A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY **H**

Higher Tier

Paper 2   Life and Environmental Sciences

8465/2H

Thursday 25 May 2023   Morning

Time allowed: 1 hour 45 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

MATERIALS
For this paper you must have:
- **a ruler**
- **a protractor**
- **a scientific calculator**
- **the periodic table (enclosed)**
- **the Physics Equations Sheet (enclosed).**

INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**

- **Answer ALL 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).**

- **Do all rough work in this book. Cross through any work you do not want to be marked.**

- **In all calculations, show clearly how you work out your answer.**

INFORMATION

- **The maximum mark for this paper is 100.**

- **The marks for questions are shown in brackets.**

- **You are expected to use a calculator where appropriate.**

- **You are reminded of the need for good English and clear presentation in your answers.**

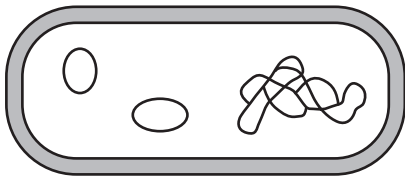**DO NOT TURN OVER UNTIL TOLD TO DO SO**

0 1

All living organisms are made of cells.

FIGURE 1 shows two types of cell.

FIGURE 1

CELL A
Bacterial cell

CELL B
Liver cell

4.4 micrometres
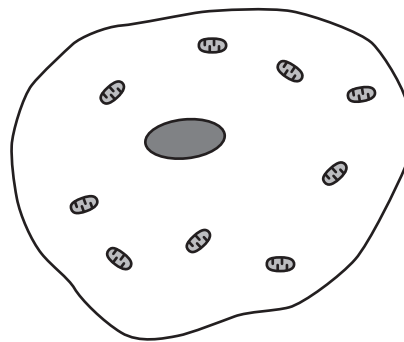
28.6 micrometres

Not to scale

0 1 . 1

Calculate how many times longer the liver cell is than the bacterial cell. [2 marks]

_____

_____

_____

Number of times longer = _____

0	1	.	2

Compare the structure of cell A with the structure of cell B.

You should include similarities and differences in your answer.

Do NOT refer to cell size. [4 marks]

_____

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| 0 | 1 | . | 3 |

In multicellular organisms, cells are organised into tissues.

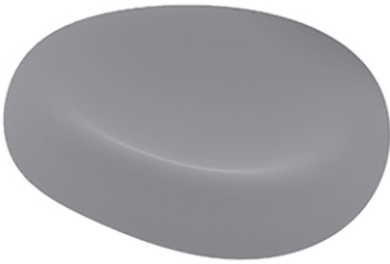**What is meant by a 'tissue'? [1 mark]**

_____

_____

_____

A scientist investigated the effect of different concentrations of sugar solution on red blood cells.
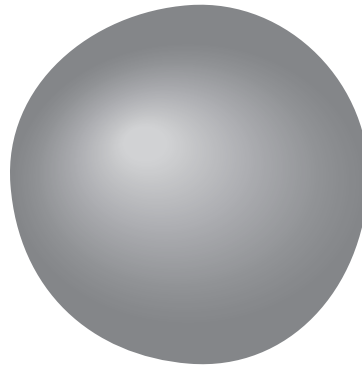
FIGURE 2 shows the effect of placing a red blood cell into a sugar solution.

FIGURE 2

Red blood cell BEFORE being placed in sugar solution

Red blood cell AFTER being placed in sugar solution

[Turn over]

| 0 | 1 | . | 4 |

What conclusion can be made from the result in FIGURE 2 on page 7? [1 mark]

Tick (✓) ONE box.

☐ **The sugar solution was less concentrated than inside the cell.**

☐ **The sugar solution was the same concentration as inside the cell.**

☐ **The sugar solution was more concentrated than inside the cell.**

A student investigated the effect of different concentrations of sugar solution on the change in mass of plant tissue.

The student used pieces of potato.

| 0 | 1 | . | 5 |

Describe a method the student could use to produce valid results. [6 marks]

_____

_____

_____

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_____

_____

The student used a valid method.

The student calculated the percentage change in mass of the pieces of potato.

TABLE 1 shows the results.

TABLE 1

CONCENTRATION OF SUGAR SOLUTION IN mol/dm^3	PERCENTAGE (%) CHANGE IN MASS
0.0	28
0.1	15
0.2	3
0.3	–5
0.4	–10
0.5	–12

[Turn over]

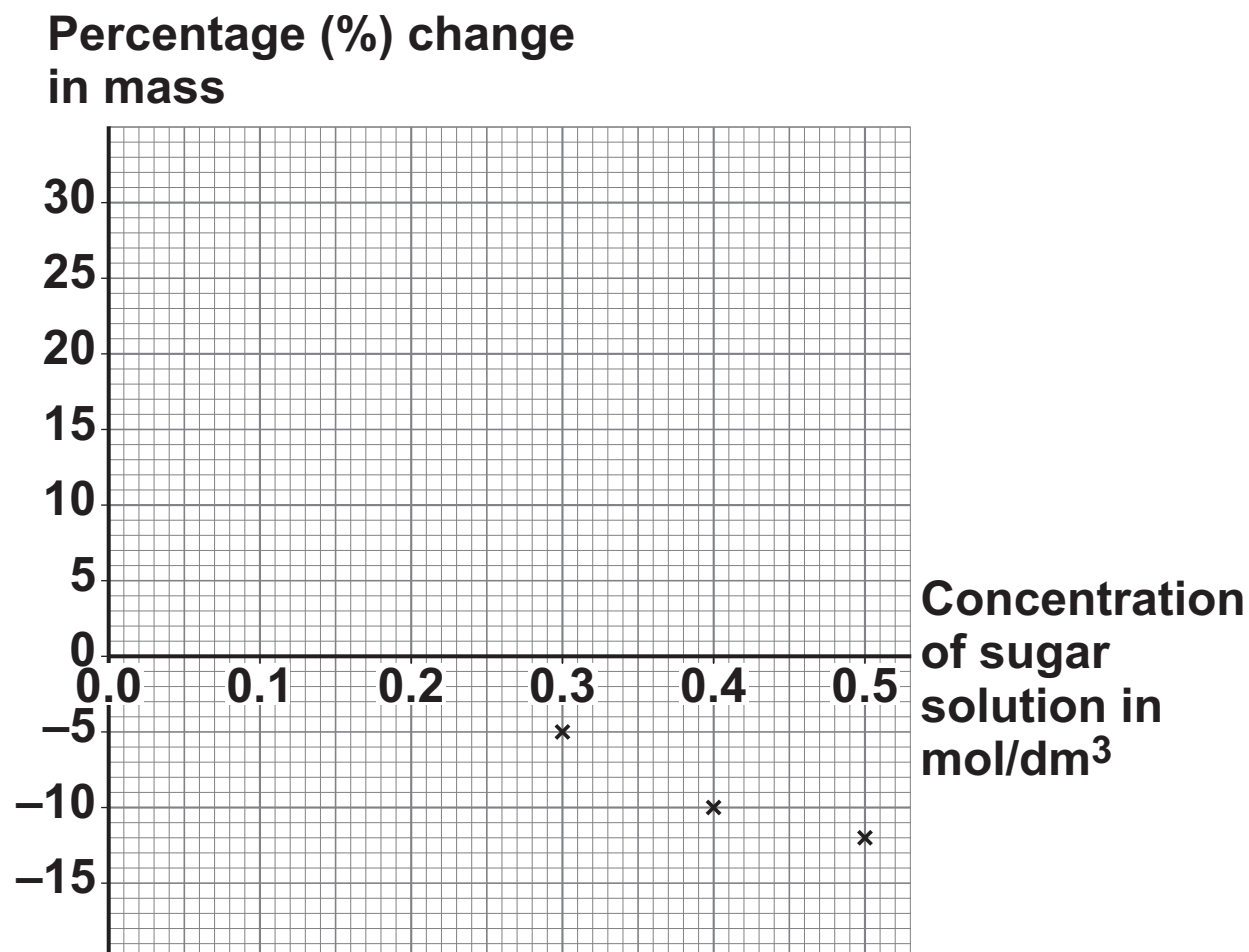| 0	1	.	6

Complete FIGURE 3.

You should:

- plot the data from TABLE 1 on page 11.
- draw a line of best fit.

Some of the results have been plotted for you.
[2 marks]

FIGURE 3

Percentage (%) change in mass vs Concentration of sugar solution in mol/dm^3

| 0 | 1 | . | 7 |

Determine the concentration of sugar solution that would cause no change in the mass of a piece of the potato.

Use FIGURE 3 on page 12. [1 mark]

Concentration of sugar solution =

_____ **mol/dm^3**

| 17 |

[Turn over]

0	2

A student investigated how the density of a liquid affects the position of a wooden block floating in the liquid.

FIGURE 4 shows the apparatus.

FIGURE 4

Wooden block

Liquid surface

Beaker

Bottom of block

Liquid

Ruler

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
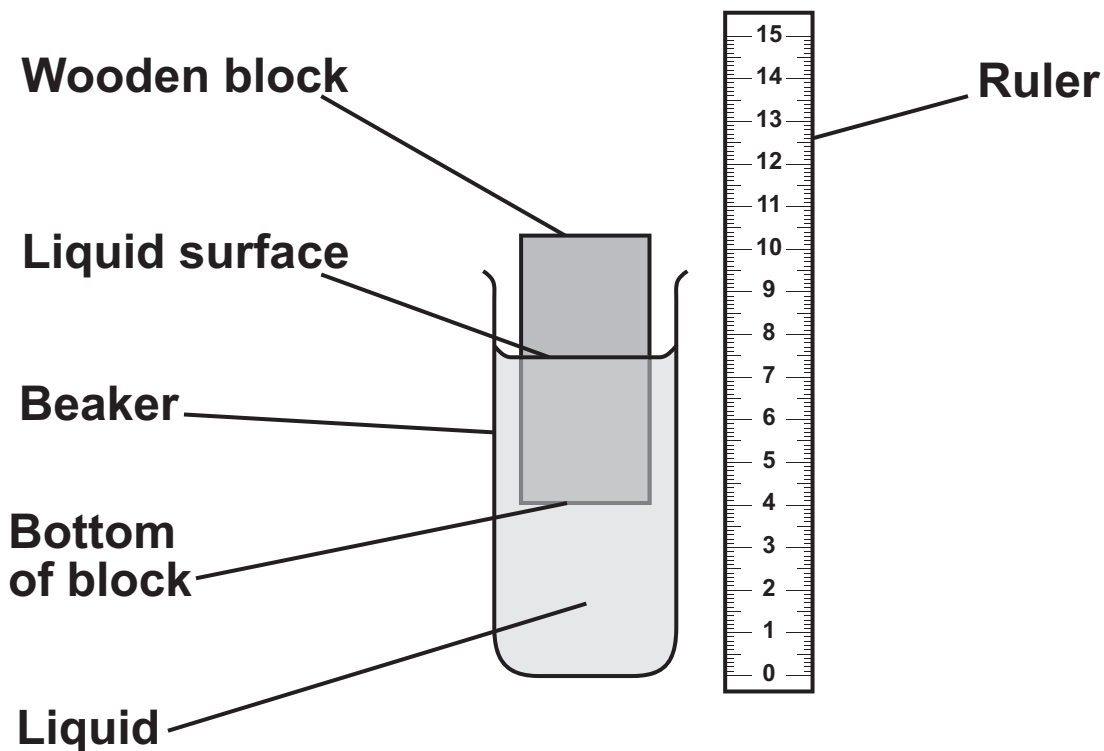
This is the method used.

1. **Put the wooden block in the beaker of liquid.**

2. **Allow the wooden block to come to rest so that it is floating in the liquid.**

3. **Measure the distance between the liquid surface and the bottom of the block.**

4. **Repeat steps 1 to 3 with liquids of different densities.**

| 0 | 2 |.| 1 |

Give the independent variable in the investigation.
[1 mark]

_____

_____

_____

| 0 | 2 |.| 2 |

Give ONE control variable for the investigation.
[1 mark]

_____

_____

_____

| 0 | 2 |.| 3 |

Give ONE possible source of error when the student measured the distance between the liquid surface and the bottom of the block. [1 mark]

_____

_____

_____

[Turn over]

| 0 | 2 | . | 4 |

TABLE 2 shows the results.

TABLE 2

LIQUID	DENSITY OF LIQUID IN g/cm^3	DISTANCE BETWEEN LIQUID SURFACE AND BOTTOM OF THE BLOCK IN cm
A	1.4	5.5
B	1.2	6.4
C	1.0	7.7
D	0.9	8.5

Give ONE conclusion from the results. [1 mark]

_____

_____

_____

Use the Physics Equations Sheet to answer questions 02.5 and 02.6.

0 2 . 5

Which equation links density (ρ), mass (m) and volume (V)? [1 mark]

Tick ($\checkmark$) ONE box.

$\square$ $\rho = m \times V$

$\square$ $\rho = \dfrac{m}{V}$

$\square$ $\rho = m \times V^3$

$\square$ $\rho = \dfrac{V}{m}$

[Turn over]

| 0 | 2 | . | 6 |

The density of the wooden block was 0.85 g/cm^3.

The mass of the wooden block was 30.6 g.

Calculate the volume of the wooden block in cm^3.
[3 marks]

_____

_____

_____

_____

_____

_____

_____

Volume of wooden block = _____ cm^3

| 0 | 2 |.| 7 |

Liquid C is water.

When liquid water is heated to its boiling point the water changes state.

What happens to the density of the liquid water as it changes state? [2 marks]

Tick (✓) ONE box.

☐   **The density decreases**

☐   **The density stays the same**

☐   **The density increases**

Give a reason for your answer.

_____

_____

_____

| 10 |

[Turn over]

0 3

The small intestine (gut) is adapted to digest and absorb food molecules.

Digested food molecules pass across the wall of the small intestine into the blood.

FIGURE 5 shows part of the wall of the small intestine.

FIGURE 5

Wall of small intestine
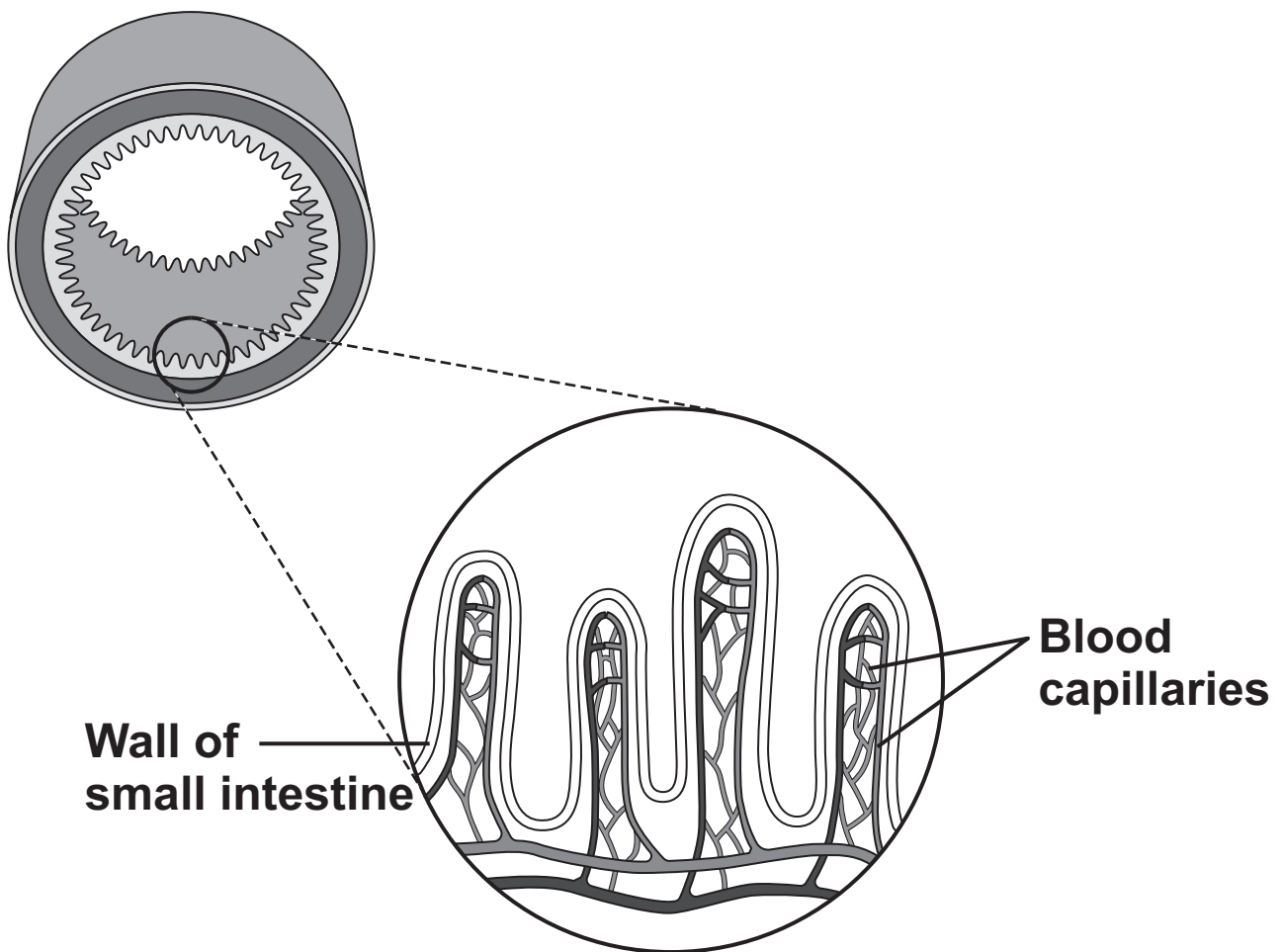
Blood capillaries

0	3	.	1

The small intestine is adapted to increase the efficiency of absorption of digested food.

Two adaptations of the small intestine are:

- **a thin wall**
- **a constant blood flow through the capillaries.**

Describe how each adaptation allows the efficient absorption of digested food. [2 marks]

Thin wall _____

_____

_____

_____

Constant blood flow _____

_____

_____

_____

A student used partially permeable tubing to make a model of a human small intestine.

FIGURE 6 shows the apparatus used.

FIGURE 6
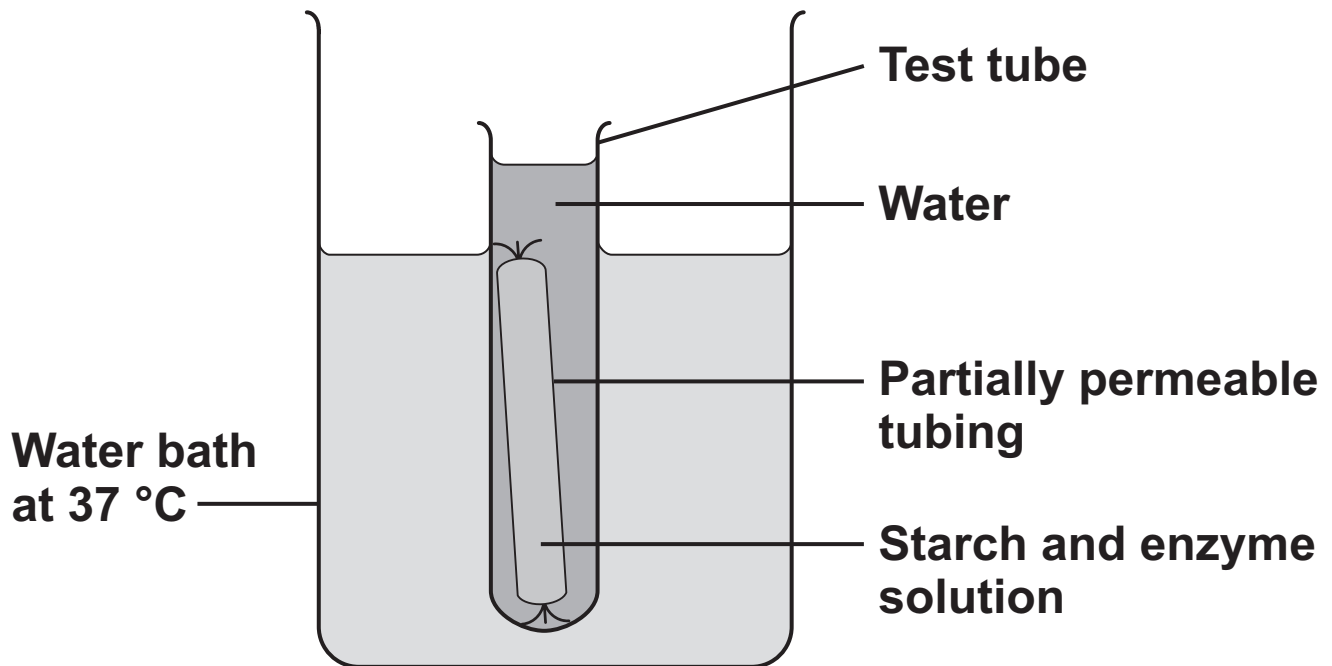
This is the method used.

1. Add starch and enzyme solution to the tubing.

2. Take a sample of the mixture from inside the tubing and a sample of the water from the test tube.
    Test each sample:

    *   using the iodine test
    *   using the Benedict's test.

3. Place the test tube into a water bath at 37 °C.

4. Repeat step 2 after 30 minutes.

| 0 | 3 | . | 2 |

What type of enzyme breaks down starch? [1 mark]

_____

_____

| 0 | 3 | . | 3 |

The water bath was kept at 37 °C.

Explain why 37 °C was the most suitable temperature for the investigation. [2 marks]

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[Turn over]

TABLE 3 shows the results.

TABLE 3

TEST	SAMPLE TESTED	RESULT OF IODINE TEST	RESULT OF BENEDICT'S TEST
1	Mixture inside tubing at start	✓	✗
2	Water from test tube at start	✗	✗
3	Mixture inside tubing after 30 minutes	✓	✓
4	Water from test tube after 30 minutes	✗	✓

KEY

✗ negative test result

✓ positive test result

| 0 | 3 | . | 4 |

Explain the results for test 3. [2 marks]

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| 0 | 3 |.| 5 |

Explain the results for test 4. [3 marks]

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10

[Turn over]

0 4

Pollutants in the atmosphere can be harmful to the environment and to human health.

Four pollutants in the atmosphere are:

- **carbon monoxide**
- **oxides of nitrogen**
- **particulates**
- **sulfur dioxide.**

0 4 . 1

Describe how carbon monoxide is produced from hydrocarbon fuels. [1 mark]

_____

_____

_____

0 4 . 2

Describe ONE harmful effect of oxides of nitrogen. [1 mark]

_____

_____

_____

FIGURE 7 shows the emissions of three atmospheric pollutants from 1970 to 2019.

FIGURE 7

Emission of pollutants in millions of kg
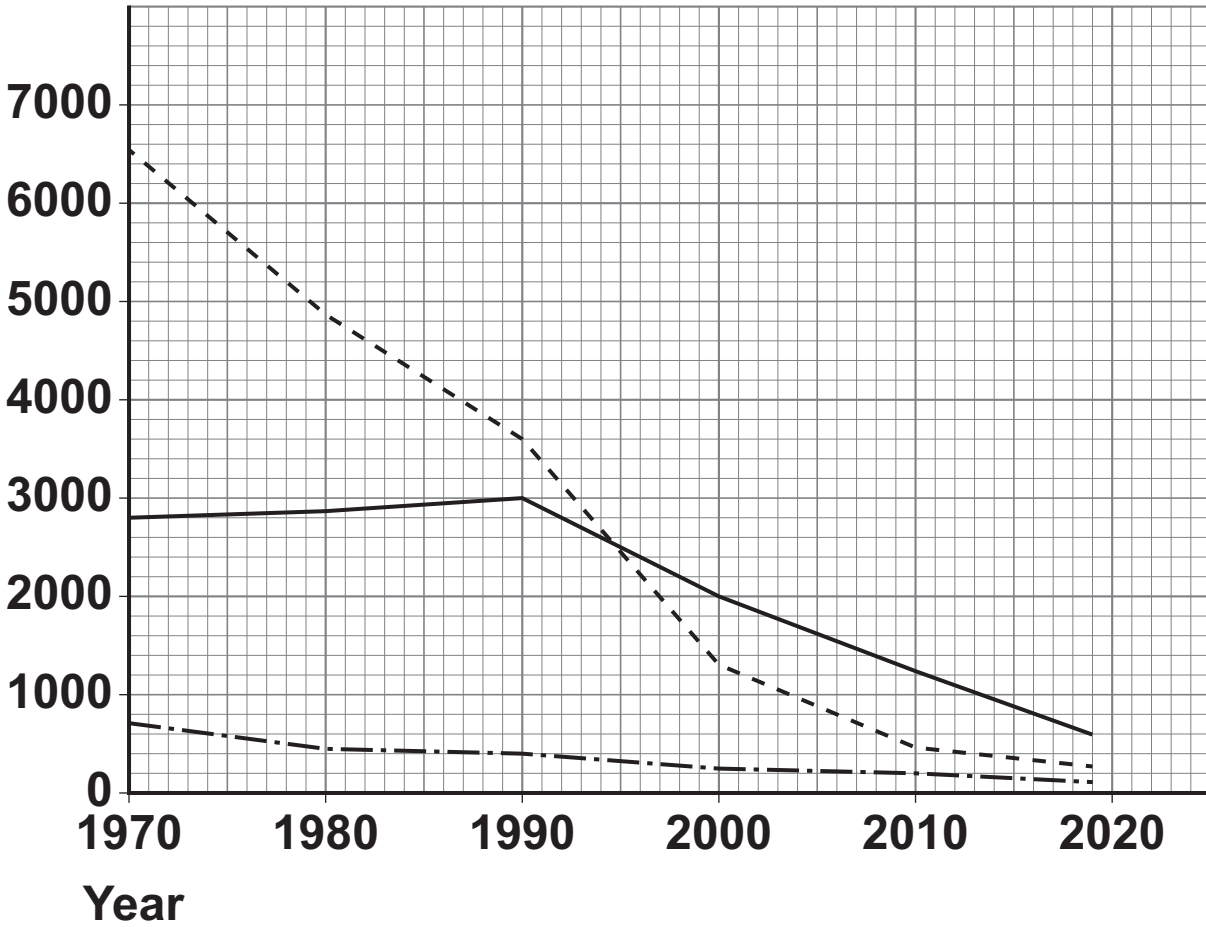
KEY

------ **Sulfur dioxide**

——— **Oxides of nitrogen**

--·—·—·- **Particulates**

[Turn over]

0 4 . 3

Determine the percentage change in emission of oxides of nitrogen from 1970 to 2019.

Give your answer to 2 significant figures. [4 marks]

_____

_____

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_____

Percentage change (2 significant figures) =

_____ **%**

| 0 | 4 | . | 4 |

Compare the changes in the emission of atmospheric pollutants from 1970 to 2019.

You should refer to:

- **sulfur dioxide**
- **oxides of nitrogen**
- **particulates.**

Use FIGURE 7 on page 27. [3 marks]

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[Turn over]

0 4 . 5

Suggest ONE reason for the change in the emission of atmospheric pollutants shown in FIGURE 7 on page 27.
[1 mark]

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Particulates are classified into different groups depending on diameter of the particulate.

TABLE 4 shows information about the different groups.

TABLE 4

PARTICULATE GROUP	PARTICULATE DIAMETER IN MICROMETRES
PM_{10}	>2.5 and <10
$PM_{2.5}$	>0.1 and <2.5
$PM_{0.1}$	<0.1

| 0 | 4 | . | 6 |

A soot particle was viewed using a microscope.

The magnification used was × 5000.

The diameter of the image of the soot particle was 7.5 mm.

Determine the particulate group of the soot particle.

1 mm = 1000 micrometres

Use TABLE 4 on page 30. [5 marks]

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[Turn over]

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Real diameter of soot particle =

_____ micrometres

Particulate group.

Tick (✓) ONE box.

PM_{10} ☐ **$PM_{2.5}$** ☐ **$PM_{0.1}$** ☐

0 4 . 7

Particulates in the air can be breathed in.

The body's defences prevent particulates larger than 10 micrometres getting into the lungs.

Describe how the body prevents the particulates reaching the lungs AND removes the particulates from the airways. [3 marks]

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18

[Turn over]

0 5

In managed forests:

- **tree seedlings are regularly planted**
- **some trees are regularly removed.**

0 5 . 1

Some of the young trees in a managed forest are removed every year.

The biomass of wood produced by the remaining trees in the forest is increased by removing the young trees.

Explain why. [2 marks]

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0 5 . 2

Explain how the processes of photosynthesis and respiration in a tree are involved in the production of new biomass for the tree. [5 marks]

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[Turn over]

0	5	.	3

Planting trees to maintain forests is good for the environment.

Explain the environmental AND biological benefits of maintaining forests. [6 marks]

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13

[Turn over]

0 6

Bees have a simple nervous system.

The bee nervous system has similar features to the human nervous system.

The bee's antenna is a sense organ.

FIGURE 8 shows a bee feeding on a flower.

FIGURE 8

Bees feed on sugar solution produced by the flowers of plants.

0 6 . 1

When an antenna of a bee touches sugar solution the bee automatically sticks out its tongue. This response is a reflex action.

Describe the nervous pathway for the reflex action.
[5 marks]

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Some species of flowers produce sugar solution that contains the chemical caffeine.

A scientist investigated the effect of caffeine on the feeding behaviour of bees.

The investigation was carried out in a laboratory.

This is the method used.

1. Feed 15 newly hatched bees on sugar solution for 24 hours.

2. Release the bees.

3. Record the number of visits made by the bees to a feeder containing sugar solution in 3 hours.

4. Repeat steps 2 and 3 for a further 2 days.

The scientist then took another 15 newly hatched bees and repeated the same method using a sugar and caffeine solution.

TABLE 5 shows the results.

TABLE 5

CONTENT OF FEEDER	MEAN NUMBER OF VISITS IN 3 HOURS PER BEE		
	DAY 1	DAY 2	DAY 3
Sugar solution	18	11	4
Sugar and caffeine solution	23	20	12

| 0 | 6 | . | 2 |

The scientist controlled the concentration of the solutions.

Give ONE other variable that should have been a control variable in the investigation. [1 mark]

_____

_____

_____

[Turn over]

0 6 . 3

The scientist concluded that:

'Caffeine affects the feeding behaviour of bees.'

Evaluate the scientist's conclusion.

Use data from TABLE 5 on page 41 and information from the method. [4 marks]

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10

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[Turn over]

0 7

Ultraviolet waves and visible light waves are types of radiation in the electromagnetic spectrum.

0 7 . 1

How does the frequency of ultraviolet waves compare with the frequency of visible light waves? [1 mark]

Tick (✓) ONE box.

☐ **The frequency of ultraviolet waves is higher than the frequency of visible light waves.**

☐ **The frequency of ultraviolet waves is the same as the frequency of visible light waves.**

☐ **The frequency of ultraviolet waves is lower than the frequency of visible light waves.**
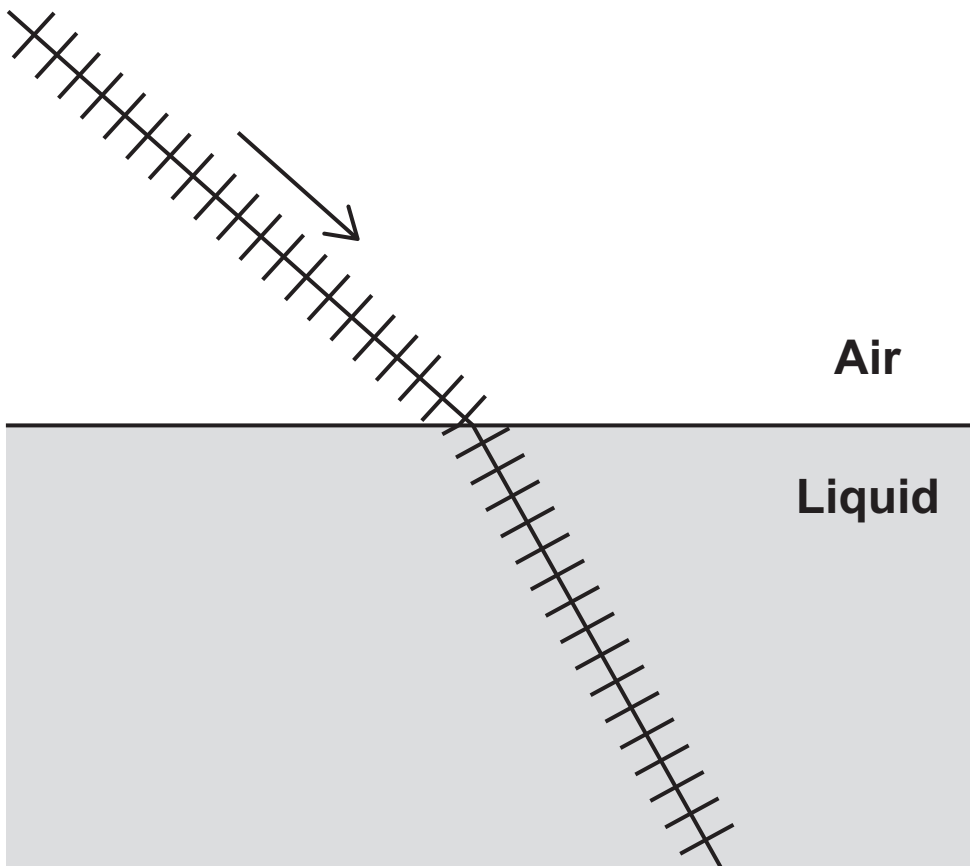
| 0 | 7 | . | 2 |

An ultraviolet wave has a wavelength of 340 nanometres.

speed of electromagnetic radiation = 3.0×10^8 m/s

Calculate the frequency of the ultraviolet wave.

Use the Physics Equations Sheet. [4 marks]

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_____

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_____

Frequency = _____ Hz

[Turn over]

0 7 . 3

FIGURE 9 shows the wavefronts of a visible light wave passing from air into a liquid.

FIGURE 9

Explain why the wave refracts as it passes from the air into the liquid. [3 marks]

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8

[Turn over]

0	8

FIGURE 10 shows a rock pool on a sea shore.

Rock pools are flooded twice a day with fresh sea water.

FIGURE 10

The sea

Rock pool

0	8	.	1

What is the community of the rock pool?
[1 mark]

Tick (✓) ONE box.

☐ **The living organisms and abiotic factors in the rock pool**

☐ **The number of different species in the rock pool**

☐ **The number of predators and prey in the rock pool**

☐ **The populations of all the species that live in the rock pool**

[Turn over]

Starfish are animals that live in rock pools.

A scientist investigated the effect that starfish had on the number of species in rock pools.

This is the method used.

1. Count the number of species in rock pool A and in rock pool B.

2. Regularly remove all the starfish from rock pool B.

3. Count the number of species in rock pool A and in rock pool B each year for 10 years.

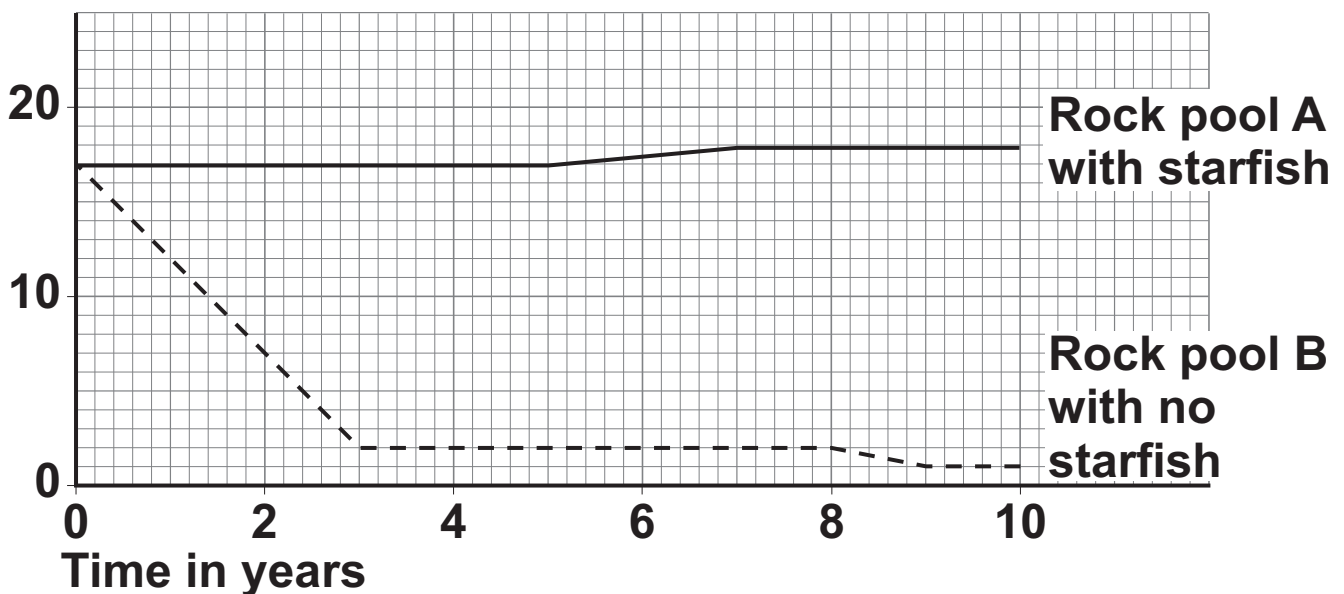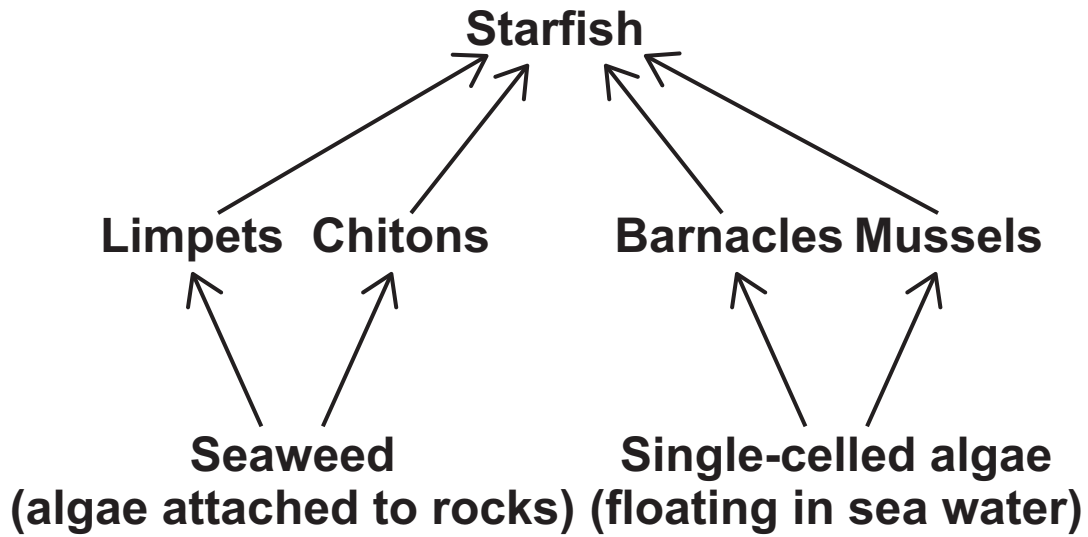FIGURE 11 shows the results.

FIGURE 11

Number of species

Time in years

Rock pool A with starfish

Rock pool B with no starfish

FIGURE 12 shows a food web in the rock pools.

FIGURE 12

Starfish

Limpets Chitons   Barnacles Mussels

Seaweed   Single-celled algae
(algae attached to rocks) (floating in sea water)

[Turn over]

Starfish usually prefer to feed on mussels.

Mussels reproduce and grow more quickly than limpets, chitons, and barnacles.

0	8	.	2

After 10 years the only species left in rock pool B was mussels.

Explain the results shown in FIGURE 11 on page 50 for rock pool B.

Use FIGURE 11 on page 50 and FIGURE 12 on page 51. [6 marks]

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| 0 | 8 |.| 3 |

Explain the results shown in FIGURE 11 on page 50 for rock pool A. [2 marks]

_____

_____

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_____

[Turn over]

Some species of starfish can reproduce by cloning (asexual reproduction) and also by sexual reproduction.

FIGURE 13 shows what happens when starfish P reproduces by each type of reproduction.

FIGURE 13

CLONING

Starfish P

Small piece of starfish breaks off

Offspring X

SEXUAL REPRODUCTION

Starfish P   Starfish Q

Gametes released into water in rock pool

Fertilisation
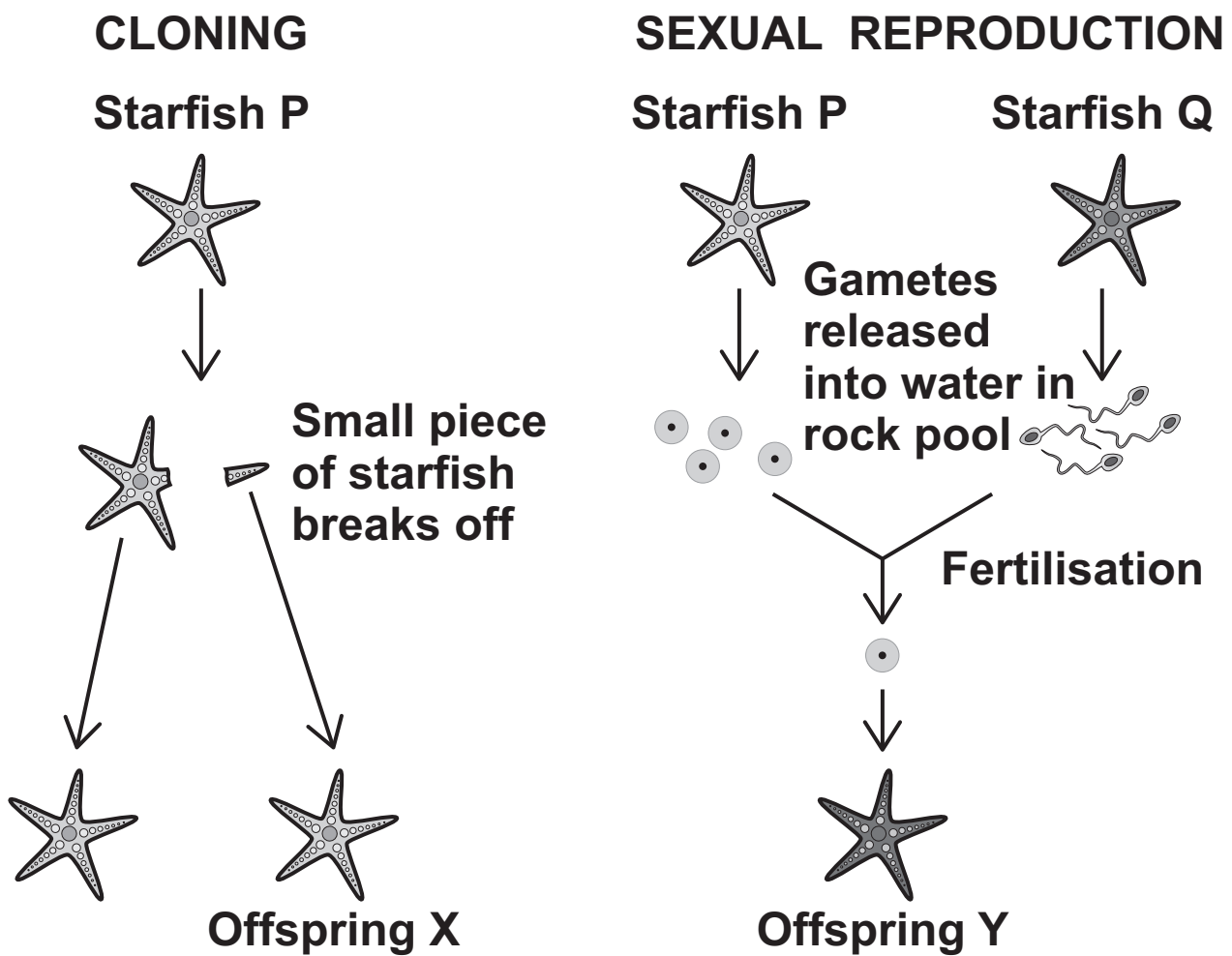
Offspring Y

08 . 4

During cloning a small piece of the starfish develops into a new starfish.

Before cell division, chromosomes replicate and the number of organelles increases.

Describe the stages in the process of cell division that produces offspring X. [3 marks]

_____

_____

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[Turn over]

0 8 . 5

Explain ONE advantage to the starfish of reproducing by cloning rather than reproducing by sexual reproduction. [2 marks]

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14

END OF QUESTIONS

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.
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