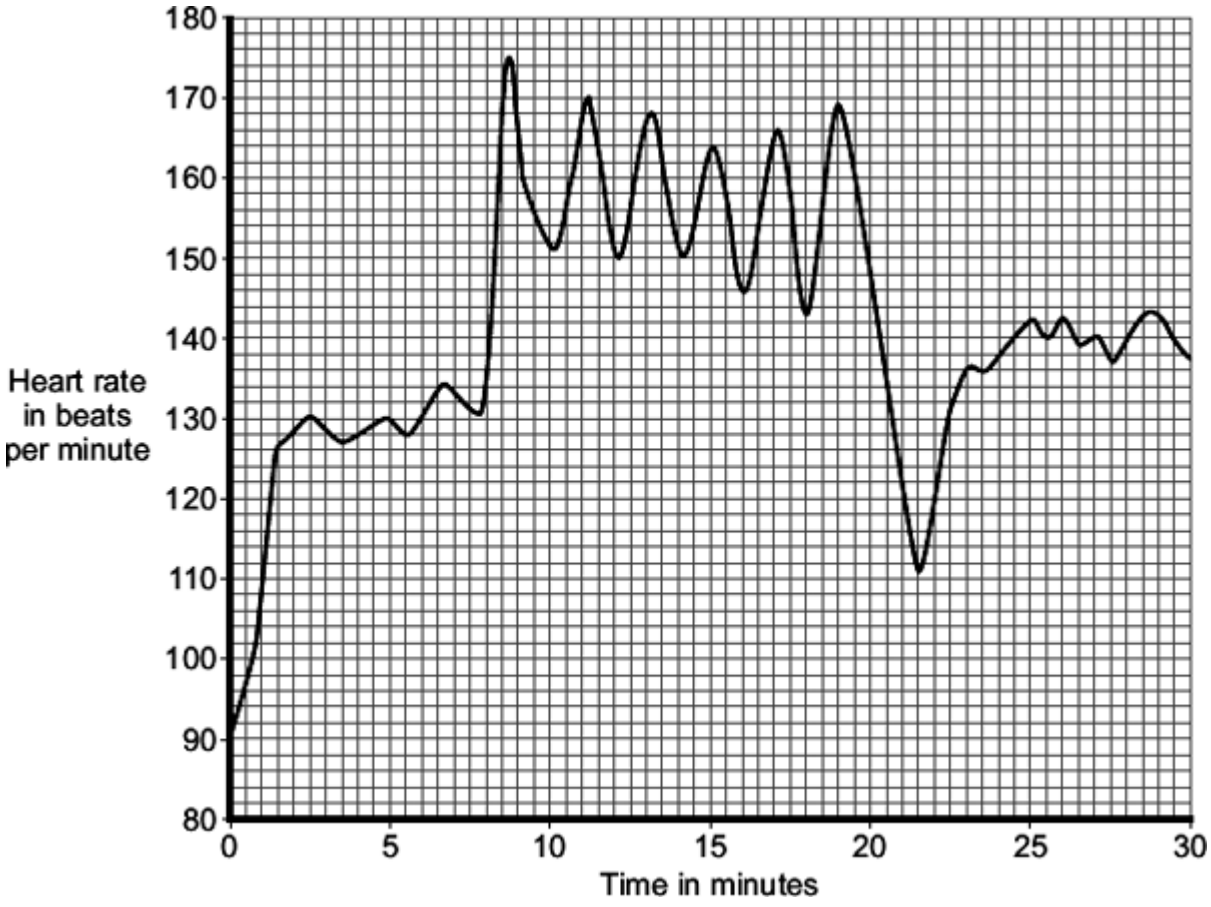
1 One type of training exercise involves alternating periods of walking and running.

The graph shows how an athlete's heart rate changed during one 30-minute training session.



(a) (i) The athlete ran 6 times during the 30-minute training session.

Describe the evidence for this in the graph.

_____

_____

(1)

(ii) Immediately after the final run, the athlete rested for a short time before he started to walk again.

For how many minutes did this rest last?

_____ minutes

(1)

(b) The heart rate increases during exercise.

This increase in heart rate increases blood flow to the muscles.

Explain, as fully as you can, why this increase in heart rate is necessary.

(4)

(Total 6 marks)

2 (a) Use words from the box to complete the equation for aerobic respiration.

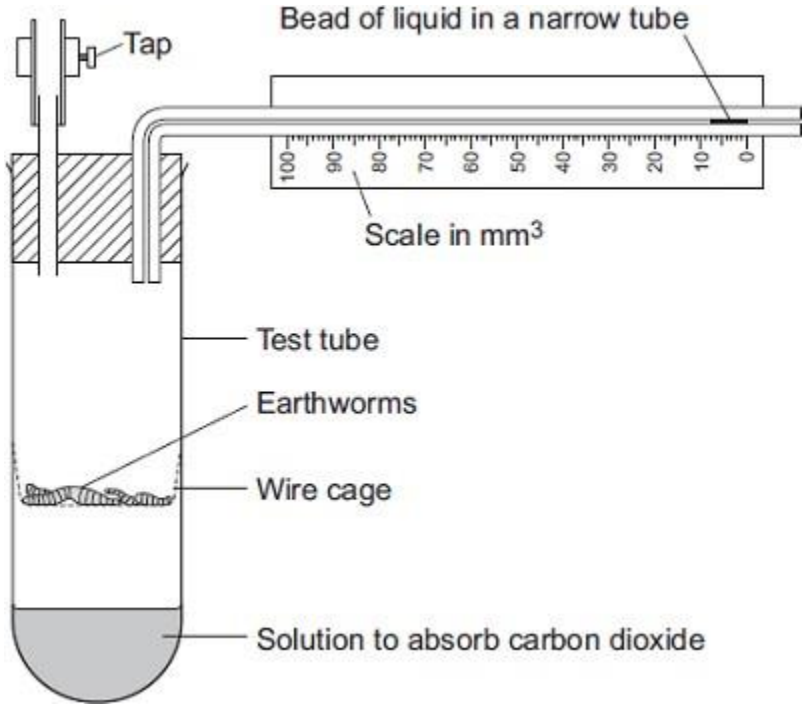
alcohol	**glucose**	**lactic acid**	**water**

_____ + oxygen ⟶ carbon dioxide + _____ (+ energy)

(2)

(b) Some students investigated the effect of temperature on the rate of aerobic respiration in earthworms.

The diagram shows the apparatus the students used.
When the tap is closed, the bead of liquid moves to the left as the earthworms take in oxygen.



The students put the test tube into a water bath at 20°C for 10 minutes.
They left the tap open during this time.

Why did the students put the test tube in the water bath at 20°C for 10 minutes?

Tick (✓) **one** box.

Because the air contains more oxygen at 20°C. ☐

Because the air contains less carbon dioxide at 20°C. ☐

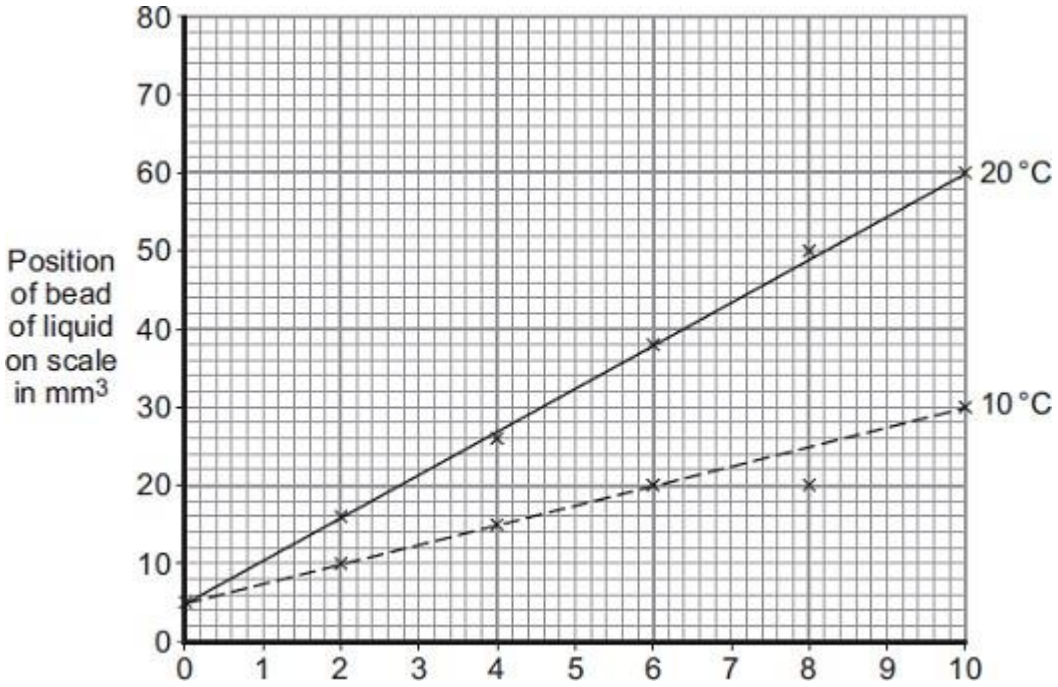
So the earthworms' body temperature would change to 20°C. ☐

(1)

(c) The students then:

- closed the tap
- started a stopwatch
- recorded the position of the bead of liquid every 2 minutes for 10 minutes
- repeated the experiment at 10°C. The

graph shows the students' results.



(i) How much oxygen did the earthworms take in during the 10 minutes at 20°C?

Use information from the graph to work out your answer.

_____

_____

_____

Volume of oxygen taken in =_____ mm^3

(2)

(ii) The earthworms took in this volume of oxygen in 10 minutes.

Use your answer from part (c)(i) to calculate how much oxygen the earthworms took in each minute.

_____

_____

Volume of oxygen taken in = _____ mm^3 per minute

(1)

(iii) The earthworms took in less oxygen each minute at 10°C than they took in at 20°C.

Explain why.

_____

_____

_____

_____

(2)

(d) When drawing the line on the graph for the experiment at 10°C, the students ignored the reading at 8 minutes.

(i) Suggest why they ignored the reading at 8 minutes.

_____

_____

(1)

(ii) One student suggested they should repeat the experiment twice more at each temperature.

How would repeating the experiment improve the investigation?

_____

_____

(1)

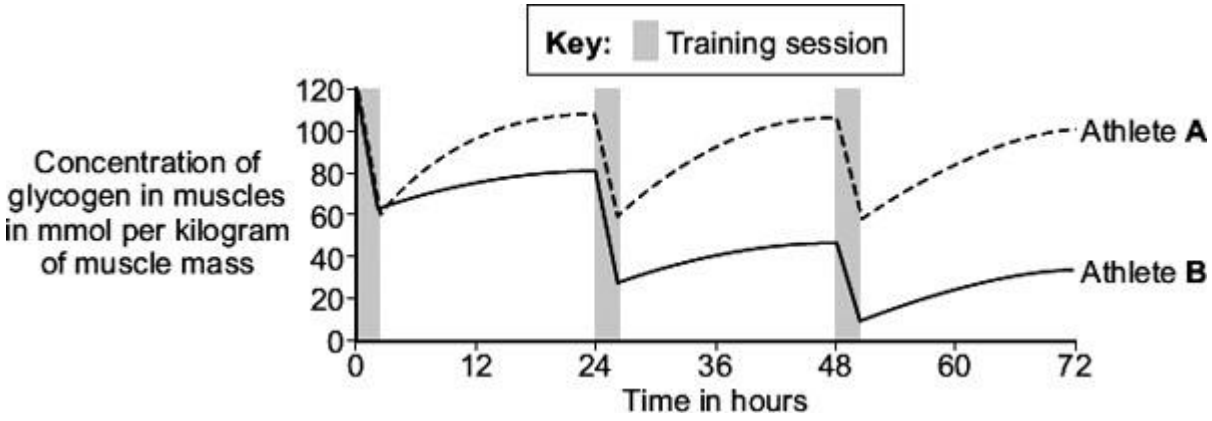
(Total 10 marks)

3 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.



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

_____

_____

_____

_____

_____

_____

(3)

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

_____

_____

_____

_____

(2)

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

_____

_____

(1)

(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.

_____

_____

_____

_____

_____

_____

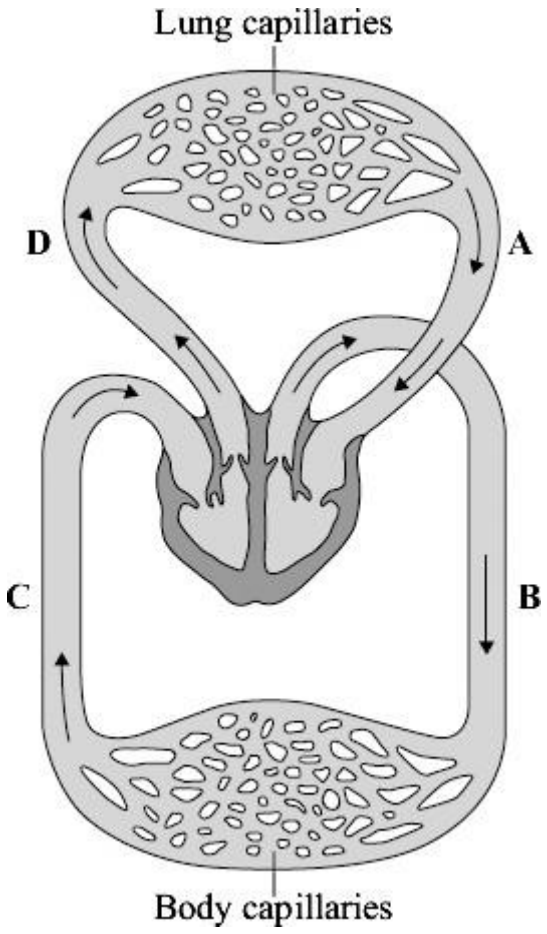
_____

_____

(4)

(Total 10 marks)

4 The diagram shows the human circulation system.



(a) (i) Give the letter of **one** blood vessel that is an artery.

(1)

(ii) Give the letter of **one** blood vessel that carries oxygenated blood.

(1)

(b) During exercise, the heart rate increases.

Explain, as fully as you can, why this increase is necessary.

(4)

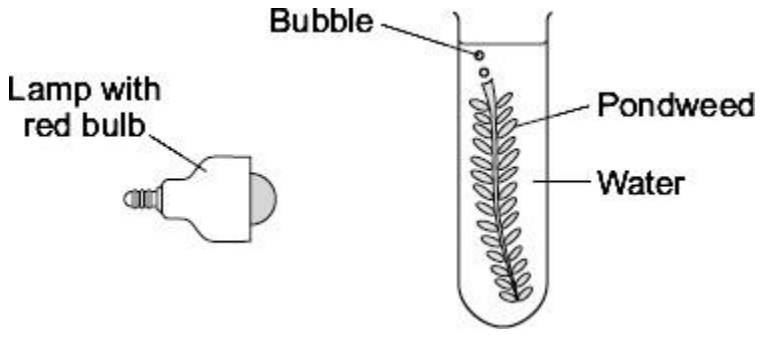
(Total 6 marks)

5 A group of pupils investigated the way in which the colour of light affects photosynthesis.

The pupils:

- put a piece of pondweed into a test tube of water
- shone light from a lamp with a red light bulb onto the pondweed
- counted the bubbles of gas produced by the pondweed every minute for three minutes.

The diagram shows the experiment.



The pupils repeated their experiment using a yellow light bulb, a green light bulb and a blue light bulb.

(a) (i) What was the independent variable in the investigation?

_____

(1)

(ii) To make the investigation fair the pupils needed to control some variables.

Suggest **one** variable that the pupils should have controlled during their investigation.

_____

(1)

(iii) It is better to count the bubbles every minute for three minutes than to count all the bubbles in three minutes.

Why?

_____

_____

(1)

(b) The table shows the pupils' results.

Colour of bulb	**Number of bubbles produced in one minute**			
	1st minute	**2nd minute**	**3rd minute**	**Mean**
Red	24	19	21	21
Yellow	18	14	15	16
Green	6	4	3	4
Blue	32	34	32	33

Algae are tiny organisms that photosynthesise.
In natural light algae grow very quickly on the sides of a fish tank.
The algae make it difficult to see the fish.

(i) What would be the best colour of light bulb to illuminate the fish tank to reduce the growth of algae?

Use the results in the table to help you to decide.

Draw a ring around **one** answer.

red **yellow** **green** **blue**

(1)

(ii) Explain why the colour you have chosen is the best.

_____

_____

_____

_____

(2)

(Total 6 marks)

6 (a) Yeast cells can respire anaerobically.

The equation for anaerobic respiration in yeast is:

glucose ⟶ alcohol + carbon dioxide (+ energy)

Give **one** way in which anaerobic respiration in yeast cells is different from anaerobic respiration in human muscle cells.

_____

_____

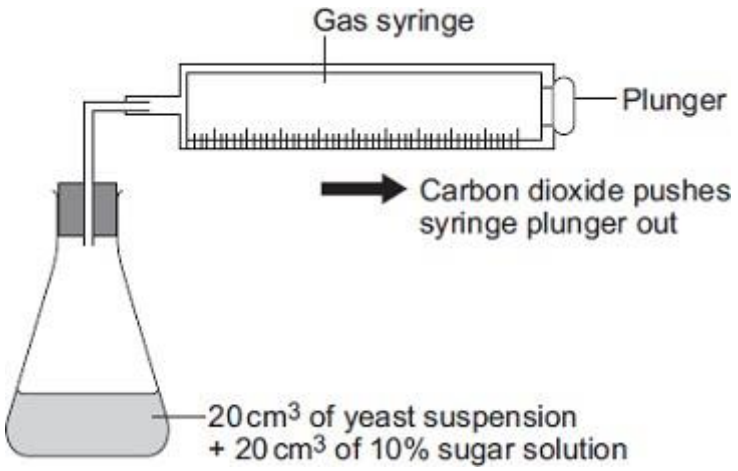
(1)

(b) Yeast can use other types of sugar instead of glucose.
Some scientists investigated the effect of three different types of sugar on the rate of anaerobic respiration in yeast.

The scientists:

- used the apparatus shown in **Diagram 1** with glucose sugar
- kept the apparatus at 20 °C
- repeated the investigation with fructose sugar and then with mannose sugar
- repeated the investigation with water instead of the sugar solution.

Diagram 1



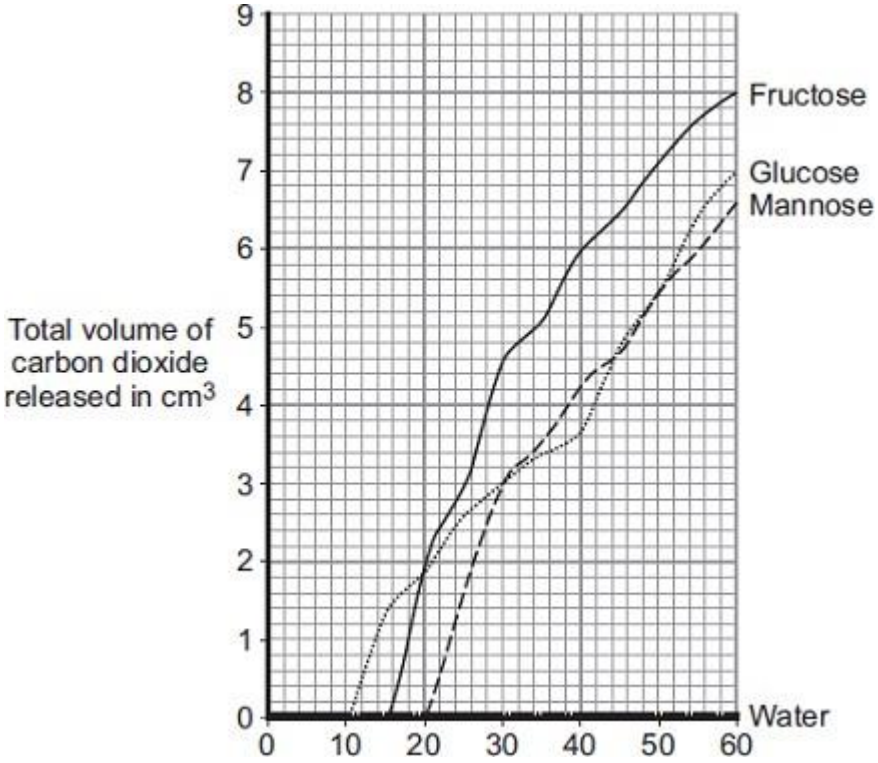
(i) Give **two** control variables the scientists used in this investigation.

_____

_____

(2)

(ii) The graph shows the scientists' results.



From this information, a company decided to use fructose to produce alcohol and **not** mannose or glucose.

Explain the reason for the company's choice.

_____

_____

_____

_____

(2)

(Total 5 marks)

7 Some students investigated the best temperature for gas production by yeast.

The students set up the apparatus as shown in **Diagram 1**.

Diagram 1

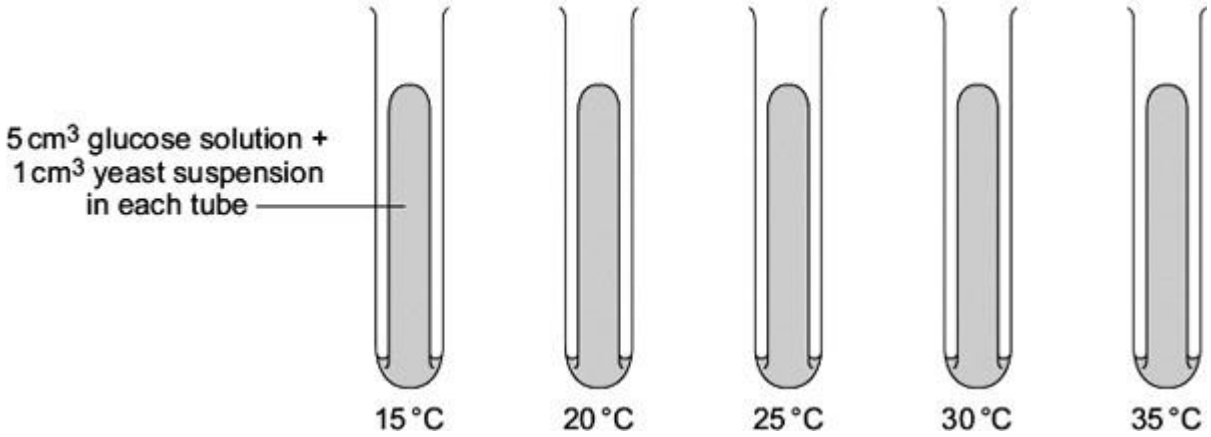
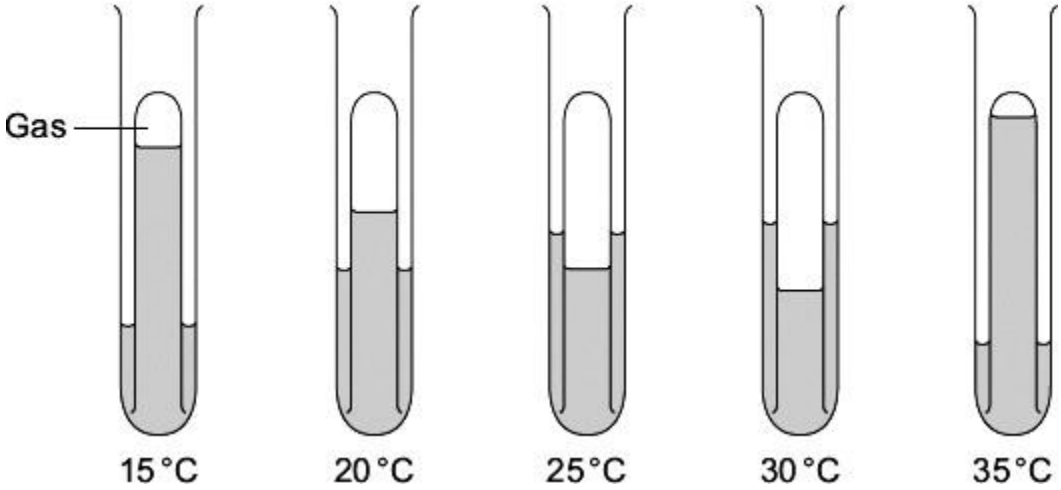


Diagram 2 shows the results after one hour.

Diagram 2



(a) In each apparatus the yeast produced a gas.

(i) Name this gas.

_____

(1)

(ii) Name the process which produces this gas.

_____

(1)

(b) One student said that the best temperature for the yeast to produce the gas was 30 °C.

What is the evidence for this in **Diagram 2?**

_____

_____

(1)

(c) A second student said that the investigation might not have produced reliable results.

(i) What should the students do next to check the reliability of their results?

_____

_____

(1)

(ii) How would the students then know if their results were reliable?

_____

_____

(1)

(d) A third student said that the investigation might not have produced an accurate value for the best temperature for gas production.

What should the students do next to check that 30 °C was an accurate value for the best temperature?

_____

_____

_____

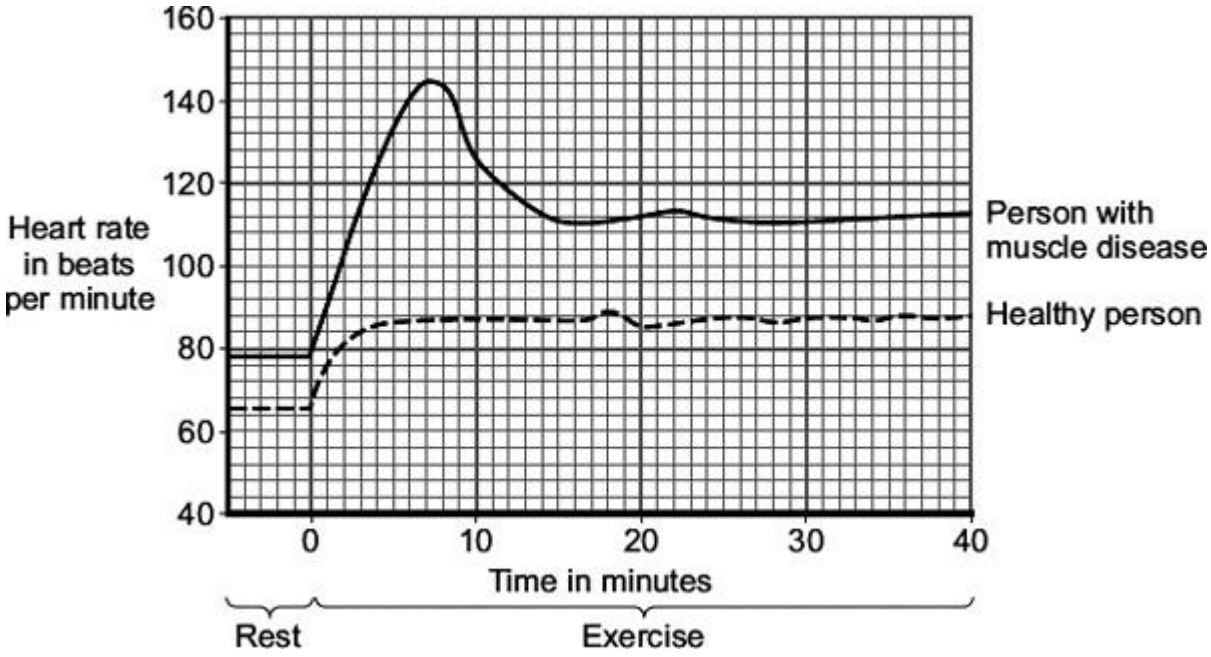
_____

(2)

(Total 7 marks)

8 Two people did the same amount of gentle exercise on an exercise cycle.
One person had a muscle disease and the other had healthy muscles.

The graph shows the effect of the exercise on the heart rates of these two people.



(a) Describe **three** ways in which the results for the person with the muscle disease are different from the results for the healthy person.

To gain full marks in this question you need to include data from the graph in your answer.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) The blood transports glucose to the muscles at a faster rate during exercise than when a person is at rest.

(i) Name **one** other substance that the blood transports to the muscles at a faster rate during exercise.

_____

(1)

(ii) People with the muscle disease are not able to store glycogen in their muscles.

The results shown in the graph for the person with the muscle disease are different from the results for the healthy person.

Suggest an explanation for the difference in the results.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Mark schemes

1 (a) (i) 6 peaks in heart rate

*accept 6 increases / spikes **or** goes very high 6 times*

allow heart rate increases each time he runs

1

(ii) 2.5 / 2½

allow 2 minutes 30 seconds

*do **not** accept 2.3 / 2:3 / 2.30*

1

(b) *more / faster / a lot **must** be stated at least once for full marks*

(more) oxygen supplied / needed

allow less anaerobic (respiration)

or (more) aerobic respiration

***or** prevents oxygen debt*

1

(more) glucose / sugar / food supplied / needed

ignore feeding

1

(more) energy needed / released

allow energy produced / made

1

(more) carbon dioxide / heat / lactic acid removed (from muscles) **or** more cooling

or less lactic acid formed

1

[6]

2 (a) LHS – glucose

1

RHS – water

allow H_2O / H2O

1

(b) so the earthworms' body temperature would change to 20°C

1

(c) (i) 56 or 55 or 54

*if incorrect answer given accept 60 - 5 for **1** mark*

*or 60 – 6 for **1** mark*

*or 60 – 4 for **1** mark*

2

(ii) one-tenth of answer to (c)(i) eg 5.5

1

(at 10°C / lower temperature):

lower rate of respiration

allow chemical reactions slower or enzymes less active

ignore breathing

do not allow anaerobic

1

worms less active / worms release less energy / worms use less energy

1

(d) (i) anomalous result / not in line with other data / does not fit the pattern

1

(ii) more representative / more reliable / can check 'repeatability' / see if get similar values / identify anomalies

ignore valid / more fair

ignore reproducible

ignore 'to remove' anomalies

do not accept more accurate or more precise

1

[10]

3 (a) (i) any **three** from:

*if diet given as answer = max **2***

- age (of athlete)
- gender (of athlete)
- starting concentration of glycogen
- type / intensity of exercise
- length of exercise period
- number of training sessions

*if none of these points gained amount of exercise = **1** mark*

- time interval between exercise sessions
- exercise at same time of day

*if last four points not awarded allow time (for exercise) for **1** mark*
ignore references to amount of energy
ignore they are both athletes

3

(ii) any **two** from:

- intensity of exercise
- amount of exercise between sessions
- starting concentration of glycogen
- fitness / health
- metabolic rate / respiration rate
- amount / mass of muscle / physique
- aspects of diet qualified, eg amount of food eaten

*do **not** accept amount of carbohydrate*

*if no other marks awarded allow height / mass / weight for **1** mark*

2

(iii) (B has) less glycogen

he = B

or (B's glycogen) fell more

accept use of approximate figures

or (B's glycogen) built up less

allow other correct observations from graph eg A is lower at end of first session

ignore rate of fall

1

(b) athlete **A** (no mark)

to gain full marks 'more' must be given at least once

athlete **A** had more glycogen / **B** has less (only if A chosen to complete marathon)

*accept converse argument for **B***

1

(glycogen / glucose) used in respiration

ignore anaerobic

1

(more) energy released / available in athlete **A**

allow 'energy made'

1

and either energy used for movement / muscle action / to run

or

(extra) glycogen → (more) glucose

1

[10]

4 (a) (i) B **or** D

1

(ii) A **or** B

1

(b) any **four** from:

more / faster must be implied at least once for full marks

- increased blood (flow)
  ignore reference to breathing
- (more) oxygen supplied **or** aerobic respiration
  *allow less anaerobic (respiration) **or** and prevents oxygen debt*
- (more) glucose / sugar / food supplied
  ignore feeding
- (higher rate of) respiration
- (more) energy needed / released
  allow made
- (more) carbon dioxide removed
- (muscles) doing (more) work **or** muscles contracting
- remove heat / cooling
- remove lactic acid **or** less lactic acid formed

4

[6]

5 (a) (i) colour of light / bulb / lamp

allow wavelength for colour

allow bulb alone

*do **not** accept light / colour unqualified*

1

(ii) any **one** from eg

- temperature
  allow heat
- light intensity **or** distance between lamp and plant / tube
  allow amount / brightness of light
  ignore light unqualified
- carbon dioxide
  allow symbols
- other light in room
  allow use a dark room
- mass / size / amount / age / type of pondweed
  allow same piece of pondweed
  ignore pondweed unqualified
- volume / amount of water
  ignore reference to time

1

(iii) improved reliability
*allow for reliability **or** less likely to lose count*

or

can spot anomalies / changes
allow reference to calculating a mean / average
ignore reference to accuracy / precision / fair

1

(b) (i) green

1

(ii) any **two** from:
ignore references to colour

- least / less bubbles / gas / oxygen / mean
  *reference to least / less needed only once, in context, for **2** marks*
- least / less photosynthesis
- least / less glucose / sugar / carbohydrate / food made
  only penalise no once, ie
  *no bubbles = **0** mark*
  *no bubbles so no photosynthesis = **1** mark*
  allow most / more green light reflected (by chloroplasts)

2

[6]

6 (a) in yeast:

'it' equals yeast

<u>makes</u> alcohol / <u>makes</u> CO^2 / does not <u>make</u> lactic acid

do not allow uses / involves alcohol / CO^2

1

(b) (i) any two from:

allow amount of yeast

- volume of yeast / suspension
- volume of sugar / solution
- concentration of sugar

  amount of sugar = max 1 for sugar
- temperature

(total) volume = 1 mark if no other volume

ignore concentration of yeast

2

(ii) most / more CO^2 given off with fructose **or**

'it' equals fructose

faster CO^2 production

or

faster respiration

allow faster fermentation

1

*do **not** allow aerobic respiration*

so (rate of) alcohol production will be greatest / more (with fructose)

1

[5]

7 (a) (i) carbon dioxide

accept CO_2 / CO2

*do **not** accept CO^2*

1

(ii) fermentation / respiration

ignore aerobic / anaerobic

1

(b) most / more gas (produced)

*do **not** allow 'a lot'*

or

allow alternative descriptions

liquid level lowest

ignore name of gas

1

(c) (i) repeat

ignore reference to average or mean

or

compare with results of others

1

(ii) if reliable - get same / similar results

*allow same pattern but **not** pattern alone*

or

allow no anomalies

small range

ignore anomalies unqualified

1

(d) use smaller intervals

can be implied

1

around 30°C **or** between 25°C and 35°C

*do **not** allow for temperatures below 25°C above 35°C*

ignore references to sensitivity or precision (of thermometer)

*NB do at 28°C, 30°C and 32°C = **2** marks*

1

[7]

8 (a) person with muscle disease:

allow reverse argument for healthy person

any **three** from:

NB all points are comparative except peak (point 3)

*allow use of **two** approximate figures as a comparison*

- higher resting rate **or** higher at start
- when exercise starts / then increases more / more rapidly

  accept description eg rise …. fall
- peaks (then falls)
- levels off later than healthy person
- higher rate during exercise

  *if no other marks awarded allow **1** mark for 'it's higher'*
- greater range

3

(b) (i) oxygen

accept adrenaline

accept O_2

*do **not** accept O, O2 or O^2*

1

(ii) cannot release sugar / glucose (from glycogen)

or

cannot store glucose / sugar (as glycogen)

1

need to receive glucose / sugar (from elsewhere)

ignore oxygen

1

for energy / respiration / cannot store energy

ignore aerobic / anaerobic

1

[7]