is at risk of developing Type 2 diabetes.

Suggest **two** ways the person could lower the chance of developing Type 2 diabetes.

[2 marks]

1 _____

_____

2 _____

_____

10

4.4.2.3 Metabolism

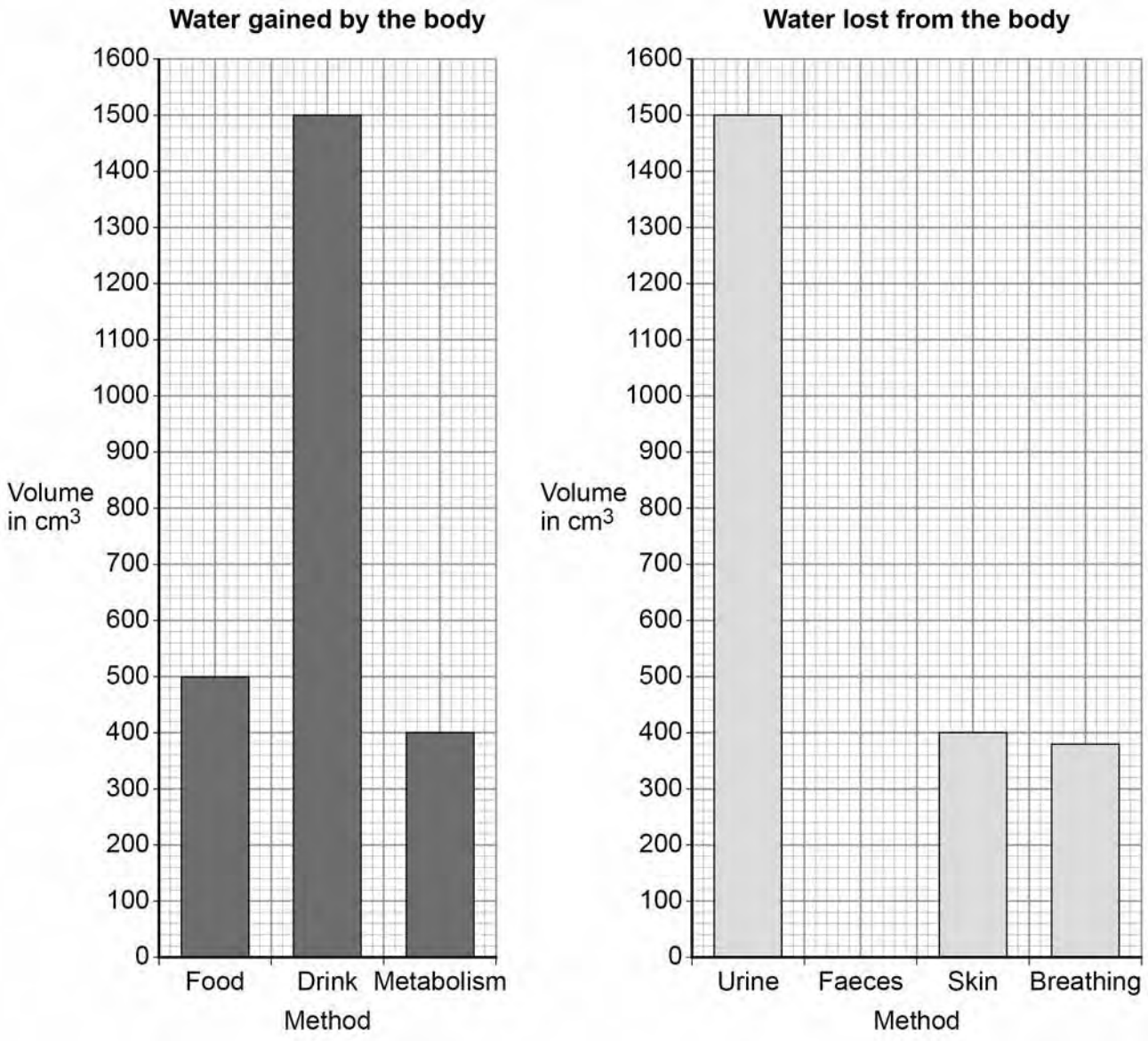
Question 09

June 2018 | 8461/2F | Original Q11

1 1 It is important to maintain water balance in the body.

Figure 15 shows how much water a person gained and lost by different methods in one day.

Figure 15



4.4.2.3 Metabolism

Question 09 · continued

When water is balanced, the volume of water taken in by the body is equal to the volume of water lost from the body.

1 1 . 1 Calculate the volume of water the person lost in one day in faeces.

Use information from **Figure 15**.

[2 marks]

Volume lost in faeces = _____ cm^3

1 1 . 2 **Figure 15** shows that one method of gaining water is by metabolism.

Which metabolic process produces water?

[1 mark]

Tick **one** box.

- Breakdown of protein to amino acids ☐
- Changing glycogen into glucose ☐
- Digestion of fat ☐
- Respiration of glucose ☐

Question 11 continues on the next page

4.4.2.3 Metabolism

Question 09 · continued

The next day, the person ran a 10-kilometre race.

The volume of water lost from the body through the skin and by breathing increased.

1 1 . 3 Explain why more water was lost through the skin during the race.

[2 marks]

1 1 . 4 Explain why more water was lost by breathing during the race.

[3 marks]

8

4.4.2.3 Metabolism

Question 10

June 2019 | 8461/2F | Original Q6

0 6 Two of the substances the body excretes are urea and carbon dioxide.

0 6 . 1 Complete the sentence.

[1 mark]

Choose the answer from the box.

carbohydrate	**lipid**	**protein**	**salt**

A person makes a lot of urea if the person's diet contains

a lot of _____.

0 6 . 2 Why must urea be excreted from the body?

[1 mark]

_____

_____

0 6 . 3 A person produces more carbon dioxide during exercise than when resting.

Complete the sentences.

[2 marks]

Choose answers from the box.

breathing	**digestion**	**egestion**
osmosis	**respiration**	

The process that makes carbon dioxide is _____.

During exercise, extra carbon dioxide can be removed from the body by increasing the rate of _____.

4.4.2.3 Metabolism

Question 10 · continued

0 6 . 4 Excess water must also be removed from the body.

If a person sweats a lot, less water will be excreted in the urine.

A healthy person did the same amount of exercise on each of 3 days.

Table 2 shows information for the 3 days.

Table 2

Day	Air temperature in °C	Volume of water consumed in cm^3	Relative amount of urine produced by the kidneys
1	30	1500	
2	20	1500	
3	15	2000	

Complete **Table 2**.

[2 marks]

Choose answers from the box.

least	medium	most

Question 6 continues on the next page

Question 10 · continued

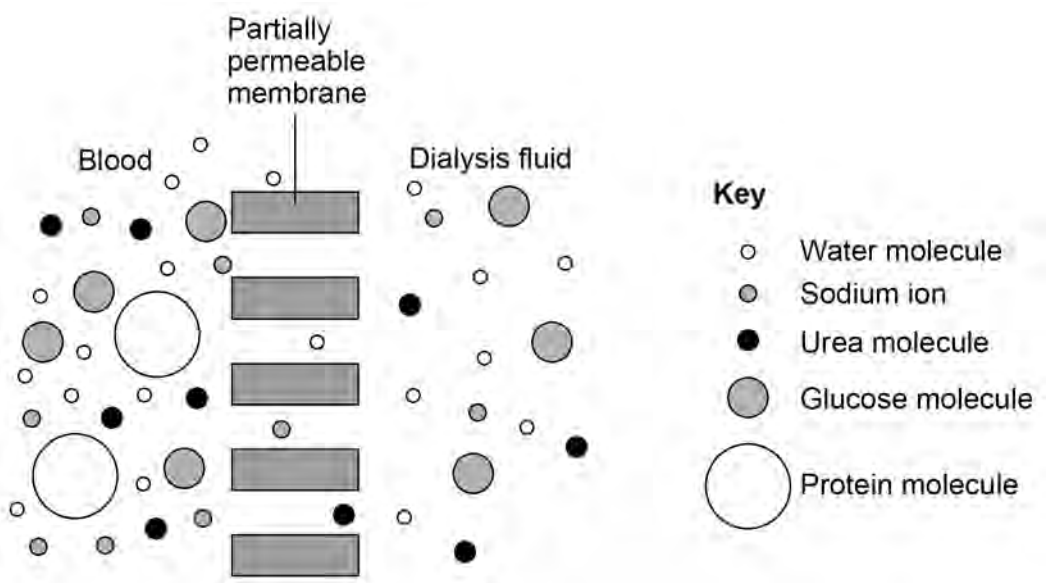
Some people have kidney disease.

Kidney disease may be treated by dialysis or by having a kidney transplant operation.

- During dialysis, a person is connected to a machine that filters the blood.
- Each dialysis session lasts about 6 hours.
- The person has several dialysis sessions each week.

Figure 12 shows how dialysis works.

Figure 12



0 6 . 5 How does urea move out of the blood during dialysis?

[1 mark]

Tick (✓) **one** box.

Diffusion ☐

Digestion ☐

Osmosis ☐

Respiration ☐

4.4.2.3 Metabolism

Question 10 · continued

0 6 . 6 Which substance in **Figure 12** does **not** pass from the blood into the dialysis fluid?

Give the reason for your answer.

[2 marks]

Substance _____

Reason _____

_____

Question 6 continues on the next page

Question 10 · continued

Two people have kidney disease.

- Person **A** is treated by dialysis.
- Person **B** has had a kidney transplant.

Figure 13 shows changes in the urea concentration in the blood of each person over 2 weeks.

Figure 13



0 6 . 7 How many dialysis sessions did person **A** have **each week**?

[1 mark]

_____

0 6 . 8 What happens to the concentration of urea in the blood between dialysis sessions?

[1 mark]

_____

0 6 . 9 Give **two** reasons why a kidney transplant is a better method for treating kidney disease than dialysis.

[2 marks]

1 _____

_____

2 _____

_____

13

4.4.2.3 Metabolism

Question 11

June 2023 | 8461/1F | Original Q2

0 2 Viruses cause disease.

0 2 . 1 What name is given to microorganisms that cause disease?

[1 mark]

Tick (✓) **one** box.

- Pathogens ☐
- Predators ☐
- Producers ☐

0 2 . 2 The body has defences to stop viruses entering.

Draw **one** line from each defence to the part of the body that provides the defence.

[2 marks]

Defence	Part of the body that provides the defence
A physical barrier that stops viruses entering	Brain
Mucus that traps viruses	Heart
	Nose
	Skin

4.4.2.3 Metabolism

Question 11 · continued

Some viruses can cause tumours to develop.

0 2 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

digestion	division	metabolism

A tumour can form when changes to cells cause uncontrolled cell _____.

0 2 . 4 Malignant tumours are cancers.

Which **two** sentences describe malignant tumours?

[2 marks]

Tick (✓) **two** boxes.

- Malignant tumours are only found in the reproductive system. ☐
- Malignant tumours contain digestive enzymes. ☐
- Malignant tumours do not change in size. ☐
- Malignant tumours have cells that can spread to other parts of the body. ☐
- Malignant tumours may form secondary tumours. ☐

Question 2 continues on the next page

Question 11 · continued

HPV is a virus that can cause one type of cancer in females.

In the UK since 2008, most 12 to 13-year-old females have been vaccinated against HPV.

Scientists investigated the percentage of 16 to 18-year-old females with HPV.

Table 2 shows the results.

Table 2

Year	Percentage (%) of 16 to 18-year-old females with HPV
2010	8.2
2012	3.2
2014	2.0
2016	1.6

0 2 . 5 What does **Table 2** show about the percentage of females with HPV from 2010 to 2016?

[1 mark]

0 2 . 6 Suggest the reason for the change you described in Question **02.5**.

[1 mark]

4.4.2.3 Metabolism

Question 11 · continued

The HPV vaccine contains an inactive form of the virus.

The inactive form of the virus is injected into the body.

0 2 . 7 Which part of the blood responds to the inactive virus?

[1 mark]

Tick (✓) **one** box.

- Platelets ☐
- Red blood cells ☐
- White blood cells ☐

0 2 . 8 What is produced by the body in response to the inactive virus?

[1 mark]

Tick (✓) **one** box.

- Antibiotics ☐
- Antibodies ☐
- Antiseptics ☐

0 2 . 9 Suggest **one** reason why some **parents** refuse to allow their children to have the HPV vaccine.

Do **not** refer to the pain of the injection in your answer.

[1 mark]

_____

_____

11

4.4.2.3 Metabolism

Question 12

June 2025 | 8461/2F | Original Q4

0 4 It is important to maintain the water balance of the body.

The volume of water a person gained and lost was measured on a day the person did no exercise.

Table 2 shows how much water the person gained and lost by different methods on the day.

Table 2

Water gained	
Method	**Volume in cm^3**
Food	550
Drink	1540
Metabolism	410
Total	2500

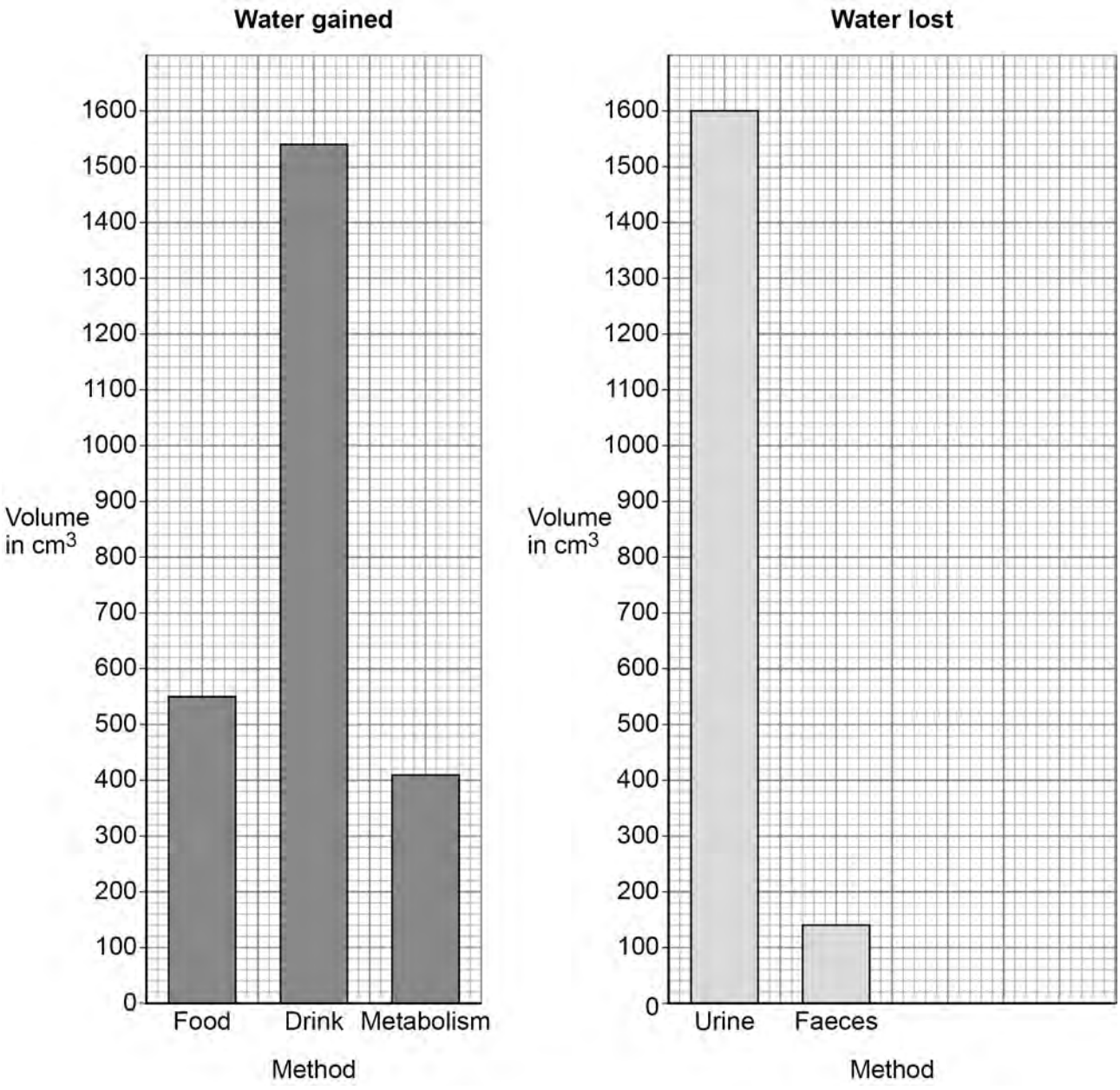
Water lost	
Method	**Volume in cm^3**
Urine	1600
Faeces	140
Sweat	420
Breathing	340
Total	2500

4.4.2.3 Metabolism

Question 12 · continued

Figure 7 shows some of the data from **Table 2**.

Figure 7



0 4 . 1 Complete **Figure 7**.

[2 marks]

You should:

- plot the data for sweat and for breathing from **Table 2**
- label each bar.

Question 4 continues on the next page

Question 12 · continued

0 4 . 2 On another day, the person ran in a long-distance race.

What would happen to the volume of water lost by sweating on the day of the race?

[1 mark]

Tick (✓) **one** box.

Decrease ☐

No change ☐

Increase ☐

0 4 . 3 The kidneys control the amount of water in the body.

Draw **one** line from each process in the kidneys to the name of that process.

[3 marks]

Process in the kidneys	Name of process
Removes water from the blood	Coordination
Takes excess water out of the body	Excretion
Takes water back into the blood	Filtration
	Reabsorption

4.4.2.3 Metabolism

Question 12 · continued

0 4 . 4 A person with kidney failure can be treated by dialysis or by a kidney transplant.

For dialysis:

- a person needs 3 dialysis sessions each week
- each session can last 6 to 8 hours
- each session has to happen in a hospital.

For a kidney transplant:

- a suitable donor is needed
- a surgical operation is needed.

Evaluate the use of a kidney transplant instead of dialysis for treating kidney failure.

Include your own knowledge in your answer.

[4 marks]

Extra space

10