2023.S26

2023J057C1EL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Final Examination 2023

Science

Common Level

Monday 12 June Morning 9:30 – 11:30

360 marks

Examination Number

Day and Month of Birth

For example, 3rd February is entered as 0302

Centre Stamp

TEACHER MODEL

2023 Science
Answers based on the marking scheme.
Additional explanations are teacher notes, not official SEC text.

Instructions

Write your Examination Number and your Day and Month of Birth in the boxes on the front cover.

There are two sections in this examination paper.

Section A	150 marks	10 questions
Section B	210 marks	5 questions

Answer **all** parts of **all** questions.

You may ask the superintendent for a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

Not all the questions carry equal marks. The number of marks for each question is stated at the top of the question.

Write your answers in the spaces provided in this booklet. You are not required to use all of the space provided. There is extra space at the end of Section A and at the back of the booklet. Label any extra work clearly with the question number and part.

This examination booklet will be scanned and your work will be presented to an examiner on screen. Anything that you write outside of the answer areas may not be seen by the examiner.

Write your answers in blue or black pen. You may use pencil for graphs and diagrams only.

TEACHER MODEL

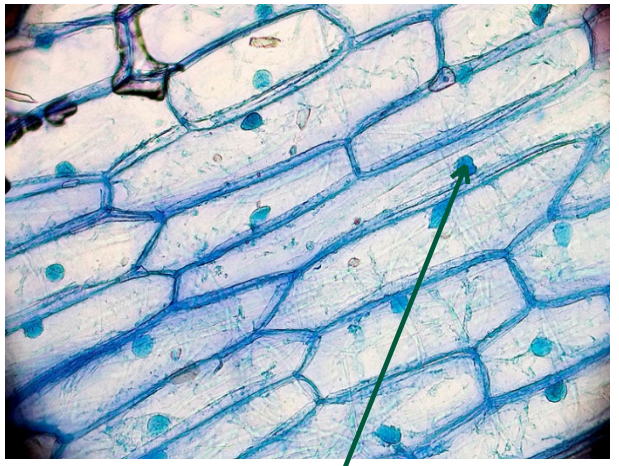
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Section A — 150 marks

Question 1 **(15 marks)**

The pictures below show cells from an onion (plant cells) and from the human cheek (animal cells).

Onion (plant cells)



Human cheek (animal cells)



(a) For each picture, draw an arrow from the letter **N** written below the picture to the nucleus of a cell.

(b) The names of some of the other parts of cells are listed below.

Cytoplasm **Cell membrane** **Cell wall**

Use the words in the list to complete the table to name each cell part described.

Description of cell part	Name
Controls the movement of substances in and out of cells	Cell membrane
Found in plant cells only	Cell wall
All of the material inside a cell, except for the nucleus	Cytoplasm

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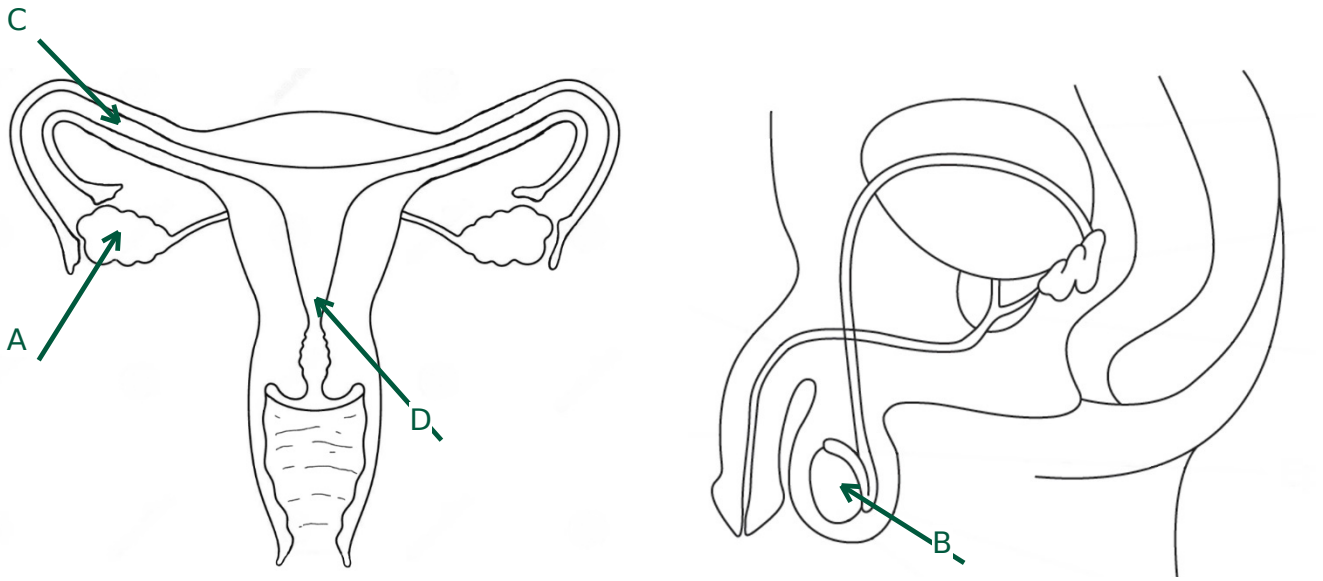
WHY / REMEMBER

The cell membrane controls movement into and out of a cell. Plant cells also have a rigid cell wall.

The arrows identify a nucleus in each microscope image.

Question 2 **(15 marks)**

The diagrams below show the reproductive systems for the human female and the human male.



(a) Use the letter **A** to label the part of the reproductive systems where the female sex cell (egg) is produced.

(b) Use the letter **B** to label the part of the reproductive systems where the male sex cell (sperm) is produced.

(c) Use the letter **C** to label the part of the reproductive systems where fertilisation usually occurs.

(d) Use the letter **D** to label the part of the reproductive systems where the foetus develops during pregnancy.

(e) Contraception reduces the chance of pregnancy.
Describe one method of contraception.

A condom forms a barrier that prevents sperm entering the female reproductive tract.

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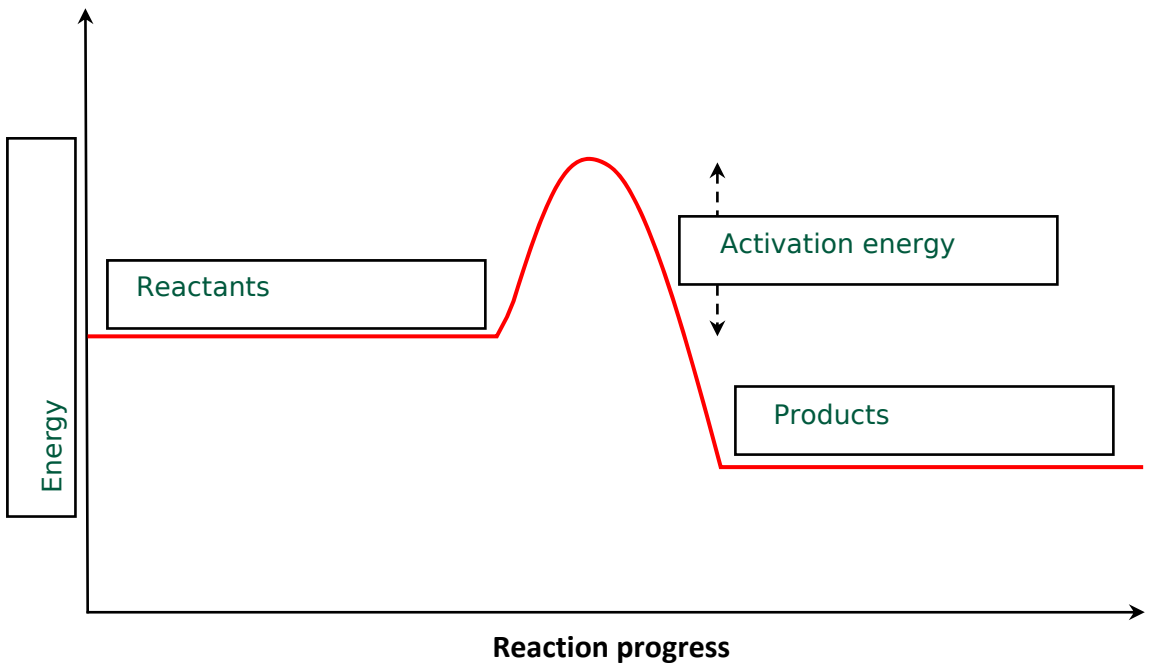
WHY / REMEMBER

Fertilisation usually occurs in an oviduct (C). A developing foetus grows in the uterus (D). These are different locations.

Question 3 **(15 marks)**

(a) The diagram below is an energy profile diagram for an exothermic reaction.
Use the words in the list below to label this diagram by filling in the boxes.

Products **Reactants** **Energy** **Activation energy**



(b) An exothermic reaction is one that gives *out* heat.
What is the name for the type of reaction that takes *in* heat?

Endothermic

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WHY / REMEMBER

The diagram is exothermic: products are at a lower energy than reactants, so energy is released overall. Part (b) asks for the opposite type: endothermic.

Activation energy is the rise from the reactants to the top of the barrier.

Question 4 **(15 marks)**

The passage below is about the three states of matter.
The following five words are missing from the passage:

chemical **conservation** **evaporation** **melting** **physical**

Write the missing words in the spaces provided.

There are three states of matter: solid, liquid and gas. When a solid is heated it turns into a liquid – this change of state is called melting. When a liquid is heated it turns into a gas – this change of state is called evaporation.

Liquid water freezes to become solid ice; this is an example of a physical change. However, when electricity is passed through liquid water it is converted into its elements, hydrogen and oxygen; this is an example of a chemical change.

When liquid water freezes, the mass of the ice formed is the same as the mass of the liquid water. This is an example of conservation of mass.



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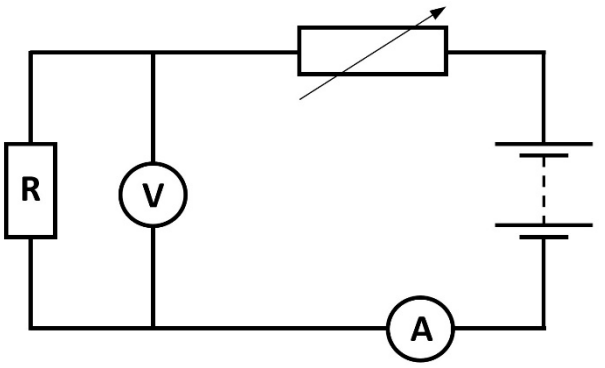
WHY / REMEMBER

A physical change does not form a new substance. A chemical reaction rearranges atoms to form new substances.

Atoms are conserved, so total mass is conserved in a closed system.

Question 5 **(15 marks)**

A student used the circuit diagram on the right to investigate how the current flowing through resistor **R** varies with the voltage (potential difference) across it.

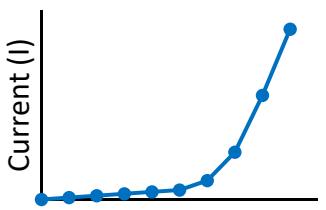


(a) **A** is an ammeter.
Does an ammeter measure current or voltage?

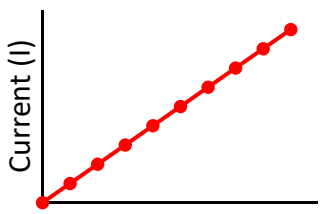
Current

(b) The student found that the current flowing through the resistor was proportional to the voltage across it.
Which graph, **X** or **Y**, shows that current is proportional to voltage?
Justify your answer.

Graph X



Graph Y



Graph Y: it is a straight line through the origin.
Voltage is directly proportional to current.

(c) A current of 6 A flows through the resistor when a voltage of 12 V is applied across it.
Calculate the resistance of the resistor.
Include the unit in your answer.

Calculation

R = V / I
R = 12 / 6 = 2 Ω

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WHY / REMEMBER

A straight line alone is not enough for direct proportionality: it must pass through the origin.

Resistance is measured in ohms (Ω).

Question 6 **(15 marks)**

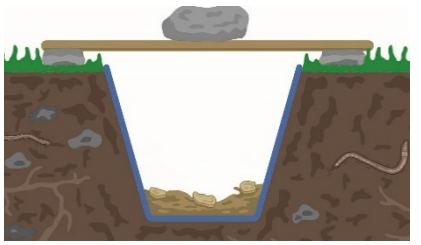
In ecology, each of the pieces of equipment shown below can be used in a habitat study.



Pooter



Net



Pitfall trap

(a) Circle the name of one of these pieces of equipment and describe how you would use it.

Place the collecting tube near the insect. Suck gently through the other tube to draw the insect into the jar. Gauze stops the insect entering your mouth.

(b) Name two resources that trees, such as those shown on the right, compete for.



Light
Water

(c) Describe one way we can help to conserve ecological biodiversity.

Protect habitats so organisms have food, shelter and suitable places to reproduce.

TEACHER MODEL

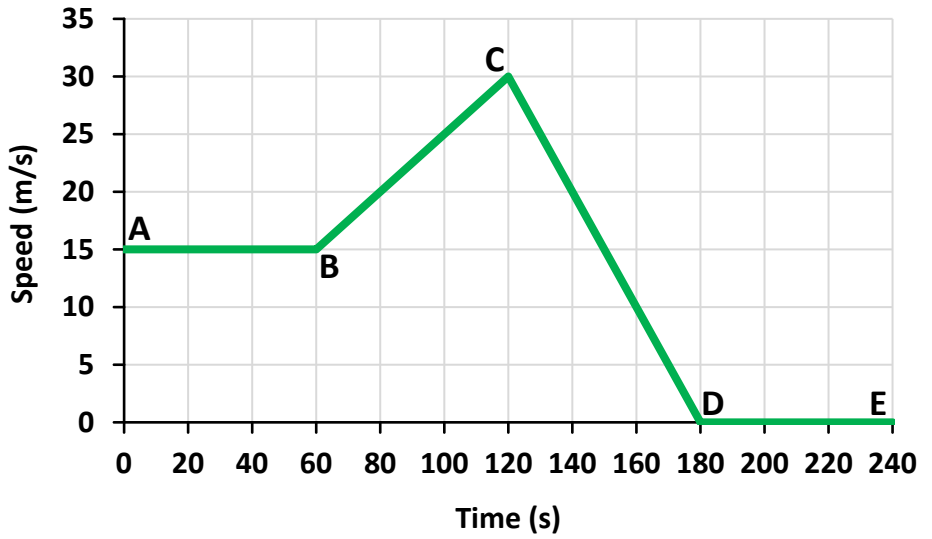
2023 Science
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WHY / REMEMBER

Competition occurs when organisms need the same limited resource. Name the actual resource, such as light or water.

Question 7 **(15 marks)**

The graph below shows how the speed of a car changed with time during a journey.



(a) What is the maximum speed of the car during this journey?

30 m s^{-1}

(b) Calculate the acceleration of the car between positions **B** and **C**.

Calculation

a = change in speed / time taken
a = (30 − 15) / (120 − 60) = 15 / 60
a = 0.25 m s^{-2}

(c) Describe the motion of the car between positions **C** and **D**.

The object slows down (decelerates).

(d) Describe the motion of the car between positions **D** and **E**.

The object is stationary: its speed is zero.

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WHY / REMEMBER

Use the duration of the interval: 120 − 60 = 60 s.

A horizontal line on a speed–time graph means constant speed. On the time axis, that speed is zero.

Question 8 **(15 marks)**

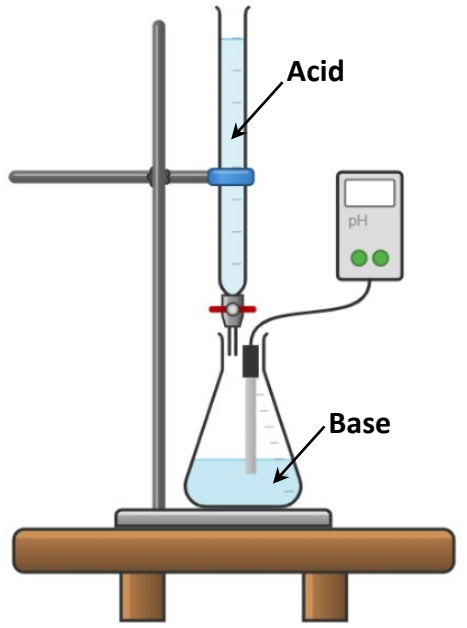
The diagram shows an experiment a student carried out to investigate the reaction between an acid and a base.

(a) Name a base that could be used in this investigation.

Sodium hydroxide solution

(b) Name an acid that could be used in this investigation.

Hydrochloric acid



(c) The diagram shows a pH probe and a pH meter, which the student used in this experiment.

Answer the following question by putting a tick (✓) in the correct box.

At the start of the experiment, the reading on the pH meter should be:

Less than 7 ☐

7 ☐

Greater than 7 ☑

(d) Another student decided to use an indicator, instead of using a pH meter, to investigate the reaction between an acid and a base.

(i) Name an indicator that could be used in this experiment.

Litmus

(ii) What colour is this indicator when added to a base?

Blue

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WHY / REMEMBER

An alkali has pH greater than 7. Litmus is blue in an alkaline solution. Always match the colour to the indicator you name.

Question 9 **(15 marks)**

(a) Complete the table below, using the Periodic Table of the elements to predict the ratio of atoms and the chemical formula for each of the compounds listed.

You should refer to page 79 of the *Formulae and Tables* booklet when answering this question.

The first row is completed for you.

Compound	First element	Second element	Ratio	Formula
Magnesium chloride	Magnesium (Mg)	Chlorine (Cl)	1 : 2	$MgCl_2$
Potassium chloride	Potassium (K)	Chlorine (Cl)	1 : 1	KCl
Hydrogen sulfide	Hydrogen (H)	Sulfur (S)	2 : 1	H_2S
Aluminium oxide	Aluminium (Al)	Oxygen (O)	2 : 3	Al_2O_3

(b) Aluminium is a metal but sulfur is a non-metal.
Outline two differences between metals and non-metals.

Metals generally conduct heat and electricity well; non-metals are generally poor conductors.
Metals are malleable; solid non-metals are usually brittle.





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WHY / REMEMBER

Formula subscripts show atom ratios. H_2S has two hydrogen atoms for every sulfur atom; Al_2O_3 has an aluminium : oxygen ratio of 2 : 3.

Question 10 **(15 marks)**



In 1932, the Irish physicist Ernest Walton and the English physicist John Cockroft produced the first artificial splitting of a nucleus by bombarding atoms of lithium with high speed protons.

Walton and Cockroft showed that mass is converted into energy when a nucleus is split. This was the first experimental proof of Albert Einstein's famous equation, $E = mc^2$.

The photograph shows Walton carrying out this experiment.
For their work, Walton and Cockroft won the Nobel Prize in physics in 1951.

(a) Protons are one type of particle found in the nucleus of an atom.

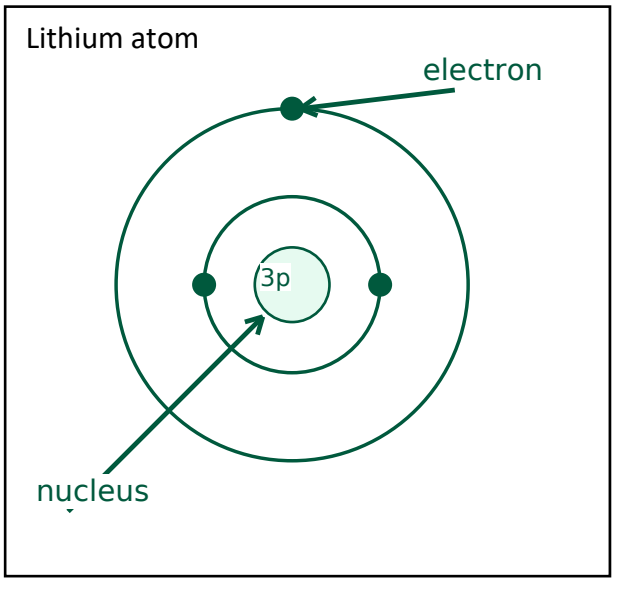
(i) Name the other type of particle found in the nucleus of an atom.

Neutron

(ii) Compare the charge of the proton with the charge of the other particle you have named.

A proton is positive; a neutron has no charge.

(b) In the space below, draw a labelled diagram of an atom of lithium showing the positions of the nucleus and the electrons.



The work of Walton and Cockroft saw the dawn of the nuclear age.

(c) State one advantage of using nuclear power to generate electricity.

Nuclear power releases very little carbon dioxide during operation, reducing reliance on fossil fuels.

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WHY / REMEMBER

A neutral lithium atom has three protons and three electrons: two electrons in the first shell and one in the second.

The nucleus also contains neutrons; the number depends on the isotope.

Additional writing space for **Section A**.
Label all work clearly with the question number and part.

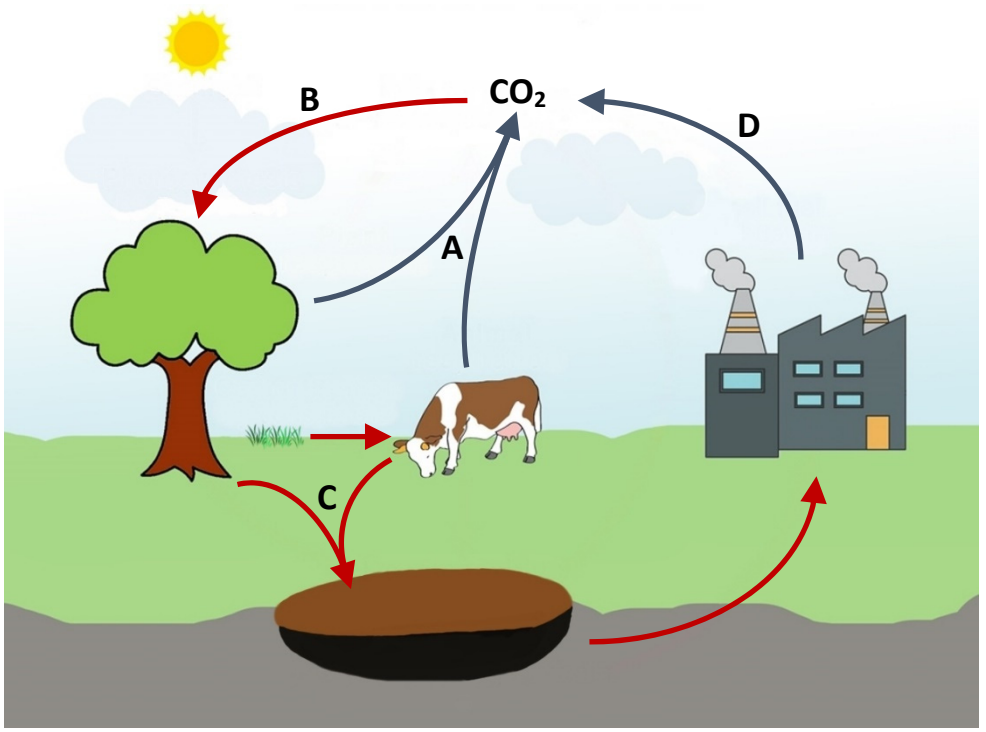
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Section B — 210 marks

Question 11 **(30 marks)**

The diagram below shows how carbon moves into and out of the air and soil.
This is part of the carbon cycle.



(a) During process **A**, plants and animals release carbon dioxide (CO_2) into the air.
Name process **A**.

Respiration

(b) During process **B**, plants take in carbon dioxide from the air to make food.

(i) Name process **B**.

Photosynthesis

(ii) Complete the chemical equation below for process **B**.
You may use either the name or the chemical formula for each substance to complete the equation.

Carbon dioxide (CO_2) + Water (H_2O) → Glucose ($C_6H_{12}O_6$) + Oxygen (O_2)

(iii) Name the green chemical found in plants which allows process **B** to happen.

Chlorophyll

TEACHER MODEL

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WHY / REMEMBER

Photosynthesis uses carbon dioxide and water to make glucose and oxygen. Chlorophyll absorbs light energy.

Respiration releases carbon dioxide back to the atmosphere.

(c) Describe how plants and animals add carbon into the soil in process **C**.

Dead plants, animals and their waste are broken down by decomposers, returning carbon compounds to the soil.

(d) Process **D** shows the burning of fossil fuels, which releases carbon dioxide into the air.
Name one such fuel.

Coal

(e) Carbon dioxide is often referred to as a greenhouse gas.
Describe two environmental concerns associated with an increase in the level of carbon dioxide in our atmosphere.

Rising sea levels can flood low-lying coasts.
More extreme rainfall can increase flooding.

(f) A scientist claims that there would be no life on Earth if there was no carbon dioxide in our atmosphere.
Do you think this statement is true or false?
Justify your answer.

True in the usual school model: carbon dioxide is needed for photosynthesis, which supplies food and oxygen for most life. It also helps maintain a habitable temperature.

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WHY / REMEMBER

Explain environmental effects, not just “global warming”.

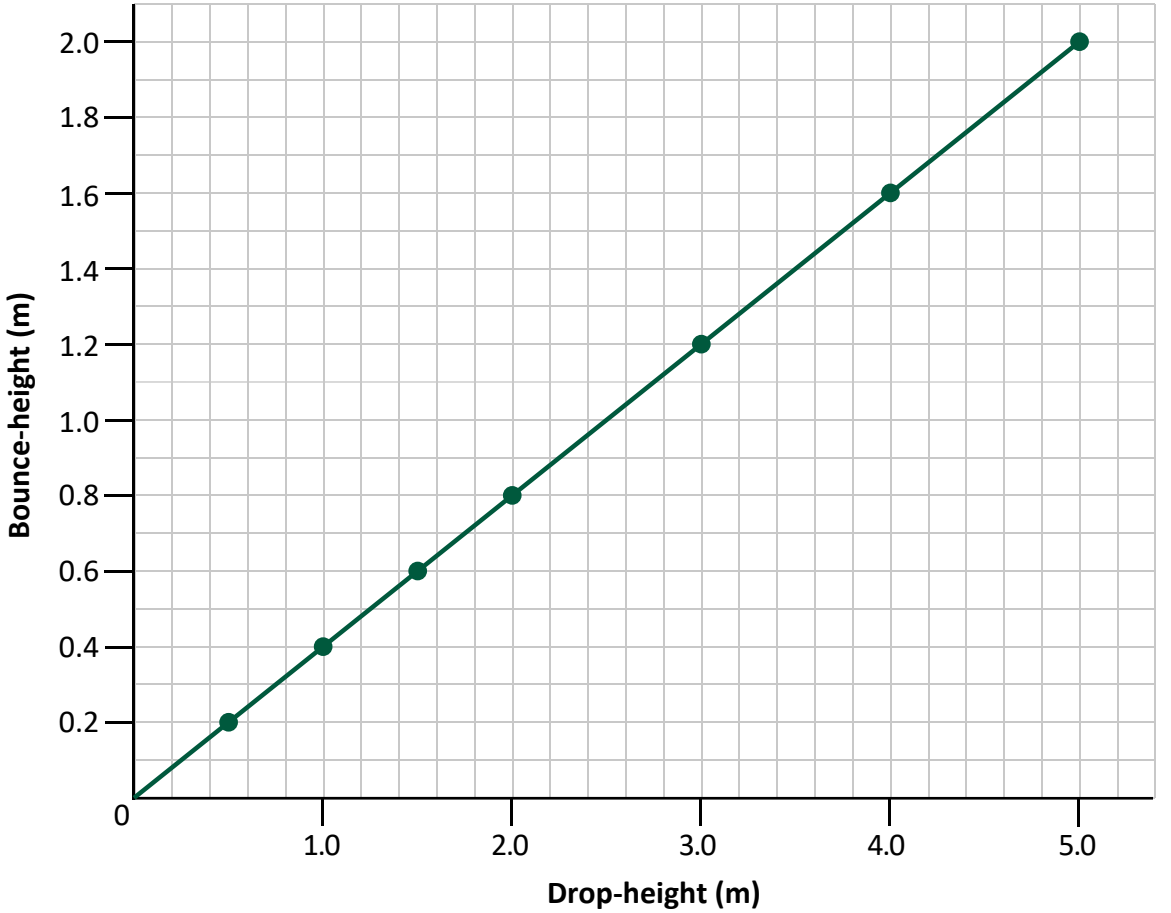
The final claim is broad: a carefully justified alternative can also be valid. Some organisms do not depend directly on photosynthesis.

Question 12 **(45 marks)**

A group of students investigated how high a ball bounces after it is dropped.
They allowed a ball to fall from a number of different drop-heights and measured how high the ball bounced each time (the bounce-height).
Their results are shown in the table below.

Drop-height (m)	Bounce-height (m)
0.5	0.2
1.0	0.4
1.5	0.6
2.0	0.8
3.0	1.2
4.0	1.6
5.0	2.0

(a) In the space below, present this information using a suitable graph or chart.
(Your graph or chart should allow the viewer to read the results of the investigation and to see any pattern.)



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WHY / REMEMBER

All seven measured points lie on a straight line through the origin.

Bounce-height = 0.4 × drop-height.

The horizontal axis is the variable changed by the students; the vertical axis is the result measured.

(b) If the ball was dropped from a height of 10 m, how high would you expect it to bounce?

4 m (assuming the same pattern continues)

(c) Which is easier to measure accurately, the drop-height of the ball or its bounce-height? Explain your answer.

Drop-height: the ball can be held still beside a ruler.
The highest point of a bounce lasts only an instant.

(d) Which is easier to measure accurately, 0.2 m or 1.6 m? Explain your answer.

1.6 m: the same absolute reading uncertainty is a smaller percentage of the larger measurement.

(e) Outline one safety precaution which the students should take when carrying out this investigation.

Keep the landing area clear so nobody trips over the ball.

(f) State the main energy conversion that takes place as the ball falls through the air.

Gravitational potential energy → kinetic energy.

(g) A student made the following statement: "Green tennis balls bounce higher than orange tennis balls." Is this a testable hypothesis?
Justify your answer.

Yes. Drop green and orange balls from the same height onto the same surface and compare bounce-heights. Keep other ball properties the same. Repeat and compare averages.

TEACHER MODEL

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WHY / REMEMBER

The 10 m prediction is an extrapolation beyond the measured range; the pattern may not continue.

A fair comparison changes colour while controlling other properties. Repeats reduce random variation.

Question 13 **(45 marks)**

The article below is from a science website. Read it and answer the questions that follow.

Do Other Planets Have Solar Eclipses?

As Earthlings, we have the privilege of seeing total solar eclipses, those dazzling events in which the Moon blocks the Sun's light from hitting our planet. But is Earth the only planet in our solar system that experiences this spectacular phenomenon?

The answer is no. Total solar eclipses can happen on other planets too. To get a solar eclipse, the first thing you need is a moon. This immediately rules out total solar eclipses on Mercury or Venus – two planets without moons.

Mars has two moons, but both are too small to create a total solar eclipse that would be visible from Mars. Rather, each of these moons can make a partial eclipse – called a "ring eclipse" – for any potential life-form watching from the ground.

The *Curiosity* rover took the image shown here of a ring eclipse as Mars' largest moon, Phobos, passed directly in front of the Sun in August 2013.



The gas giants – Jupiter, Saturn, Uranus and Neptune – can all have total solar eclipses, as they have large moons and the Sun appears small to them. But because these planets are made of gas, it would be impossible to stand on them and see such solar eclipses.

Remember – never look at an eclipse without proper eye protection!

(a) **(i)** What is a solar system?

The Sun and the objects that orbit it.

(ii) Our solar system is part of the Milky Way galaxy. What is a galaxy?

A large collection of stars held together by gravity.

(b) **(i)** Name a planet in our solar system which has no moon.

Mercury (Venus is also correct)

(ii) Name Mars' largest moon.

Phobos

(c) Why should you never look at an eclipse without proper eye protection?

Sunlight can permanently damage the retina. Use proper solar viewing protection.

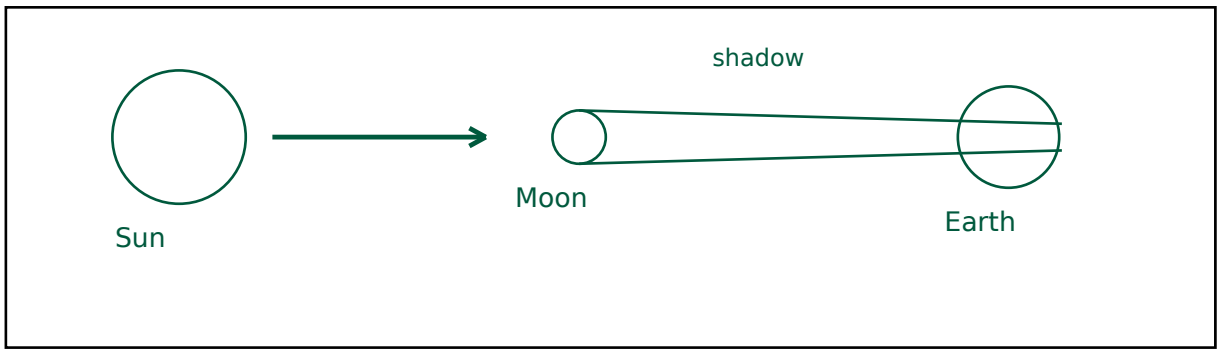
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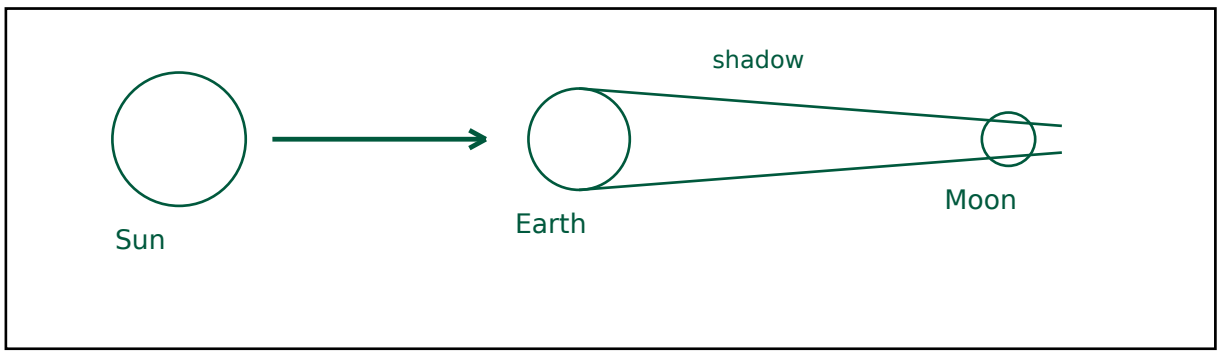
WHY / REMEMBER

A solar system has a star and its orbiting objects. A galaxy contains enormous numbers of stars and their systems.

(d) **(i)** Draw a labelled diagram to show a model of a *solar* eclipse.



(ii) Draw a labelled diagram to show a model of a *lunar* eclipse.



(e) Why does the Sun appear small when observed from the gas giant planets?

They are much farther from the Sun, so its apparent (angular) size is smaller.

(f) Currently we use robots such as the *Curiosity* rover to explore Mars.
Outline two reasons why it is difficult for humans to explore Mars themselves.

The journey is very long and needs food, water and oxygen.
Space radiation is hazardous to human health.

(g) For hundreds of years, astronomers believed that the Sun orbited the Earth. We now know that to be incorrect.

Outline another example of how our scientific understanding of something has changed over time.

The early “plum pudding” atom model was replaced after alpha-particle scattering showed a tiny, dense nucleus and that the atom is mostly empty space.

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WHY / REMEMBER

Solar eclipse: Moon between Sun and Earth.
Lunar eclipse: Earth between Sun and Moon.

Diagrams show alignment, not scale.

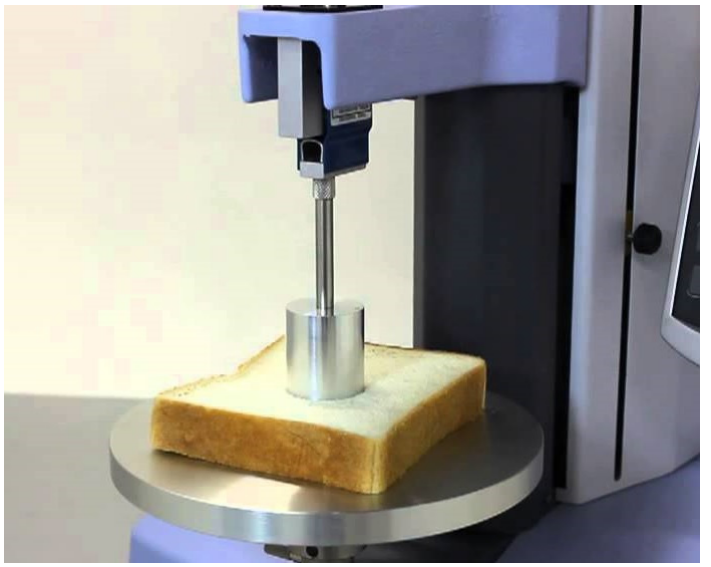
Scientific models change when new evidence cannot be explained by the old model.

Question 14 **(45 marks)**

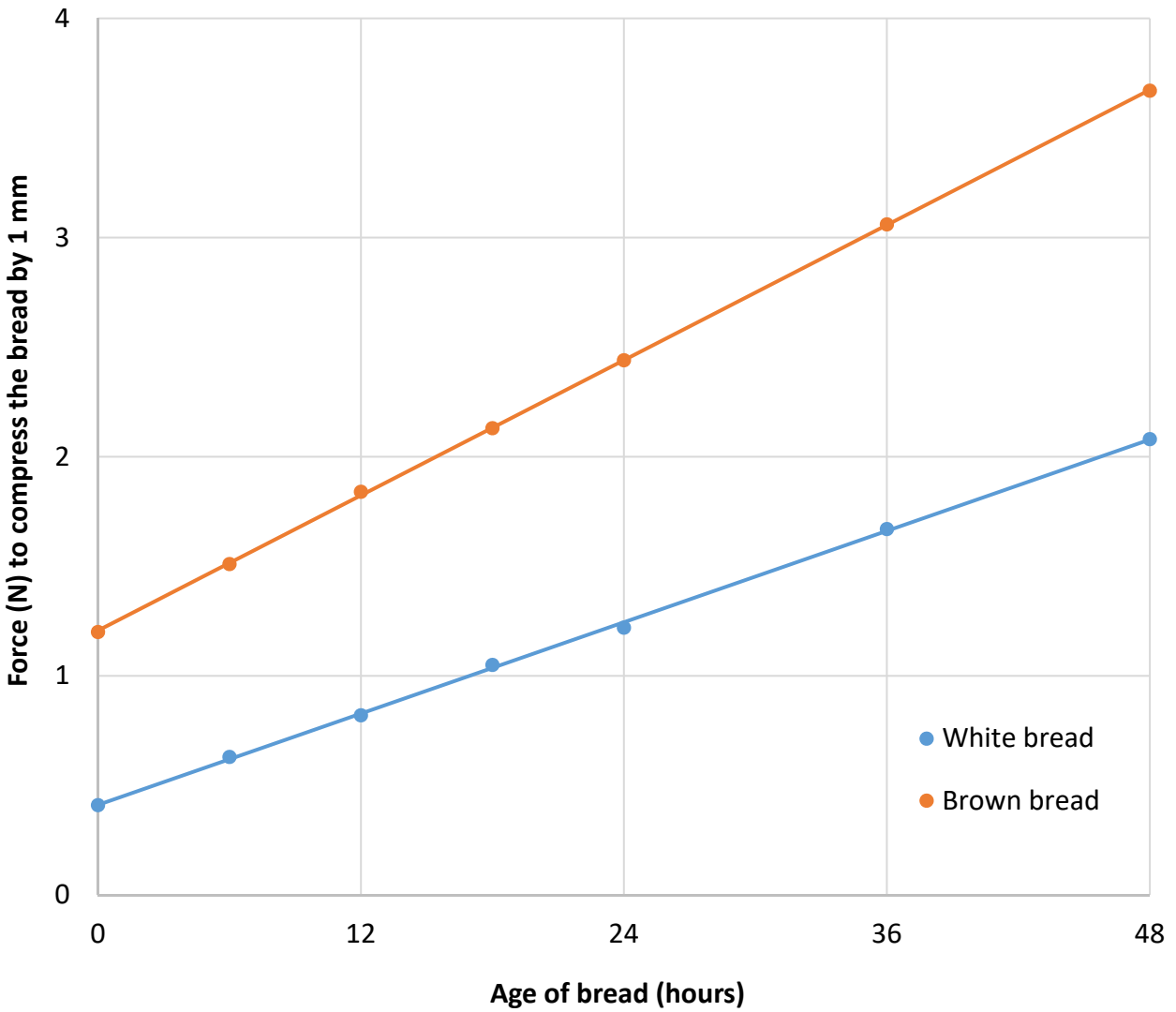
Bakers and food scientists are interested in the physical properties of bread.

One property they investigate is how hard or easy it is to compress (squash) the bread.

They do this by measuring the force needed to compress the bread by 1 mm, as in the photograph.



The graph below shows the force needed to compress samples of white bread and brown bread by 1 mm, and how this force changes with the age of the bread (the time since the bread was baked).



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WHY / REMEMBER

Greater compression force means harder bread. Both curves rise as bread ages.

The graph compares hardness, not nutritional value, so it cannot tell you which bread is healthier.

(a) What is the unit of force?

Newton (N)

(b) Name an instrument suitable for measuring a distance of 1 mm.

Callipers

(c) State two variables which must be kept constant during this experiment to ensure that it is a fair test.

Thickness of each bread sample.
Amount of compression (1 mm).

(d) In the table below place a tick (✓) next to any conclusion that is supported by the graph and a cross (×) next to any conclusion that is **not** supported by the graph.

Conclusion	✓ or ×
White bread is easier to compress as it gets older.	×
Old white bread is harder to compress than fresh brown bread.	✓
Brown bread is healthier for you than white bread.	×
White bread becomes harder to compress faster than brown bread.	×

(e) Bread is a good source of carbohydrate.
Carbohydrate is a nutrient that is an essential part of our diet.

(i) Name another essential nutrient in our diet.

Protein

(ii) Name a good source of this nutrient.

Beans

(iii) Why is this nutrient an essential part of our diet?

Growth and repair of body tissues.

TEACHER MODEL

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WHY / REMEMBER

The last claim is not supported: the brown-bread line rises faster. A steeper slope means a larger increase in force per hour.

(f) A boy bit off a piece of a brown bread sandwich.



A short time later, the cells in the boy's body were able to use the energy contained in the bread's carbohydrate.

Describe the processes that happened to the bread (and the carbohydrate in it) from when the boy put the bread into his mouth to when his cells used the energy in the carbohydrate.

Teeth break the bread into smaller pieces.

Digestive enzymes break carbohydrate down into simple sugars such as glucose.

Glucose is absorbed through the wall of the small intestine into the blood.

The blood carries glucose to body cells.

Cells release energy from glucose by respiration.

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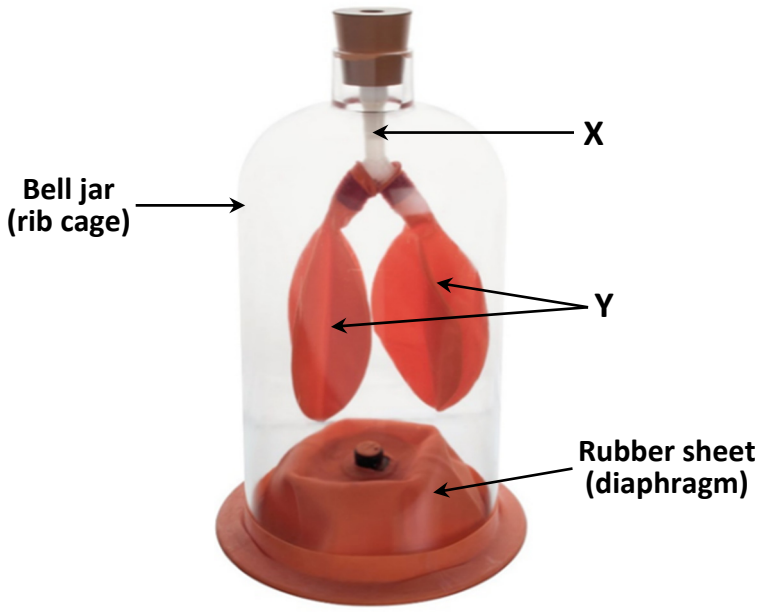
WHY / REMEMBER

Digestion breaks large food molecules into small soluble molecules. Absorption moves these into the blood.

Respiration is a separate process in cells that releases usable energy.

Question 15 **(45 marks)**

The picture below shows a laboratory model of the human breathing system.
The bell jar represents the rib cage and the rubber sheet represents the diaphragm.



(a) **(i)** Name the part of the breathing system represented by the tube labelled **X**.

Trachea (windpipe)

(ii) Name the part of the breathing system represented by the balloons labelled **Y**.

Lungs

(b) Describe what happens to the balloons (**Y**) when the rubber sheet (diaphragm) is pulled down.

The balloons inflate. Pulling the sheet down increases the volume and lowers pressure, so air enters the balloons.

(c) Describe one flaw or limitation in this model.
Explain why this is a flaw or limitation.

The bell jar is rigid, whereas the human rib cage moves during breathing. The model cannot show rib movement.

TEACHER MODEL

2023 Science
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WHY / REMEMBER

Pulling the sheet down models contraction of the diaphragm. Increased chest volume lowers pressure, drawing air in.

(d) As the blood travels past the breathing system, some gases move between the air and the blood.

(i) Explain why the air we breathe in contains more oxygen than the air we breathe out.

Oxygen moves from the lungs into the blood and is used by body cells for respiration.

(ii) Explain why the air we breathe in contains the same amount of nitrogen as the air we breathe out.

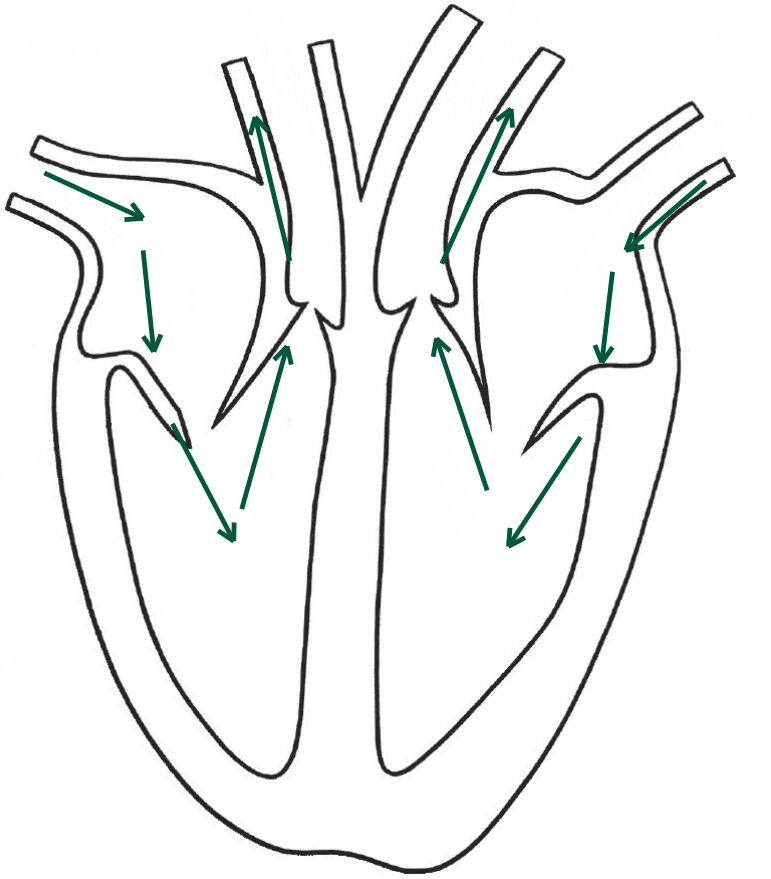
Most nitrogen is not used by the body, so it is breathed out again.

After it leaves the breathing system, blood travels to the organ which pumps it all around the body. This organ is shown in the diagram below.

(e) Name the organ shown.

Heart

(f) Draw arrows on the diagram to show the direction of blood flow.



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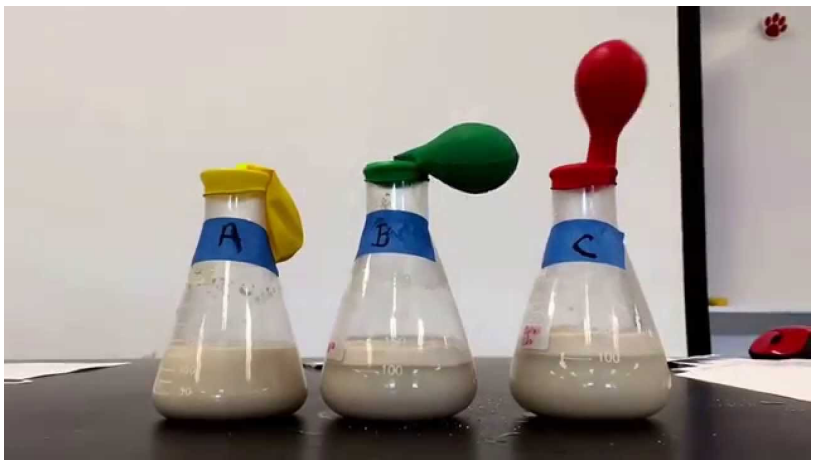
WHY / REMEMBER

Follow the arrows through the chambers. The right side of the heart appears on the left of this front-view drawing.

Body → right atrium → right ventricle → lungs.

Lungs → left atrium → left ventricle → body.

Micro-organisms such as yeast also release gases.
The photograph below shows an investigation into the factors that affect the volume of gas released by yeast.



A (5 °C) **B (20 °C)** **C (35 °C)**

In each case, the gas released is collected in the balloon attached to the top of the reaction flask.

Test **A** was carried out at 5 °C.

Test **B** was carried out at 20 °C.

Test **C** was carried out at 35 °C.

As the reaction temperature increased (from **A** to **C**), a greater volume of gas was collected in the balloon.

(g) Suggest two reasons why an increase in reaction temperature might lead to an increase in the volume of gas collected.

Particles have more kinetic energy at higher temperature.
There are more frequent successful collisions, so the reactions producing gas happen faster.

(h) Describe one positive role and one negative role which micro-organisms play in human health.

Positive: useful gut bacteria aid digestion.
Negative: pathogenic micro-organisms cause disease.

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2023 Science
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WHY / REMEMBER

Temperature affects reaction rate. At very high temperatures enzymes can denature, so “hotter is faster” has limits.

A positive and a negative role are both needed in part (h).

Additional writing space for **Section B**.
Label all work clearly with the question number and part.

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Texts

Text on page 18: Geggel, Laura. *Do Other Planets Have Solar Eclipses?* http://www.livescience.com (5 August 2017).

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Junior Cycle Final Examination – Common Level

Science

Monday 12 June
Morning 9:30 – 11:30