Essential SCIENCE

# Webinar for Science Teachers:

## Effective Teaching and Learning for Junior Cycle Exam Performance

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19th March, 2024

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# Agenda

1. Overview of the structure of the exam paper
2. Various categories of questions asked
3. Problematic areas for students, from marking schemes and examiners' reports
4. Synthesising findings into classroom teaching and learning strategies
5. Maximising the effectiveness of preparing students for exam questions
6. Q&A

# “Assessment is the tail that wags the dog”

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The layout of the exam paper and distribution of marks are summarised in the table below.

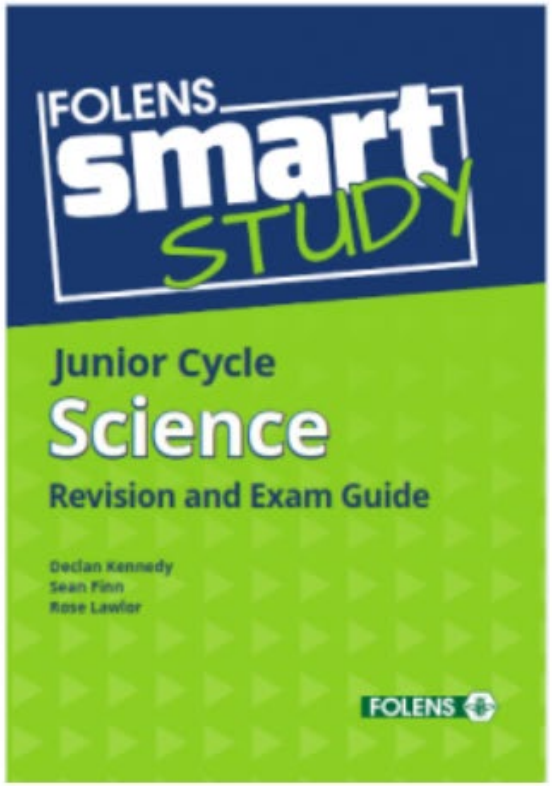
| Section | Type of question | Number of marks | Percentage |
|---|---|---|---|
| A<br>(Questions 1–10) | 10 short filler-in questions; includes graph questions and multiple-choice questions | 10 x 15 = 150 marks | 37.5% |
| B<br>(Questions 11–16) | 6 short filler-in questions; includes graph questions and lab practical work | 4 x 30 = 120 marks<br>2 x 45 = 90 marks | 52.5% |
| | | Total = 360 marks | 90% |
| Assessment Task<br>(Science in Society investigation) | Account of your assessment task written in the SEC booklet | 40 marks | 10% |
| | **OVERALL TOTAL** | **400 marks** | **100%** |

Summary of distribution of marks on the exam paper and the Assessment Task

Note: The above format was that used in the 2018 Sample Exam Paper and in the 2019 Examination Paper. However, in the 2022 Exam Paper, Section B (Q 11- 15) consisted of 2 x 30 marks, 2 x 45 marks and 1 x 60 marks questions. Also, in the 2023 Exam Paper, Section B (Q. 11 -15) consisted of 1 x 30 marks and 4 x 45 mark questions. The overall total of 360 marks is unchanged. The Assessment Task has not been examined since 2019, i.e. all marks are now calculated on the written paper alone.

Smart Study Science p. ix (Folens)

# Smart Study – Junior Cycle Science




**SMART Study Science is the ideal revision book for the Junior Cycle final exam. Written by an expert author team.**

**It includes:**

- **Exam paper overview & study tips**
- **Exam tips to help maximise marks**
- **Suggested answers to the SEC sample paper**

**The aid you need to succeed!**

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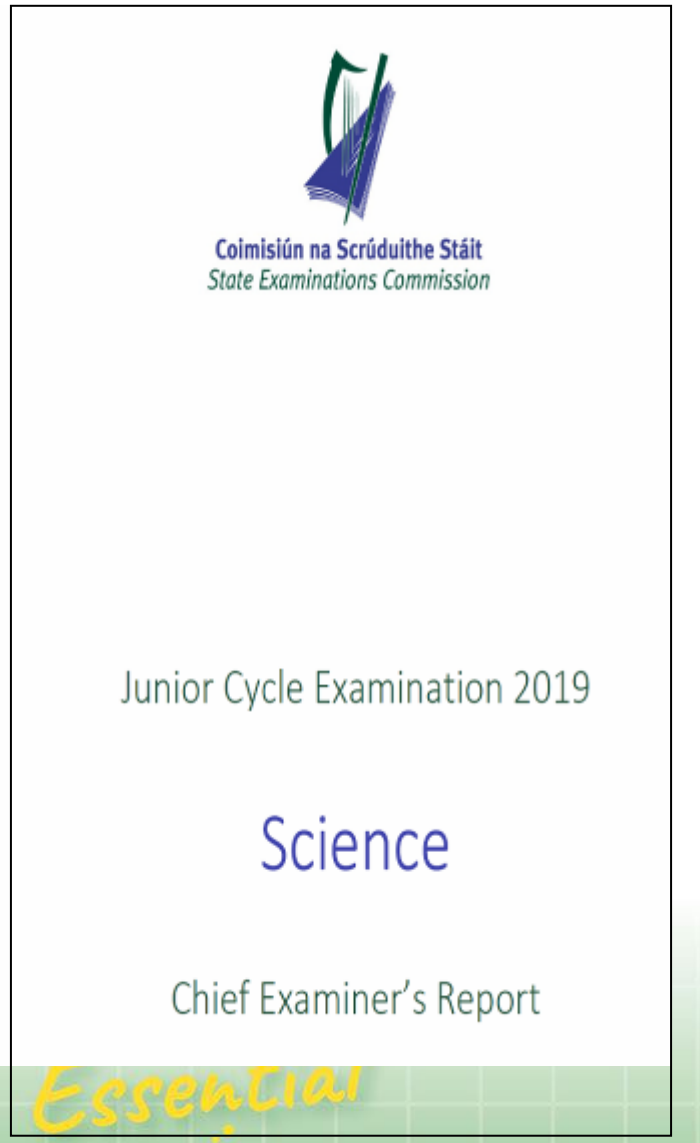


"Questions asked candidates to evaluate evidence and demonstrate their:

- Scientific knowledge
- Understanding
- Reasoning
- Problem-solving abilities"

- Chief Examiner's Report 2019 (p. 3)


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# 1. Questions that test knowledge of key terms and definitions

## SEC examination question

**(a)** What is meant by the boiling point of a substance?

*The boiling point is the temperature at which a liquid changes to a gas throughout the liquid.*

**EXAM TIP!** You must mention the phrase 'throughout the liquid' to get full marks in your exam.

(p.157)

## SEC examination question

**(a)** What do you understand by the term sustainability?

*Sustainability is the use of a resource so that it does not run out.*

**EXAM TIP!** Learn off this definition of sustainability, as this was the definition that was required on the marking scheme of the examination.

(p. 273)

## SEC examination question

**(a)** Figure 11.11 shows bacterial cells dividing in order to reproduce. This is an example of asexual reproduction. Describe one difference between sexual and asexual reproduction.

*Sexual reproduction involves two parents. Asexual reproduction involves one parent.*

OR

*Greater variation in offspring results from sexual reproduction. Offspring from asexual reproduction are all the same.*

OR

*Fertilisation is involved in sexual reproduction. There is no fertilisation involved in asexual reproduction.*

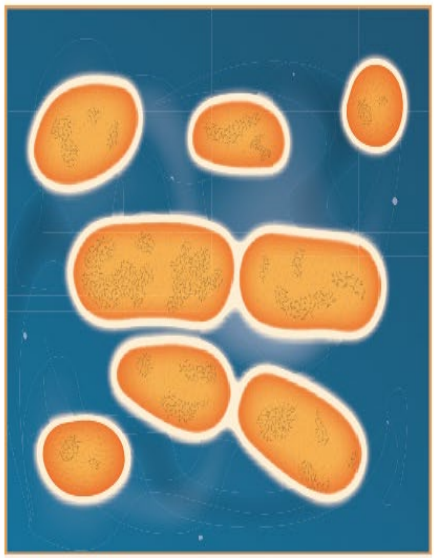

Figure 11.11

(p. 101)

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## SEC examination question

Complete the table below for the instruments shown in Figure 29.26. In each case, state what physical quantity the instrument measures. Also state the unit used for that measurement.

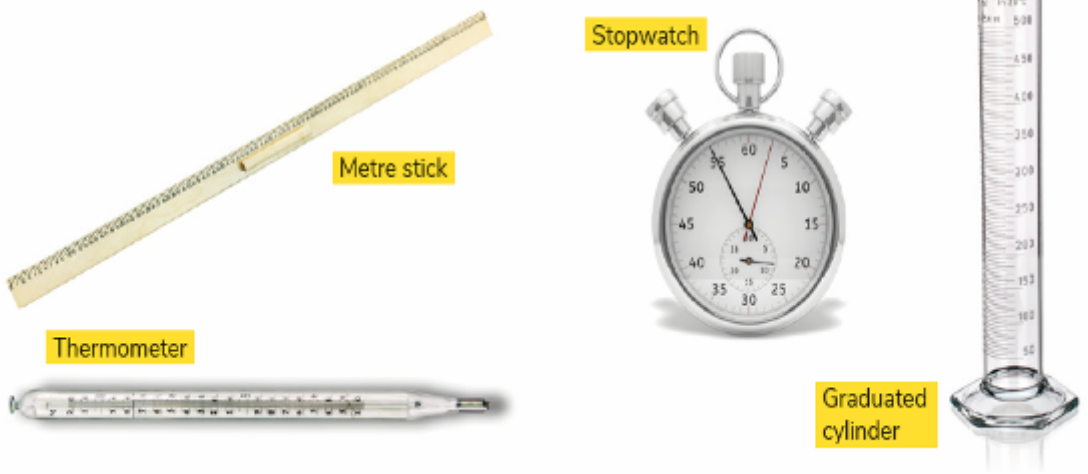



Figure 29.26

| Instrument | Quantity measured | Unit |
|---|---|---|
| Metre stick | *Length* | *Metre (m)* |
| Stopwatch | *Time* | *Second (s)* |
| Graduated cylinder | *Volume* | *Centimetre cubed ($cm^3$)* |
| Thermometer | *Temperature* | *Degrees Celsius (°C)* |

Table 29.5

p. 288

## SEC examination question

Figure 39.21 shows some of the processes involved in the carbon cycle.

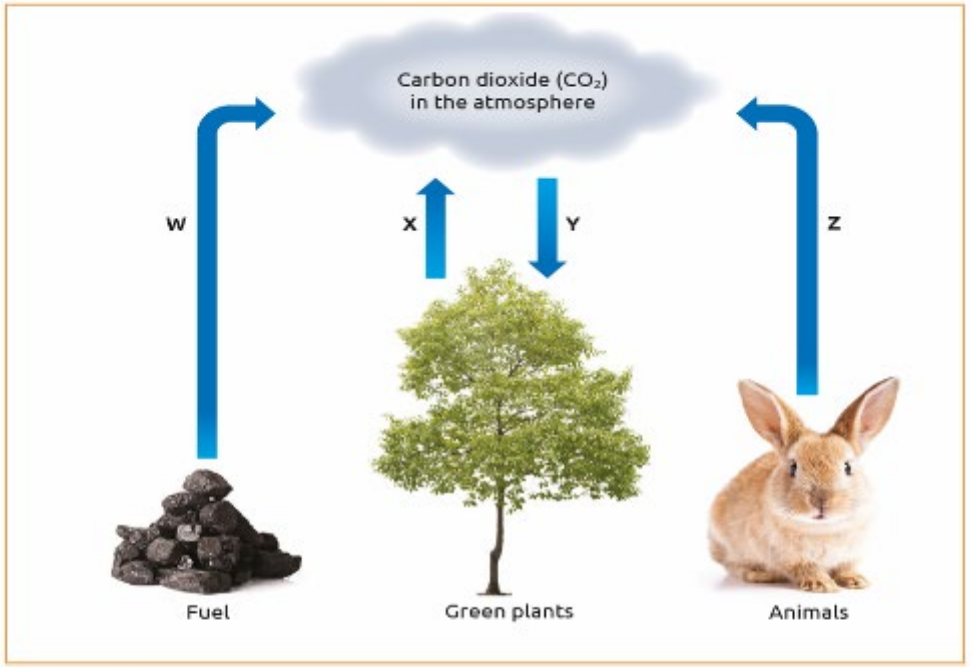



Figure 39.21

Each of the blue arrows W, X, Y and Z represents one of the following three processes:

| Respiration | Photosynthesis | Combustion |
|---|---|---|

In Table 39.1, write the name of each process. (Note that one process appears twice.)

| Process | Name |
|---|---|
| W | *Combustion* |
| X | *Respiration* |
| Y | *Photosynthesis* |
| Z | *Respiration* |

Table 39.1

## SEC examination question

The planet Jupiter is the largest planet in our solar system. It is described as a gas giant. Jupiter has four large moons and many smaller ones. These large moons were discovered in 1610 by Italian scientist Galileo Galilei. Data about the size and density of some other objects in our solar system are given in Table 37.2.

| Object | Diameter (km) | Density (g/cm³) |
|---|---|---|
| Mercury | 4,880 | 5.43 |
| Earth | 12,700 | 5.51 |
| Earth's moon | 3,470 | 3.34 |
| Mars | 6,780 | 3.93 |
| Jupiter | 140,000 | 1.33 |
| The sun | 139,000,000 | 1.41 |

**Table 37.2**

| Material | Density (g/cm³) |
|---|---|
| Water | 1.0 |
| Granite | 2.8 |
| Basalt | 3.0 |
| Iron | 8.0 |

**Table 37.3**

The densities of four materials commonly found in planets and moons are given in Table 37.3.

**(a)** A solid of mass 12 g has a volume of 1.5 cm³. Calculate the density of the material. Hence, identify the material as either water, granite, basalt or iron.

*Density* $= \frac{\text{mass}}{\text{volume}} = \frac{12\text{g}}{1.5\ \text{cm}^3} = 8\ \text{g/cm}^3$

*From Table 37.3, since the density of iron is 8 g/cm³, the material is iron.*

**(b)** Granite and basalt are found in the Earth's crust. Use the data given in the tables to state whether or not it is likely that all of the Earth is made of these rocks. Justify your answer.

*It is not likely that all of the Earth is made up of granite and basalt. The reason for this is because the density of the Earth is 5.51 g/cm³, but the density of granite is 2.8 g/cm³ and the density of basalt is 3 g/cm³. Since the Earth has a much greater density than either of these rocks, it must be mainly made up of substances that have a greater density than either granite or basalt.*

**(c)** Use the data given for Jupiter and Earth to explain why Jupiter is described as a gas giant.

*Jupiter is described as a gas giant because it has a low density of 1.33 g/cm³ compared to the density of the Earth, which is 5.51 g/cm³. Since gases usually have lower densities than solids, Jupiter is likely to be made up of gas. Jupiter is described as a 'giant' because it has a very large diameter compared to the planet Earth.*

**(d)** Callisto is a moon and Mercury, of a similar size, is a planet. What is the difference between a moon and a planet?

*A moon is a natural satellite of a planet. A planet is a celestial body that is in orbit around a star.*

**(e)** Scientists estimate that our solar system began to form about 4.6 billion years ago. Scientists also estimate that our universe formed 13.8 billion years ago. Describe two things that scientists believe happened during the early formation of the universe – before the formation of solar systems.

*During the early formation of the universe, all the mass and energy of the universe existed in a tiny bubble smaller than the size of a pinhead. This was extremely hot and dense and suddenly exploded. This explosion is called the Big Bang. Over a period of time, protons, neutrons and electrons were made. Eventually, these combined to form atoms. After a billion years, these giant clouds of atoms were pulled together by gravity to make the first stars.*

## SEC examination question

**(a)** Figure 38.17 shows the Earth orbiting the sun. Complete the diagram to show the shape, location and motion of the moon in the Earth-sun-moon system.

*See Figure 38.17.*

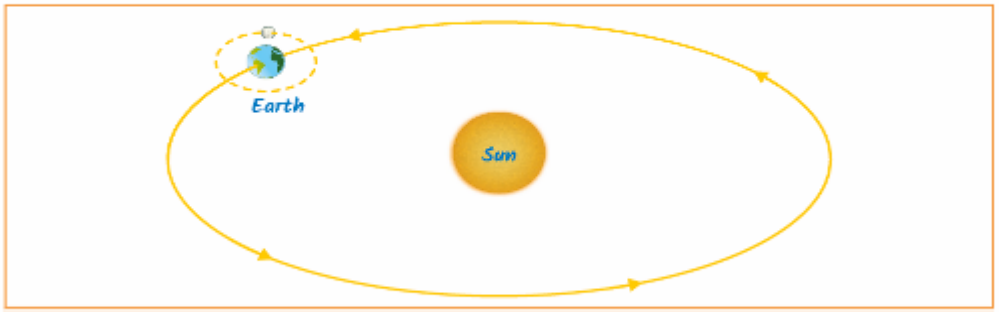



Figure 38.17

**EXAM TIP!**

Hint: The moon needs to be shown as:
- Round
- Closer to the Earth than to the sun
- Orbiting the Earth

**(b)** At the time of the first moon landing, the moon was in a waxing crescent phase as seen from Earth. The images below show different phases of the moon in sequence, from left to right. Place a tick (✓) in the box beneath the image which shows the moon in a waxing crescent phase.

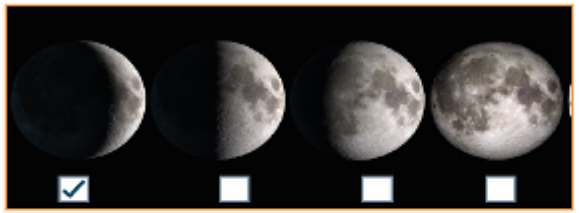


Figure 38.18

**(c)** Shade in the image of the moon to illustrate the next phase of the moon in the sequence above.

*See Figure 38.19.*

**(d)** On 2 January 2019, the Chinese Chang'e 4 lander touched down on the far side, or 'dark side', of the moon. Explain why this side of the moon is never visible from Earth.

*The moon spins on its axis at the same rate (in the same time) as it takes to orbit the Earth.*

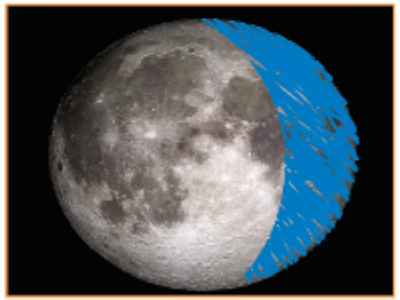


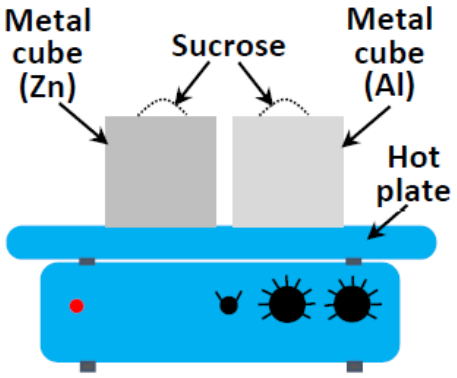
Figure 38.19


**Question 13** **(45 marks)**

A student carried out a series of experiments to investigate the properties of sucrose (table sugar).

In the first experiment, the student investigated the melting point of sucrose.

Two metal cubes of equal volume were placed on a hotplate as shown in the diagram. One was made of zinc (**Zn**) and the other was made of aluminium (**Al**). One gram of sucrose was placed on top of each cube and the hotplate was turned on.




**(a)** What is meant by the melting point of a substance?

**(b)** Is melting an example of a physical change or a chemical change? Explain your answer.

(2022 Q13)

The **melting point** is the temperature at which a solid changes to a liquid.

Essential Science p. 153.

Answered badly. Must mention the word TEMPERATURE. “Heat” not acceptable. Many students did not mention BOTH states (solid AND liquid)

A **physical change** is a change that does not result in the formation of any new substance.

Essential Science p. 194

Answered badly. Many students did not refer to no new substance being formed.

**(f)** The dials on the hotplate were made of plastic, a non-metal. State two properties of non-metals.

| |
|---|
| |
| |


Badly answered

2022 Q13 (f)

Some properties of **non-metals** can be summarised as follows:

- Non-metals are not good conductors of heat.
- Non-metals are not good conductors of electricity.
- Non-metals that are solids tend to be brittle in their solid form. That is, they cannot be hammered into different shapes but shatter instead. For example, crystals of sulfur shatter when struck.

You may recall from Chapter 26 that non-metals tend to gain electrons. For example, when sodium metal reacts with chlorine gas, each chlorine atom gains an electron.

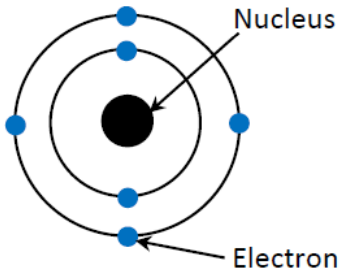
$$Cl + \text{electron} \xrightarrow{\text{gains an electron}} Cl^-$$

A **non-metal** is an element that tends to form negative ions.

Essential Science p. 261

**Question 3** **(15 marks)**

An atom of element **X** is shown in the diagram.



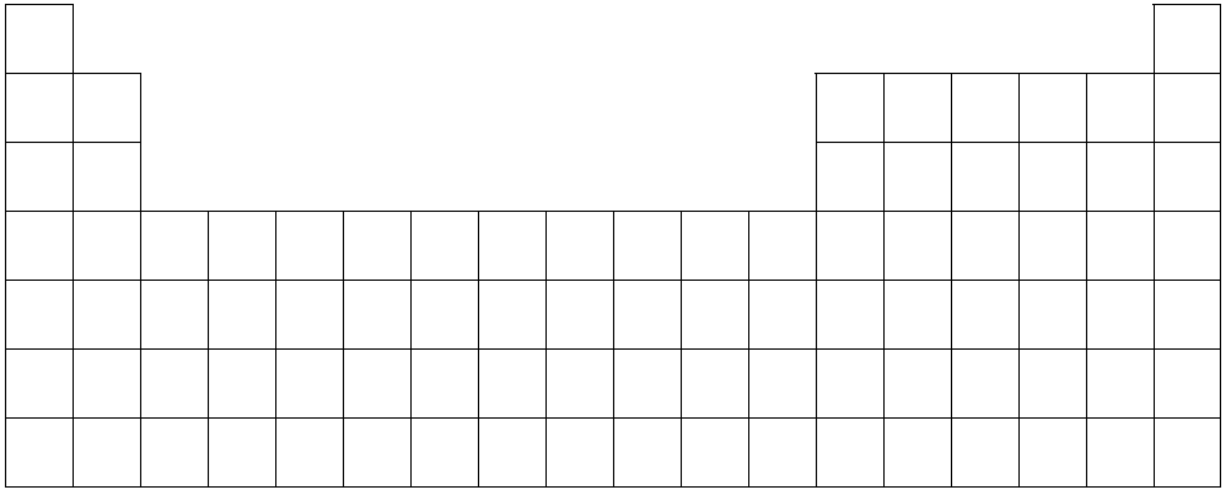

**(a)** Name one subatomic particle found in the nucleus of an atom.

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

The charge on the electron is:

Positive ☐ Negative ☐ Neutral ☐

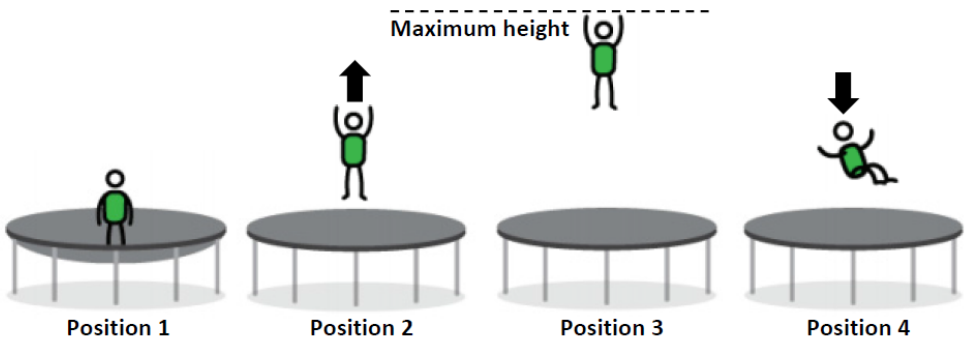
**(c)** Place an **X** on the Periodic Table shown below to indicate the position of element **X**.
You may use the Periodic Table on page 79 of the *Formulae and Tables* booklet to help you answer this question.



**Question 15** **(60 marks)**

Energy exists in many forms. The energy stored by an object due to its position or shape is called potential energy. The energy of an object due to its motion is called kinetic energy.

Potential energy is converted to kinetic energy when a person jumps on a trampoline.
The diagrams show the position of a person at certain times while jumping.




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

**(i)** Identify a position where the person has least kinetic energy.

Position **1** ☐ Position **2** ☐ Position **3** ☐ Position **4** ☐

**(ii)** Identify a position where the trampoline has its greatest potential energy.

Position **1** ☐ Position **2** ☐ Position **3** ☐ Position **4** ☐

**(b)** Name a force responsible for the motion of the person in position **4**.

**(c)** Heat energy is also produced when a person uses a trampoline.
Describe one possible source of this heat energy.

**(g)** On Earth, a mass of 128 g has a weight of approximately 1.25 N.
Explain the underlined terms.

2022 Q 15

**(c)** **(i)** EU agriculture has reduced its greenhouse gas emissions by 20% since 1990. Name a greenhouse gas which drives climate change and is produced by agricultural practices.

2022 Q14


In part (ii) students had to supply two pieces of information to get the 3 marks

Proton: positive or +1 or +

AND

Neutron: neutral or 0 or no charge

**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.

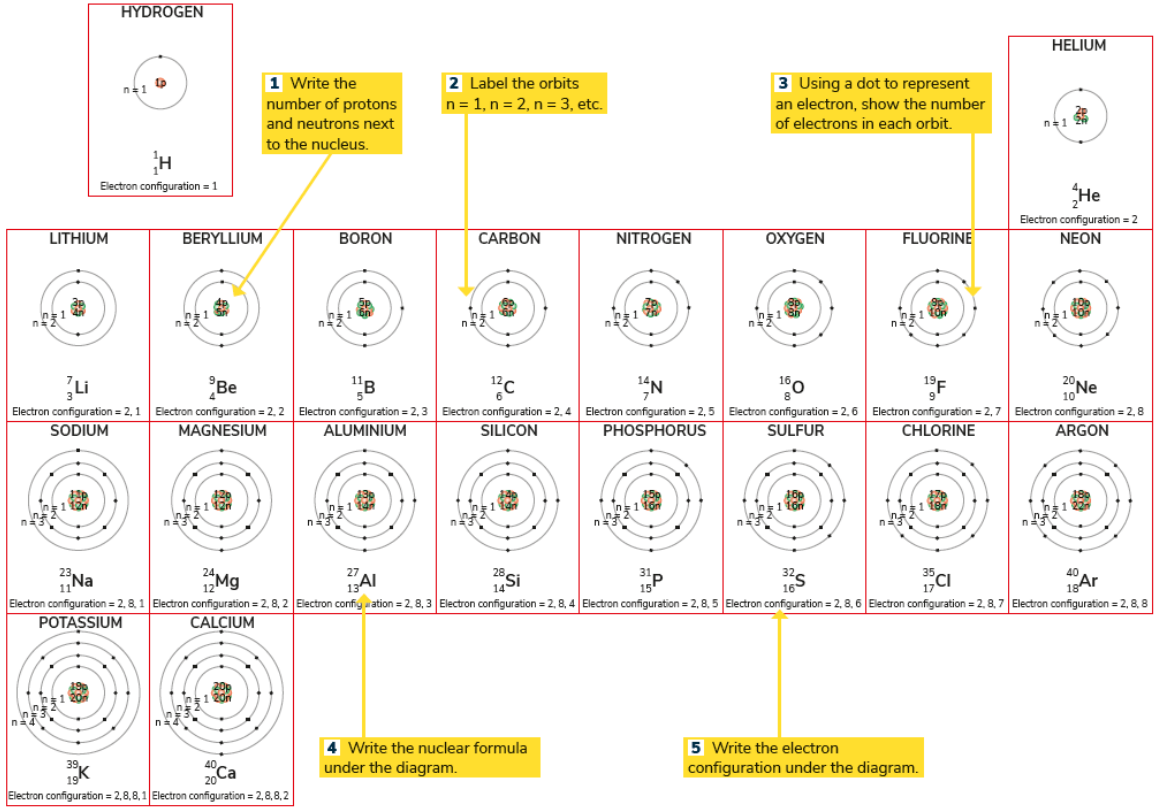
**(ii)** Compare the charge of the proton with the charge of the other particle you have named.

(2023 Q10)

**(b)** In the space below, draw a labelled diagram of an atom of lithium showing the positions of the nucleus and the electrons. (2023 Q10)

Lithium atom


This question was poorly answered.
See summary of atomic structures of first 20 elements on p. 246 Essential Science



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

(2023 Q10)

**(a)** What is the unit of force?

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

(2023 Q. 14)

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

(2023 Q3)


“endo” was not acceptable. Students must write out the full name “endothermic”.

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

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

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

**(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.

**(ii)** Name a good source of this nutrient.

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

(2023 Q14)

(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.

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


0 marks awarded for wrong spelling, e.g. methyl orange NOT methylene orange.

(2023 Q8)


"Evidence of high levels of knowledge – and lower levels of understanding, application and analysis - was seen in candidates' answers to questions related to each of the four contextual strands of the specification"

- Chief Examiner's Report p. 6.

## SEC examination question

Natural gas contains methane ($CH_4$). Methane is a fuel. Methane burns in oxygen to produce carbon dioxide and water. The diagram below (Figure 21.12) represents the reaction.

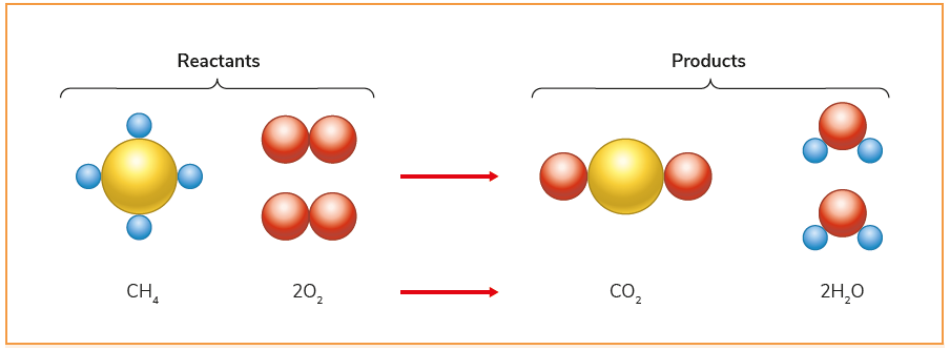



Figure 21.12

**(a)** Count the number of each type of atom in the products to complete the table below.

| Element | Type of atom | Number of atoms in reactants | Number of atoms in products |
|---|---|---|---|
| Carbon |  | 1 | 1 |
| Hydrogen |  | 4 | 4 |
| Oxygen |  | 4 | 4 |

Table 21.3

**(b)** Mass is conserved during this reaction. What evidence is there for this?

*There are equal numbers of each type of atom on both sides of the equation.*

**EXAM TIP!** You must use the phrase 'equal numbers of each type of atom' to get full marks in your exam.

**(c)** The burning of methane is an example of a chemical change. Describe one difference between a physical change and a chemical change.

*A physical change is a change that does not result in the formation of any new substance. A chemical change is a change that results in the formation of one or more new substances.*

2019 Q4

- See Essential Science p. 200.

This weakness among students can be addressed by getting them to undertake lots of examination-style questions in the **end of chapter questions**, **the Assessment Skills Book (Workbook), the Laboratory Notebook, videos and the many online Worksheets on each chapter.**

A **physical change** is a change that does not result in the formation of any new substance.

A **chemical change** is a change that results in the formation of one or more new substances.

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# 2. Questions that ask students to draw labelled diagrams or insert labels on a diagram or blanks in a sentence.

## SEC examination question

A student carried out an experiment to investigate the reaction between an acid and a base.
A thermometer was used to monitor changes in temperature during the reaction.

**(a)** The student noted a rise in temperature as the acid-base reaction took place. Is this an example of an endothermic or an exothermic reaction?

*Exothermic*

**(b)** Figure 24.15 shows an energy profile diagram for the reaction between an acid and a base.
On the diagram, show the activation energy for this reaction.

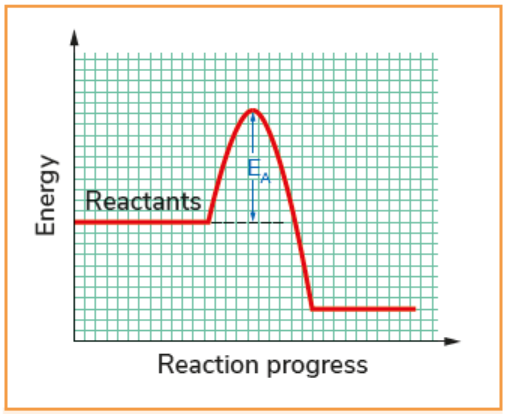



Figure 24.15

**EXAM TIP!**

When drawing in the line for the activation energy, to get full marks you must show the tip of the arrow touching the top of the curve.

p. 233

## SEC examination question

Some chemical reactions proceed quickly while some proceed at a slower rate. During your studies you investigated the effect of a number of variables on the rate of production of a common gas.

**(a)** Name a common gas that could be produced in the laboratory.

*Hydrogen*

**(b)** Draw a labelled diagram of how this gas could be produced. Include labels for any equipment and chemicals used.

*The labelled diagram is shown in Figure 22.22.*

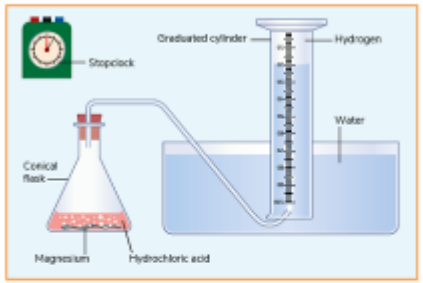



Figure 22.22

**(c)** Explain how you tested this gas to confirm its identity. Include the result of the test.

*A lighted taper is brought near the mouth of a test tube of hydrogen gas.*

*The hydrogen burns with a pop, as hydrogen forms an explosive mixture with air.*

A student carried out an experiment to investigate the effect of temperature on the rate of production of a certain gas. The first reaction happened at 20 °C and the second one at 30 °C.

In both cases the gas produced was passed through water as it was collected. This was to ensure that the gas was always at room temperature (a constant) when its volume was measured.

The student recorded the following results:

| Time (s) | Volume of gas ($cm^3$) for reaction at 20 °C | Volume of gas ($cm^3$) for reaction at 30 °C |
|---|---|---|
| 0 | 0 | 0 |
| 30 | 7 | 10 |
| 60 | 13 | 16 |
| 90 | 17 | 19 |
| 120 | 19 | 20 |
| 150 | 20 | 20 |

**Table 22.6**

**(d)** In the space below, draw graphs for both sets of results.

*The graph is shown in Figure 22.23.*

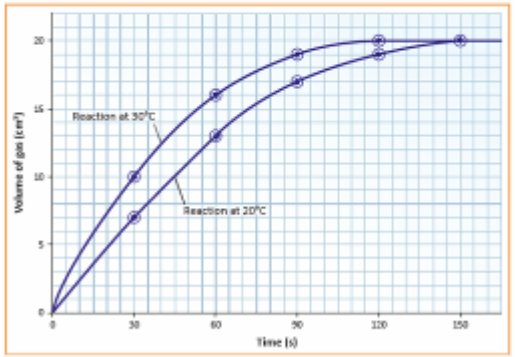


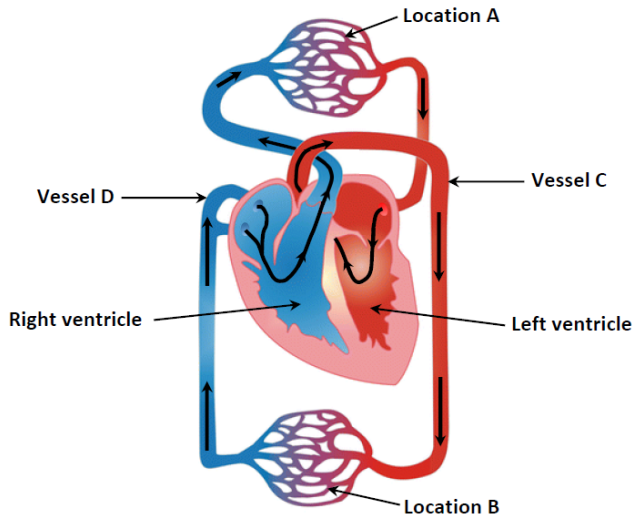

Figure 22.23

**(e)** State two conclusions the student could have drawn from the results.

1. *The reaction takes place more quickly at 30 °C than at 20 °C. We see this from the fact that at the beginning of the experiment, the graph for the reaction at 30 °C is steeper than the graph for the reaction at 20 °C. We conclude that the higher the temperature, the faster the rate.*
2. *The same final volume of gas was given off in both cases.*

**Question 10** **(15 marks)**

The diagram shows the human heart and some of the blood vessels of the circulatory system.
The arrows indicate the direction in which the blood flows as it travels around the body.




**(a)** The table below lists statements about the diagram.
Indicate if each statement is true or false by putting a tick (✓) in the correct column.

| Statement | True | False |
|---|---|---|
| The blood in vessel **C** is deoxygenated. | | |
| The organs found at location **A** are part of the respiratory system. | | |
| Carbon dioxide leaves the blood at location **B**. | | |
| Vessel **D** is a vein. | | |

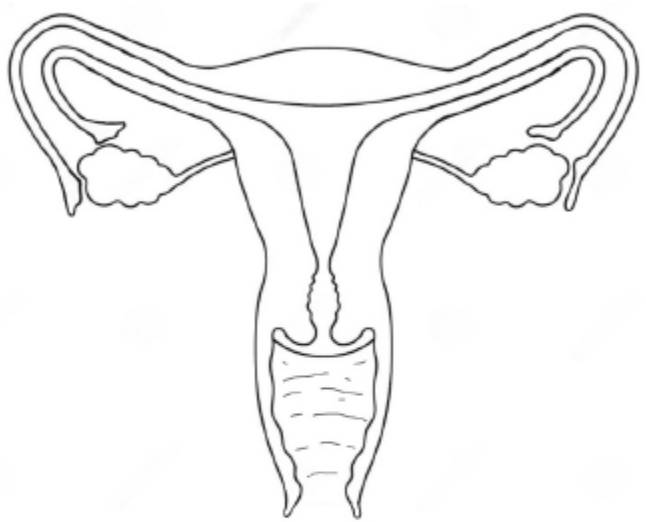
**(b)** Vessel **C** has thicker walls than vessel **D**.
Explain why.

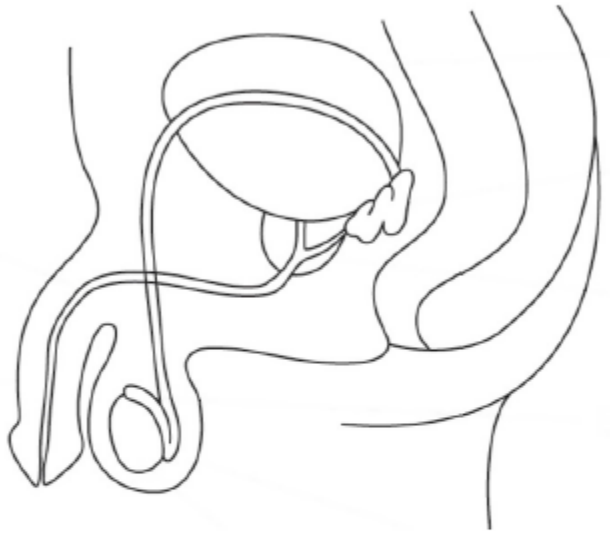
| |
|---|
| |
| |
| |

2022 Q10

**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.

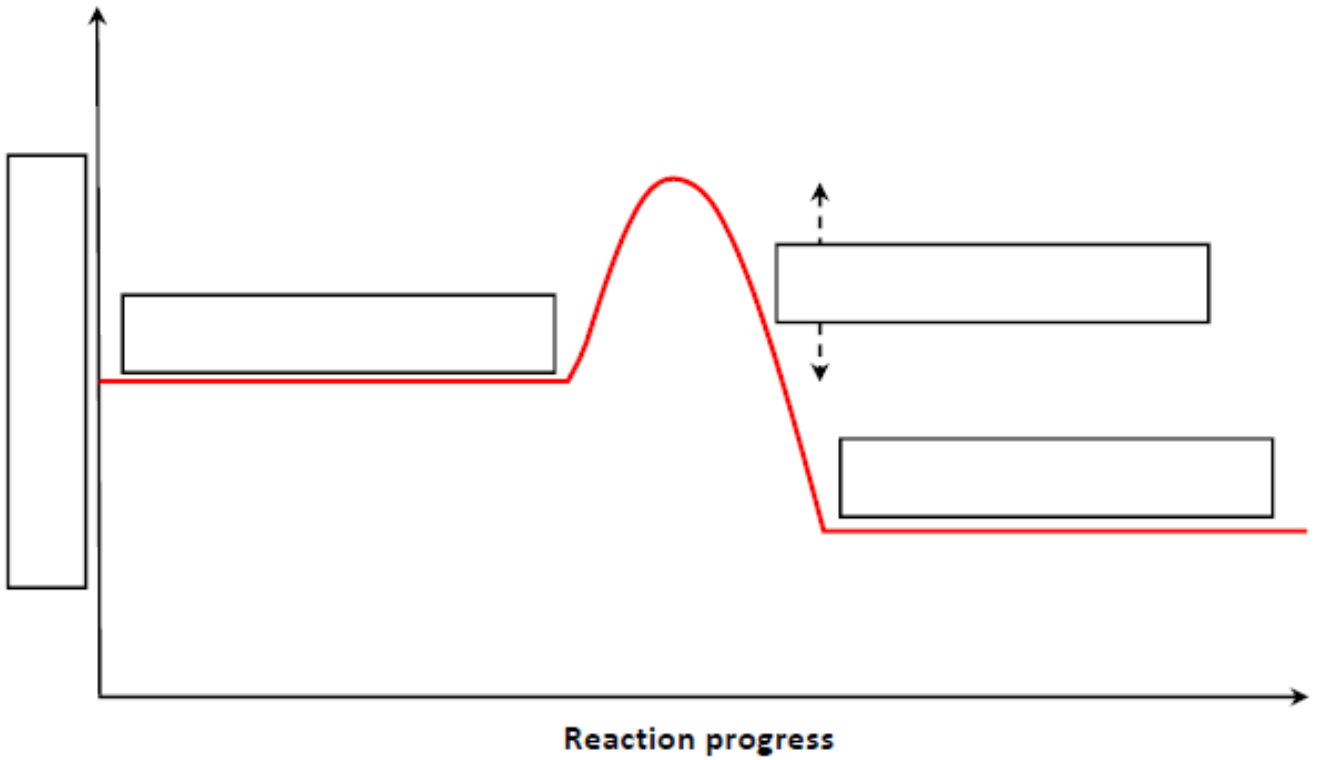
**(d)** Use the letter **D** to label the part of the reproductive systems where the foetus develops during pregnancy.

(2023 Q2)

**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**



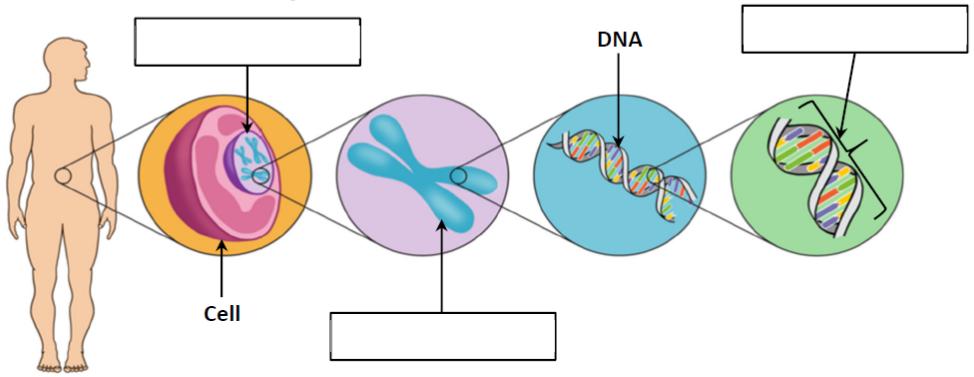


Students commonly lost marks for "Energy" on Y axis

(2023 Q3)

**Question 12** **(30 marks)**

The diagram illustrates the organisation of genetic information within human cells.
Some of the labels are missing.




**(a)** Use each of the words listed below to complete the labels on the diagram above.

**Chromosome** **Nucleus** **Gene**

**(b)** Name an instrument which could be used in the laboratory to view human cells.

A normal human brain cell contains 46 chromosomes.
Answer questions **(c)** and **(d)** by putting a tick (✓) in the correct box.

**(c)** How many chromosomes are present in a human sperm cell?

- 23 ☐
- 46 ☐
- 69 ☐
- 92 ☐

**(d)** The sperm cell fertilises an egg cell. How many chromosomes should be present in the resulting zygote?

- 23 ☐
- 46 ☐
- 69 ☐
- 92 ☐

2022 Q12

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

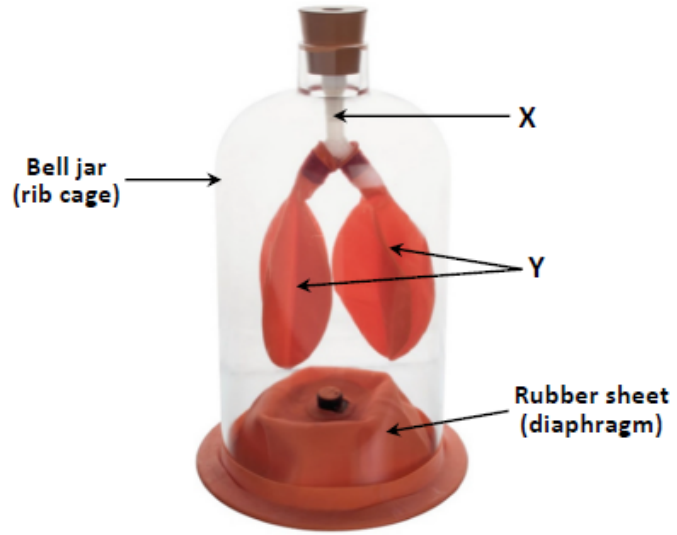
**(ii)** Draw a labelled diagram to show a model of a *lunar* eclipse.

(2023 Q13)

2023 Q15

**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.

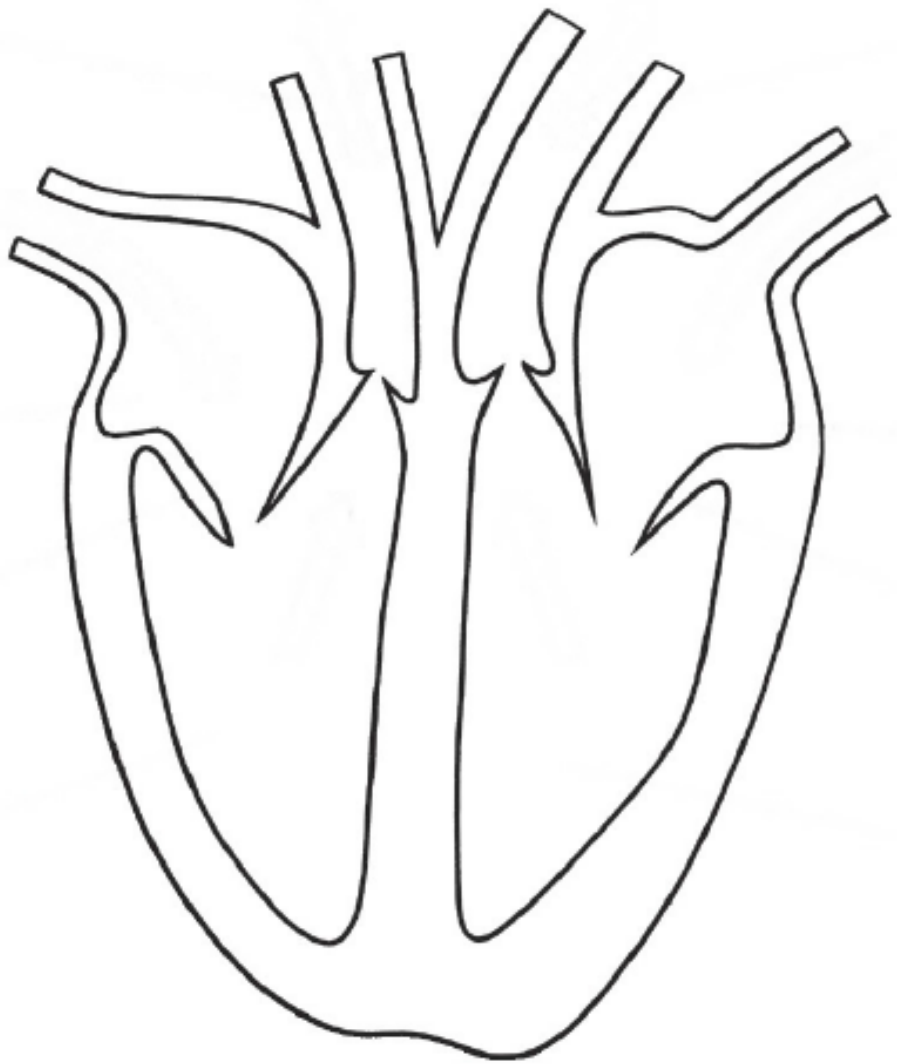



**(a)** **(i)** Name the part of the breathing system represented by the tube labelled **X**.

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

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

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



(2023 Q. 15)

# 3. Questions that ask students to complete a table or complete a sentence (cloze tests)

## SEC examination question

Match each of the following subatomic particles to their descriptions in the table below.

Electron  Neutron  Proton

**EXAM TIP!**

To remember the charges on subatomic particles, think of **p**ositive **p**roton and **n**eutral **n**eutron.

| Description | Particle |
|---|---|
| Positively charged | *Proton* |
| Negatively charged | *Electron* |
| No charge | *Neutron* |

**Table 25.3**

p. 239

**(iii)** Complete the table below by matching the part of the digestive system from the diagram with its function.

| Function | Part of digestive system |
|---|---|
| Absorbs water from fully-digested matter | |
| Secretes hydrochloric acid to kill bacteria in food | |
| Absorbs fully-digested food into the bloodstream | |

2022 Q14(h) (iii)

"A much lower level of achievement was shown in answers to question 4(b) which required candidates to cite evidence for the conservation of mass during a chemical reaction"
Chief Examiner's Report p. 6

## SEC examination question

Natural gas contains methane ($CH_4$). Methane is a fuel. Methane burns in oxygen to produce carbon dioxide and water. The diagram below (Figure 21.12) represents the reaction.

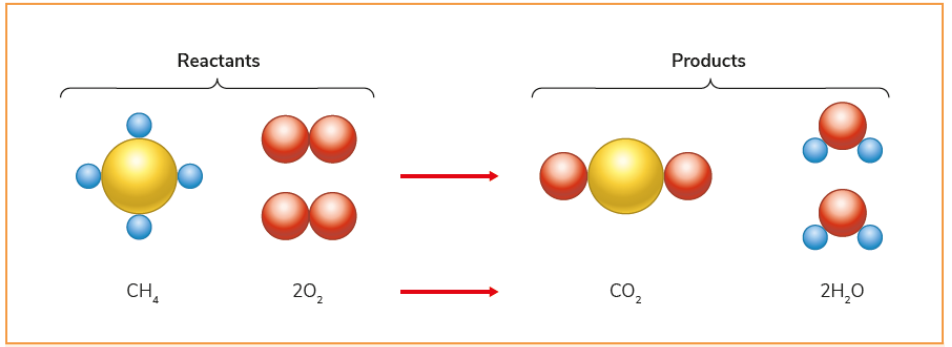



Figure 21.12

**(a)** Count the number of each type of atom in the products to complete the table below.

| Element | Type of atom | Number of atoms in reactants | Number of atoms in products |
|---|---|---|---|
| Carbon |  | 1 | 1 |
| Hydrogen |  | 4 | 4 |
| Oxygen |  | 4 | 4 |

Table 21.3

**(b)** Mass is conserved during this reaction. What evidence is there for this?

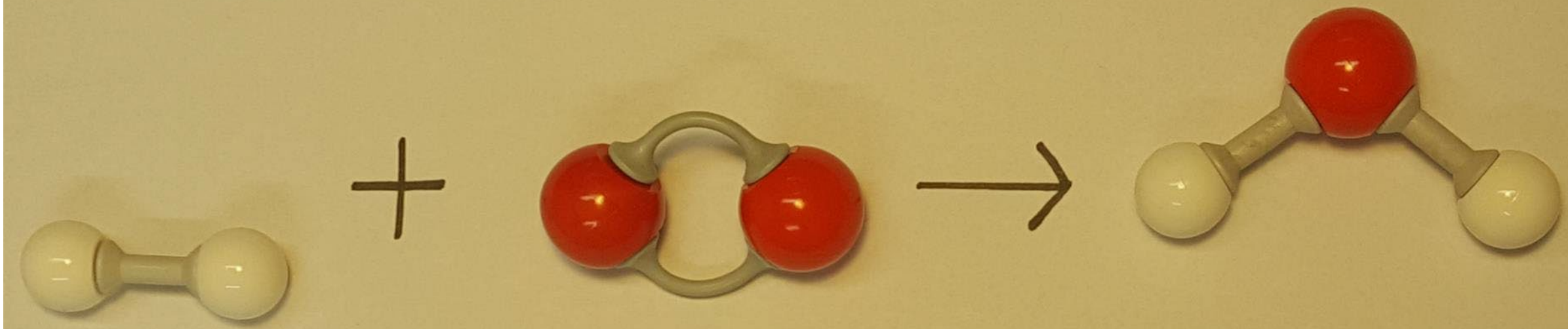
*There are equal numbers of each type of atom on both sides of the equation.*

**EXAM TIP!** You must use the phrase 'equal numbers of each type of atom' to get full marks in your exam.

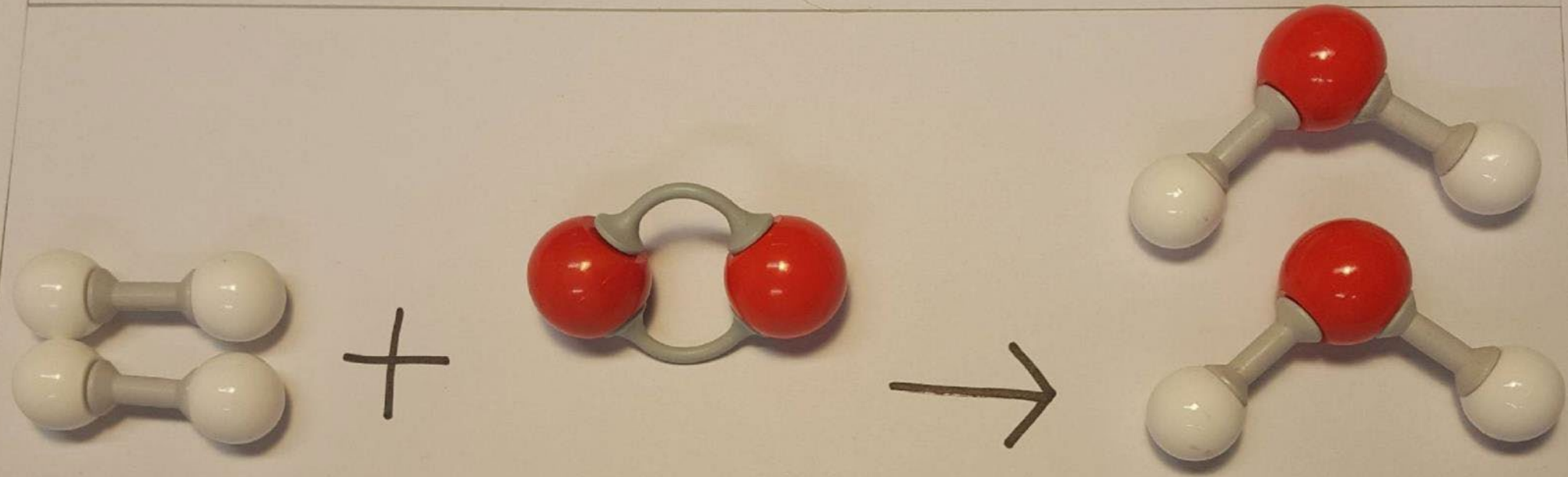
**(c)** The burning of methane is an example of a chemical change. Describe one difference between a physical change and a chemical change.

*A physical change is a change that does not result in the formation of any new substance. A chemical change is a change that results in the formation of one or more new substances.*

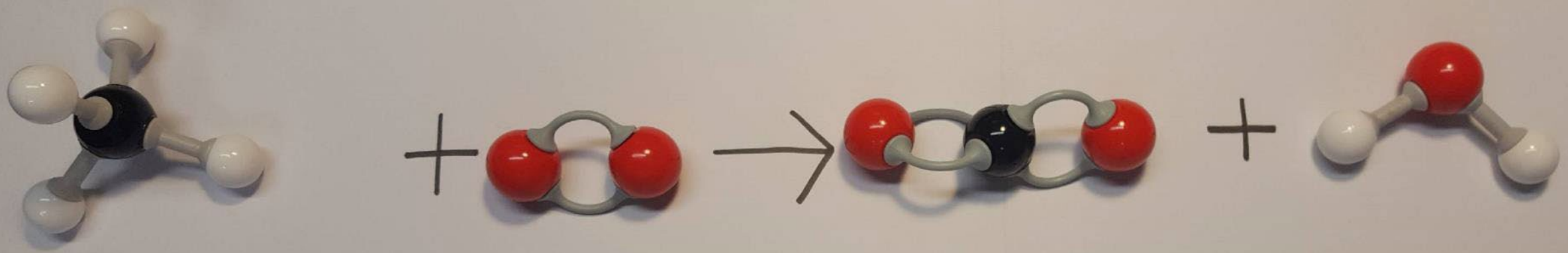
p. 216



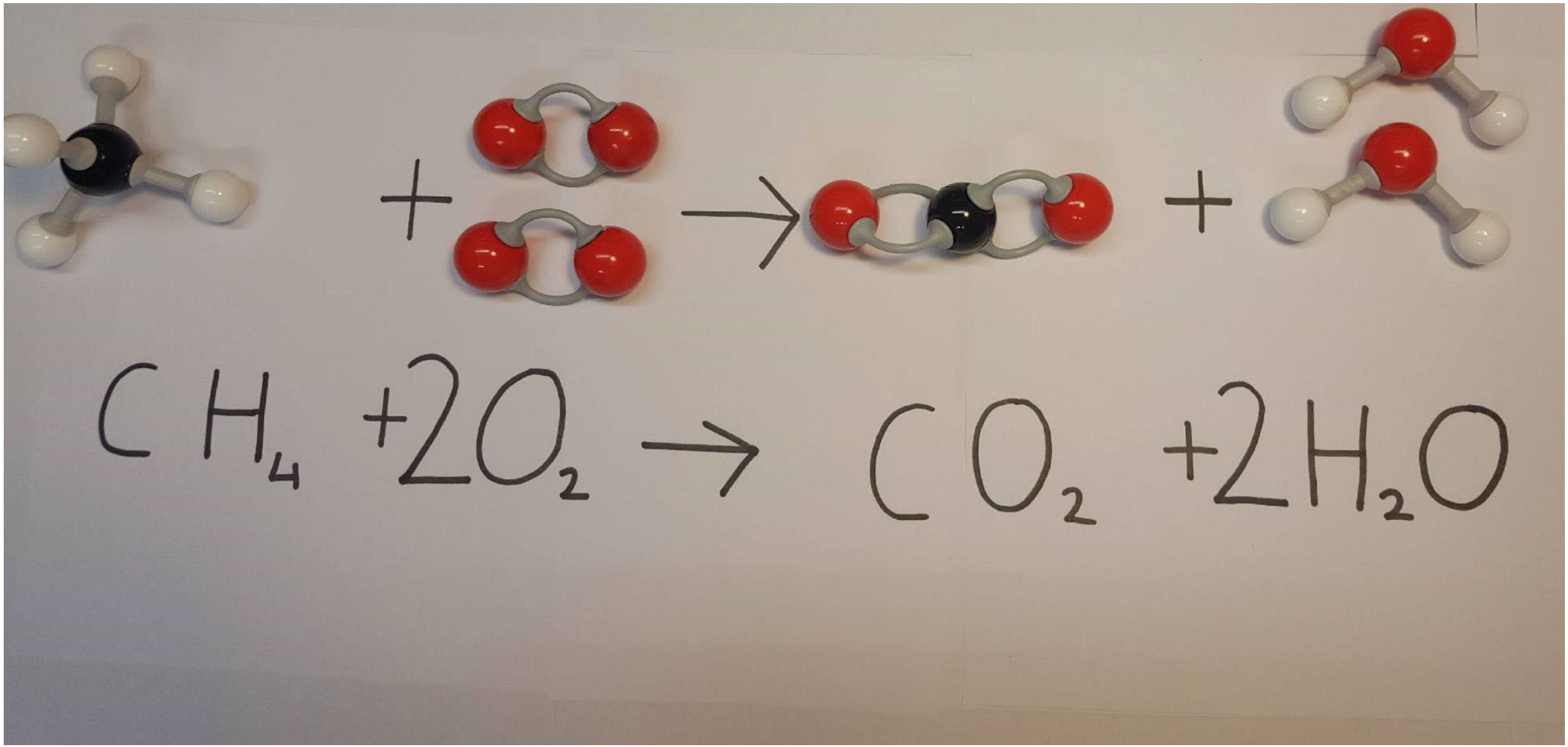
$$H_2 + O_2 \rightarrow H_2O$$



$$2H_2 + O_2 \rightarrow 2H_2O$$



$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$


$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

# Which Molymod set to buy?

Lennox Lab Supplies are the Irish agents for Molymod

**Organic (Student) Set**
**Article Ref: MMS-008** - 50 atoms
Supplied in a 4- compartment box

contents

20 hydrogen (I), 12 carbon (IV), 6 oxygen (II), 4 nitrogen (III, IV), 2 sulphur (IV, VI), 1 phosphorus (IV), 4 halogen (I), 1 metal (I) Links: 26 medium (grey), 12 long flexible (grey), 26 short (white), 1 short link remover tool

**(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 | |
| Found in plant cells only | |
| All of the material inside a cell, except for the nucleus | |

(2023 Q. 3)

**(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) | : | |
| Hydrogen sulfide | Hydrogen (H) | Sulfur (S) | : | |
| Aluminium oxide | Aluminium (Al) | Oxygen (O) | : | |

(2023 Q.9)

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

| |
|---|
| |
| |
| |


A **metal** is an element that tends to form positive ions.

(p. 260 Essential Science)

Malleable – metals can be beaten into shapes
"Metals can be shaped" is not accepted – 0 marks

(2023 Q 9)


**Evaporation** is the changing of a liquid to a gas at the surface of the liquid.

The **boiling point** of a liquid is the temperature at which a liquid changes to a gas throughout the liquid.

(Essential Science p. 154 – 155)

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 _____. When a liquid is heated it turns into a gas – this change of state is called _____.

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

(2023 Q 4)

# 4. Questions that ask students to interpret a diagram or identify parts in a diagram.

## SEC examination question

The chamber of the heart marked X in Figure 5.20 pumps blood around the body and generates a pulse.

**(a)** Name chamber X.

*The left ventricle*

**(b)** Explain why some of the tubes connected to the heart are coloured red and some of them are coloured blue.

*Red is showing oxygenated blood.*

*Blue is showing deoxygenated blood.*

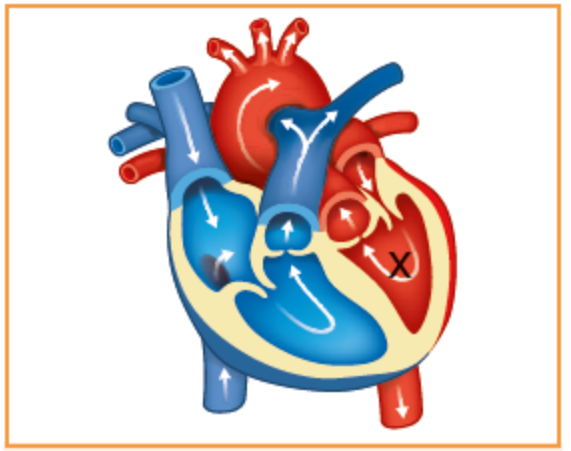



Figure 5.20

p. 43

## SEC examination question

Figure 17.15 shows the arrangement of particles in the elements aluminium and chlorine at room temperature.

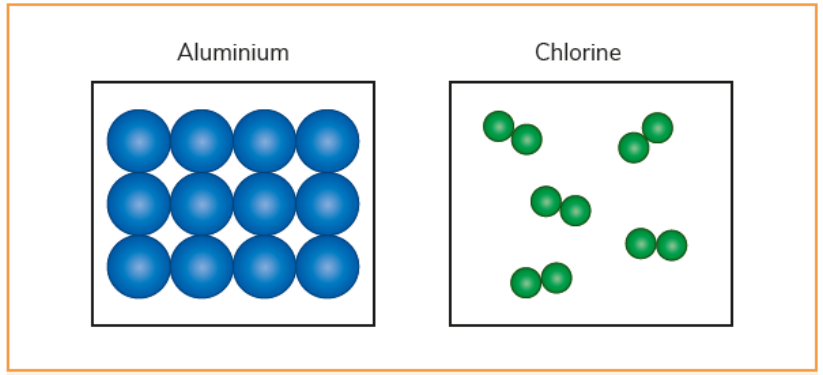



Figure 17.15

**(a)** What evidence is there in the diagrams to support the classification of these substances as elements?

*The two substances are elements since the particles (atoms) in aluminium are all the same. Also, all the particles (atoms) in chlorine are the same as each other.*

**(b)** Which of these elements is a solid at room temperature? Justify your answer.

*Aluminium is a solid at room temperature. Aluminium must be a solid as the particles (atoms) are packed closely together.*

p. 166

## SEC examination question

All biological organisms are made up of cells.

**(a)** Name the instrument shown in Figure 3.15, which is used to examine cells.

*Microscope*

**(b)** Name the labelled part of the instrument, which makes the cells look bigger.

*Objective lens*

Figure 3.15

**(c)** The picture below shows cells from an onion, which are typical plant cells.
In the box, write the name of any one part of the cell you have named.
Draw an arrow from the box to the part of the cell you have named.

*Nucleus*

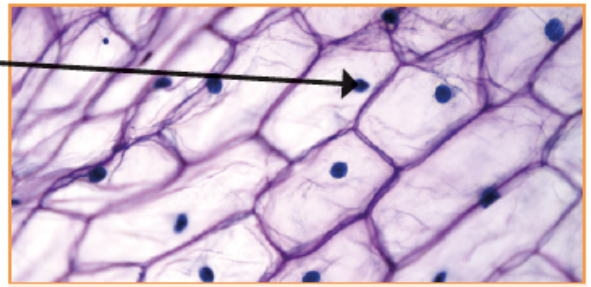


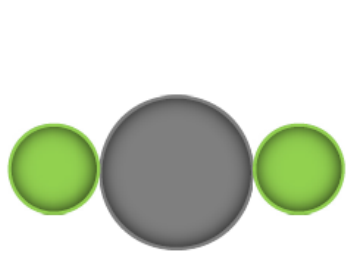
Figure 3.16

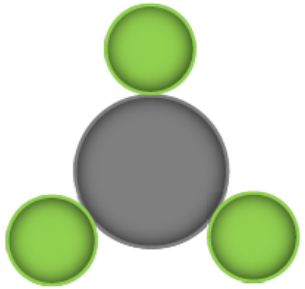
**(d)** State the function of the part of the cell you have chosen.

*Nucleus: To control the activities of the cell.*

p. 25


**(d)** Element **X** forms a compound with hydrogen. Element **X** is shown in grey. Hydrogen is shown in green. Circle the diagram below which represents the compound formed. Justify your answer.





2022 Q3

Must mention that element X (carbon) has 4 electrons in its outer orbit
OR carbon needs 4 electrons
OR carbon has combining power of 4

**WORKED EXAMPLE 26.8**

Using the Periodic Table, predict the number of chlorine atoms that will combine with an atom of carbon. Hence, write the formula of the compound formed when carbon reacts with chlorine.

**Answer**

- One carbon atom combines with four hydrogen atoms.
- One hydrogen atom combines with one chlorine atom.
- Therefore, one carbon atom will combine with four chlorine atoms to form $CCl_4$ (Figure 26.24). Note that in the $CCl_4$ molecule, each chlorine atom simply replaces each H atom in $CH_4$.

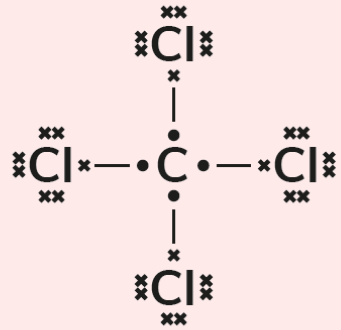


**Figure 26.24** One carbon atom combines with four chlorine atoms to form the $CCl_4$ molecule.

(p. 253 Essential Science)

A molecule of methane consists of one carbon atom joined to four hydrogen atoms (Figure 26.16).

### Why is $CH_4$ the formula of methane?

- Figure 26.6 shows us that there are four electrons in the outer orbit of a carbon atom.
- As already stated, chemists have found that most atoms try to have eight electrons in the outer orbit.
- For carbon to get these eight electrons, the four electrons in the outer orbit of a carbon atom are **shared** with four atoms of hydrogen, as shown in Figure 26.17.
- The carbon atom and the four hydrogen atoms are joined, or **bonded**, together.
- The force of attraction that holds a molecule of methane together is called a **chemical bond**. Thus, in methane, there are four chemical bonds.
- Since this type of chemical bond involves sharing electrons, we call it a **covalent bond**. The word *covalent* means 'sharing'.

A **covalent bond** is the force of attraction between atoms in a molecule when pairs of electrons are shared.

- In short, we say that a molecule of methane is held together by four covalent bonds. Each covalent bond is shown in Figure 26.17 by a straight line.

All the examples of compounds that we will meet in the remainder of this chapter contain covalent molecules. Therefore, these compounds are called **covalent compounds**.

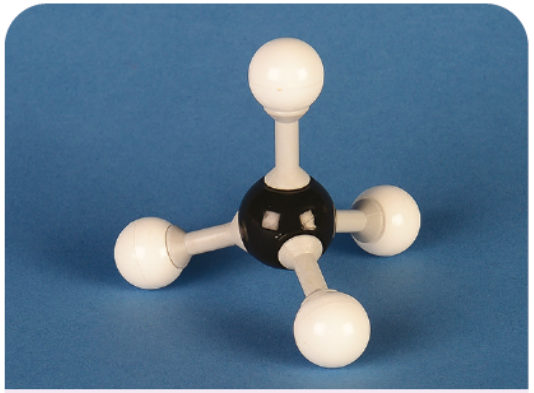


**Figure 26.16** A molecule of methane consists of one carbon atom joined to four hydrogen atoms. Therefore, the formula of methane is $CH_4$.

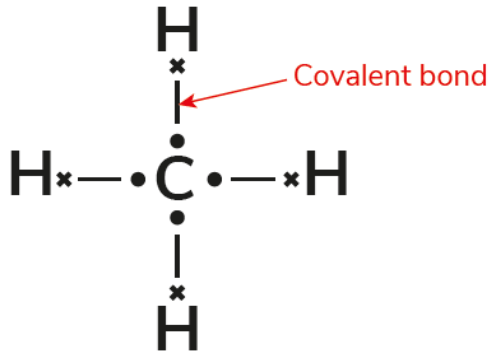
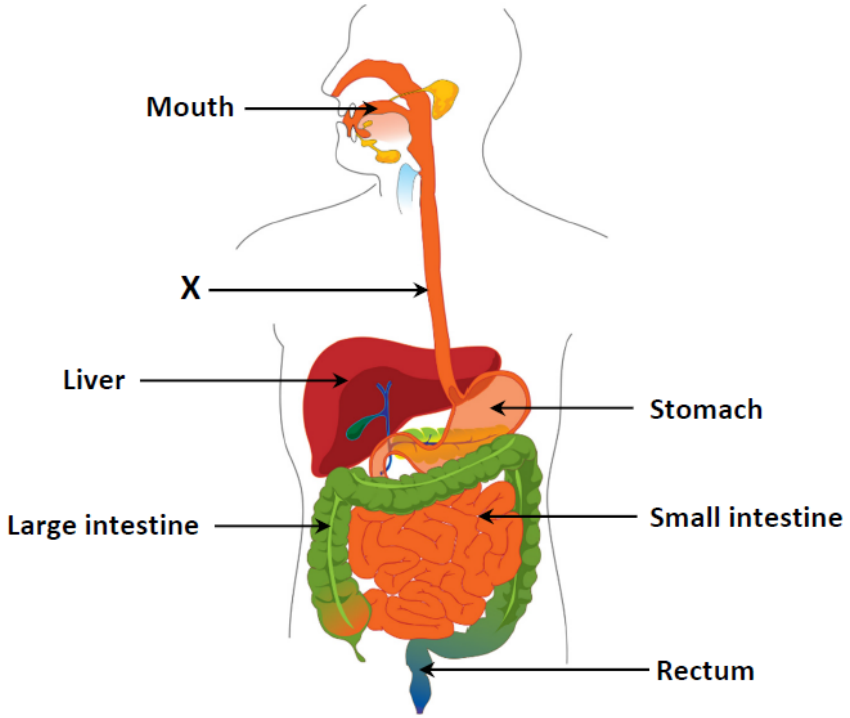



**Figure 26.17** In the methane molecule, a carbon atom is joined by covalent bonds to four hydrogen atoms.

Explanation why $CH_4$ is the formula of methane is given in Essential Science p. 251

**(h)** Food is broken down in the digestive system. The diagram below shows the anatomy of the human digestive system and some of its associated organs.



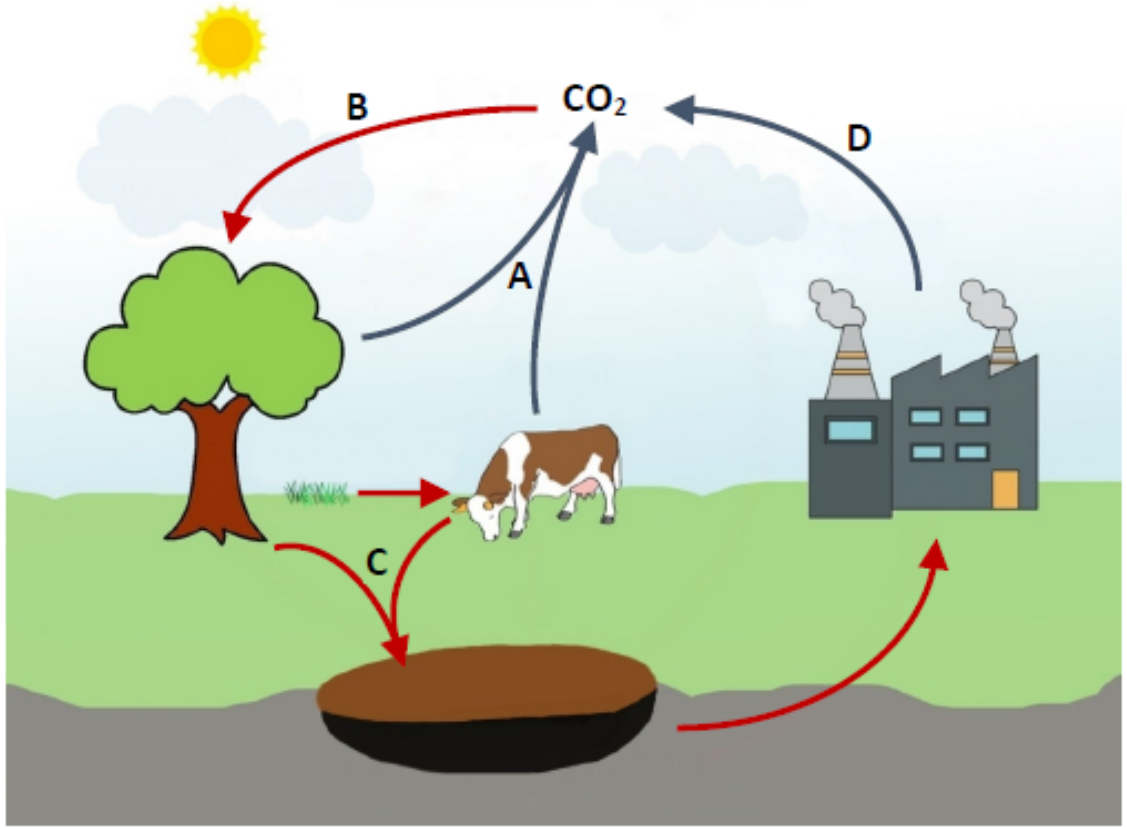

**(i)** On the diagram, draw a circle around a part of the digestive system which is also a part of the respiratory system.

**(ii)** Identify structure **X**.

| |
|---|
| |

2022 Q 14 (h)

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**.

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

**(i)** Name process **B**.

(2023 Q14)

# 5. Questions that ask students to draw graphs and interpret data presented in graphs.

"While students, in many instances, perform well on questions that require them to recall information, they frequently perform less well on questions that require them to use higher-order skills, including understanding, application, analysis, evaluation and synthesis."
Chief Examiner's Report p. 8

## SEC examination question

Figure 31.26 represents the journey of a cyclist.

**(a)** Name an instrument that could be used to measure the time taken for the journey.

*Timer*

**(b)** Calculate the average speed of the cyclist as he travelled from point A to point B.

*From the graph, the cyclist travelled 100 m in 40 seconds.*

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{100\ \text{m}}{40\ \text{s}} = 2.5\ \text{m s}^{-1}$$

**(c)** Describe the cyclist's motion between points B and C of his journey.

*Since the distance is not changing, the cyclist must be stopped. This may also be seen from the fact that the slope of the graph from B to C is zero. Zero slope means zero speed.*

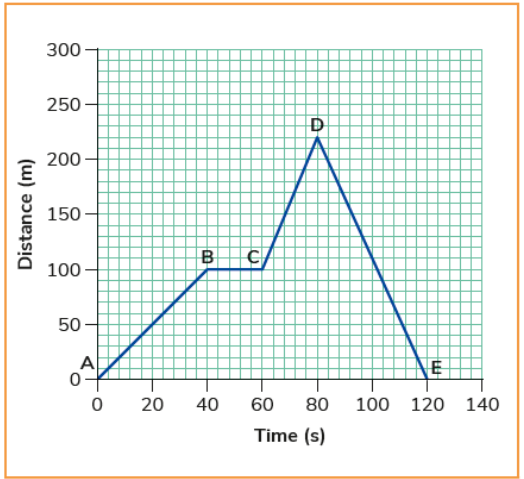



Figure 31.26

**(d)** The cyclist's speed as he travelled from point A to point B was less than his speed as he travelled from point C to point D. What evidence is there in the graph to support this?

*The slope of a distance time graph tells us the speed. Since the slope of the graph from A to B is less steep than the slope of the graph from C to D, the cyclist was moving more slowly between A and B.*

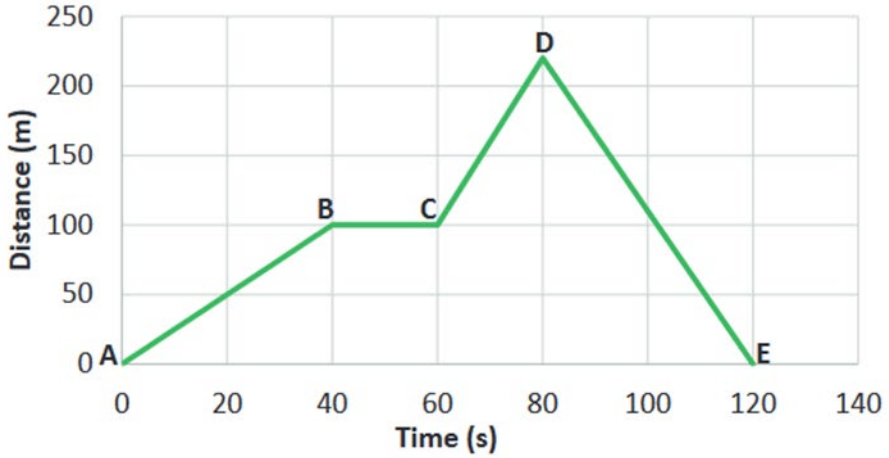
**(e)** Describe what the cyclist did at point D.

*At point D the cyclist begins to return to the start point. (The distance to the start point is becoming less between D and E. At E, the cyclist has returned to the start point.)*

p. 312

# **2019** Q 7. Interpretation of graphs

The graph below represents the journey of a cyclist.





**(a)** Name an instrument that could be used to measure the time taken for the journey.

**(b)** Calculate the average speed of the cyclist as he travelled from point **A** to point **B**.

Calculation

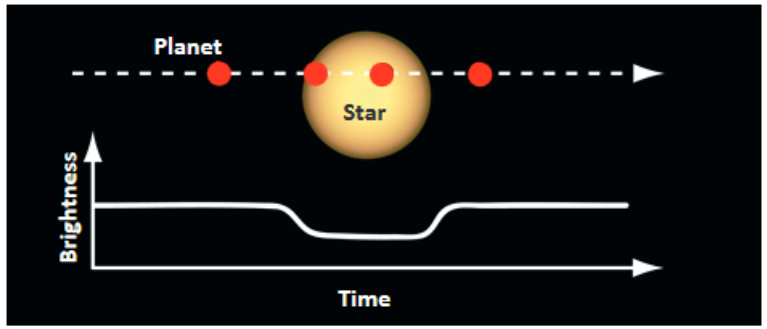
**(c)** Describe the cyclist's motion between points **B** and **C** of his journey.

**(d)** The cyclist's speed as he travelled from point **A** to point **B** was less than his speed as he travelled from point **C** to point **D**. What evidence is there in the graph to support this?

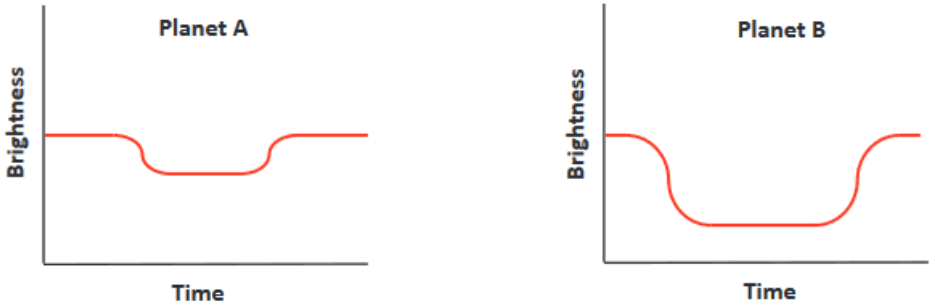
**(e)** Describe what the cyclist did at point **D**.

# **2019** Q 10. Interpretation of graphs

**(c)** The image below shows a planet passing in front of a star. This partial eclipse is called a transit. The brightness of the light detected from the star decreases as the planet transits the star and blocks its light.




The graphs below show how the brightness of a star changed over time as two planets, **A** and **B**, transited the same star.




Which planet, **A** or **B**, took the shortest time to transit the star?

Which planet, **A** or **B**, is the largest? Give a reason for your answer.

| | | | |
|---|---|---|---|
| (c) | A | 3 | |
| | B | 3 | |
| | Reason: greater decrease in brightness / blocks more light | 3 | **9** |

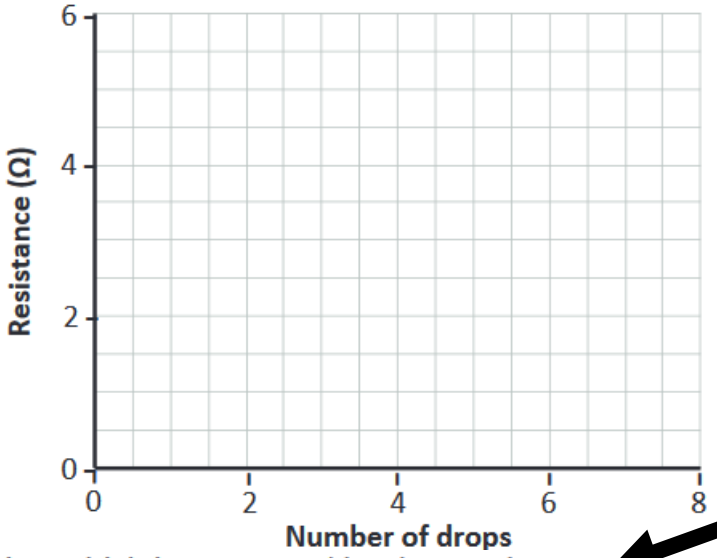

Time inserted incorrectly here

# 2019 Q 12 Bar chart unacceptable here

The student made different concentrations of a solution of red food dye by varying the number of drops of dye added to 20 $cm^3$ of water. The resistance of the LDR was then determined using meter **X**. The following results were obtained.

| Number of drops of food colouring | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Resistance (Ω) | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |

**(a)** In the space below, draw a graph of the results obtained.


State one conclusion which is supported by the results.

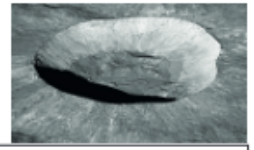
| Q12 | | Marks | |
|---|---|---|---|
| (a) | Points plotted | 9×1 | 12 |
| | Correct line drawn (for points plotted) | 3 | |

**Needed to link X and Y axis**

| | | |
|---|---|---|
| (b) | Resistance increases with number of drops (or concentratic | **3** |

# 2019 Q 16

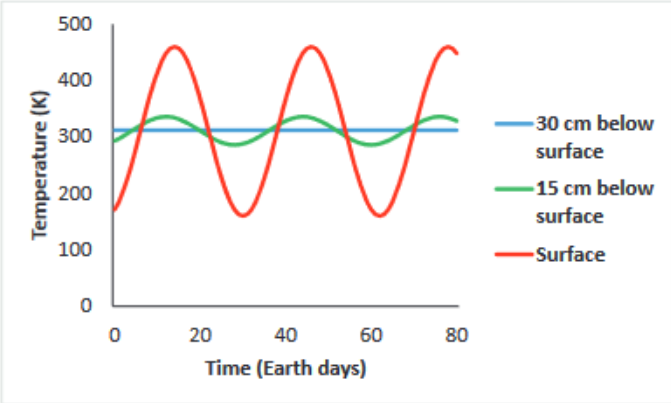
**(d)** The dark circles visible on the Moon's surface are craters. Craters occur when objects with high speed strike the surface of the Moon. Examples of such objects are asteroids and comets.



What is an asteroid?

ALERT!

**(e)** Many investigations were carried out during missions to the Moon. One investigation measured the temperature of the lunar surface at various depths. The graph shows the temperatures measured at different depths over a period of time.



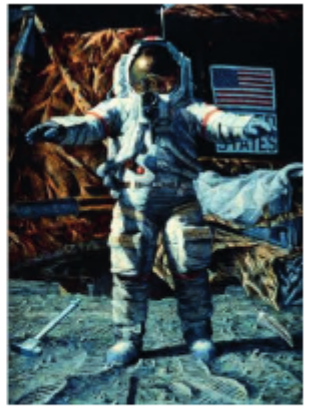

Describe how the temperature on the surface of the Moon (red line) changed with time. Suggest an explanation for this pattern.

ALERT!

Describe the relationship between the depth below the surface of the Moon and the change in temperature. Suggest an explanation for this relationship.

| | | | |
|---|---|---|---|
| (d) | Rock orbiting the Sun / rock in space | | 3 |
| (e)i | Describe: temperature increased and decreased<br>Explain: increased in sunlight / decreased when not in sunlight | 3<br>3 | 6 |
| (e)ii | Describe: the greater depth, the smaller the change in temperature<br>Explain: objects at depth not exposed to temperature extremes | 3<br>3 | 6 |

**(g)** During the Apollo 15 mission to the Moon in 1971, astronaut David Scott conducted the famous hammer and feather experiment.



The hammer and feather were dropped at the same time from the same height and hit the surface of the Moon at the same time.

A hammer falls much faster on Earth than it does on the Moon. Explain why.

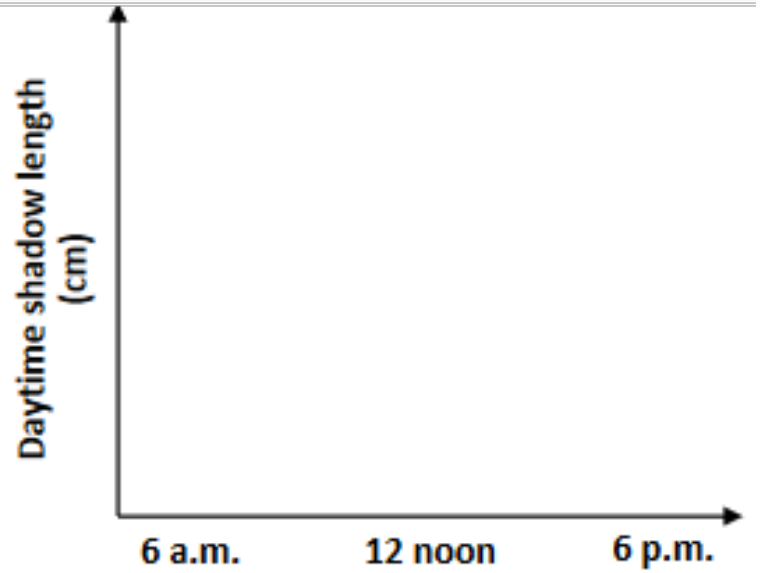
ALERT!

# 2022 Q 11

**(e)** Name an instrument the students could have used to measure the length of the shadow.

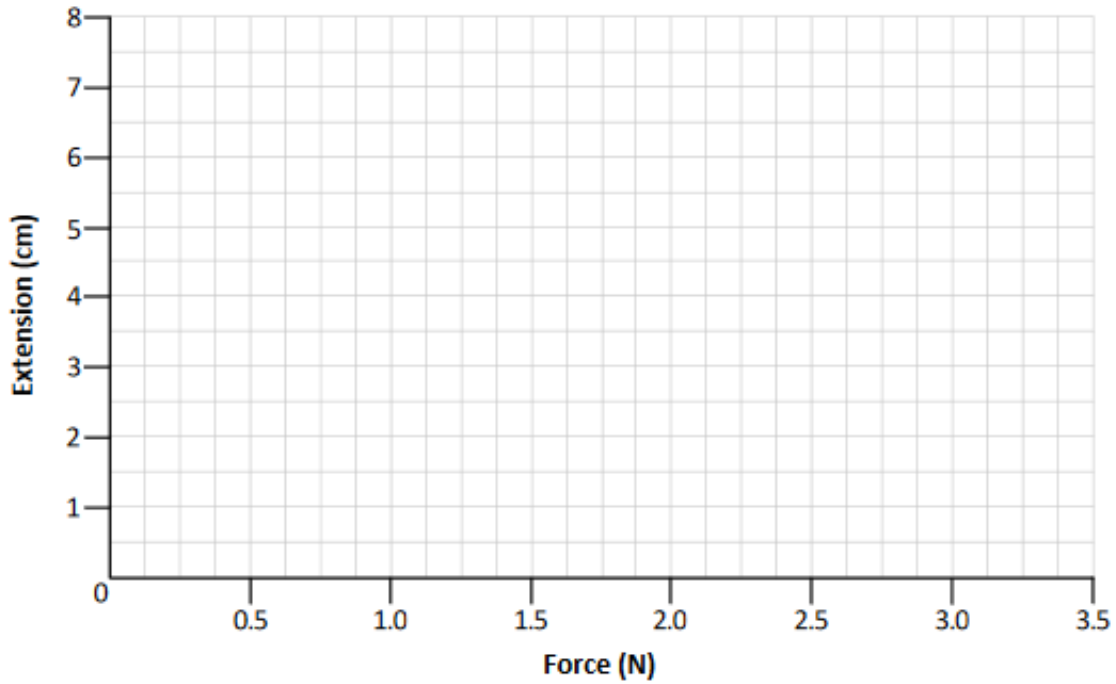
**(h)** Group **A** also investigated how the length of the shadow cast by the pole changed during a sunny day in June.

Using the axes on the right, sketch the curve the students should have obtained.



| Force (N) | | 0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 |
|---|---|---|---|---|---|---|---|---|---|
| Extension (cm) | Spring P | 0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 |
| | Spring Q | 0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 |

**(d)** In the space below, draw a line graph of force against extension for **each** spring.

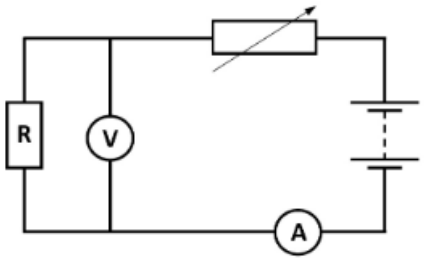



Label one of the lines. **No bar charts.**

# 2022 Q 5

**Question 5** **(15 marks)**

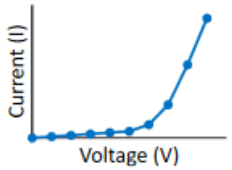
A student used the circuit diagram on the right to investigate how the current flowing through resistor **R** varies with the voltage (potential difference) across it.



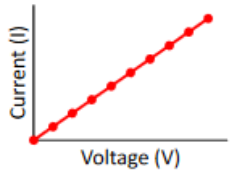

**(a)** **A** is an ammeter.
Does an ammeter measure current or voltage?

**(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**

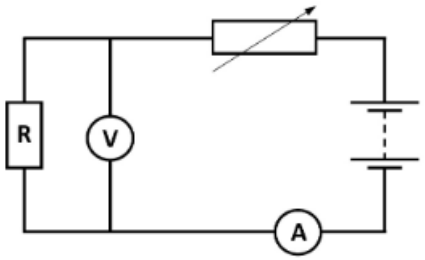



| Q5 | | Marks |
|---|---|---|
| (a) | Current Do not accept amps/ amperes/ *A/I* | 3 |
| (b) | **Y**<br>*Justify:* straight line Do not accept 'goes through 'origin' or 'straight' | 3<br>3 |
| (c) | 2<br>Ω / ohms | 3<br>3 |

# 2022 Q 5

**Question 5** **(15 marks)**

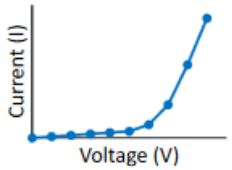
A student used the circuit diagram on the right to investigate how the current flowing through resistor **R** varies with the voltage (potential difference) across it.



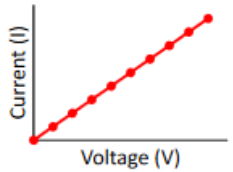

**(a)** **A** is an ammeter.
Does an ammeter measure current or voltage?

**(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**



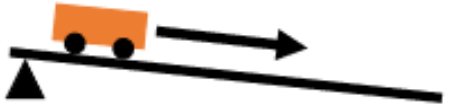

**Graph Y**



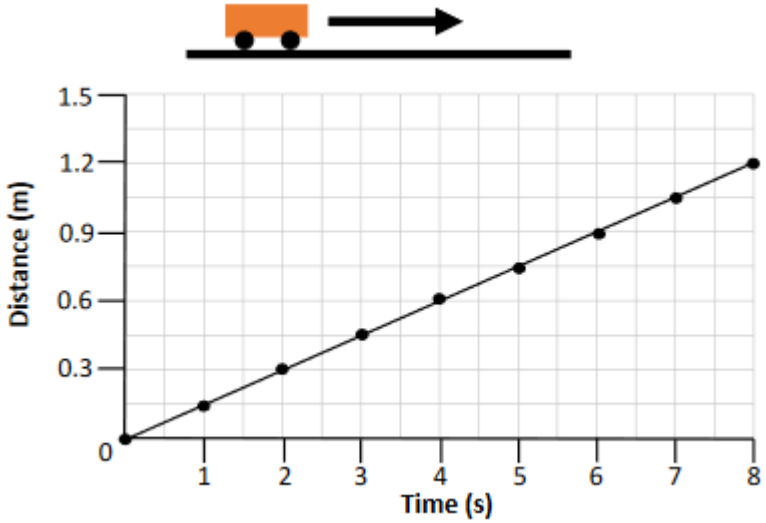

| Q5 | | Marks |
|---|---|---|
| (a) | Current Do not accept amps/ amperes/ *A/I* | 3 |
| (b) | **Y**<br>*Justify:* straight line Do not accept 'goes through 'origin' or 'straight' | 3<br>3 |
| (c) | 2<br>Ω / ohms | 3<br>3 |

**2022 Q 6** Hypotheses: Must not be a question. Should link two variables (if….. then….).

The student carried out a second distance-time investigation when the track was sloped.



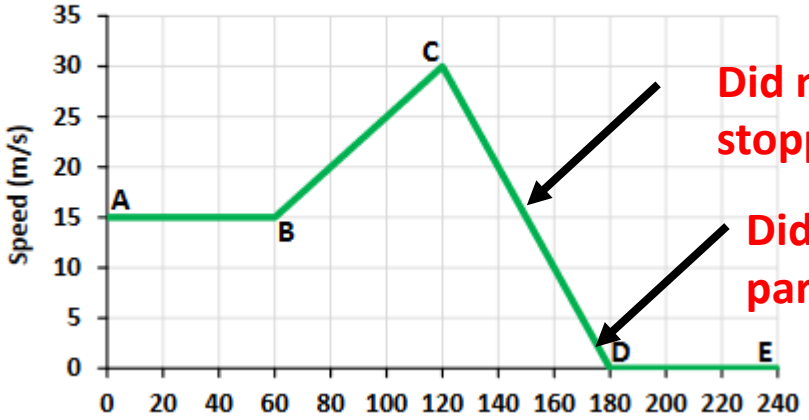
**(b)** Write a suitable hypothesis for this second investigation.




**(d)** On the graph above, sketch the expected result for **your** hypothesis.

# 2022 Q.7

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




Did not accept stopping/stops/declining


Did not accept parked or idle.

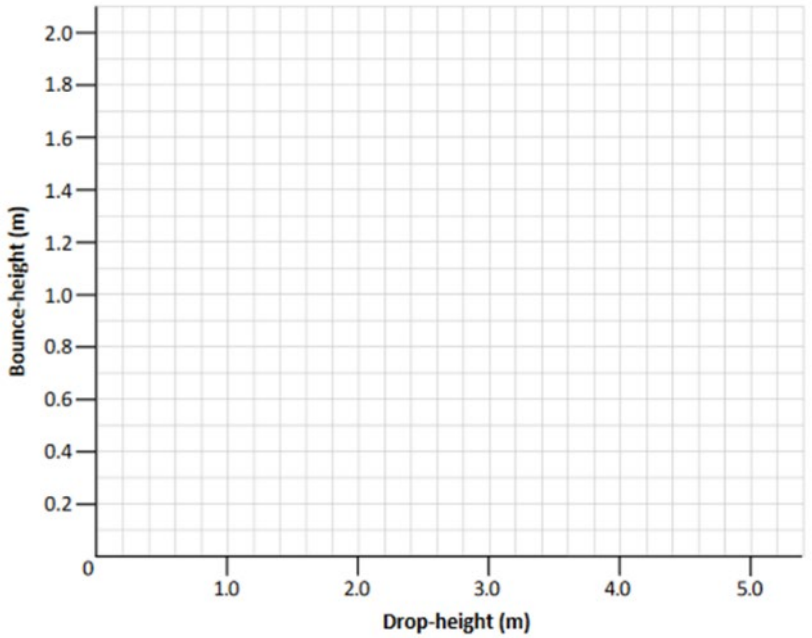

**(c)** Describe the motion of the car between positions **C** and **D**.

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

# 2023 Q 12

| 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.)




**Marks lost if widths of bars in bar chart were not consistent.**


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

**1.6 m as less percentage error**


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

(e) Safety glasses (goggles)/ care when working at a height or explained/ fall hazards/ helmet/ care when dropping ball i.e. don't hit anyone)


**Lab Coat/ Glasses/ tie back hair/ gloves → 0**

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

**PE instead of Potential energy → 0**
**Moving energy for Kinetic → 0**

## SEC examination question

A group of students investigates how solubility in water changes with temperature for solid compounds 1, 2 and 3. Figure 18.12 shows the results obtained.

**(a)** Hot water was needed during the investigation. Name an instrument used to heat water in the laboratory.

*Hotplate (or Bunsen burner).*

**(b)** Describe one safety precaution which should be taken when heating water in the laboratory.

*You should always wear safety glasses in case any splashes of water enter your eyes.*

*(Other safety precautions are to wear a white coat to protect your clothes and to wear thick gloves when handling beakers of hot water.)*

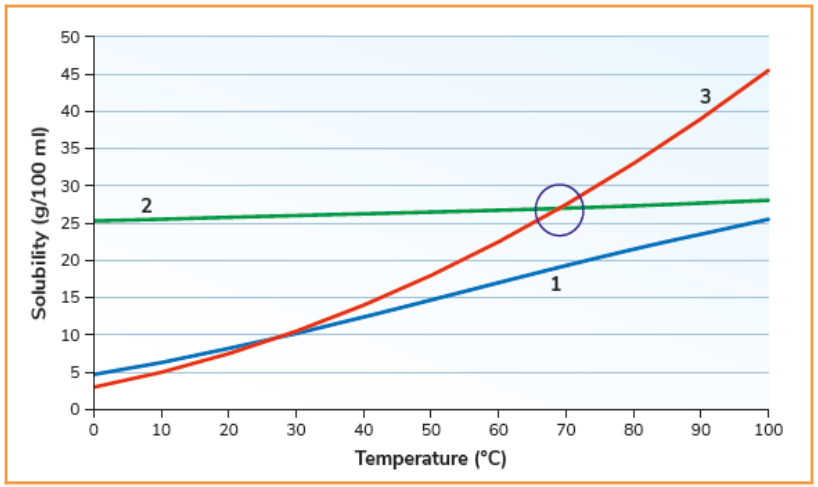



Figure 18.12

**(c)** The general trend for solids is that solubility increases with temperature. Which compound shows the greatest increase in solubility from 0 °C to 100 °C?

*Compound 3 because at 100 °C, 45 g will dissolve in 100 g of water. The other two compounds have lower solubility values.*

**(d)** On the graph, circle the point where compound 2 has the same solubility as compound 3.

*This point is circled as shown in Figure 18.12.*

**(e)** State one advantage of presenting scientific data using a graph.

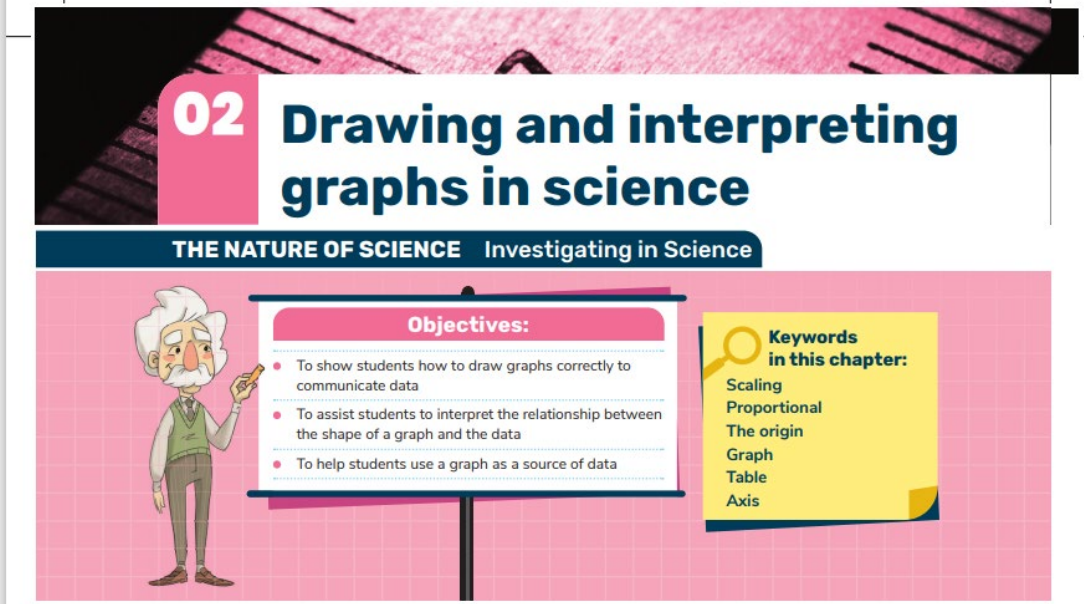
*A graph makes it easier to show and interpret trends or relationships between the variables.*

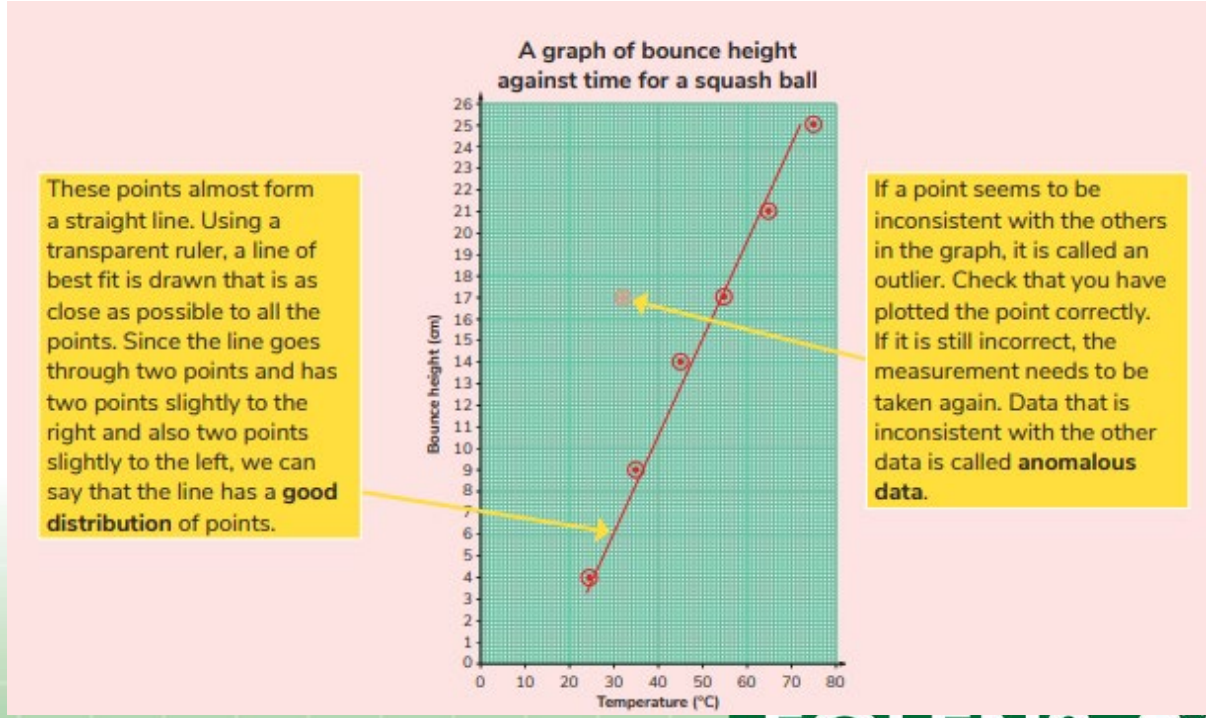
# Chief Examiners Report 2019

***Students' ability to engage with graphs is important and deserves emphasis. Such skills include:***

- *choosing what sort of graph*
- *drawing including the choice of axes and scales*
- *using graphs –to extract information*
- *notice trends and patterns, and draw conclusions.*
- *It is important that students have experience of engaging with graphs that compare two or more sets of bivariate data.*
- *It is also important that students have experience of using graphs that present information from an unfamiliar context.*

# Dedicated Chapter on Graphs




Essential SCIENCE

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# **Revision** of graph technique throughout the book

## 31.4 Using distance–time graphs to calculate speed

Consider the journey of a walker when she leaves her house (Figure 31.8). We will measure the distance from her house each second for 5 seconds. The results are filled into Table 31.2.

| Time (s) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Distance (m) | 0 | 2 | 4 | 6 | 8 | 10 |

**Table 31.2** Distance travelled over a certain time by a walker

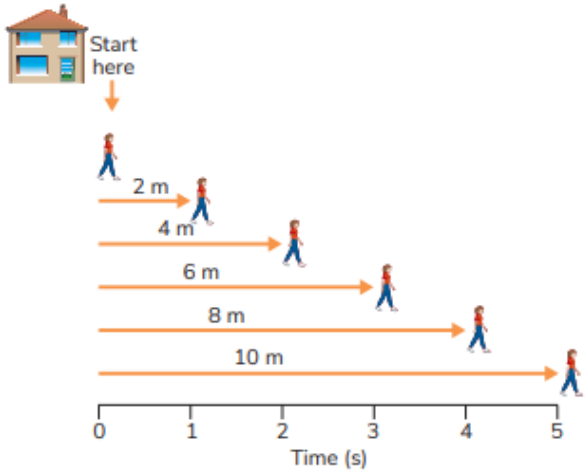



**Figure 31.8** Observing the change in distance of a walker over 5 seconds

- We can represent this information more simply by using a distance–time graph. Time is placed on the x-axis (horizontal axis) and distance on the y-axis (vertical axis). (Drawing graphs is covered in Chapter 2.)
- The key features of drawing any graph are summarised in Figure 31.9.

**(a)** Draw a graph of distance versus time.

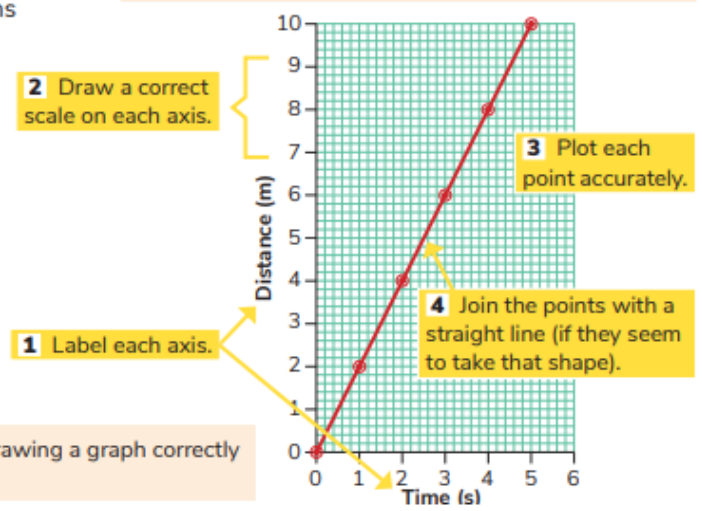



**Figure 31.9** The four essentials for drawing a graph correctly (as described in Chapter 2)

**(c)** Use your graph to work out how long it took the walker to travel 5 m.

**Solution:** The method is shown in Figure 31.11.

**Answer:** From the graph, the time = 2.5 s.

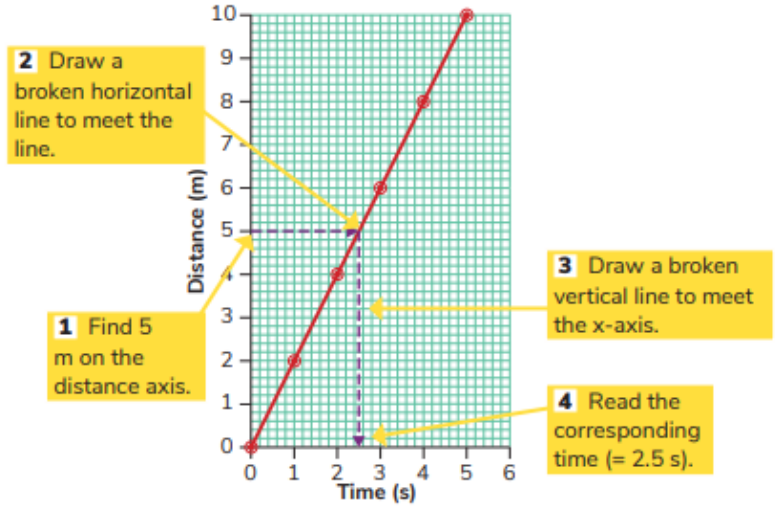



**Figure 31.11** Using a graph to find the time it took for a certain distance to be travelled

# Plenty of **practice** drawing and interpreting unfamiliar graphs throughout the book.

## W31.7

A stone was dropped from the top of a cliff and the distance it fell was measured at the intervals of time given in Table W31.2.

| Time (s) | 0 | 1 | 2 | 3 | 4 | 4.5 |
|---|---|---|---|---|---|---|
| Distance (m) | 0 | 5 | 20 | 45 | 80 | 100 |

Table W31.2

**(a)** Draw a graph of distance against time in Figure W31.4. A smooth curve through the plotted points is required.

**(b)** Use the graph to find how far the stone had fallen in 3.5 seconds.

_____

**(c)** Calculate the average speed of the falling stone between the times of 2 and 4 seconds. Give the unit with your answer.

_____

**(d)** In this experiment is distance fallen directly proportional to time? Justify your answer.

_____

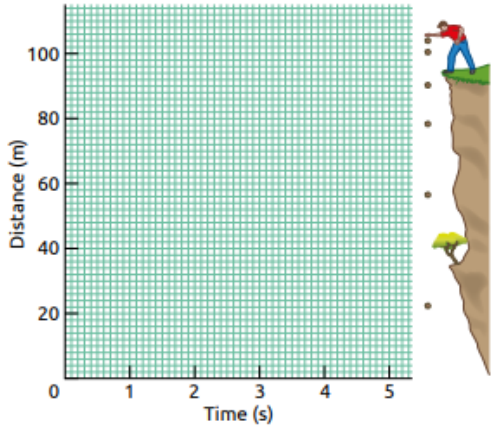


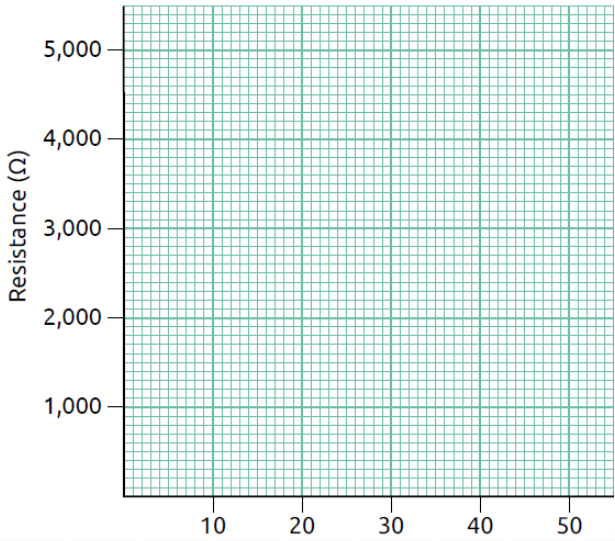

Figure W31.4

## W35.6

**d)** A lamp is placed a distance *d* from the LDR in the circuit described in Figure W35.4. The switch is closed and the resistance of the LDR is calculated. This process is repeated for a number of different values of *d*. The results are given in Table W35.3. Draw a graph of resistance versus distance *d* in the graph paper provided in Figure W35.5.

| Resistance (Ω) | 200 | 800 | 1,800 | 3,200 | 5,000 |
|---|---|---|---|---|---|
| Distance *d* (cm) | 10 | 20 | 30 | 40 | 50 |

Table W35.3




Essential SCIENCE

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# Practice at drawing and interpreting unfamiliar graphs

## W2.4

A toy car was allowed to run down a track. As the angle of the track changed, the speed of the car was measured. The results are summarised in Table W2.4.

| Angle (degrees) | Speed (m/s) |
|---|---|
| 20 | 1 |
| 30 | 2 |
| 40 | 3 |
| 50 | 4 |
| 60 | 5 |
| 70 | 6 |

Table W2.4

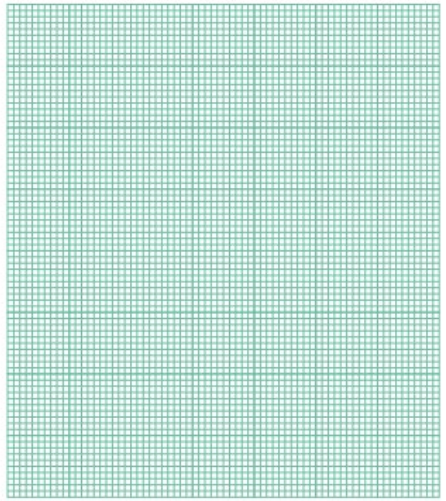


Figure W2.4

**(a)** Using the graph paper in Figure W2.4 plot a graph of the angle of the track against the speed.

**(b)** What is the shape of your graph? _____

**(c)** What can you conclude about the relationship between the angle of the track and the speed of the car?

_____

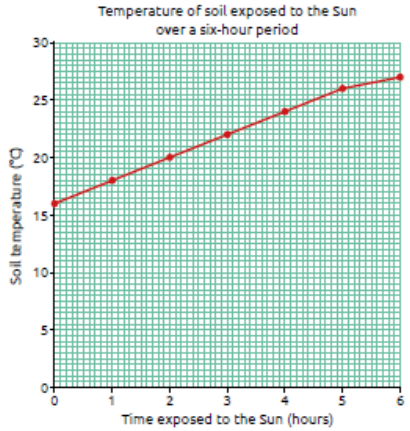



Figure W2.5

Relationship _____

_____

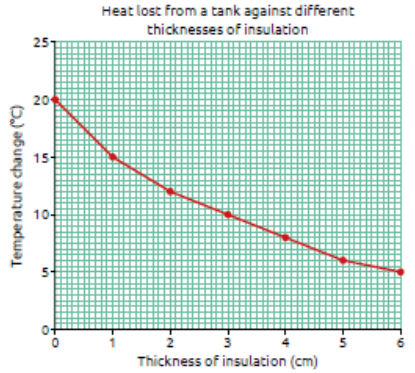



Figure W2.6

Relationship _____

_____

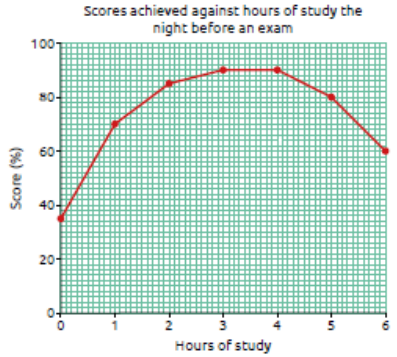



Figure W2.7

Relationship _____

_____

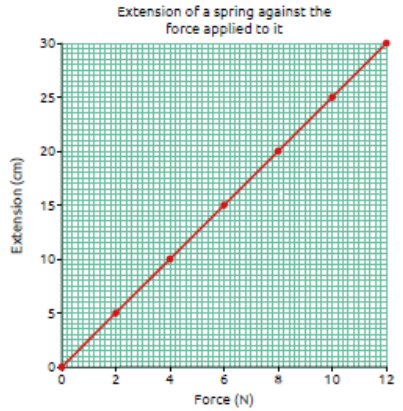



Figure W2.8

Relationship _____

_____

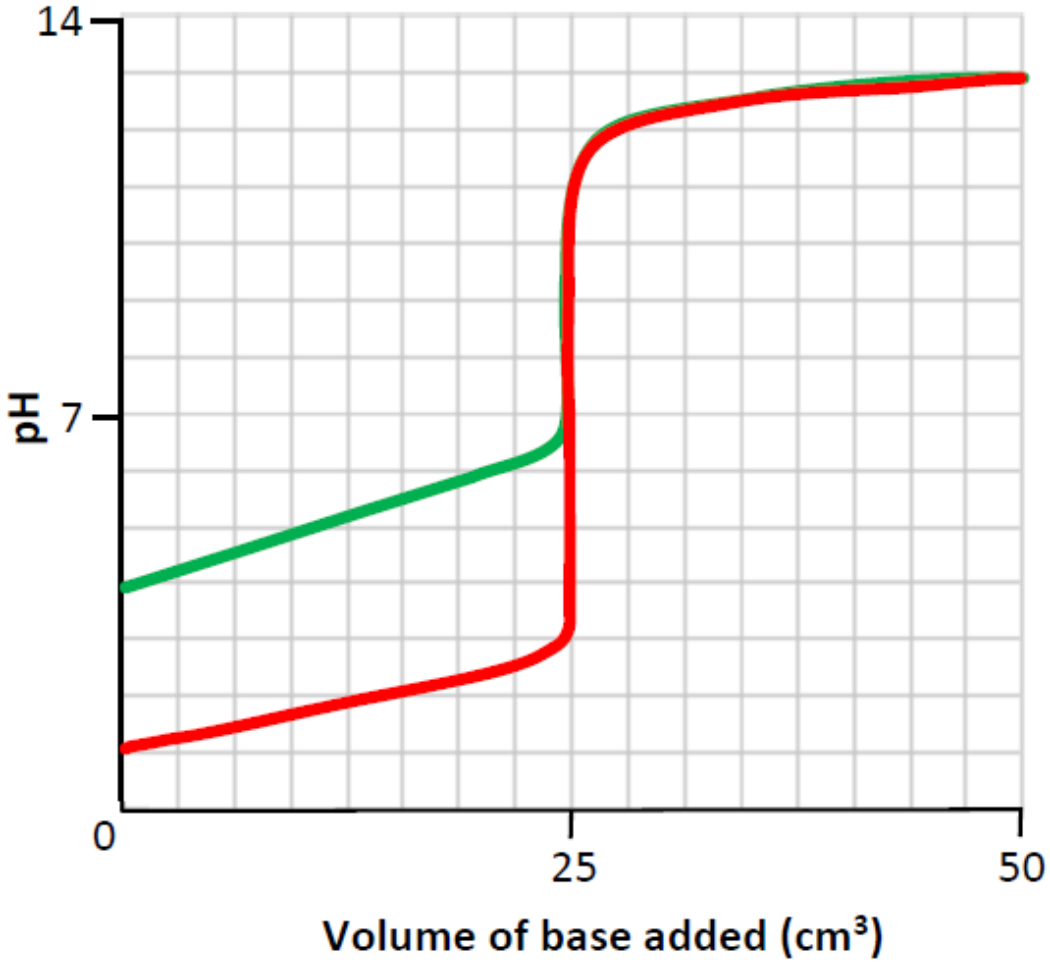
Essential SCIENCE

The student opened the tap on each burette and allowed the base to flow into the beakers of acid. The changes in pH were recorded as the base was added. The graph shows both sets of results.

**(c)** What was the pH of the solutions when 50 $cm^3$ of base had been added?

**(d)** What is the pH of a neutral solution?

**(e)** Identify a laboratory base the student could have used in this investigation.




(2022 Q. 9)

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 |

## 41.2

Seán and Máire carried out an Extended Experimental Investigation to study how the height of bounce of a squash ball depends on the temperature of the squash ball. They heated the squash ball to various temperatures and dropped it from the same height (Figure 41.5) each time. The height of the bounce was measured each time after the ball was dropped.

**(a)** Is this investigation an exploratory-type investigation or a variable-type investigation? Explain your answer.

**(b)** Name the independent variable in this investigation.

**(c)** Name the dependent variable in this investigation.

**(d)** Name the control variables in this investigation.

**(e)** Why was the ball dropped from the same height each time the experiment was carried out?

**(f)** What type of graph could be used to summarise the data?

**(g)** Suggest a suitable hypothesis for this investigation.

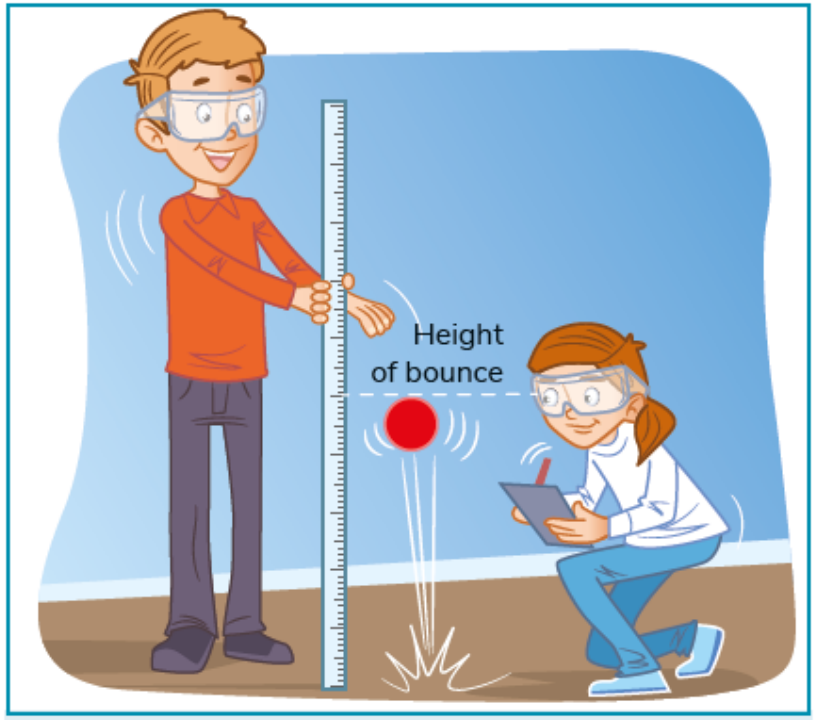
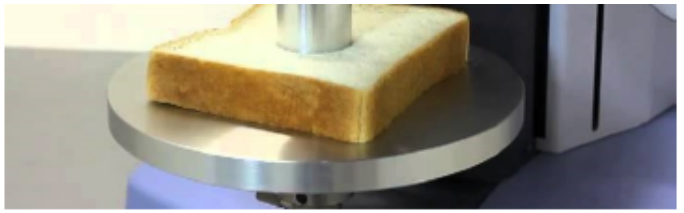
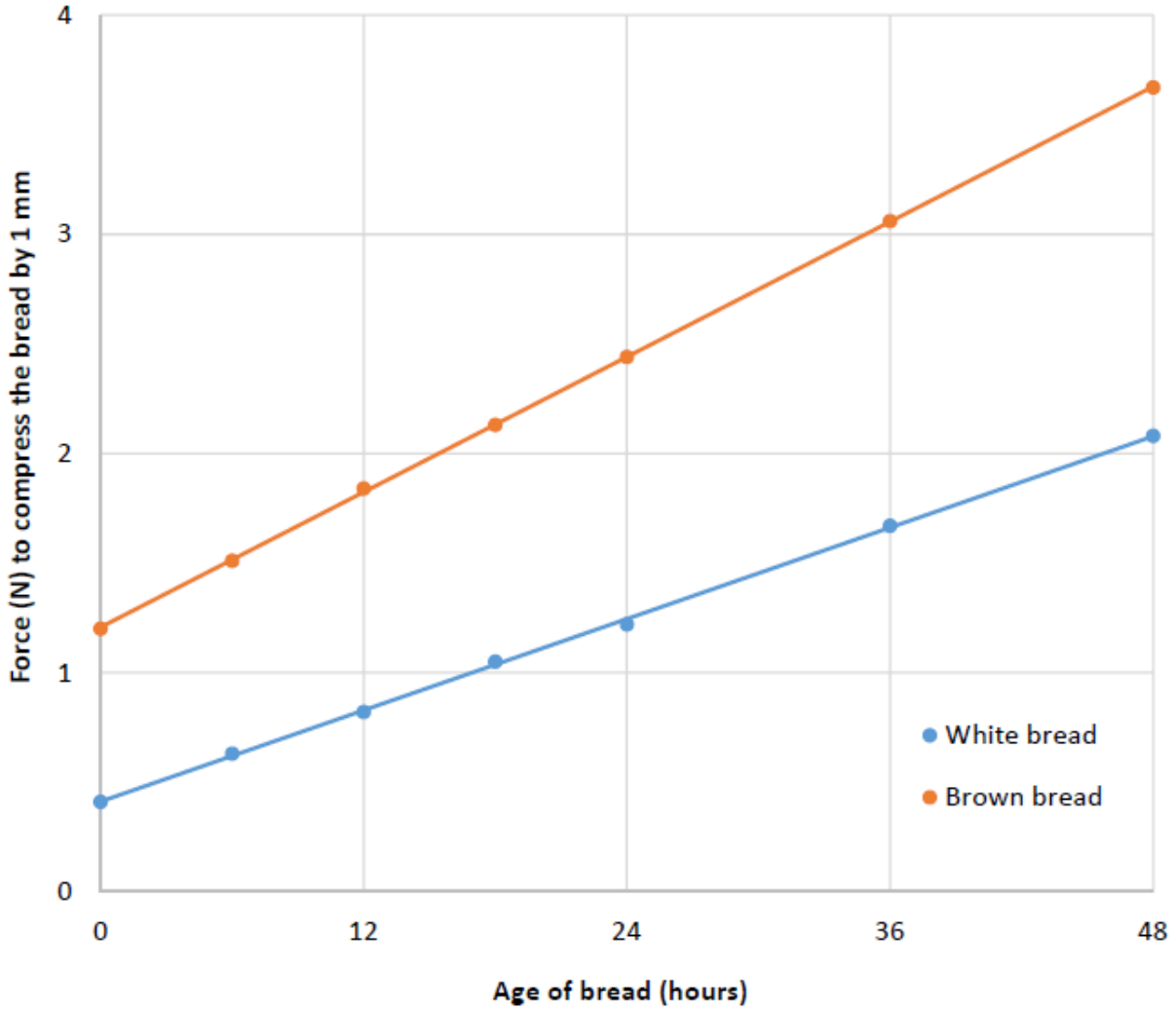



**Figure 41.5**

(Essential Sc p. 428)

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).






(2023 Q14)

**(a)** What is the unit of force?

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

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

(2023 Q. 14)

**(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. | |

(2023 Q14)

# 6. Questions that ask students to perform calculations.

## SEC examination question

A student was asked to measure the density of a block. The dimensions of the block are shown in Figure 30.12. The mass of the block is 128 g.

**(a)** Calculate the volume of the block.

volume = length × width × height

= 8 × 2 × 4 = 64 cm³

**(b)** Calculate the density of the block. Include the unit for your answer.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{128\ \text{g}}{64\ \text{cm}^3}$$

$$= 2\ \text{g/cm}^3$$

**(c)** Figure 30.13 shows three glasses of water labelled A, B and C. An egg was placed into each glass. The image was made when the eggs were stationary.

Which glass (A, B or C) contains the egg with the greatest density? Give a reason for your answer.

Egg C has the greatest density as it sinks the most in water.

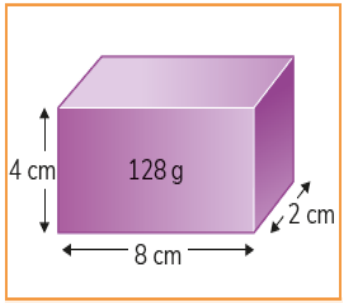


Figure 30.12

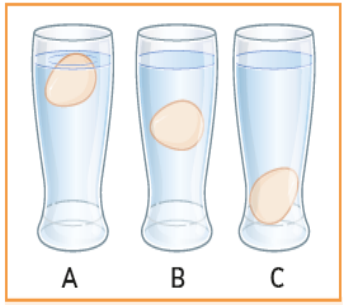


Figure 30.13

p. 298

## SEC examination question

Sankey diagrams are named after H. Riall Sankey (Figure 33.30), a Tipperary-born engineer, following his 1898 description of the energy efficiency of a steam engine. Sankey diagrams show the flow of energy to and from a device. The Sankey diagrams for a filament lamp and a compact fluorescent lamp (CFL) are shown in Figures 33.31 and 33.32.

Figure 33.30

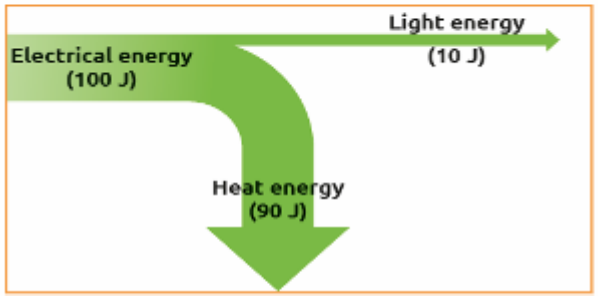



Figure 33.31 Sankey diagram of a filament lamp

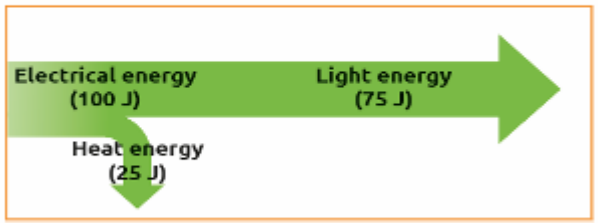



Figure 33.32 Sankey diagram of a CFL

*In a Sankey diagram, the width of each arrow is proportional to the quantity of energy flowing. Therefore, the thicker the arrow, the greater the amount of energy flowing.*

**(a)** Examine Figures 33.31 and 33.32. Which lamp is more efficient? Justify your answer.

*The efficiency of each bulb can be compared by calculating their per cent efficiency.*

$$\%\ \text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times \frac{100}{1}$$

$$\%\ \text{efficiency of filament lamp} = \frac{10}{100} \times \frac{100}{1} = 10\%$$

$$\%\ \text{efficiency of CFL} = \frac{75}{100} \times \frac{100}{1} = 75\%$$

*The CFL is much more efficient, as 75% of the incoming energy is converted into light in comparison to only 10% of the filament lamp. Much less energy is dissipated as heat in the CFL.*

**(b)** Why is it important to improve the energy efficiency of household devices, such as lamps?

*The more energy efficient a device is, the less energy is wasted. Therefore, it costs less to run an energy-efficient device since less electricity is used. Most of the energy used to generate electricity comes from burning fossil fuels. This burning produces carbon dioxide, which causes global warming. It is important to conserve fossil fuels as they are non-renewable and will eventually run out. Energy-efficient appliances use less electricity and help to conserve fossil fuels.*

Human health is affected by environmental factors such as nutrition.
The table below compares the nutritional value of two similar foods, **Food A** and **Food B**.

| Nutrient | Food A<br>Mass per 80 g serving | Food B<br>Mass per 80 g serving |
|---|---|---|
| **Sugar** | 18 g | 7 g |
| **Saturated fat** | 7 g | 3 g |
| **Cholesterol** | 55 mg | 33 mg |
| **Sodium** | 330 mg | 200 mg |
| **Protein** | 12 g | 20 g |

**(e)** Identify one piece of evidence from the table which shows that the two foods were compared fairly.

**(f)** Which food, **A** or **B**, would be a better choice as part of a healthy diet? Use two pieces of evidence from the table to support your answer.

**(g)** Calculate the percentage protein in food **A**.

Calculation

2022 Q14

# Appendix on the 8 essential equations in physics.

## Appendix: Physics equations

In your Physics course there are eight essential mathematical equations that you need to know for your exam. These appear in the State Examinations Commission Formulae and Tables booklet that is available to you in the exam. The table below gives a summary of these formulae.

| Topic | Formula | Page number in textbook | Page number in Formulae and Tables booklet |
|---|---|---|---|
| Density | $\text{density} = \frac{\text{mass}}{\text{volume}}$ | Page 293 | Page 57 |
| Speed | $\text{speed} = \frac{\text{distance}}{\text{time}}$ | Page 301 | – |
| Acceleration | $\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$ | Page 308 | – |
| Work | work = force × distance | Page 340 | Page 55 |
| Weight (on Earth) | weight = mass (kg) × 10 | Page 319 | – |
| Weight | weight = mass × acceleration due to gravity ($W = m \times g$) | Page 321 | Page 56 |
| Current electricity | voltage = current × resistance ($V = I \times R$) | Page 361 | Page 61 as ($R = \frac{V}{I}$) |
| Electrical power | power = voltage × current ($P = V \times I$) | Page 367 | Page 62 |

The essential formulae for your Junior Cycle exam

### Current electricity

The relationship between voltage (V), current (I) and resistance (R) is given by the equation $V = IR$.

This equation is placed in a triangle, as shown in Figure 3. By placing your finger over the variable you are looking for, you should get the equation needed to find it.

$$\text{voltage} = \text{current} \times \text{resistance}$$

$$\text{current} = \frac{\text{voltage}}{\text{resistance}}$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

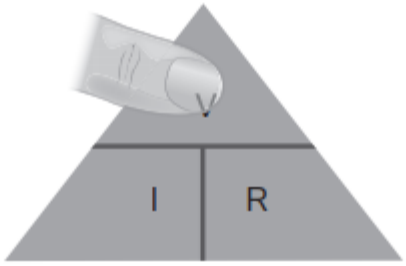



**Figure 3** The triangle method for finding voltage, current or resistance

# Chief Examiners Report

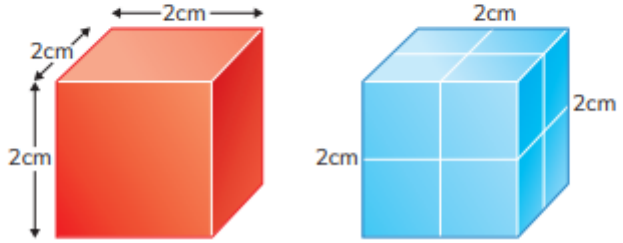
- **Observation:** Answers to questions also indicated that many candidates struggled to understand the use of compound scientific units.
- ***Recommendation:*** *Candidates should* ***show their calculation*** *work clearly. Calculations should be fully completed; an answer should not be left as ⁸⁄₂, for instance – this calculation should be completed to give 4. Candidates should remember* ***to give units*** *where relevant with all numerical answers, irrespective of whether or not the question explicitly asks for units.*

# All exemplar calculations – three step

### Calculating the volume of a cube or a rectangular-shaped object

The volume of the cube in Figure 29.16 can be calculated by breaking it down into cubes of side 1 cm. You may be able to figure out that the cube is made of eight such cubes. This can be calculated as follows.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Step 1: Write the formula** | volume of cube | = | length | × | width | × | height |
| **Step 2: Fill in the formula** | | = | 2 cm | × | 2 cm | × | 2 cm |
| **Step 3: Write the answer with the correct units** | | = | 8 $cm^3$ | | | | |




## WORKED EXAMPLE 30.1

A dry stone is placed on a balance. The mass is found to be 36 g. Using a graduated cylinder containing water, the volume of the stone is found to be 12 $cm^3$. What is the density of the stone?

**Step 1: Write the formula** $\text{density} = \frac{\text{mass}}{\text{volume}}$

**Step 2: Fill in the equation** $= \frac{36\ \text{g}}{12\ \text{cm}^3}$

**Step 3: Write the answer with the correct units** $= 3\ \text{g/cm}^3$

*Knowledge questions such as questions 7(a) and 13(f) – done very well, but students performed less well on, for example, question 16(f), which asked candidates to apply their understanding of mass, weight and gravity in the context of different moons and planets.*

## SEC examination question

Figure 32.23 shows the mass and weight of four objects (A, B, C and D) on the Earth, Earth's moon, Jupiter and Venus.

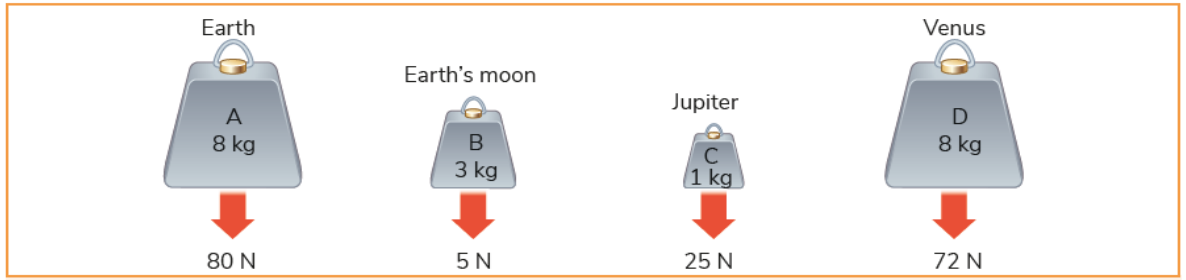



Figure 32.23

**(a)** Which object, A, B, C or D, has the smallest mass?

*C has the smallest mass (1 kg).*

**(b)** How can you tell that the force of gravity is less on Venus than it is on the Earth?

*Object A and D have the same mass. However, when both objects of the same mass are placed on different planets, object D on Venus has less weight. Therefore, the force of gravity on Venus is less than that of the Earth.*

**(c)** During the Apollo 15 mission to the moon in 1971, astronaut David Scott conducted the famous hammer and feather experiment. The hammer and feather were dropped at the same time from the same height and hit the surface of the moon at the same time. A hammer falls much faster on Earth than it does on the moon. Explain why.

*A hammer falls much faster on Earth than it does on the moon because the gravitational force on the Earth is greater than that on the moon.*

Figure 32.24

p. 326

# Weight and Gravity covered twice. Once in forces and again in celestial bodies.

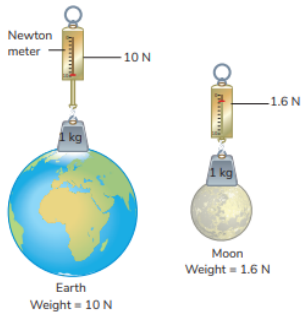



**Figure 32.12** The weight of an object depends on location. In this case, the weight of a 1 kg mass is compared on the surface of the Earth and the surface of the moon.

3. **The distance from the centre of the planet (the radius of the planet):** The larger the distance, the smaller the force. For instance, a 60 kg student would weigh approximately 600 N on the surface of the Earth but would weigh approximately 500 N at a height of 500 km above the surface of the Earth (Figure 32.13).

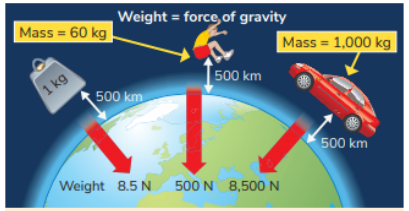



**Figure 32.13** The weights of objects above the surface of the Earth are lower than if they are on the surface of the Earth.

*Where did the scientists get the value of 10 from? This value is called the 'g' value (**acceleration due to gravity**) and has been calculated from information on the mass of planet Earth and the average distance from the centre of the Earth to the surface. It is the force experienced by a 1 kg mass if it is placed at the surface of the Earth. This topic will be covered further in Chapter 37.*

| Mass | Weight |
|---|---|
| The amount of matter in a substance | The measure of the force of gravity on a body |
| Remains constant everywhere in the universe<br>Can never be zero for an object | Depends on the amount of gravity in that location<br>Can be zero if no gravity is present |
| Unit = kilogram | Unit = newton |

**Table 32.2** Differences between mass and weight

The above points are summarised in Figures 32.14 and 32.15.

My MASS on Earth is 120 kg. My WEIGHT is approximately 1,200 N.

My MASS on the moon is 120 kg. My WEIGHT is approximately 192 N.

My MASS is always 120 kg!

**Figure 32.14** The weight of a body will change depending on location. The mass will not change just by moving it.


**Figure 32.15** This apple has a mass of 100 g and a weight of 1 newton.

In Worked Example 32.1 we saw how to calculate the weight of a body on the surface of the Earth. We can calculate the weight of a body on the surface of another planet or moon using the following equation:

**weight** of an object = mass of object in kilograms × g value (acceleration due to gravity) at that location

$W = m \times g$

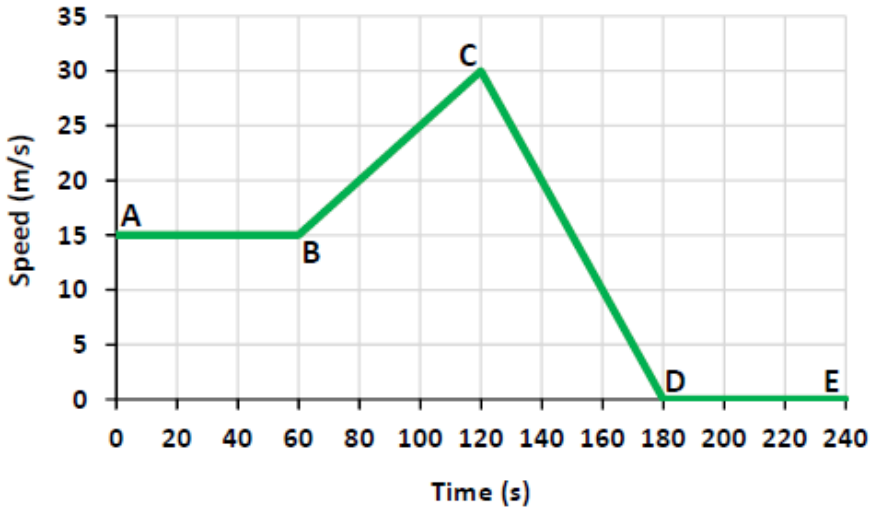
Essential SCIENCE

**(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 |
| --- |
| |

(2023 Q. 5)

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?

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

Calculation

(2023 Q7)

# 7. Questions that test students' knowledge of laboratory procedures and apparatus.

## SEC examination question

Students were given permission to remove some green plants from the habitat to take back to their school laboratory. They did this in order to investigate factors that affect photosynthesis.

**(a)** Imagine that you are one of the students. You have been asked to carry out an experiment to investigate how any one factor affects photosynthesis.

Name one factor which could affect photosynthesis and which you might investigate.

*I would investigate the factor light.*

List two factors which you would keep constant (fixed) during the experiment to ensure that it is a fair test.

*I would keep temperature and the type of plant constant.*

**(b)** Write a suitable hypothesis for this experiment.

*I predict that if leaves are exposed to light, photosynthesis will take place in the leaves. I also predict that if I keep some leaves in the dark, no photosynthesis will take place in these leaves.*

**(c)** Draw a labelled diagram of the set-up of your experiment.

**EXAM TIP!** Be sure to label any diagrams that you draw. No labels, no marks!

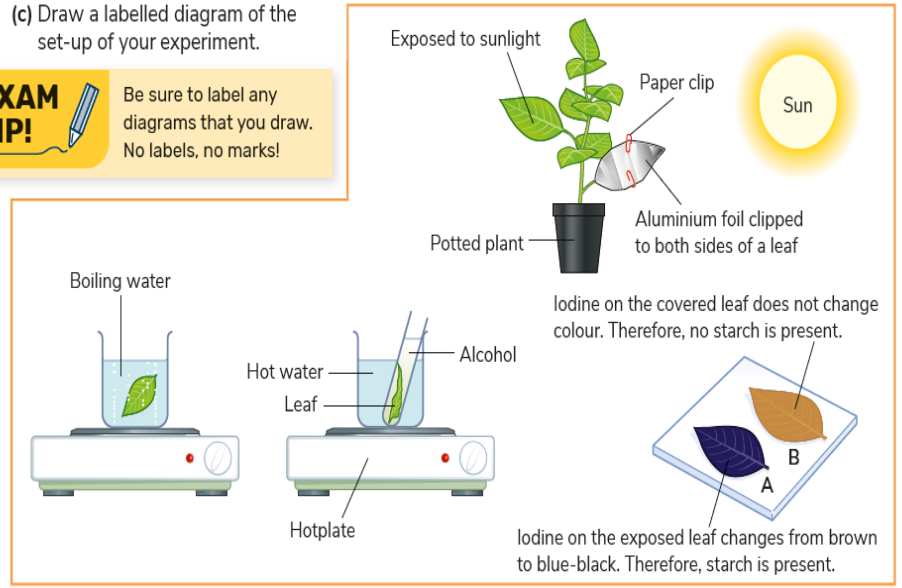



Figure 8.12

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## SEC examination question

A group of students carried out a habitat study.

**(a)** Use some of the words in the list to name the pieces of equipment in Table 14.6, which can be used in a habitat study.

Beating tray  Pooter  Net  Pitfall trap

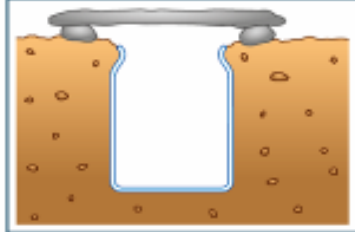
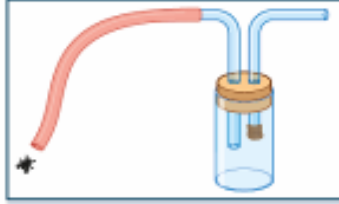
| Picture | Name |
|---|---|
|  | *Pitfall trap* |
|  | *Pooter* |

**Table 14.6**

**(b)** The students also used a quadrat during their habitat study. What shape is a quadrat? Describe how the students might have used the quadrat.

*A quadrat is square in shape.*

1. *A pencil was thrown over the shoulder.*
2. *The quadrat was placed where the pencil landed.*
3. *Using a table for results, the organism chosen was marked as present or absent.*
4. *Steps 1–3 were repeated nine more times.*
5. *The number of throws of the quadrat in which the organism was found was counted and recorded.*

**(c)** In one part of the habitat, the students used the quadrat 30 times and found that a certain species was present on 18 occasions. Calculate the percentage frequency of that species.

$$\text{percentage frequency} = \frac{\text{number of quadrats in which the species is present}}{\text{number of quadrats thrown}} \times 100$$

$$= \frac{18 \times 100}{30} = 60\%$$

p. 138

## SEC examination question

When baking soda is added to a test tube of citric acid solution, fizzing occurs and a gas is produced. Describe how you could investigate how pH changes during the reaction.

1. *Add a small length of universal indicator paper to the citric acid solution (Figure 20.11(a)). (You could also use universal indicator solution.)*
2. *Note the colour of the universal indicator paper. Compare this colour to the colour chart supplied with the indicator paper. Note the pH reading.*
3. *Add the baking soda to the test tube of citric acid solution.*
4. *Note the colour changes as the reaction takes place (Figure 20.11(b) and (c)). Compare the colours observed to the colour chart on the pH indicator. Note the corresponding pH readings.*

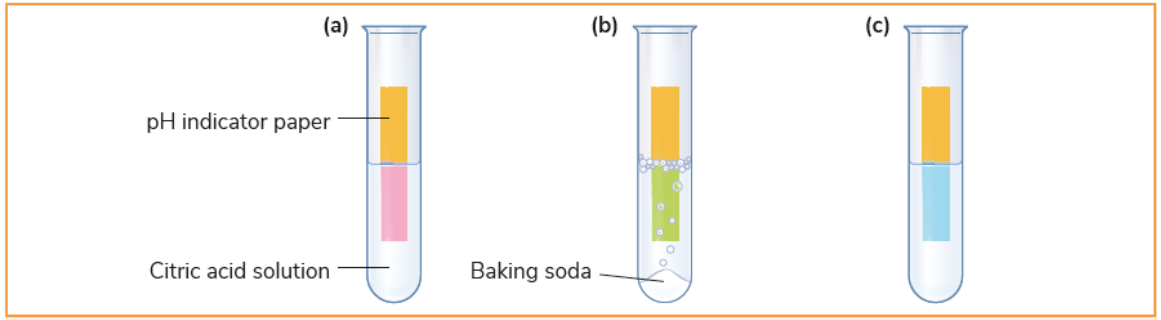



**Figure 20.11** The changes in pH when baking soda is added to citric acid can be investigated using pH universal indicator paper.

**EXAM TIP!**

You are **not** expected to remember the colour changes observed with universal indicator. You only need to be able to explain how to investigate the pH changes.

*An alternative method of carrying out this experiment is to place a pH sensor in the test tube of citric acid. Connect the pH sensor to a computer or smartphone, then add the baking soda to the test tube of citric acid solution. Note the changes in pH on the screen of the computer or mobile phone at regular intervals.*

(p. 191)

# SEC examination question

A student investigated the relationship between the potential difference (voltage) across a resistor and the current flowing through it. The circuit diagram in Figure 35.19 shows the arrangement of the apparatus used by the student.

Examine the circuit diagram and answer the questions below.

**(a)** The instrument labelled V measures voltage. Name instrument V.

*Voltmeter*

**(b)** The instrument labelled A measures current. Name instrument A.

*Ammeter*

**(c)** In the circuit diagram above, draw a circle around the symbol for the switch.

*See the blue circle in Figure 35.19.*

**(d)** The student found that current is proportional to voltage for this resistor. Using the axes provided, draw a sketch of a graph to show this relationship.

*See the graph in Figure 35.20.*

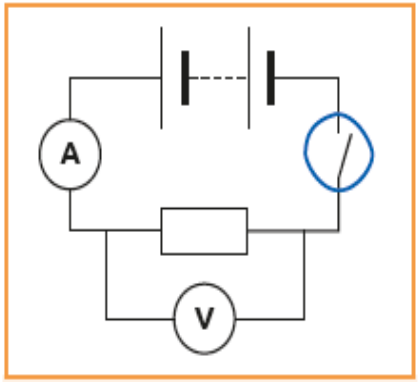



Figure 35.19

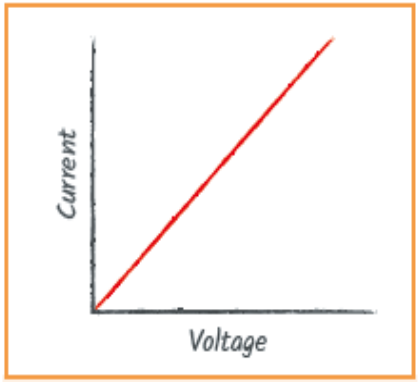



Figure 35.20

p. 368

## SEC examination question

A student carried out an experiment to investigate the reaction between an acid and a base. A pH indicator was used to monitor changes in pH during the reaction.

**(a)** Name a pH indicator the student could have used during the investigation.

*Litmus*
OR
*Methyl orange*
OR
*Universal indicator*

**(b)** What colour is this indicator when placed in acid?

*Litmus is red in an acid*
OR
*Methyl orange is red in an acid*
OR
*Universal indicator is red (or orange or yellow) in an acid.*

**(c)** When an acid and a base react, they neutralise each other to produce a neutral solution. On the pH scale, what number represents a neutral solution?

*7*

p. 224

## EXPERIMENT 7.1

**To investigate how temperature affects respiration**

This experiment is summarised in Figure 7.8.

Full step-by-step instructions for carrying out this experiment are given in Experiment 7.1 in the *Student Laboratory Notebook* accompanying this textbook.

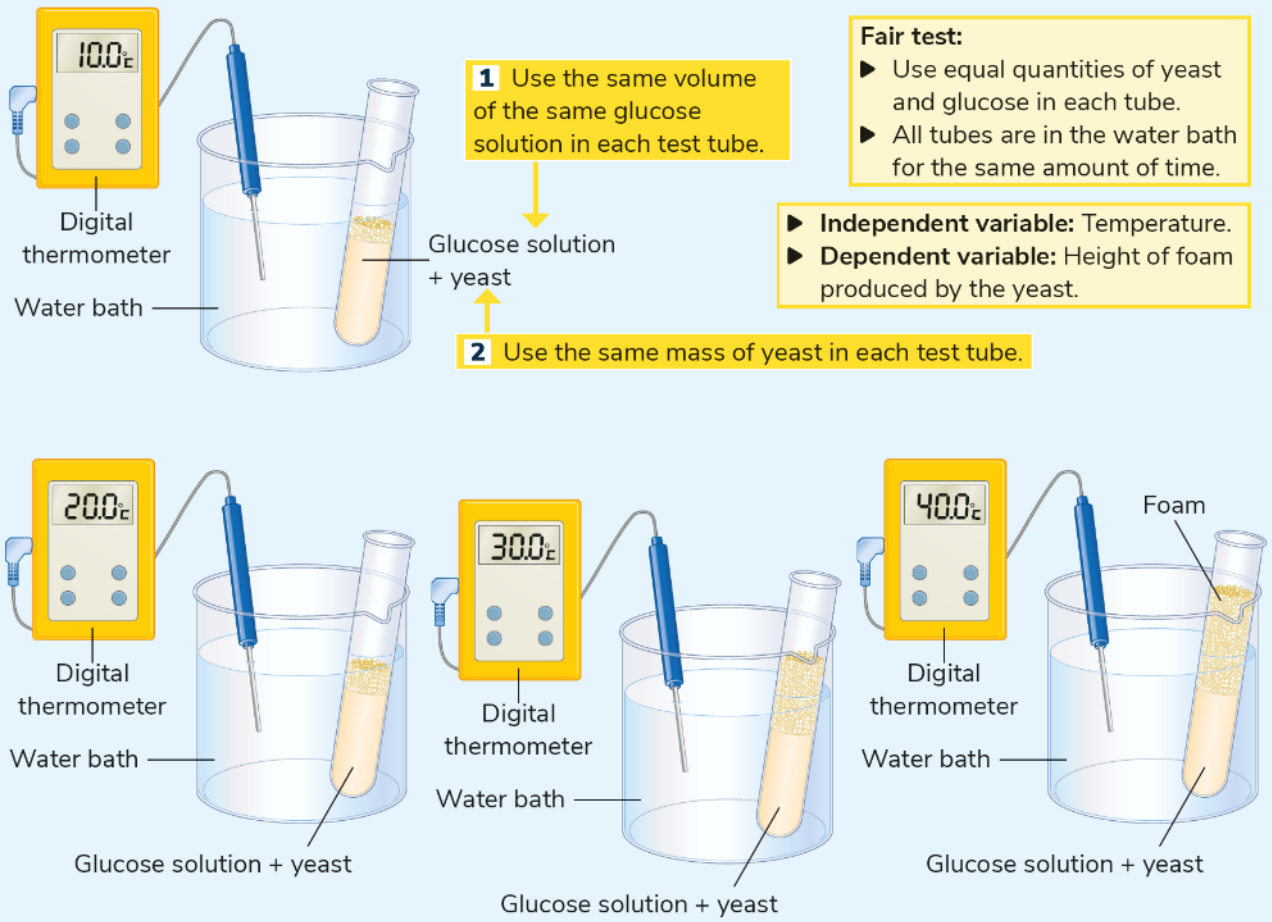



**Figure 7.8** The investigation is set up at four different temperatures.

A Folens video of this experiment is available online.

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and 2023 Q15

**(b)** In the space below, draw a labelled diagram of the arrangement of the apparatus used to determine the boiling point of water.

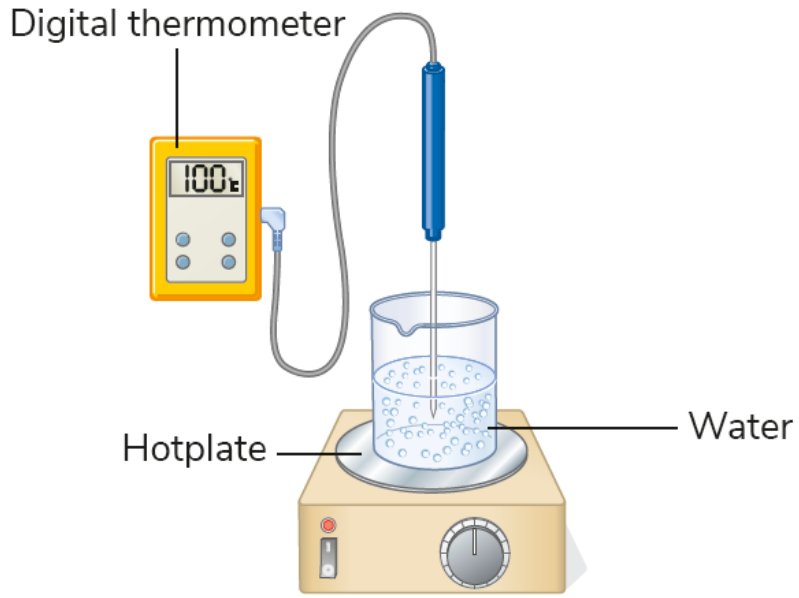



**Figure 16.20**

"Candidates have good understanding of experimental design and the use of standard laboratory equipment and techniques."

Chief Examiners Report p. 5,

A student investigated the solubility of a compound in water. She added some of the compound to 50 $cm^3$ of water at 20 °C and stirred the mixture until the compound was completely dissolved. She repeated this until no more of the compound dissolved. She found that the greatest mass of the compound that she was able to dissolve was 15 g.

**(c)** Calculate the solubility of the compound in $g/cm^3$.

| Calculation |
| --- |
| |

**(d)** Describe two things that the student could have done to allow a greater mass of the compound to be dissolved.

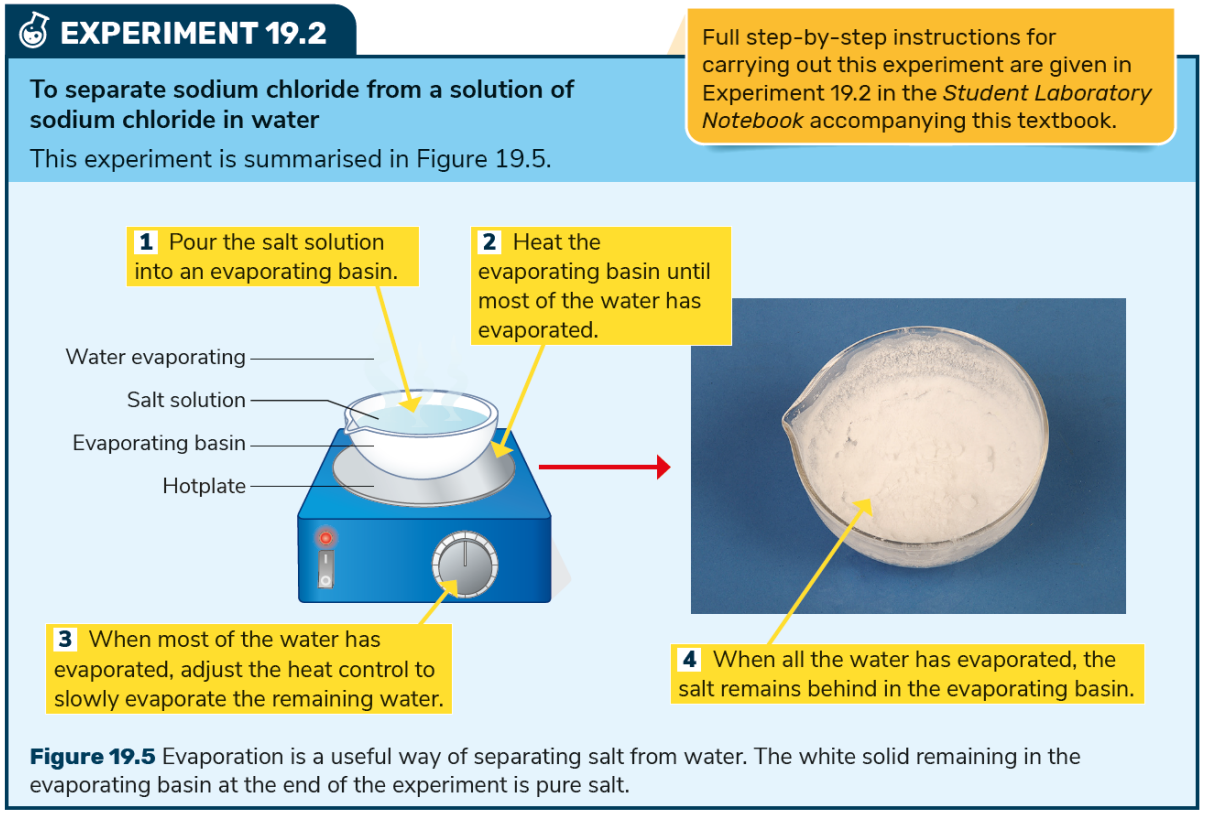
| |
| --- |
| |
| |
| |
| |
| |
| |

2022 Q5

2022 Q13 (h)

**(h)** The student was then given the task of separating the sucrose from the water. Describe how the student could have separated these two substances. You should include a labelled diagram in your answer **and** indicate the location of the sucrose at the end of the separation.


Badly answered. Many students did not mention the word evaporation (or distillation).
Transfer of knowledge from isolating salt from salt solution to isolating sucrose from sucrose solution was a problem for many students.
Marks also lost due to diagrams not being labelled and no indication where sucrose is located at end of separation.

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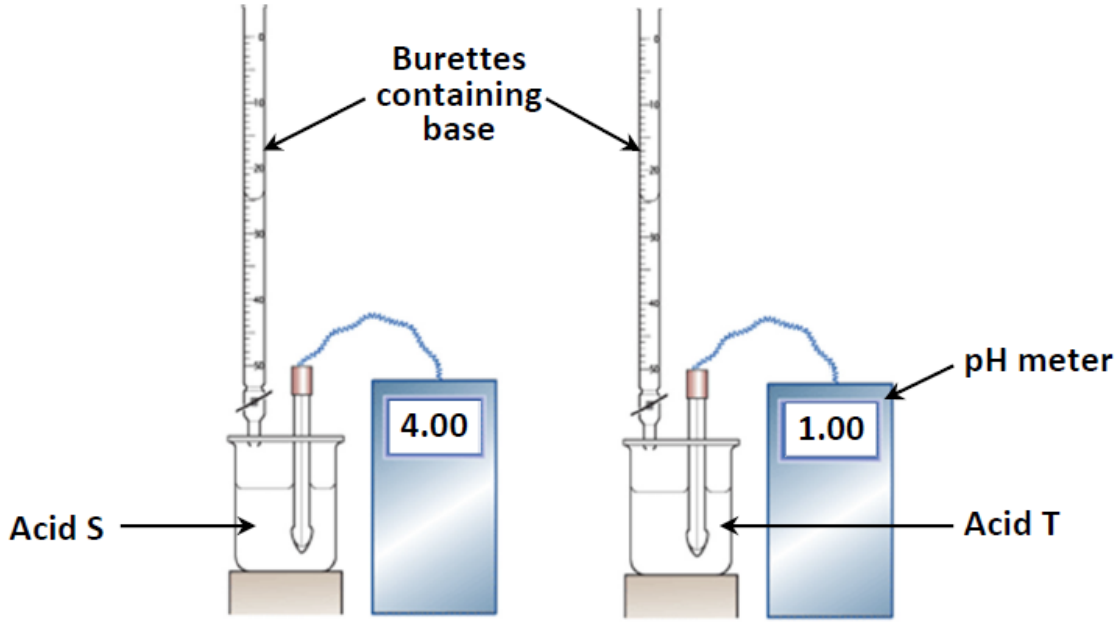
**Question 9** **(15 marks)**

A student was given two acids, **S** and **T**. He set up the apparatus shown below to investigate how the pH of **S** and **T** changed when they reacted with a base. The diagrams below show the pH of **S** and **T** at the start of the investigation.




**pH readings at the start of the investigation**

**(a)** Which acid, **S** or **T**, was more acidic at the start of the investigation?

**(b)** State one safety precaution the student should have followed when handling the acids.

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

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

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

(2023 Q.12)

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

(2023 Q. 12)

# Students need to be clear on the concept of a hypothesis

Science can be described as knowledge obtained and tested through the **scientific method**. The scientific method can be summarised in the six steps shown in Figure 1.2.

The word *hypothesis* is often used when discussing the scientific method.

A **hypothesis** is a proposed explanation of why certain events take place.

A hypothesis is an 'educated guess' or a proposition or a suggestion to explain what is happening when you are carrying out a scientific investigation. (The plural of hypothesis is hypotheses.) A hypothesis is like a suggested explanation that has not yet been proven. When a hypothesis is supported by a considerable body of evidence and is found to be able to explain observations, it may be called a **theory**.

(Essential Science p. 3)

# 8. Questions that ask students to show a detailed understanding of certain ideas in science

## SEC examination question

Elements can be classified as metals or non-metals. Table 27.3 shows some of the properties of three elements from the Periodic Table.

| | Melting point (°C) | Boiling point (°C) | Conductor of electricity |
|---|---|---|---|
| **Element 1** | 1,538 | 2,682 | Yes |
| **Element 2** | –7 | 59 | No |
| **Element 3** | –101 | –34 | No |

**Table 27.3**

**(a)** Which element (1, 2 or 3) is most likely to be a metal? Justify your answer.

*Element 1 is most likely to be a metal because it conducts electricity.*

**(b)** Which element (1, 2 or 3) is a liquid at room temperature (20 °C)? Justify your answer

*Element 2 is a liquid at room temperature because:*

*(i) The melting point (–7 °C) of Element 1 is below room temperature (20 °C). In other words, it turns to a liquid at –7 °C.*

*(ii) The boiling point of Element 1 is above room temperature (20 °C). In other words, it does not boil until 59 °C. Therefore, at 20 °C it is still a liquid.*

**EXAM TIP!**

Both of the above points were required for full marks. Therefore, when explaining the state of a substance at room temperature, you must mention both the melting point and the boiling point.

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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.

SEC 2023 Q14 (f)

"It is recommended that students practice and develop the skills needed to produce paragraph-length answers".
Chief examiners report 2019

## SEC examination question

Sickle cell anaemia is an inherited human disease. It causes the body to produce red blood cells that have an irregular shape. The gene for the disease is passed on from generation to generation.

Examine the pattern of inheritance for sickle cell anaemia shown in the family tree below (Figure 10.23) and answer the questions that follow.

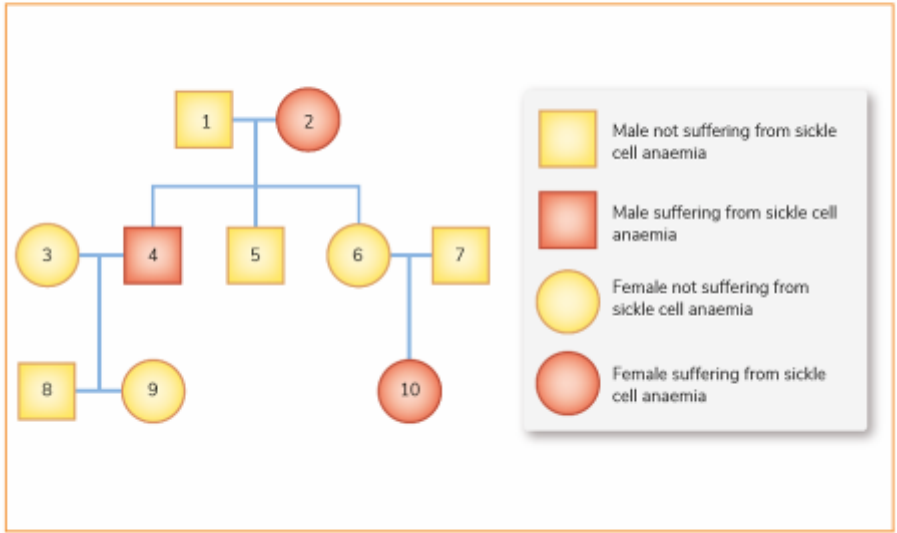


Figure 10.23

**(a)** Square 1 and circle 2 are a married couple. How many children did this couple have?

*Three*

**(b)** Some non-sufferers may be carriers of the disease. This means that they have inherited the sickle cell gene, but they don't suffer from the disease. What evidence is there from the diagram that Persons 6 and 7 are both carriers?

*Their child, 10, is a sufferer.*

**(c)** Suffering from sickle cell anaemia is an example of a genetically controlled characteristic. Classify the characteristics below as being either genetically controlled or **not** genetically controlled by placing a tick (✓) in the correct column in each case.

| Characteristic | Genetically controlled | Not genetically controlled |
|---|---|---|
| Eye colour | ✓ | |
| How to cycle a bike | | ✓ |

**(d)** Answer the following question by placing a tick (✓) in the correct box.

The function of red blood cells is to:

- Fight infection ☐
- Clot blood ☐
- Carry oxygen ☑

## SEC examination question

(a) Figure 11.11 shows bacterial cells dividing in order to reproduce. This is an example of asexual reproduction. Describe one difference between sexual and asexual reproduction.

*Sexual reproduction involves two parents. Asexual reproduction involves one parent.*

OR

*Greater variation in offspring results from sexual reproduction. Offspring from asexual reproduction are all the same.*

OR

*Fertilisation is involved in sexual reproduction. There is no fertilisation involved in asexual reproduction.*

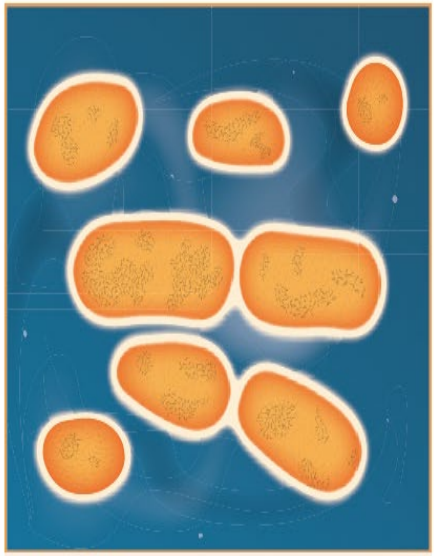

Figure 11.11

(b) Over time, a bacterial population can evolve. Outline the theory of evolution by natural selection.

*A population will produce much more offspring than its environment can support.*

*Therefore, there will be a struggle for existence.*

*Mutations cause variations among the organisms of a species.*

*Some organisms will become better adapted to their environment.*

*This means the better-adapted members will survive to breed and pass their genes on to their offspring. This is the survival of the fittest.*

*The members that have not adapted will become extinct. A new species will come about from the better-adapted organisms. This will happen over a number of generations.*

(2019)

p. 101

Essential SCIENCE

FOLENS

Answers to the question to determine the chemical formula for aluminium chloride were of “a generally poor standard”
- Chief Examiner’s Report. p. 6

## SEC examination question

The Periodic Table was developed by Dmitri Mendeleev. It was published 150 years ago in 1869. To celebrate the International Year of the Periodic Table, the European Chemical Society has designed a new kind of Periodic Table called ‘the 90 elements that make up everything’ (Figure 26.27).

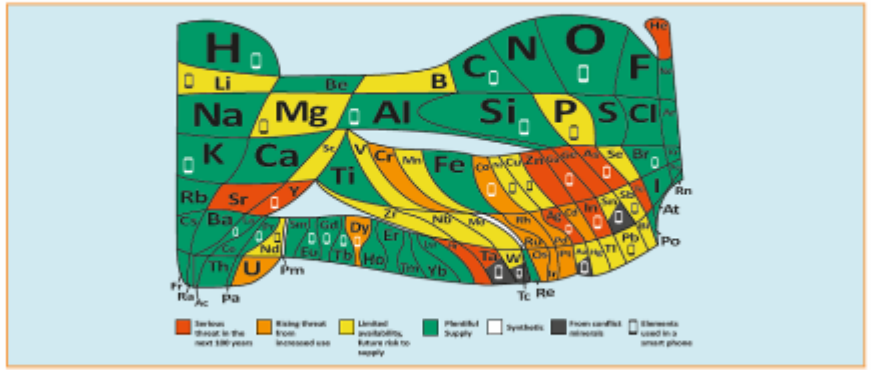


Figure 26.27

(a) From the figure, identify a gas that is a component of the Earth’s atmosphere and that is in plentiful supply. (Details about the composition of the atmosphere are covered in Chapter 39.)

*Nitrogen (or oxygen)*

**EXAM TIP!** A common error made by students in answering this question is to give hydrogen as the answer. Hydrogen is an explosive gas and is not found in the air.

(b) Why should the use of the gas helium (He) in birthday balloons be avoided?

*The availability of helium is seriously threatened.*

(c) The element indium (In) is used in smartphones. At current usage rates, indium will be used up in 50 years. Suggest one way humans could contribute to sustaining levels of this element for future generations.

*Recycle the indium in phones.*

(d) Aluminium reacts with chlorine to form the compound aluminium chloride. Use the Periodic Table on page 79 of the State Examinations Commission Formulae and Tables booklet to predict the ratio of aluminium to chlorine in this compound. Hence, write the chemical formula for aluminium chloride.

*Aluminium is in Group III.*

*Chlorine is in Group VII.*

*The ratio of Al:Cl is 1:3.*

*The chemical formula for aluminium chloride is $AlCl_3$.*

**EXAM TIP!** Even if you get the wrong formula, you may still get some marks by stating the correct groups for each element.

Also badly answered in 2022 and 2023 so we can expect this type of question to be a feature of future exam questions.

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Essential SCIENCE

FOLENS

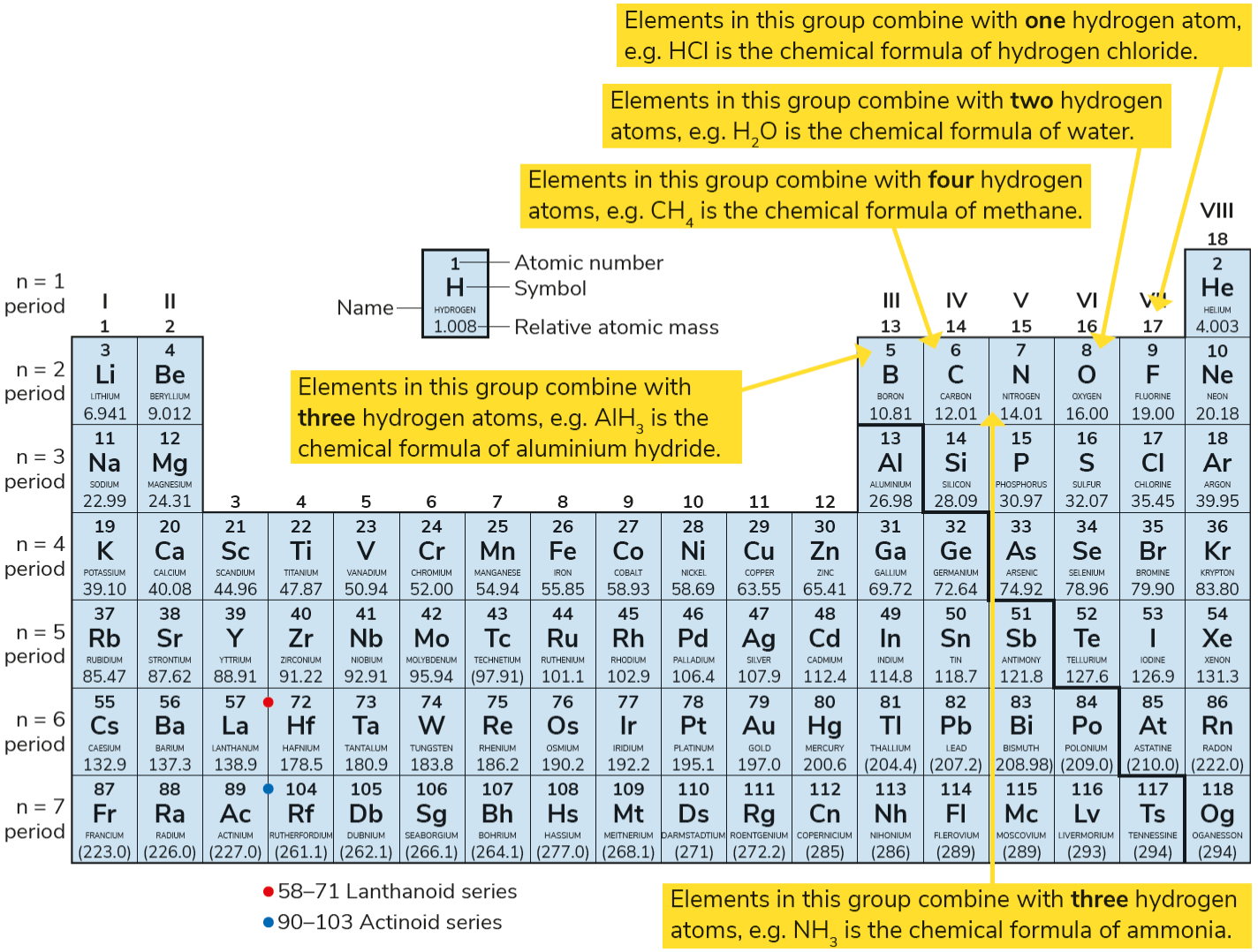


**Figure 26.15** The Periodic Table allows us to understand the ratios of atoms in compounds.

(p. 250)

**Question 4** **(15 marks)**

The theory of evolution by natural selection describes how organisms evolve and change over generations.

**(a)** A student made the following statements about the theory of evolution by natural selection. Indicate if each of the statements is true or false by putting a tick (✓) in the correct column.

| Statement | True | False |
|---|---|---|
| Evolution involves genetic mutations. | | |
| Natural selection is based on competition. | | |
| Natural selection involves survival of the weakest. | | |

Organisms can evolve and adapt, making them better suited to their environment. The organisms pictured below have adaptations that help them survive in their habitats. A fox is an omnivore (an animal that eats plant and animal matter). A rose bush is an autotroph (an organism that makes its own food).

**Fox**

**Rose bush**

**(b)** Describe one way a fox is adapted to help it survive in its habitat.

**(c)** Describe one way a rose bush is adapted to help it survive in its habitat.

(2022 Q6)

**(e)** Coat colour in a breed of dog is controlled by a single gene. There are two possible versions (alleles) of this gene – black coat (**B**) and white coat (**b**). The gene for black coat is dominant to the gene for white coat.

In their cells, dogs contain two versions of the gene for coat colour. Possible pairs are **BB** (black), **Bb** (black) and **bb** (white).

The table below illustrates a genetic cross between a male dog with genotype **Bb** and a female dog with genotype **bb**. The table is incomplete.

| | Male dog | Female dog |
|---|---|---|
| **Parent genotype** | **Bb** | **bb** |
| **Sex cells produced** | **B** or **b** | **b** |
| **Offspring genotype** | ◯ or ◯ | |

(2022 Q17)

**(i)** Complete the table by writing the two possible genotypes of the offspring that could result from this cross.

# 9. Questions that require students to read a short article and answer some questions based on the article

## SEC examination question

Read the article below, adapted from an Irish newspaper, and answer the questions that follow.

**UCC study: High-fibre foods ease stress effects**

Interest has been growing in recent years in the link between gut bacteria and stress-related disorders. Researchers at University College Cork (UCC) have shown that microorganisms in the gut (intestines) are really important for our brain health.

Bacteria in the gut produce fatty acids, which are a source of nutrition for cells in this part of the body. Foods such as grains and vegetables contain high levels of fibre and will stimulate gut bacteria to produce these fatty acids.

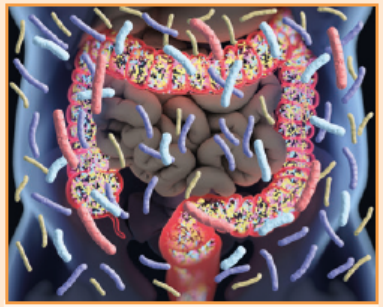

Figure 12.15

The UCC study involved feeding mice the fatty acids normally produced by gut bacteria and then subjecting them to stress. Using behavioural tests, the mice were assessed for anxiety and depressive-like behaviour. The researchers found that there was a decreased level of this type of behaviour when fatty acids were consumed. These results provide new insights into mechanisms related to the impact of the gut bacteria on our brains and behaviour.

*The Irish Examiner*

p. 112

**(a)** Name a type of food that is high in fibre.

*Grains/cereals or vegetables are high in fibre.*

**(b)** The study involved feeding mice fatty acids and then subjecting them to stress. Describe a control experiment which the scientists could have used in this experiment.

*Mice not fed fatty acids and subjected to stress or mice fed fatty acids and not subjected to stress.*

**(c)** What observation did the scientists note about the behaviour of the mice after they had been fed fatty acids?

*The scientists noted a decreased level of depressive-like behaviour.*

**(d)** Do you agree or disagree with the use of animals (such as mice) in scientific research? Explain your answer.

**EXAM TIP!**

You can agree or disagree, but you must give an explanation.

p. 112

*I agree with the use of animals in scientific research. Animals need to be used in drug trials before the drugs can be tested on humans.*

OR

*I disagree with the use of animals in scientific research. Animals should have rights just like people and they shouldn't be put in any sort of pain.*

**(e)** Human health is affected by environmental factors such as stress. Name another environmental factor which has an effect on human health.

*Another environmental factor which has an effect on human health is air quality or nutrition or exercise.*

**(f)** This article highlights a beneficial role of microorganisms in human health. State another example of how bacteria could have an effect on human health.

*Bacteria can cause disease.*

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## WORKED EXAMPLE 1.1 (SAMPLE ASSESSMENT ITEM)

Read the following article and answer the questions below.

# BLUE MONDAY IS YEAR'S SADDEST DAY

If you woke up feeling grumpier than usual this morning, you're probably not alone, as experts reckon today is one of the gloomiest days of the year.

Researchers say the third Monday in January is when people are unhappier than at any other time of the year. Apparently it's all to do with the grey and depressing weather, breaking our New Year's resolutions and not having much cash to spend in the shops.

**(a)** Do you think this article is from a scientific journal? Explain your answer.

*This article makes a number of statements about the factors that affect people's moods. It lists three factors that affect our level of happiness: the poor weather conditions, breaking New Year's resolutions and lack of money to spend. However, these are just the opinions of the author and no evidence is given to support these opinions. Therefore, this article is not from a scientific journal.*

**(b)** Does this article provide any evidence for the existence of 'Blue Monday'? Give reasons for your answer.

*No evidence is provided for the existence of 'Blue Monday'. The author states: 'Researchers say the third Monday in January is when people are unhappier than at any other time of the year.' However, the author does not provide answers to any of the following questions:*

- *Who carried out the research?*
- *Was the research carried out in a scientifically correct way?*
- *What evidence did the researchers gather that proves the existence of 'Blue Monday'?*

**(c)** Outline a fair, scientific way to investigate if weather has an effect on people's moods.

*A scientific way to investigate if weather has an effect on people's moods would involve the following steps:*

- *Design a questionnaire to get an indication of people's mood on a particular day.*
- *Distribute the questionnaire to a large number of people.*
- *Make sure that people of different age groups, gender, wealth, race, etc. are represented in the survey.*
- *Note the weather conditions on the day when the questionnaires were completed by each person.*
- *Repeat the survey with the same people on a day when the weather conditions are different.*
- *Analyse the data and see if there is any evidence to suggest that people's moods have changed under different weather conditions.*

**Question 14** **(45 marks)**

Read the following article, adapted from a European Union (EU) website, and answer the questions that follow.

The European Green Deal outlines a plan to make Europe the first climate-neutral continent by 2050. This involves boosting the economy, caring for nature, and improving our health and quality of life. The *Farm to Fork Strategy* is at the heart of the Green Deal. It addresses the challenges of sustainable food systems and recognises the links between healthy people, healthy societies and a healthy planet.

We need to do much more to keep ourselves and the planet healthy. The increasing occurrence of droughts, floods, forest fires, and new pests are a constant reminder that our food system is under threat and must become more sustainable.

Since 1990, EU agriculture has reduced its greenhouse gas emissions by 20%. However, food systems remain one of the key drivers of climate change and environmental degradation. The European Commission aims to further reduce greenhouse gas emissions from agriculture by 2050.

The move towards a sustainable food system will not happen without a shift in our diets. It is essential to take action to change consumption patterns and reduce food waste. While about 20% of the food we produce is wasted, obesity is also rising. Over half of the adult population are now overweight, contributing to a high occurrence of diet-related diseases and related healthcare costs.

*Farm to Fork Strategy*, European Union, May 2020

(2022 Q14)

**(a)** State one aim of the European Green Deal.

**(b)** Name a natural phenomenon which threatens our food supply system.

**(c)** **(i)** EU agriculture has reduced its greenhouse gas emissions by 20% since 1990. Name a greenhouse gas which drives climate change and is produced by agricultural practices.

**(ii)** Describe an initiative that could be undertaken to reduce the production of this gas.

# 10. Multiple choice questions.

## SEC examination question

Figure 9.16 shows a human female sex cell surrounded by human male sex cells. Answer questions (a), (b) and (c) by putting a tick in the correct box.

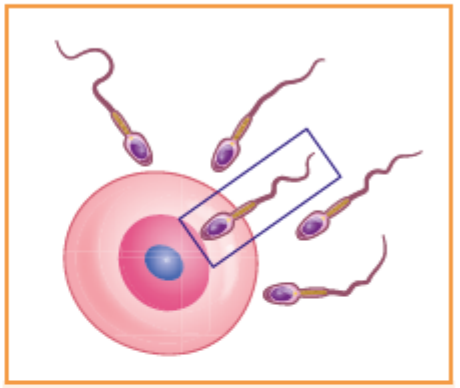


Figure 9.16

**(a)** What is the human female sex cell called?

Sperm ☐ Egg ☑ Vagina ☐ Penis ☐

**(b)** What is the human male sex cell called?

Sperm ☑ Egg ☐ Vagina ☐ Penis ☐

**(c)** Where in the female reproductive system is the female sex cell produced?

Womb ☐ Testes ☐ Vagina ☐ Ovary ☑

**(d)** In the diagram, draw a box around the male sex cell that is fertilising the female sex cell.

*See the box in Figure 9.16.*

**(e)** State one way of reducing the chance that sexual intercourse could result in fertilisation.

*The use of a condom by the male*

*The use of the contraceptive pill by the female*

p. 79

**Question 6** **(15 marks)**

The photographs below show the Moon as seen from the Earth at certain times during the lunar cycle. The images are not in the correct order.

**Image 1**

**Image 2**

**Image 3**

**Image 4**

Answer questions **(a)**, **(b)** and **(c)** by putting a tick (✓) in the correct box.

**(a)** Which image, **1**, **2**, **3** or **4**, shows a New Moon?

Image **1** ☐ Image **2** ☐ Image **3** ☐ Image **4** ☐

**(b)** Which image, **1**, **2**, **3** or **4**, shows the Moon during a waxing crescent phase?

Image **1** ☐ Image **2** ☐ Image **3** ☐ Image **4** ☐

**(c)** Approximately how long is the lunar cycle?

1 day ☐ 1 week ☐ 1 month ☐ 1 year ☐

(2022 Q6)

**(e)** An object weighs less on the Moon than on Earth.
Put a tick (✓) in the box next to the sentence that explains why:

It is colder on the Moon than on Earth. ☐

The Moon has a smaller radius than Earth. ☐

The Moon has a smaller mass than Earth. ☐

The Moon has no atmosphere. ☐

(2022 Q6)

**(c)** Select a letter, **A**, **B**, **C** or **D**, which represents a position of the Earth when day and night last approximately the same length of time.

Position **A** ☐ Position **B** ☐ Position **C** ☐ Position **D** ☐

**(d)** Which one of the following statements explains why seasons occur on Earth?
Put a tick (✓) in the correct box.

The Moon moves around its axis. ☐

The tilted Earth moves around the Sun. ☐

The tilted Earth moves around its axis. ☐

There are sunspots on the surface of the Sun. ☐

2022 Q11

**(c)** How many chromosomes are present in a human sperm cell?

- 23 ☐
- 46 ☐
- 69 ☐
- 92 ☐

**(d)** The sperm cell fertilises an egg cell. How many chromosomes should be present in the resulting zygote?

- 23 ☐
- 46 ☐
- 69 ☐
- 92 ☐

2022 Q12

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.

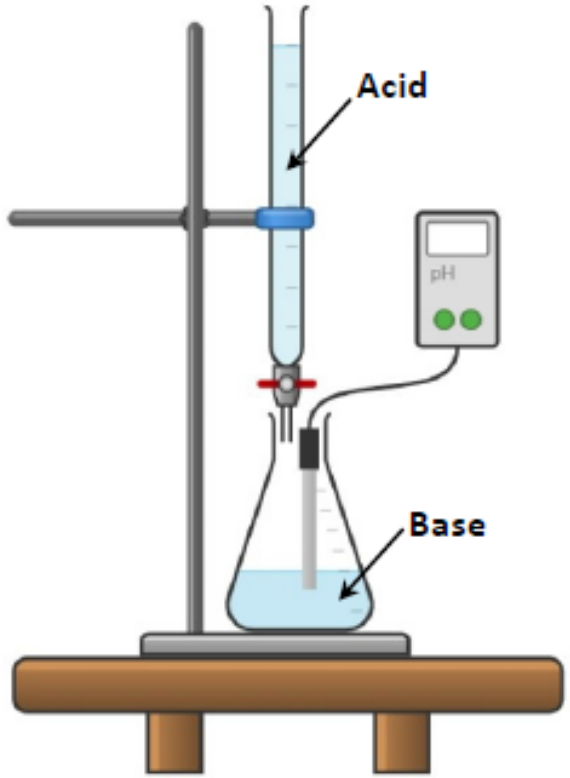
**(b)** Name an acid that could be used in this investigation.

**(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 ☐



Preparing students to answer all 10 categories of questions is the key to success on the examination paper.

# Reducing the Cognitive Load on Students

As a result of feedback from teachers, in the second edition we have cut down on the long sections of text in *Essential Science*. This is in keeping with the findings of research in how students learn key concepts in science.

Diagrams are now being used to get in all the important points – short and clear.

## 3.2 The characteristics of life

**Living things** have the following characteristics:

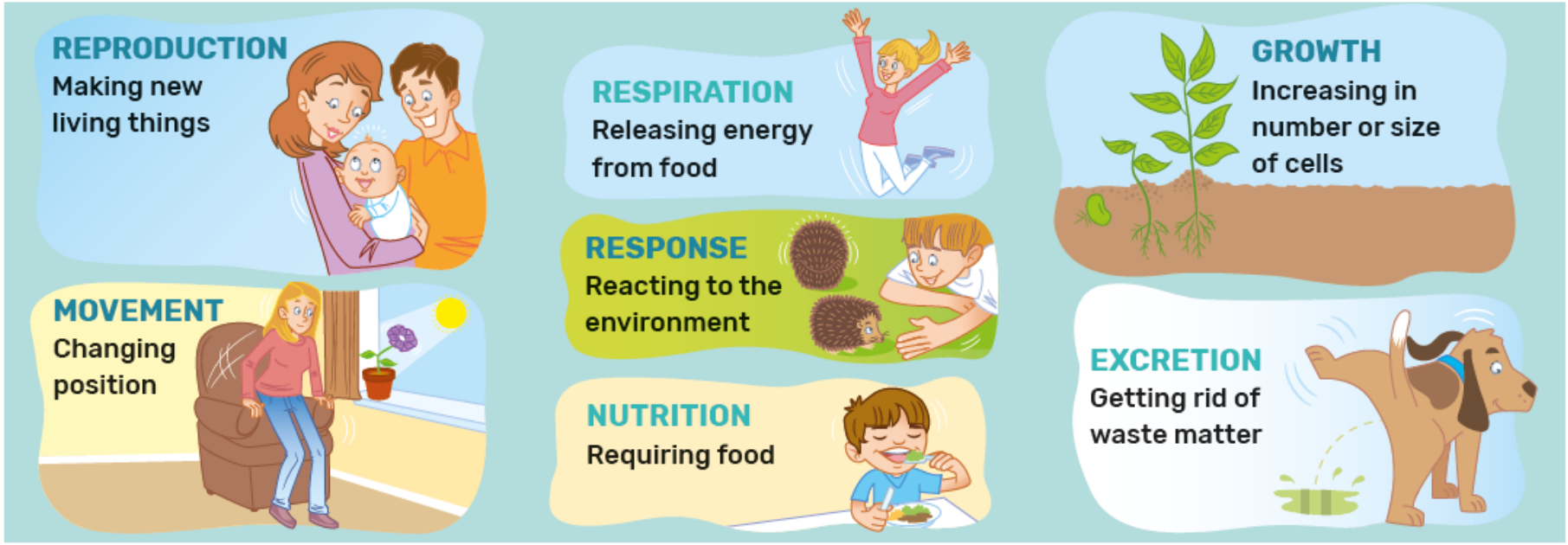
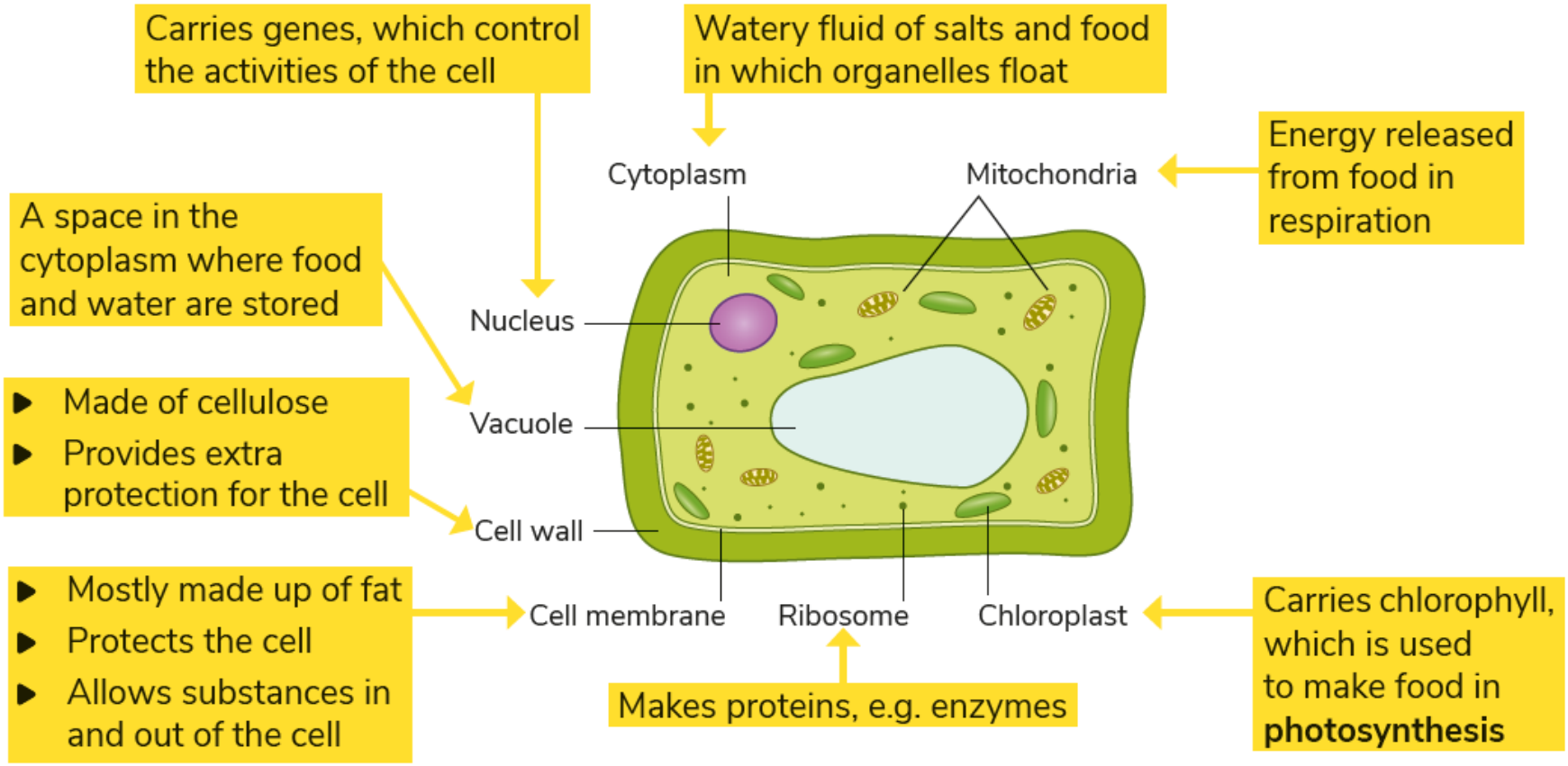



**Figure 3.3** The characteristics of life. Something is living if it has these characteristics or traits.

What would usually  entail a separate labelled diagram and a table of functions is now replaced with this:



# We have also given the human systems the *labelled diagram with functions* treatment.

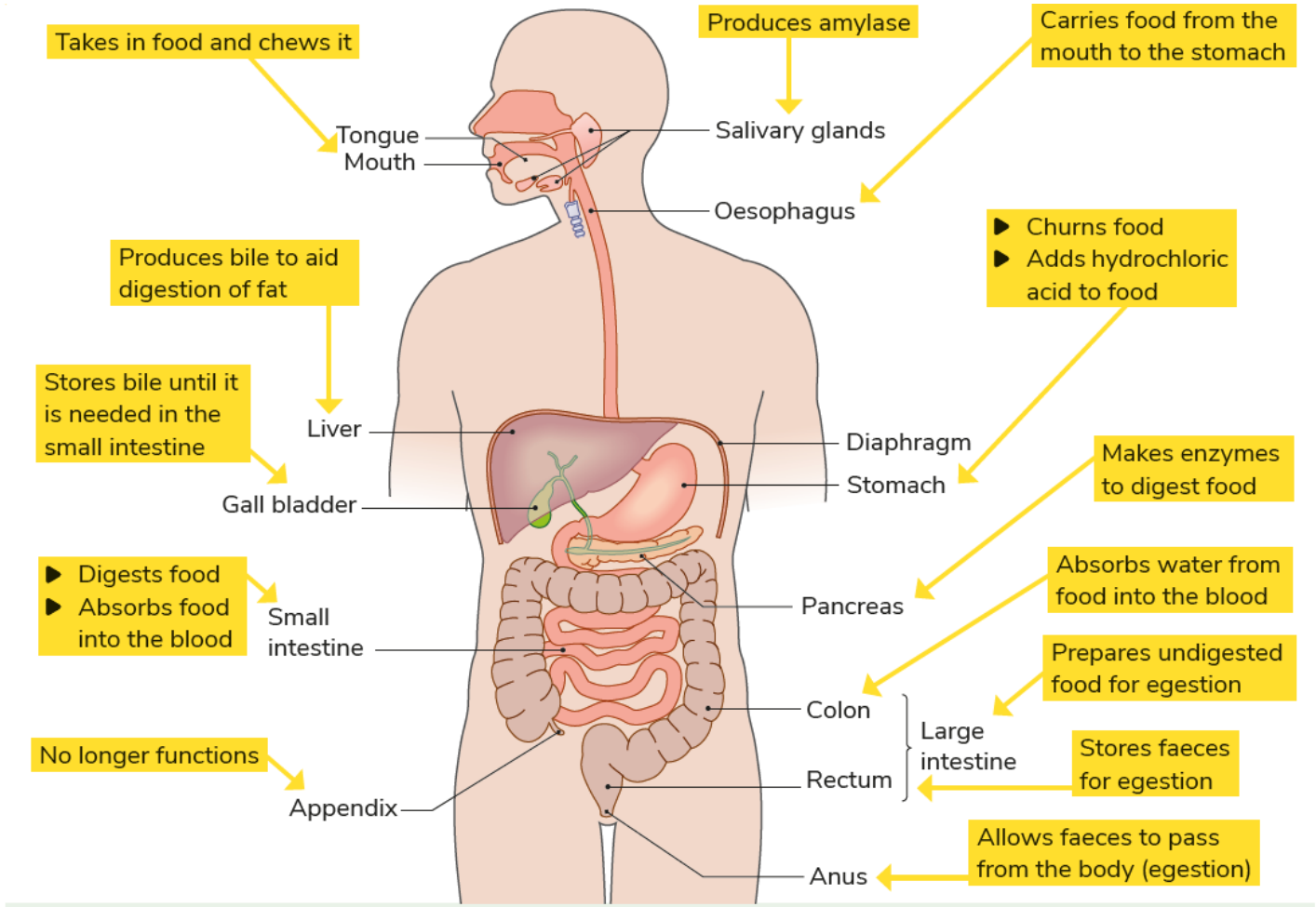



**Figure 4.5** The human digestive system and the functions of its organs

Being aware of cognitive load is a modern idea in teaching science.

Callouts on diagrams help the learner to match functions with parts more easily – thus reducing the cognitive load.

The Royal Society of Chemistry and the Institute of Physics promote easinng cognitive load.

# Respiratory system

Figure 6.2 shows the human respiratory system. The diagram also shows the function of each organ.

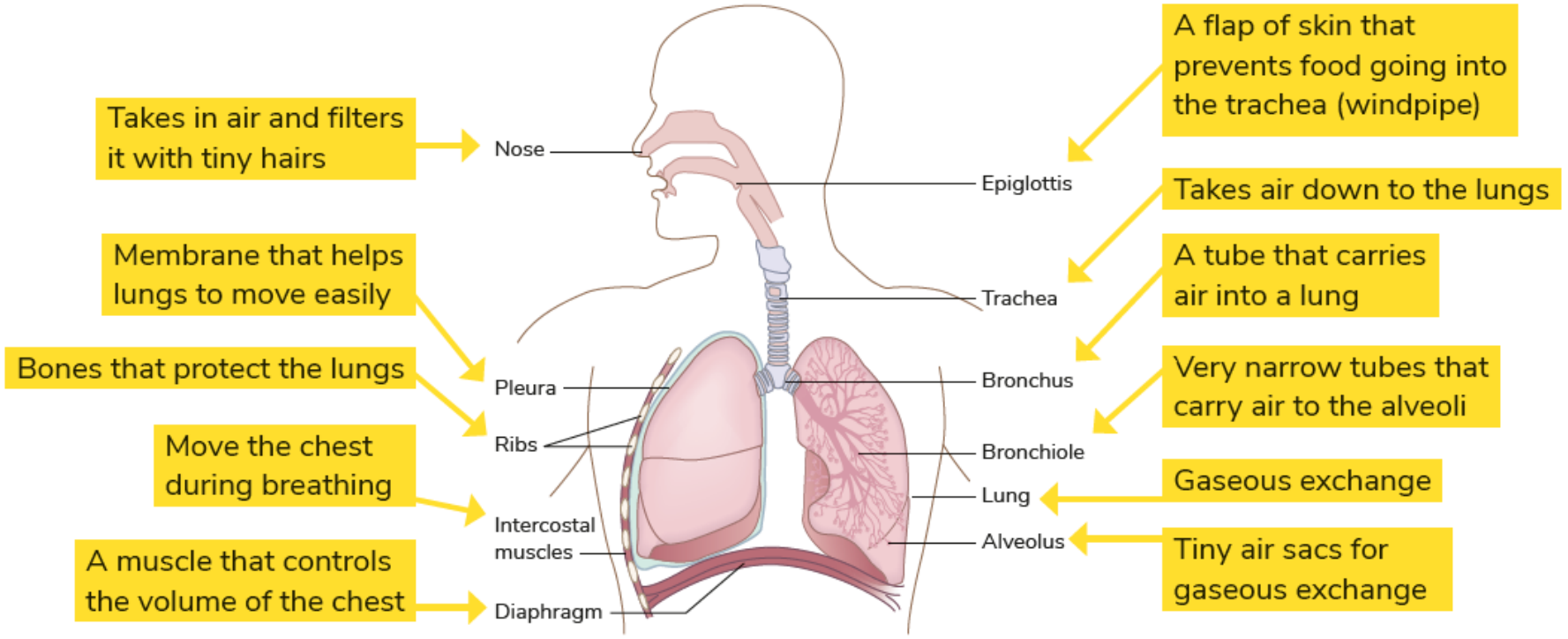



**Figure 6.2** The respiratory system showing the functions of the organs

# 9.2 The human male reproductive system

Figure 9.2 shows the internal organs of the male reproductive system. Figure 9.3 shows the external male reproductive organs.

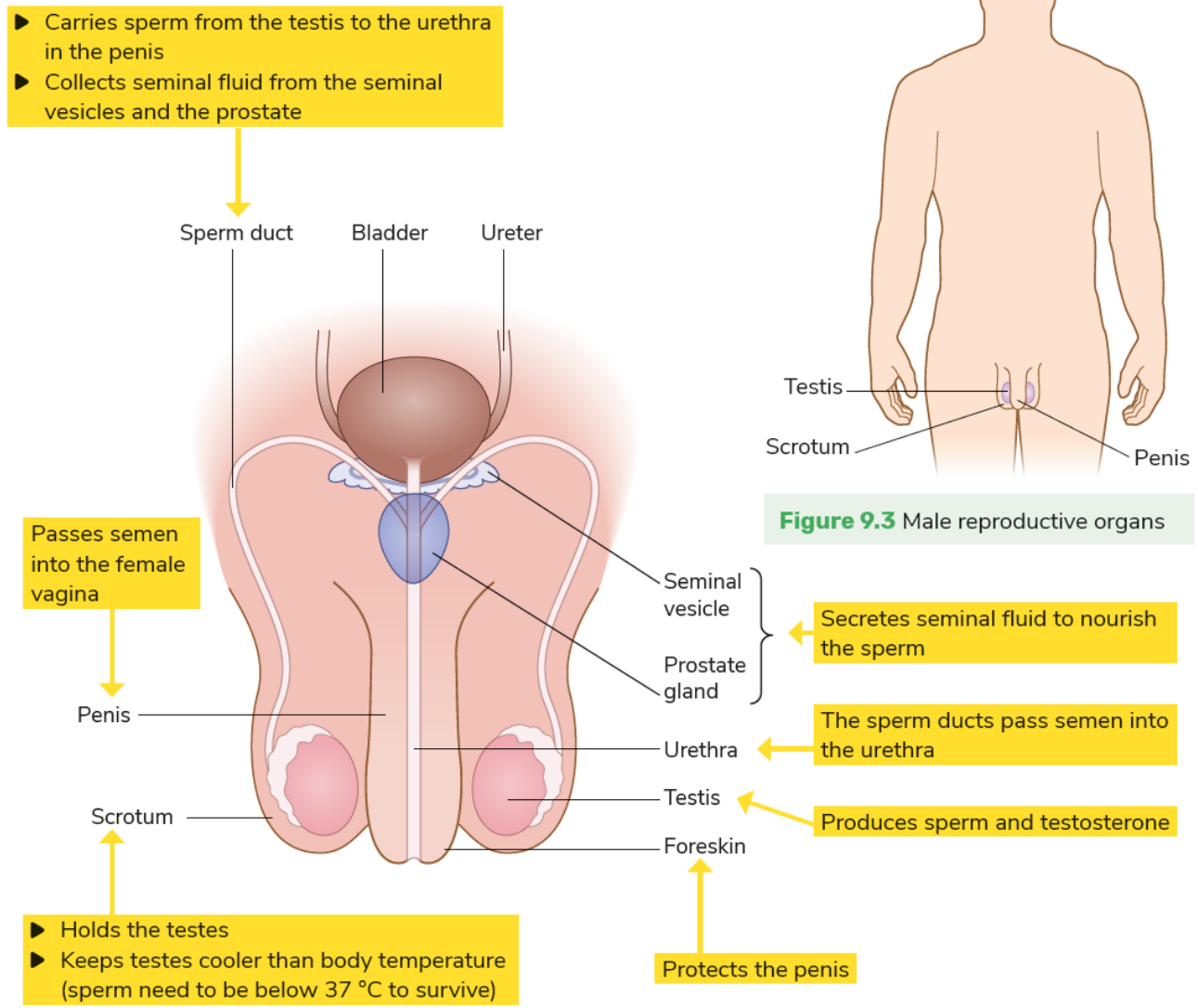



**Figure 9.2** Parts and functions of the male reproductive system




**Figure 9.3** Male reproductive organs

# 9.3 The human female reproductive system

Figure 9.4 shows the internal organs of the female reproductive system. Figure 9.5 shows an overview of the female reproductive organs.

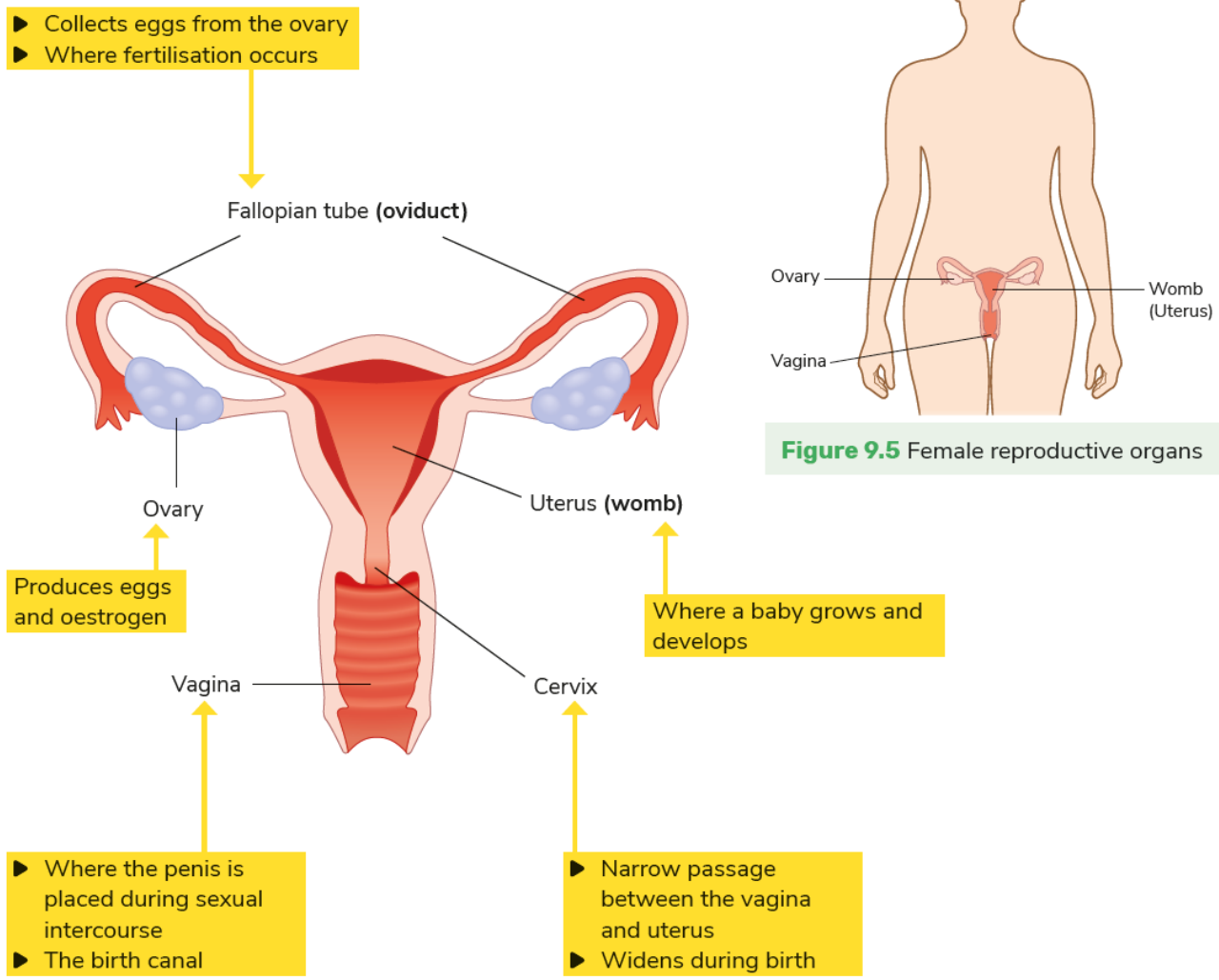


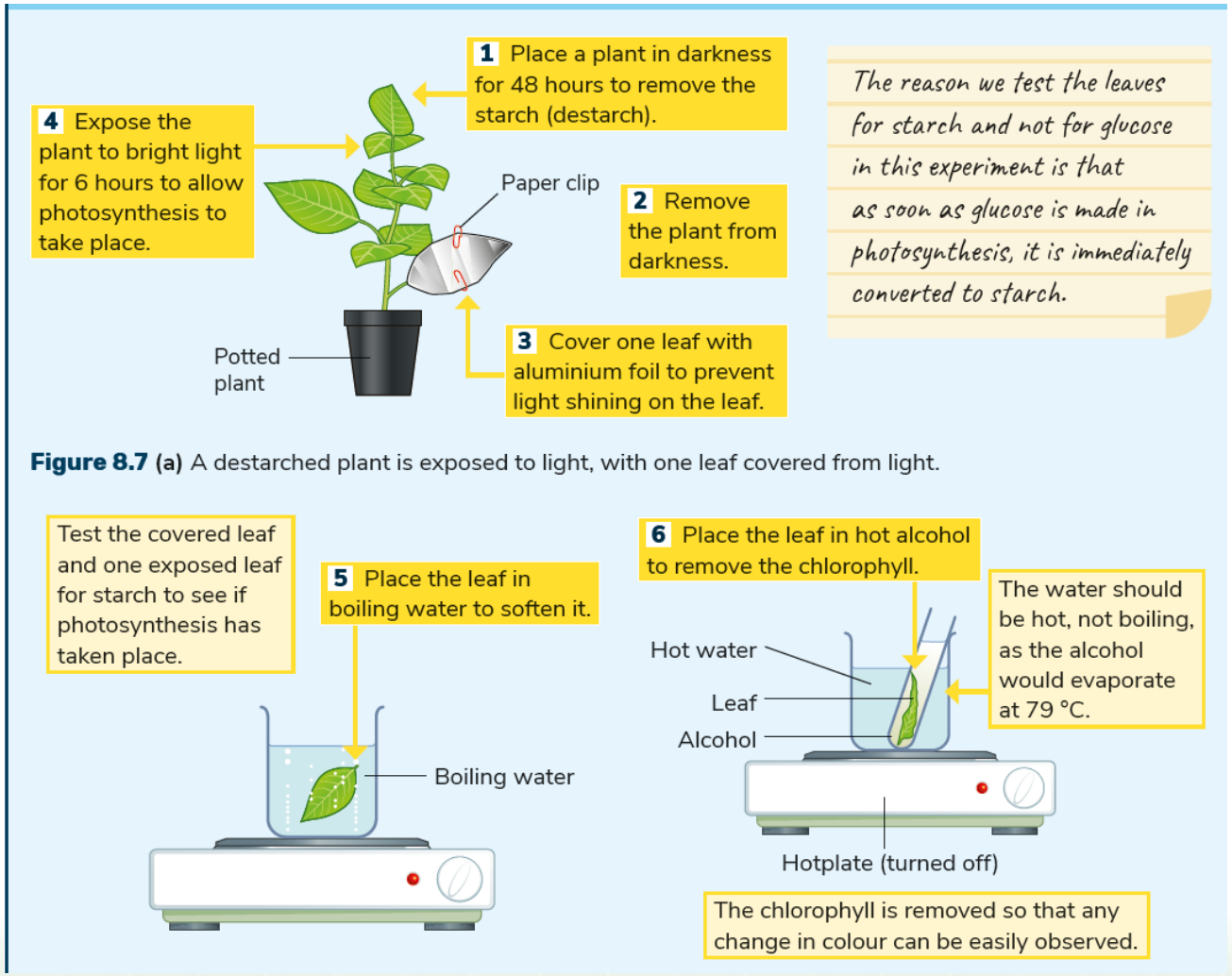

**Figure 9.4** Parts and functions of the female reproductive system




**Figure 9.5** Female reproductive organs

For experiments, callouts are used to huge benefit.

- Plain black writing for the labels
- Yellow background for the steps in the procedure
- Pink background for other important points



# Examination preparation

## 11.4 Natural selection

Charles Darwin made a number of important observations as a result of studying organisms so closely. These observations led him to come up with the theory of natural selection (Table 11.1).

| Observations | Conclusions |
|---|---|
| 1. Darwin observed that living things produce a very large number of potential adults. For example, an oak tree produces vast numbers of acorns; frogs produce vast numbers of eggs in frog spawn.<br>2. One would expect that population numbers would explode, but they don't. | 1. There is a struggle for existence. Organisms are constantly in competition for food, mates and space. As a result of this competition, many of the population die. |
| 3. There are differences within members of a species. (A lot of these differences arise due to mutations.) | 2. Because of these differences, some organisms are better adapted to survive in their environment.<br>▶ These organisms live to reproduce and so pass their genes on to their offspring.<br>▶ The organisms that are less well adapted die off, so their genes are not passed on (Figure 11.8). |

**Table 11.1** Darwin's conclusions from the observations that he made

## SEC examination question

**(a)** Figure 11.11 shows bacterial cells dividing in order to reproduce. This is an example of asexual reproduction. Describe one difference between sexual and asexual reproduction.

*Sexual reproduction involves two parents. Asexual reproduction involves one parent.*

OR

*Greater variation in offspring results from sexual reproduction. Offspring from asexual reproduction are all the same.*

OR

*Fertilisation is involved in sexual reproduction. There is no fertilisation involved in asexual reproduction.*

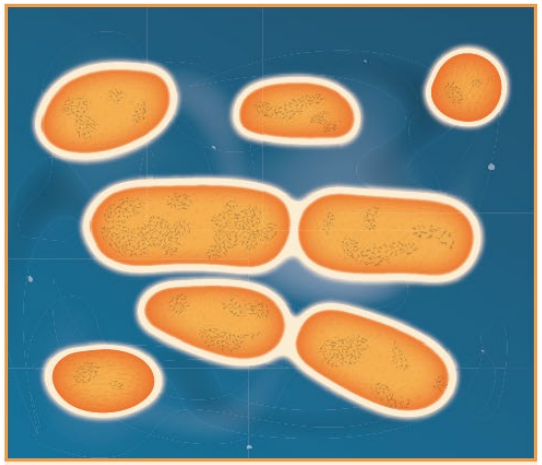


Figure 11.11

**(b)** Over time, a bacterial population can evolve. Outline the theory of evolution by natural selection.

*A population will produce much more offspring than its environment can support.*

*Therefore, there will be a struggle for existence.*

*Mutations cause variations among the organisms of a species.*

*Some organisms will become better adapted to their environment.*

*This means the better-adapted members will survive to breed and pass their genes on to their offspring. This is the survival of the fittest.*

*The members that have not adapted will become extinct. A new species will come about from the better-adapted organisms. This will happen over a number of generations.*

"It is recommended that students practice and develop the skills needed to produce paragraph-length answers".
Chief examiners report 2019

The chief examiner, in his report on the 2019 exam, made reference to the fact that the concept of a control was only answered correctly by 12% of candidates.
This type of question was also asked in 2023.

## EXPERIMENT 4.2

**To test a sample of food for the presence of glucose**

Full step-by-step instructions for carrying out this experiment are given in Experiment 4.2 in the *Student Laboratory*

The control: Water with Benedict's solution added. A control experiment is used for comparison to show what happens without the experimental treatment.

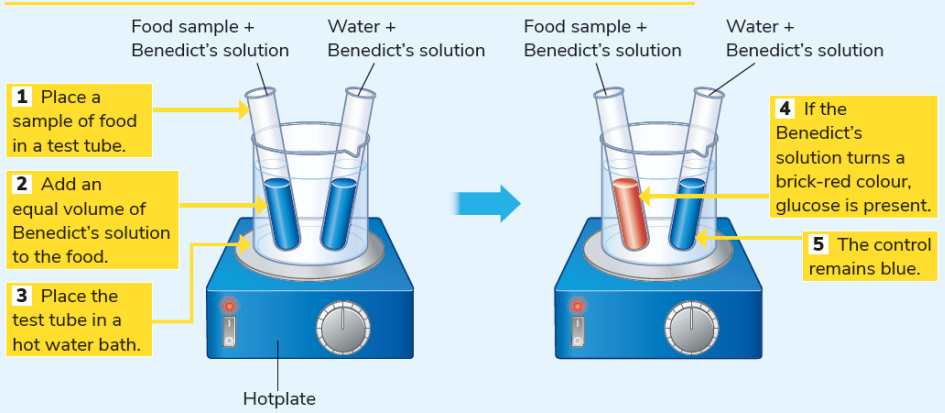



**Figure 4.3** To test a sample of food for the presence of glucose

A Folens video of this experiment is available online.

## EXPERIMENT 4.3

**To investigate the digestion of starch by the enzyme amylase**

This experiment is summarised in Figure 4.8.

Full step-by-step instructions for carrying out this experiment are given in Experiment 4.3 in the *Student Laboratory Notebook* accompanying this textbook.

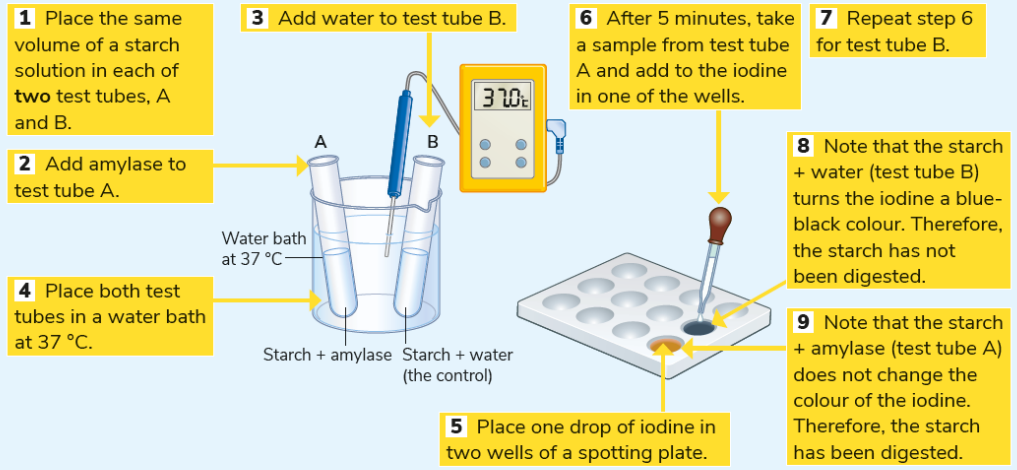
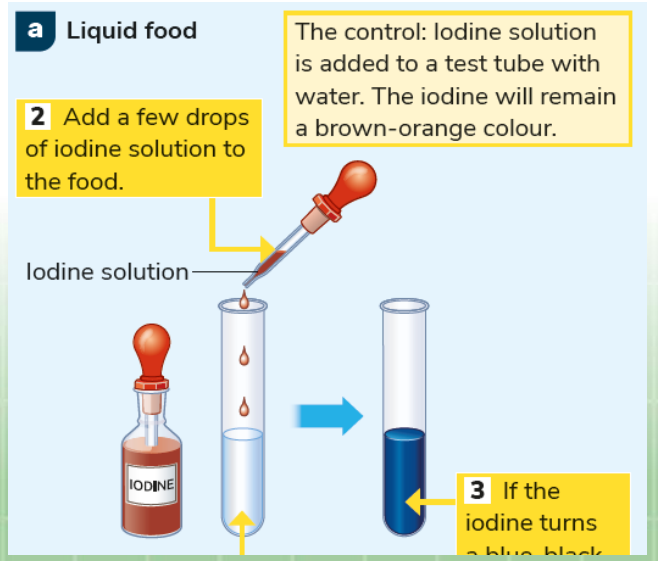
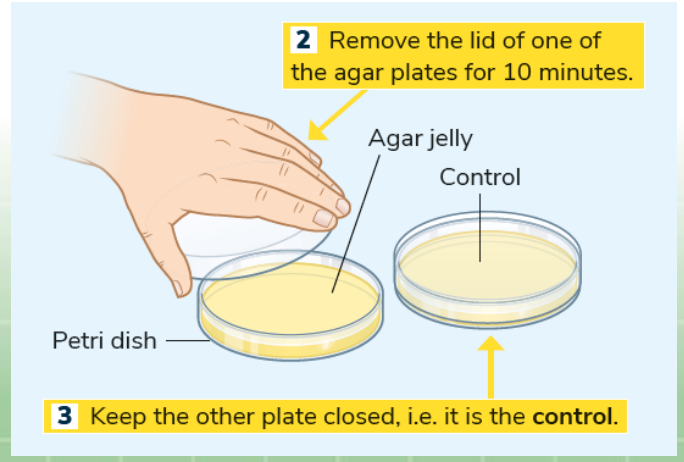



**Figure 4.8** To investigate the digestion of starch by the enzyme amylase



## Experiment 17.1

Full step-by-step instructions for carrying out this experiment are given in Experiment 17.1 in the *Student Laboratory Notebook* accompanying this textbook.

**To make a mixture using iron and sulfur and then change the mixture into the compound iron sulfide**

### Introduction

In this experiment you will make a mixture of the elements iron and sulfur. You will study some of the properties of this mixture. You will then heat some of the mixture to cause a chemical reaction to occur, forming a new compound. You will then study the properties of the compound formed.

### Method and observations

- Some iron filings are weighed out on a clock glass using the laboratory balance.
- Some sulfur is weighed out on another clock glass using the laboratory balance, Figure 17.8.
- The iron filings and sulfur are placed in a mortar and the mixture is ground very well using a pestle.
- The mixture is divided into two parts.
- A bar magnet is used to separate the iron filings from the sulfur in one part of the mixture.
- The other part of the mixture is placed in a test tube and heated in the fume cupboard using a Bunsen burner.
- The bottom of the test tube is heated until the mixture begins to glow, Figure 17.9. The Bunsen burner is removed for a while and then heating is continued.
- The grey material formed is removed from the test tube. It is tested with a magnet. It is found that it is not attracted to the magnet.


**Figure 17.8** Investigating the properties of a mixture of iron and sulfur and of the compound iron sulfide

First Edition p. 158

Essential SCIENCE

## EXPERIMENT 17.1

**To make a mixture using iron and sulfur and then change the mixture into the compound iron sulfide**

This experiment is summarised in Figure 17.12.

Full step-by-step instructions for carrying out this experiment are given in Experiment 17.1 in the *Student Laboratory Notebook* accompanying this textbook.

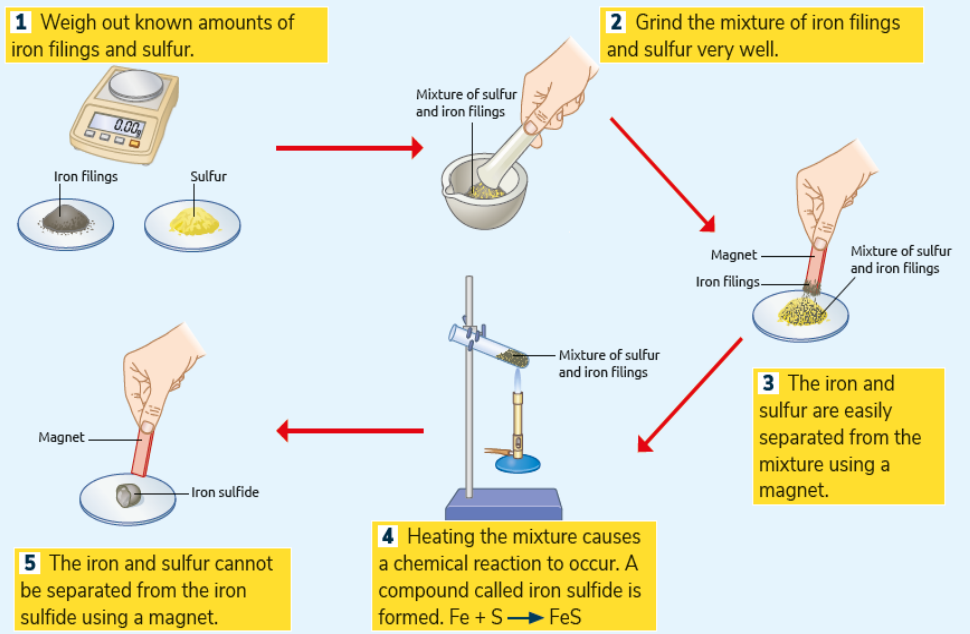



**Figure 17.12** Investigating the properties of a mixture of iron (Fe) and sulfur (S) and of the compound iron sulfide (FeS). Iron sulfide has different properties than the elements from which it is made.

A Folens video of this experiment is available online.

Students are asked on the examination papers for the steps involved in various experimental procedures.

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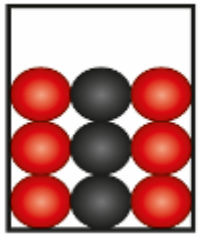
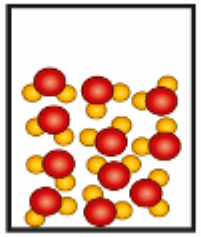
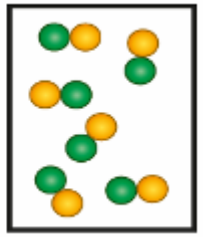
FOLENS



**(a)** Carbon dioxide ($CO_2$) is a compound and consists of molecules. Each molecule is made up of one atom of carbon (drawn in black) joined to two atoms of oxygen (drawn in red). The diagram represents solid carbon dioxide ('dry ice').



**(b)** Water ($H_2O$) is a compound and consists of molecules. Each molecule is made up of one atom of oxygen joined to two atoms of hydrogen. It is usually a liquid at room temperature.



**(c)** Hydrogen chloride (HCl) is a compound and consists of molecules. Each molecule is made up of one atom of hydrogen joined to one atom of chlorine. It is usually a gas at room temperature.

**Figure 17.7** Examples of particle theory diagrams for some compounds

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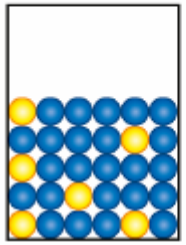
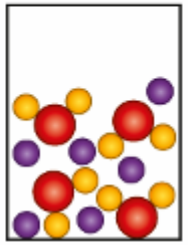
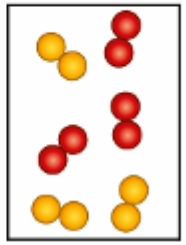
Some examples of particle theory diagrams of mixtures are shown in Figure 17.11.



**(a)** A mixture of two solids, e.g. iron filings and sulfur



**(b)** A mixture of two liquids, e.g. water and methylated spirits (for simplicity, the particles of methylated spirits are represented as purple spheres)



**(c)** A mixture of two gases, e.g. hydrogen and oxygen

**Figure 17.11** Examples of particle theory diagrams for some mixtures

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# Teaching the concept of Activation Energy

- The plastic bottle contains millions of these molecules, which are colliding with each other and with the walls of the bottle.
- Imagine you are standing on the street looking at people passing by. Some are walking slowly, others are walking quickly and some may be running.
- A similar situation occurs in the case of the gas molecules – they are moving at different speeds. Some are moving more slowly than others and therefore have lower amounts of energy. When gas molecules with low kinetic energies collide, they simply bounce apart without any reaction taking place.
- If molecules with high enough kinetic energies collide, products are formed. This is an effective collision.
- Chemists have found that a certain minimum amount of energy is necessary for a chemical reaction to occur when molecules collide. This energy is called the **activation energy**.

The **activation energy** is the minimum energy that colliding particles must have for a chemical reaction to occur.

In Chapter 22 we saw that reactions are faster at higher temperatures. We can use the collision theory to explain this observation.

**How do we explain why reactions are faster at higher temperatures?**

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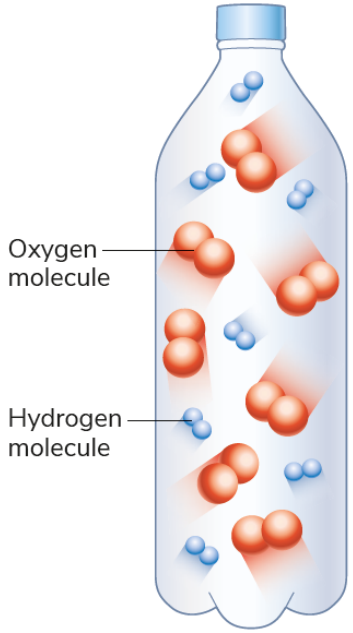


**Figure 24.5** This bottle contains a mixture of hydrogen gas and oxygen gas. The particles of hydrogen gas and oxygen gas are continually colliding with each other and with the walls of the bottle.

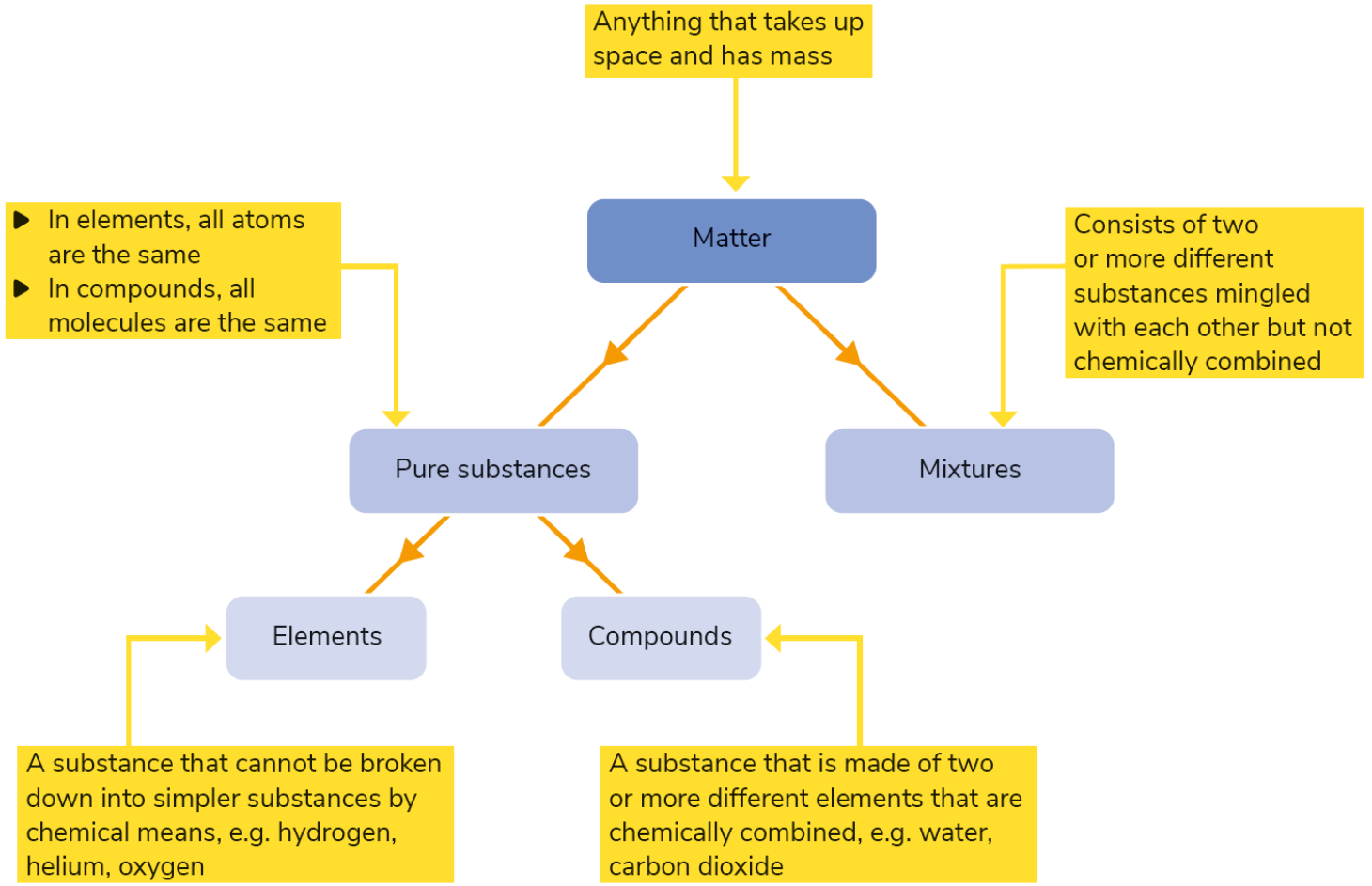


**Figure 17.9** All the substances (matter) in the world are either pure substances or mixtures. All pure substances are either elements or compounds.

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## EXPERIMENT 18.2

**To investigate the effect of temperature on solubility and to use the data obtained to plot a solubility curve**

This experiment is summarised in Figure 18.8.

Full step-by-step instructions for carrying out this experiment are given in Experiment 18.2 in the *Student Laboratory Notebook* accompanying this textbook.

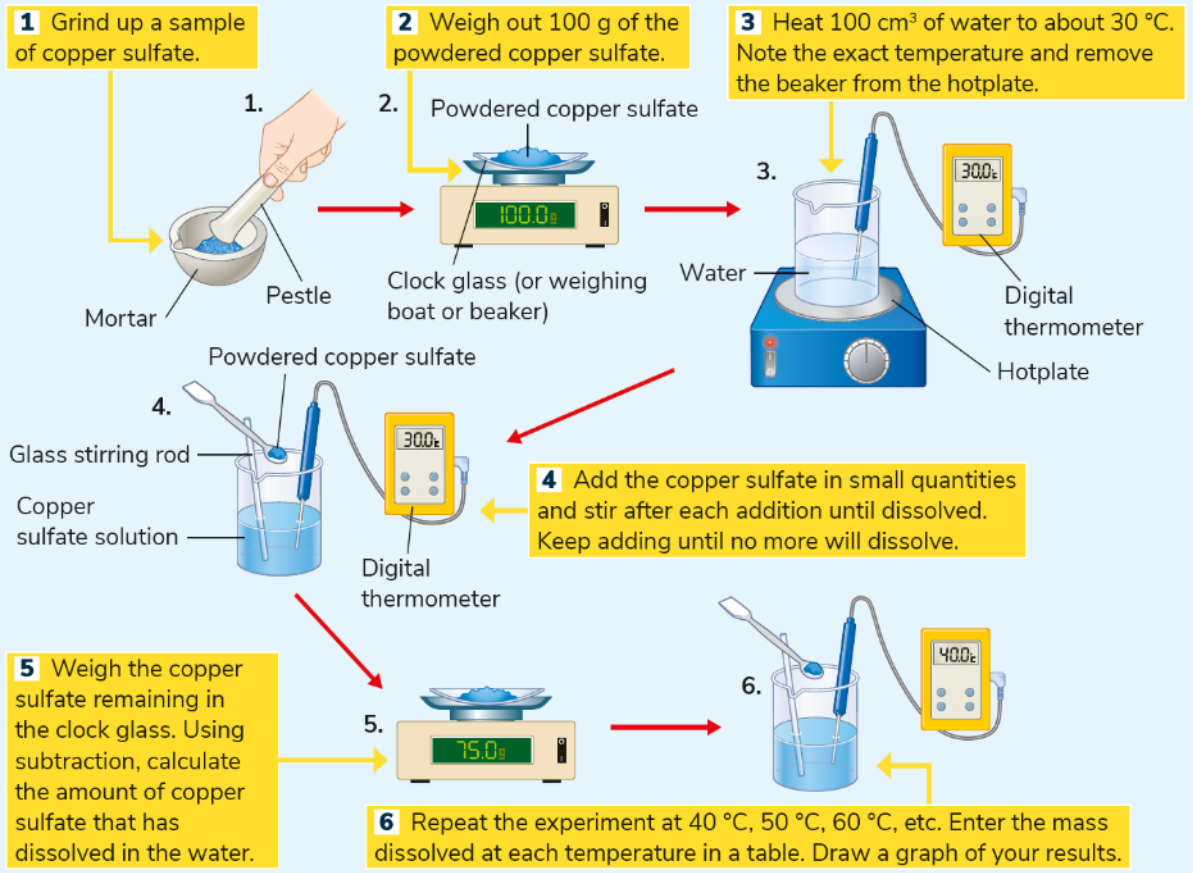


**Figure 18.8** Summary of the steps involved in investigating the effect of temperature on solubility and to use the data obtained to plot a solubility curve

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## EXPERIMENT 21.2

**To investigate if mass is unchanged when a chemical change takes place**

This experiment is summarised in Figure 21.11.

Full step-by-step instructions for carrying out this experiment are given in Experiment 21.2 in the *Student Laboratory Notebook* accompanying this textbook.

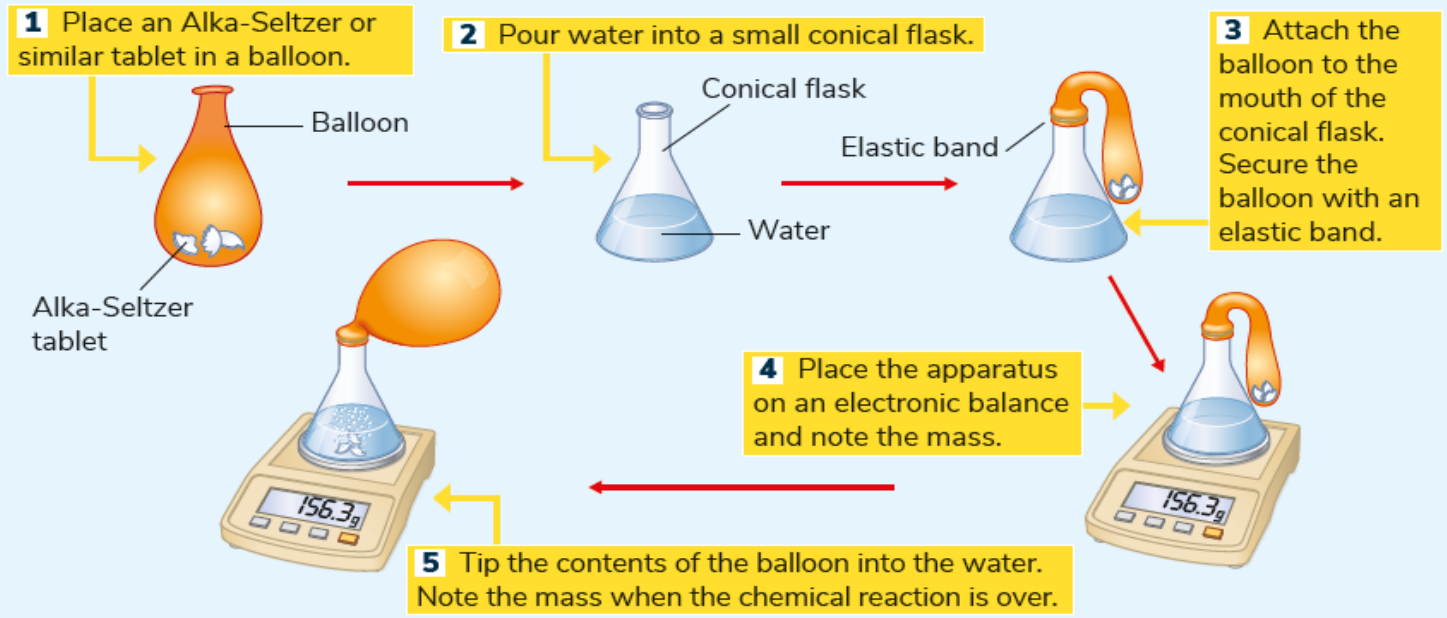


**Figure 21.11** A chemical change takes place when the Alka-Seltzer tablet comes in contact with water. No change is observed in the total mass before or after the chemical reaction has taken place. This verifies the law of conservation of mass.

A Folens video of this experiment is available online.

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# Integrated instruction- make material easier to visualise/learn.

## Experiment 29.2

Full step-by-step instructions for carrying out this experiment are given in Experiment 29.2 in the *Student Laboratory Notebook* accompanying this textbook.

### To find the density of an irregular-shaped object

#### Introduction

In this experiment you will find the mass and the volume of a stone and then calculate its density.

#### Key steps in procedure

- The mass of the stone is found by placing it on a balance.
- The volume of the stone is found by gently lowering it completely into a filled overflow can and noting the volume of water that flows out using a graduated cylinder.
- (Remember to read the bottom of the meniscus at eye level!)

#### Calculations

Divide the mass of the stone by the volume of water. You have now calculated the density of an irregular-shaped object.

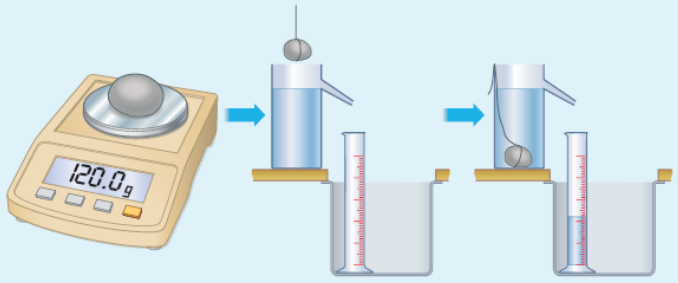


**Figure 29.3** Finding the density of a stone

A Folens video of this experiment is available online.

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## EXPERIMENT 30.1

Full step-by-step instructions for carrying out this experiment are given in Experiment 30.1 in the *Student Laboratory Notebook* accompanying this textbook.

### To find the density of an irregular-shaped object

This experiment is summarised in Figure 30.3.

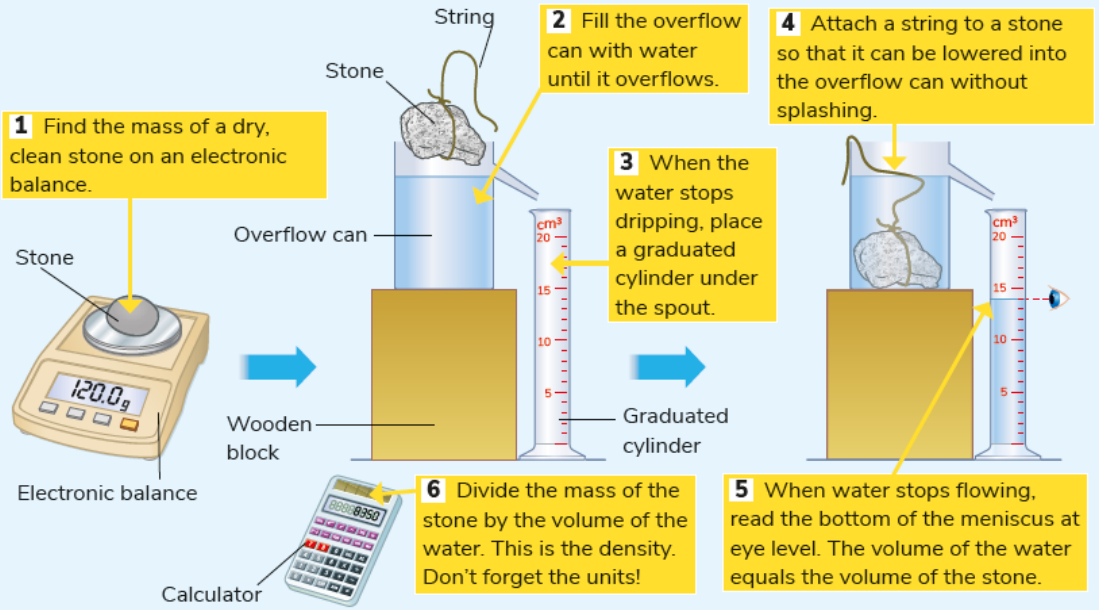


**Figure 30.3** Finding the density of a stone

Additional experiments using a similar method can be found in the *Student Laboratory Notebook* accompanying this textbook. Experiment 30.2 describes how to find the density of a regular solid. Experiment 30.3 describes how to find the density of a liquid.

Folens videos of these experiments are available online.

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# Emphasis on step-by-step method on the physics section

*Emphasis on a step by step method of carrying out calculations to unsure that students will get attempt marks for work that is partially correct.*

*Candidates should show their calculation work clearly. Calculations should be fully completed.*
- SEC Chief Examiner's Report p. 8

**WORKED EXAMPLE 30.1**

A dry stone is placed on a balance. The mass is found to be 36 g. Using a graduated cylinder containing water, the volume of the stone is found to be 12 $cm^3$. What is the density of the stone?

**Step 1: Write the formula** $\text{density} = \frac{\text{mass}}{\text{volume}}$

**Step 2: Fill in the equation** $= \frac{36\ g}{12\ cm^3}$

**Step 3: Write the answer with the correct units** $= 3\ g/cm^3$

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# Questions made more appealing using additional diagrams where possible.

In keeping with the SEC Exam Paper many questions are illustrated as shown.

## WORKED EXAMPLE 31.1

**(a)** An athlete ran a 2,000 m race in 6 minutes. What was her average speed?

**(b)** An aeroplane travelled from Dublin to Cork, a distance of 200 km, in 40 minutes. What was the average speed of the aircraft during the journey?

**Answer**

**(a)** Since the units of speed are metres per second, first convert minutes to seconds:

6 minutes = 6 × 60 = 360 s

**Step 1: Write the formula** $\text{speed} = \frac{\text{distance}}{\text{time}}$

**Step 2: Fill in the equation** $= \frac{2{,}000}{360}$

**Step 3: Write the answer with the correct units** $= 5.56 \text{ m s}^{-1}$


Figure 31.2

**(b)** 40 minutes = 40 × 60 = 2,400 seconds

200 km = 200,000 m

$\text{speed} = \frac{\text{distance}}{\text{time}} = \frac{200{,}000 \text{ m}}{2{,}400 \text{ s}} = 83.3 \text{ m s}^{-1}$

Figure 31.3

## DO THE MATHS!

**Q:** The speed of a person is 5 m $s^{-1}$. What does this mean?

**A:** It means that the person is covering 5 metres of ground each second. After 1 second the person has travelled a total distance of 5 m. After 2 seconds the person has travelled a total distance of 10 m. After 3 seconds the person has travelled a total distance of 15 seconds, etc.

*Since we divided metres by seconds, we write the unit as m/s. This is often written as m $s^{-1}$.*

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# Questions made more appealing using diagrams where possible

**WORKED EXAMPLE 31.4**

**(a)** A car increases its velocity from 0 m/s to 10 m/s in 5 seconds. What is its acceleration?
**(b)** A car reduces its velocity from 5 m $s^{-1}$ to 0 m $s^{-1}$ in 10 seconds. What is the acceleration?
**Answer**

**(a)**

**Step 1: Write the formula** acceleration $= \frac{\text{change in velocity}}{\text{time taken}}$

**Step 2: Fill in the equation** $= \frac{10\text{ m/s} - 0\text{ m/s}}{5\text{ s}}$

**Step 3: Write the answer with the correct units** = 2 m/s/s or 2 $m\ s^{-2}$

Figure 31.16

**(b)** acceleration $= \frac{\text{change in velocity}}{\text{time taken}} = \frac{0\text{ m s}^{-1} - 5\text{ m s}^{-1}}{10\text{ s}} = -0.5\text{ m/s/s} = \mathbf{-0.5\ m\ s^{-2}}$

Figure 31.17

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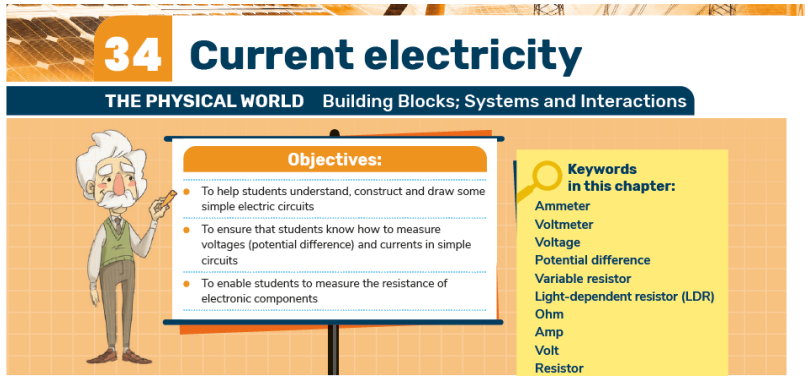
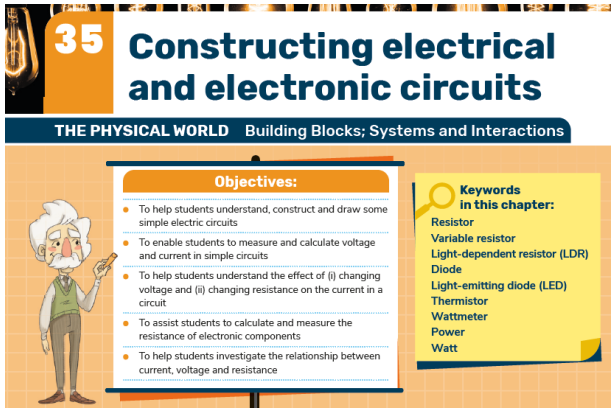
# Electricity chapter split into two different sections


Greater teacher choice to complete topic consecutively or to take a break, revise and build on previous knowledge.

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# Additional diagrams to help students visualise/model various concepts

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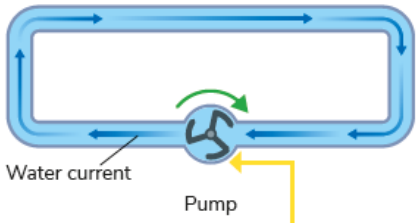
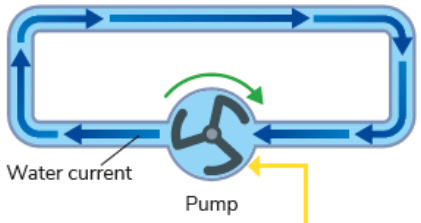
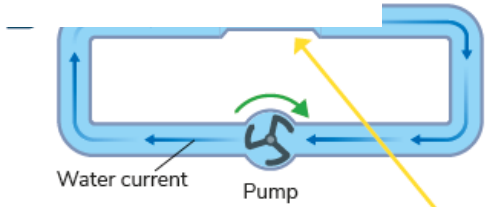
## 34.11 A model to simulate current, voltage and resistance



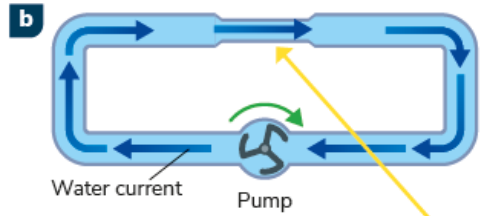

Voltage can be represented by a pump. A small pump produces a low rate of flow of water around the circuit.




A more powerful pump will create a greater flow of water around the circuit. Similarly, a higher-voltage battery will push more electrons around the circuit every second. A larger electric current will flow.

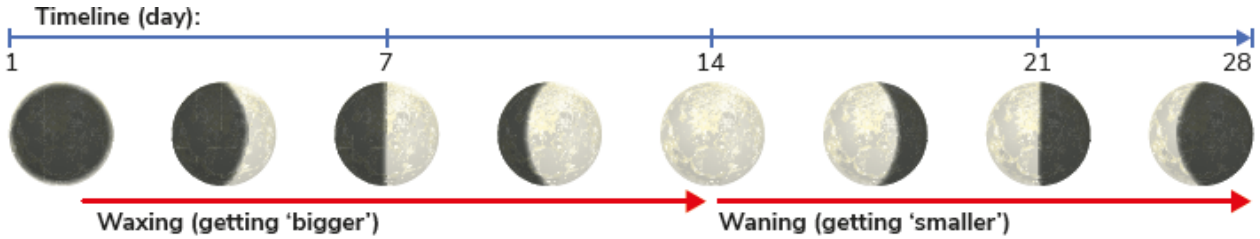



**Resistance** can be thought of as a narrowing in part of a circuit. As this part of the pipe is narrow, it offers a high resistance to the flow of water. Therefore, less water flows around the circuit every second. Similarly, in an electric circuit, a high resistance causes less current to flow.




As this part of the pipe is not as narrow as diagram (a), it offers a lower resistance to the flow of water. Therefore, more water flows around the circuit every second. Similarly, in an electric circuit, a low resistance causes more current to flow.

**Figure 34.22** A water model to represent resistance




During a new moon, the moon is completely dark. It will begin to get bright from **right to left**.

As part of the moon is lit, it appears crescent-shaped. The moon continues to get bigger (waxing) from **right to left**.

Eventually you see half of the moon lit (the first quarter). The moon continues to get brighter from **right to left**.

As more than half of the moon is lit, it is called a waxing gibbous. The moon continues to get brighter (waxing) from **right to left**.

During a full moon, you see the entire lit face of the moon. The moon will begin to darken (waning) from **right to left**.

After a waning gibbous, the moon will continue to darken from **right to left**.

After the third quarter, the moon will continue to darken from **right to left**.

After the waning crescent, the moon will continue to darken from **right to left** and eventually will become completely dark (a new moon).

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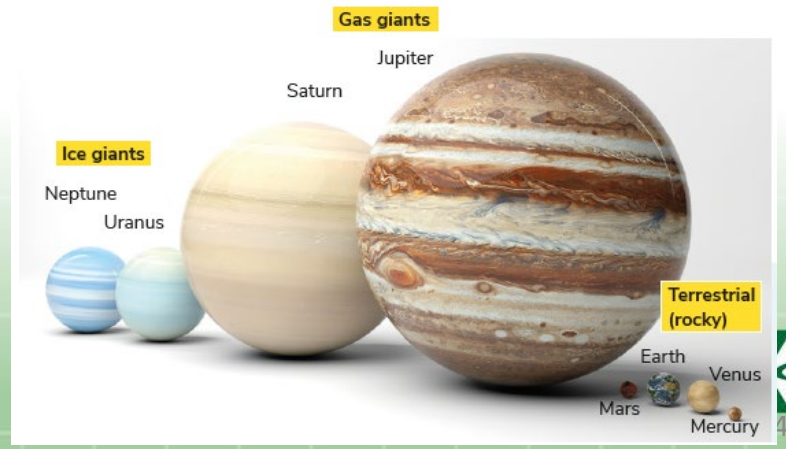


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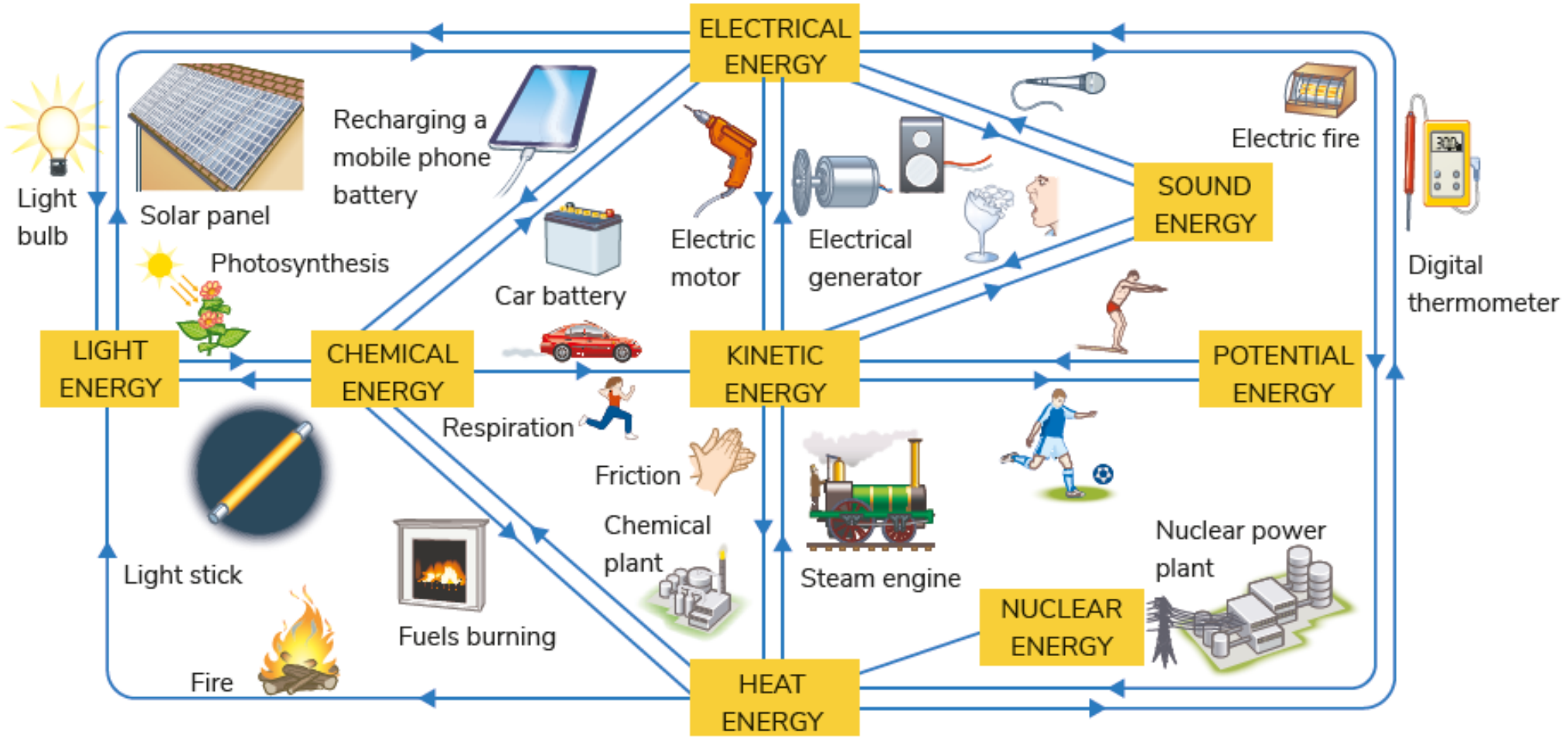



**Figure 33.11** Some energy conversions

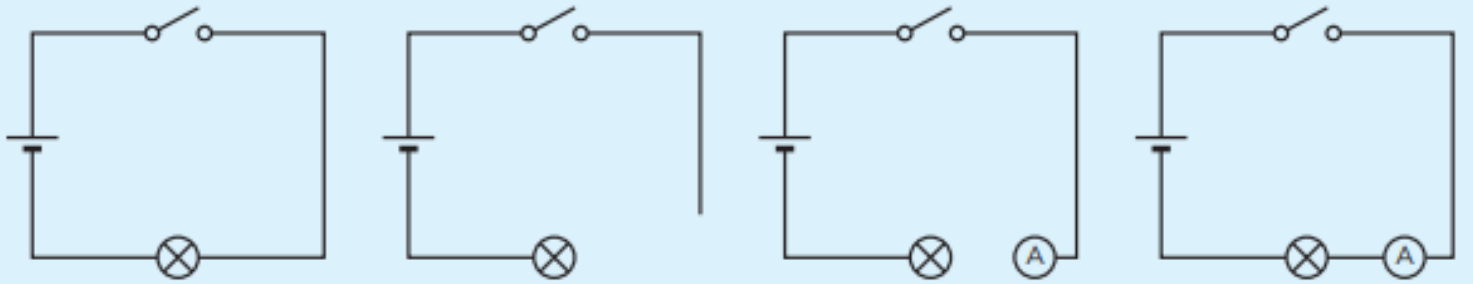
# Additional diagrams with matching photos

## EXPERIMENT 34.2

**To measure the current in a circuit using an ammeter**

This experiment is summarised in Figure 34.6.

Full step-by-step instructions for carrying out this experiment are given in Experiment 34.2 in the *Student Laboratory Notebook* accompanying this textbook.




**1** Make a circuit with a switch and a battery. Turn on the switch to make sure the bulb works.

**2** Remove a wire from one side of the bulb.

**3** Connect an ammeter into the circuit.

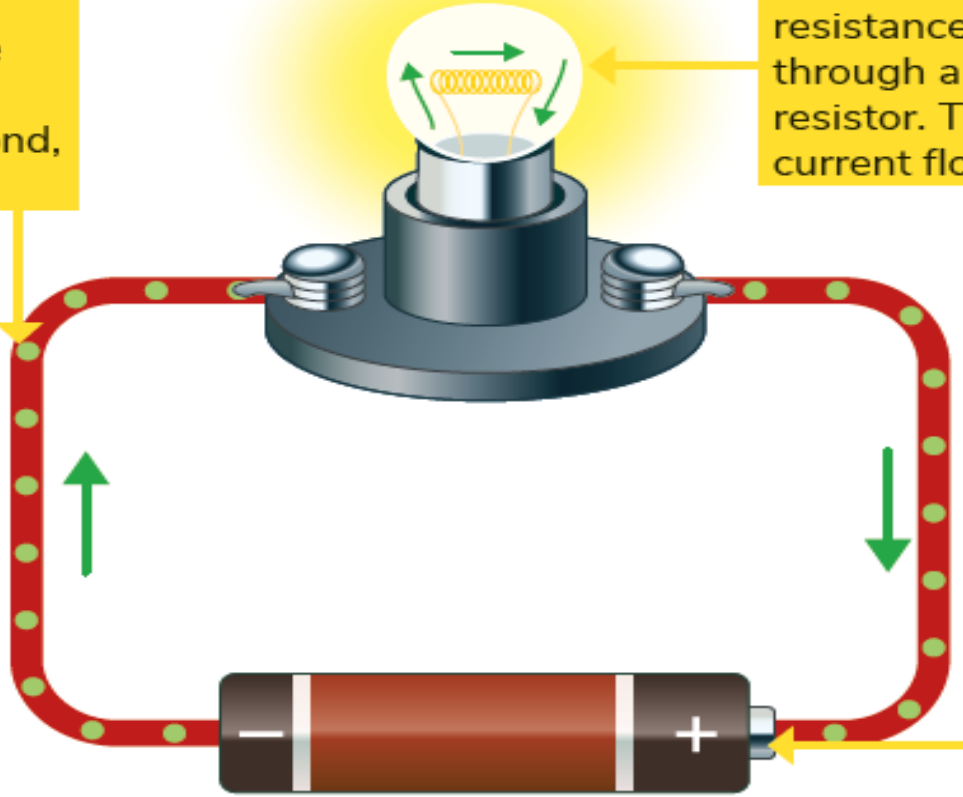
**4** Use an additional wire to complete (make) the circuit. The bulb should light up and a reading should appear on the ammeter.

**Figure 34.6** How to connect an ammeter in a circuit

A Folens video of this experiment is available online.

**2** The flow of electrons is called **current**. The unit of current is the **amp (A)**. The more electrons that pass a point in the circuit per second, the greater the current.

**3** The very thin wire in the bulb tries to slow down the current. Since the bulb offers **resistance**, it is called a resistor. The unit for resistance is the **ohm (Ω)**. Current flowing through a resistor causes heating in the resistor. The greater the resistance, the less current flows.




**1** The battery pushes electrons around the circuit. The amount of 'push' is measured by the **voltage** of the battery. The unit of voltage is the **volt (V)**. The greater the voltage, the greater the current. (Another name for voltage is **potential difference**.)

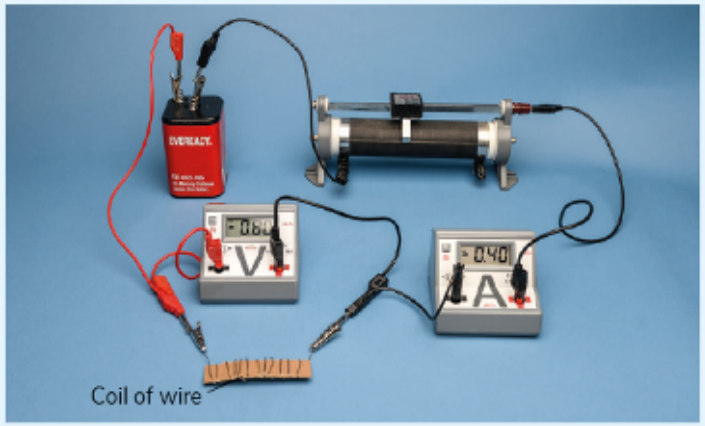
**Figure 35.1** The three key terms in current electricity are voltage, current and resistance.

## EXPERIMENT 35.1

**To determine the resistance of a conductor by investigating how the voltage across the conductor varies with the current flowing**

This experiment is summarised in Figure 35.6.

Full step-by-step instructions for carrying out this experiment are given in Experiment 35.1 in the *Student Laboratory Notebook* accompanying this textbook.



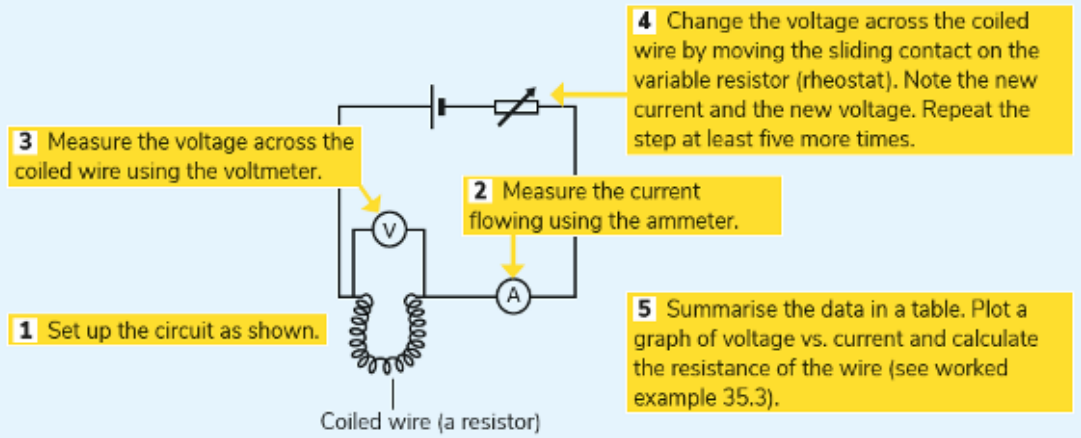




**Figure 35.6** Investigating how the voltage across the coiled wire varies with the current flowing through it allows us to determine the resistance of the coiled wire.

A Folens video of this experiment is available online.

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# Sankey Diagrams

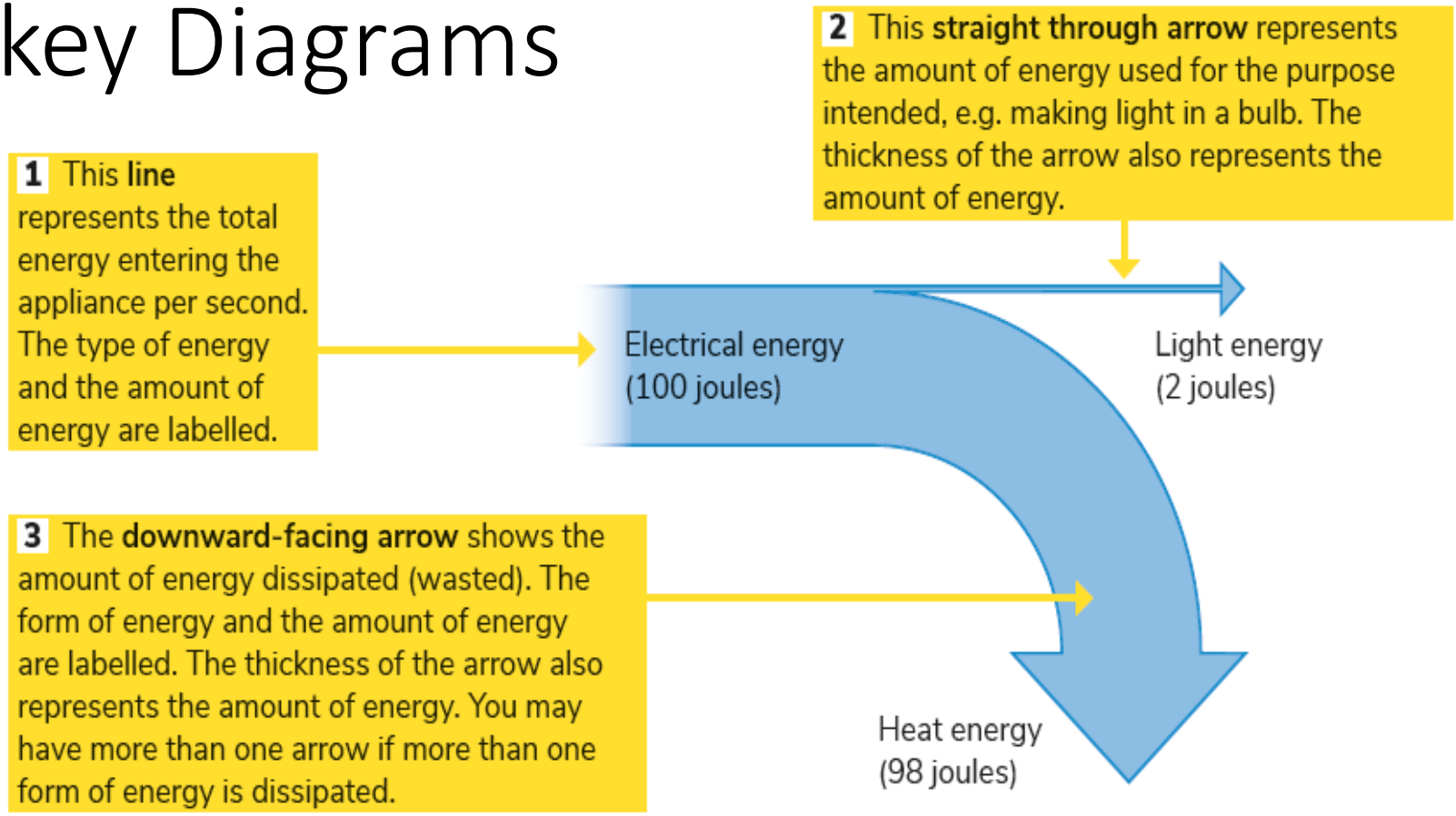


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**Figure 33.13** Sankey diagrams show the flow of energy entering and leaving a device.

# Overcoming common misconceptions/errors that are evident from marking of past examination questions

# Exam tips to point out some misconceptions

**EXAM TIP!**

If you are asked to give a use for a graduated cylinder, a vague answer such as 'to measure a liquid' will not gain full marks. The correct answer is 'to measure the **volume** of a liquid'. Many students lose marks by not being clear when stating the function of instruments.

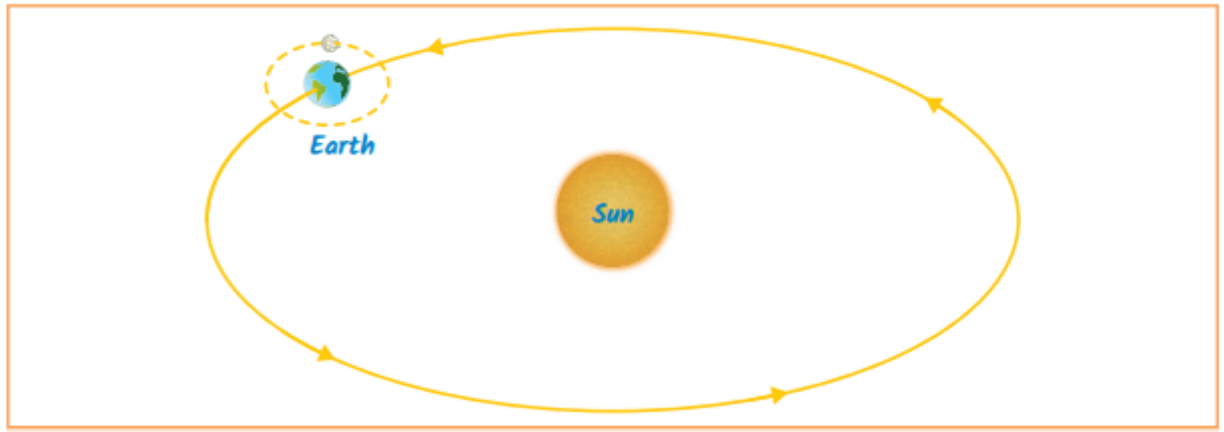



Figure 38.17

**EXAM TIP!**

These symbols are named on page 73 of the State Examinations Commission *Formulae and Tables* booklet.

**EXAM TIP!**

You must include the units to get full marks in the exam.

**EXAM TIP!**

Hint: The moon needs to be shown as:

- Round
- Closer to the Earth than to the sun
- Orbiting the Earth

**EXAM TIP!**

In your exam you may get some marks (attempt marks) for an incorrect answer *if* you show how you got your answer. It is very important that you follow the step-by-step method as shown above so that you can get these marks if you make a mistake! This is also very important in Maths.

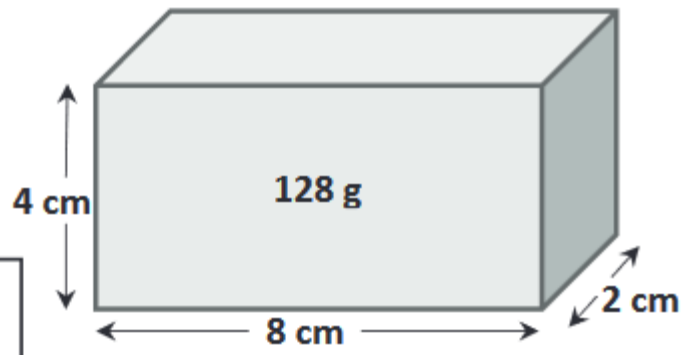
# 2019 Q2 Calculations and **UNITS**

**Question 2** **(15 marks)**

A student was asked to measure the density of a block.

The dimensions of the block are shown in the diagram.

The mass of the block is 128 g.




**(a)** Calculate the volume of the block.

Calculation

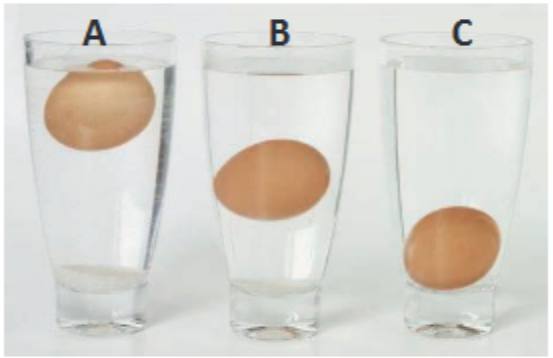
**(b)** Calculate the density of the block. Include the unit for your answer.

Calculation


# 2019 C sinks the **MOST**

## Sinking on own → 0

**(c)** The photograph below shows three glasses of water labelled **A**, **B** and **C**. An egg was placed into each glass. The photograph was taken when the eggs were stationary.




Which glass (**A**, **B** or **C**) contains the egg with the greatest density?

Give a reason for your answer.

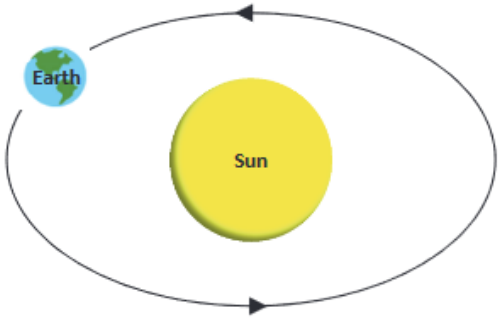
| | | | |
|---|---|---|---|
| (b) | 2<br><br>Units: g/cm$^3$ | 3<br><br>3 | **6** |
| (c) | C<br><br>Reason: sinks most / lowest / bottom | 3<br><br>3 | **6** |

# 2019 Q 16

**Question 16** **(45 marks)**

2019 marks the 50th anniversary of man's first landing on the Moon. Since then there have been a number of other missions to the Moon.

**(a)** The diagram below shows the Earth orbiting the Sun. Complete the diagram to show the shape, location and motion of the Moon in the Earth-Sun-Moon system.



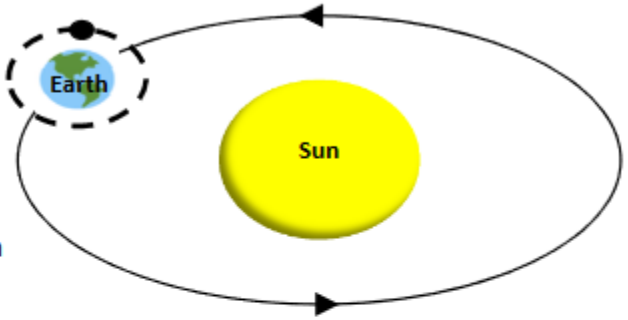


**(b)** At the time of the first landing, the Moon was in a waxing crescent phase as seen from Earth. The images below show different phases of the Moon in sequence, from left to right. Place a tick (✓) in the box beneath the image which shows the Moon in a waxing crescent phase.

Shade in the image of the Moon on the left to illustrate the next phase of the Moon in the sequence above.

**(c)** On January 2nd 2019, the Chinese Chang'e-4 lander touched down on the far side or 'dark side' of the Moon.

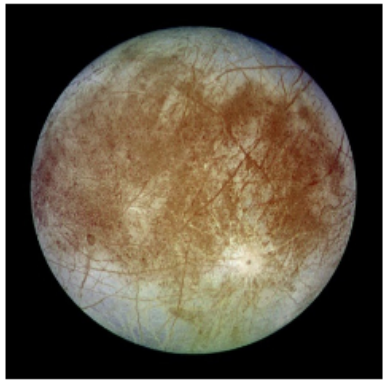
Explain why this side of the Moon is never visible from Earth.

| Q16 | | Marks | |
|---|---|---|---|
| (a) | Circular Moon<br>  <br><br>Closer to Earth than Sun<br>Orbit indicated around Earth | 3<br>3<br>3 | 9 |
| (b) | First image (image on the left)<br>  <br>Right part of moon shaded | 3<br>3 | 6 |
| (c) | The Moon spins (on its axis)<br>at same rate (in the same time) it takes to orbit the Earth | 3<br>3 | 6 |

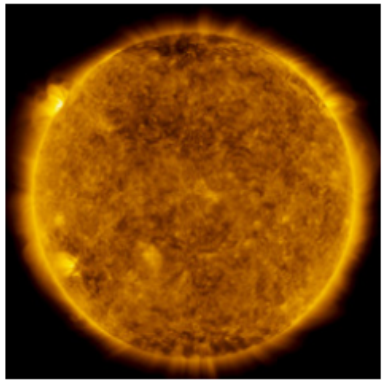
# 2022 Q 2

**Question 2** **(15 marks)**

The images below show three celestial objects found in our solar system.
The objects are not shown on the same scale.



**Moon**



**Star**

**Planet**

**(a)** Match the name of each celestial object with the correct description in the table below.

| Description | Name of celestial object |
|---|---|
| Consists of burning gas | |
| Orbits a planet | |
| Orbits a star | |


**(b)** Which of the celestial objects above has the largest diameter?

# 2022 Q 2

**(c)** Draw a labelled diagram to show the positions of a moon, a star and a planet during a lunar eclipse, i.e., an eclipse of the moon.

| | | |
|---|---|---|
| (b) | Star | **3** |
| (c) | *Labelled diagram:*   | **3** |

**Collinear and at least two named**

**2022 Q 6**


**(d)** Explain why the Moon is visible from Earth.

**(e)** An object weighs less on the Moon than on Earth.
Put a tick (✓) in the box next to the sentence that explains why:

| | |
|---|---|
| It is colder on the Moon than on Earth. | ☐ |
| The Moon has a smaller radius than Earth. | ☐ |
| The Moon has a smaller mass than Earth. | ☐ |
| The Moon has no atmosphere. | ☐ |

(d) Light of Sun **reflected** from Moon. Sun illuminates Moon. Did not accept Sun **Shines** on Moon.

# 2022 Q 8 Very poorly answered.

**Question 8** **(15 marks)**

During your studies you learned about a scientific model that helps us understand the origin of the universe.

**(a)** Name the model you studied.


Outline two pieces of evidence that support this model.


In September 2021, the SpaceX Inspiration4 mission successfully orbited the Earth. This was the world's first all-civilian space mission and represents a new era for human space exploration.

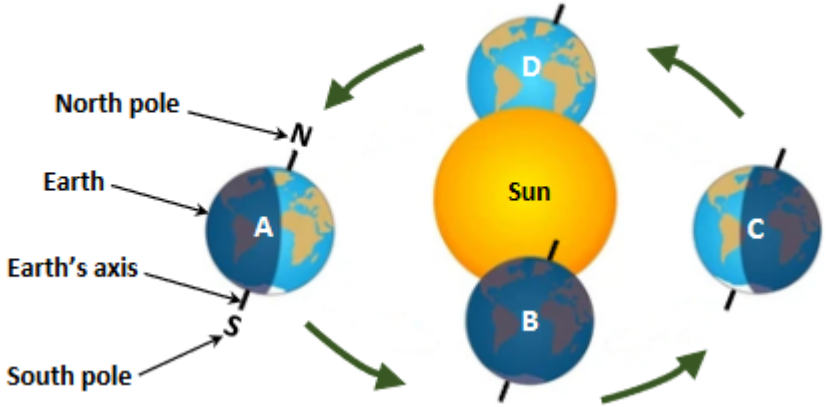

**(b)** Outline one benefit and one hazard of space exploration.

| Q8 | | Marks |
|---|---|---|
| (a) | Big Bang (theory) | 1 |
| | *Evidence:*<br>Expansion of universe or galaxies (red shift) // cosmic or background radiation // ratio or presence of hydrogen and helium in gas clouds in distant galaxies ***Any two*** | 1+1 |
| (b) | Correct benefit<br>Correct hazard | 6<br>6 |

**Could Kill you → 0**
**Dangerous → 6**

**2023 Did not accept: you could die, bad for health, no gravity, dangerous.**

# 2022 Q 11




**(a)** Starting at position **A**, what will be the position of the Earth when 18 months have passed? Put a tick (✓) in the correct box.

Position **A** ☐ Position **B** ☐ Position **C** ☐ Position **D** ☐

**(b)** Which letter, **A**, **B**, **C** or **D**, represents the position of the Earth during summer in the northern hemisphere? Justify your answer.

| |
|---|
| |


NB. When explaining Seasons must say **tilted** not leaning etc.

# 2022 Q 14

**(c)** **(i)** EU agriculture has reduced its greenhouse gas emissions by 20% since 1990. Name a greenhouse gas which drives climate change and is produced by agricultural practices.

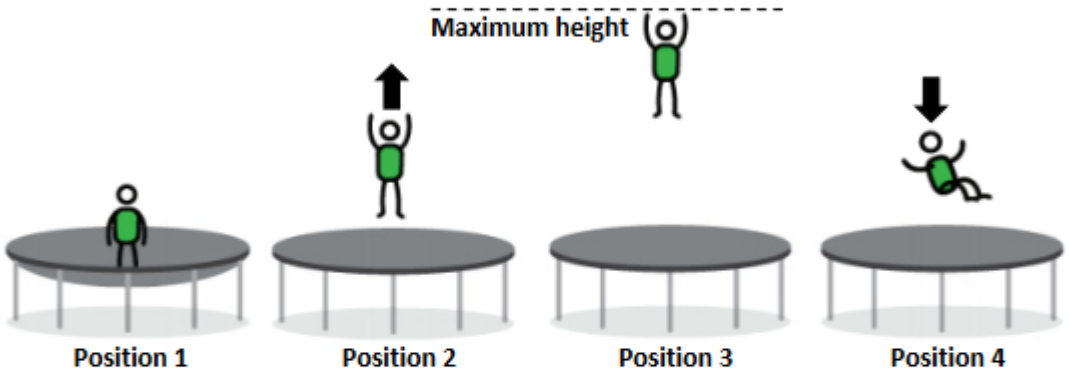

**(ii)** Describe an initiative that could be undertaken to reduce the production of this gas.

# 2022 Q 15

**Question 15** **(60 marks)**

Energy exists in many forms. The energy stored by an object due to its position or shape is called potential energy. The energy of an object due to its motion is called kinetic energy.

Potential energy is converted to kinetic energy when a person jumps on a trampoline.
The diagrams show the position of a person at certain times while jumping.




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

**(i)** Identify a position where the person has least kinetic energy.

Position **1** ☐ Position **2** ☐ Position **3** ☐ Position **4** ☐

**(ii)** Identify a position where the trampoline has its greatest potential energy.

Position **1** ☐ Position **2** ☐ Position **3** ☐ Position **4** ☐


**(c)** Heat energy is also produced when a person uses a trampoline.
Describe one possible source of this heat energy.

# 2023 10 (c)


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

| |
|---|
| |
| |
| |

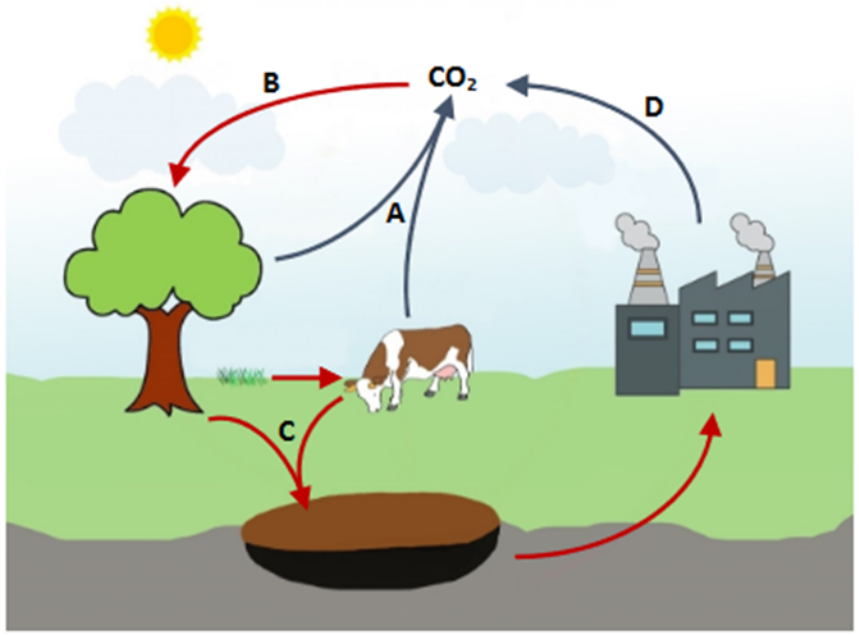
| | | |
|---|---|---|
| **(c)** | Low carbon footprint (reduces carbon emissions) / reliable / efficient / clean / doesn't produce greenhouse gases / cost effective | **3** |

**Did not accept** : Renewable/ sustainable/ cheap/ replaced fossil fuels/ Generates more energy/ more powerful/ more electricity.

# 2023 Q 11

**Question 11** (30

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




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

| | | |
|---|---|---|
| **(c)** | Decay / decomposition | 3 |

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

**'Gas' on own → 0**


**(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.

| | | |
|---|---|---|
| **(e)** | Extreme weather events *or* described / flooding / global warming / species extinction/ climate change / melting of icecaps / rise in sea levels / other correct<br>***Any two*** | 2(3) |

**Increasing Heat/ Reducing Air Quality → 0**

# 2023 Q 13

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

| | | |
|---|---|---|
| (a) | (i) | Sun //<br>and the objects that orbit it |
| | (ii) | Collection of stars |

**Must say orbit. Circle, rotate → 0**


**No marks for definition of galaxy as collection of *solar systems or suns.***

# Science in Society Assessment Task

## **Science in Society Assessment Task** (10%).

- A full chapter (Chapter 40) on the Science in Society Assessment Task.
- Chapter 40 includes SEC booklet with model answers completed for each section of the booklet to show students the depth of answering required to get full marks.
- A blank SEC booklet included in the Assessment Skills Book to help students practice writing up the Science in Society Asssessment Task.

*Many of the skills which students develop while undertaking the Assessment Task are assessed in the examination paper.* (Chief Examiner's Report 2019)

# 40 Science in Society Assessment Task

**THE NATURE OF SCIENCE** Science in Society; Investigating in Science; Communicating in Science

**Objectives:**

- To give students an understanding of how to carry out research on a Science in Society topic
- To make students familiar with the various categories of data that can be collected during a research project
- To give students an appreciation of the need to evaluate claims and opinions studied in a research project

**Keywords in this chapter:**

Evidence
Primary
Secondary
Research
Reliability
Bias

## 40.1 Science in Society Assessment Task

The State Examinations Commission (SEC) examination paper that you will undertake at the end of Third Year is worth 90 per cent of the marks awarded to you by the SEC. The remaining 10 per cent of marks are awarded by the SEC based on the answers that you write in the SEC Assessment Task booklet. When you complete this booklet, it is sent to the SEC to be marked with your written examination. A copy of the Assessment Task booklet is printed in the Assessment Skills Book accompanying this textbook.

The questions in the Assessment Task booklet are based on the Science in Society Investigation that you completed as part of the second Classroom-Based Assessment (CBA) that you undertook in Third Year. You will recall that the first CBA, undertaken in Second Year, was an Extended Experimental Investigation (EEI). The EEI involved laboratory practical work. The Science in Society Investigation does not involve any laboratory practical work. Instead, you will carry out research on a Science in Society issue. You may recall that we discussed Science in Society in Chapter 1. There are hundreds of Science in Society issues that you could investigate. Your teacher will guide you in choosing a suitable topic.

## 40.2 Primary and secondary data

When you carried out your Extended Experimental Investigation, you collected data yourself rather than use data that had been collected by somebody else. Data collected by the researcher him or herself are called primary data. The word data means 'factual information'. Data is the plural of datum.

**Primary data** are data collected by the researcher him or herself.

Primary data are commonly collected by students for research projects (Figure 40.1). The data are often used when reporting the results of research projects carried out by the researcher.

Data that have not been collected by the researcher him or herself are called **secondary data**.


**Figure 40.1** Primary data are data that you have collected yourself as part of carrying out an investigation or a research project.



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Secondary data are usually available from a number of sources, such as websites, books, journals and government records (Figure 40.2). Secondary data have already been collected at some time in the past. For example, census data of the population of Ireland are available from government organisations. Also, data on examinations are available from the State Examinations Commission. A great deal of secondary data are available online.

**Secondary data** are data collected by somebody other than the researcher.

**Figure 40.2** Secondary data are data collected by somebody other than the researcher. A lot of secondary data are available online.

## 40.3 The research question

When choosing a Science in Society topic to research, you should choose one in which you are interested. If you are interested in the topic, it will help to motivate you to work hard on it. When thinking about the topic, consider some of the following areas:

- An application of science that has an effect on **human health**.
- An application of science that has an effect on the **environment**.
- An application of science that has an effect on **society in general**.

When you have decided on the topic on which you wish to carry out research, you need to draw up a research question.

A **research question** is the question that an investigative study sets out to answer.

It is important to choose a research question carefully. Never choose a research question that can be answered by a 'yes' or 'no' answer.

**Bad research question:** Is a diet of junk food damaging to your health?

**Good research question:** How does a diet of junk food damage your health?

When writing a research question, use words such as *How? What? Why?* and *To what extent?*

Other examples of good research questions are:

- Why is burning fossil fuels bad for the environment?
- Why should our government consider allowing a nuclear power plant to be built in Ireland?
- What are better alternatives to incinerators for disposing of our waste?
- How can the level of recycling be improved in my neighbourhood?
- How can I reduce my carbon footprint?
- What effects on our health are caused by the frequent use of mobile phones?
- In what ways do the benefits of space travel outweigh the hazards?
- Why is alcohol consumption so high in Ireland and what strategies are needed to reduce it?
- How can we reverse the decline in our bee population?
- How does the frequent playing of computer games affect our health?
- Why are obesity levels high among teenagers in Ireland and how can we address the problem?
- To what extent can wind farms solve Ireland's energy problems?

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**Students are guided through the filling out of the SEC booklet step-by-step with explanations of what is required by each question and model answers supplied.**

## 40.4 Completing the SEC Science in Society Investigation Task booklet

There are four questions in the SEC booklet. Each question is worth 10 marks. It is important to ensure that you answer each question fully, as shown in worked example 40.1. To help you understand what is required in each question, a sample Science in Society topic on electric cars is given.

**WORKED EXAMPLE 40.1**

### Section A: Investigation and Research

**Question 1**

**(a) State your research question.**

*In this section, just write a sentence stating your research question.*

*To what extent do electric cars contribute to improving the quality of air?*

**(b) Why did you choose this research question?**

*In this section, give a reason why you are interested in this topic.*

*I became interested in the topic of electric cars because our neighbour recently purchased an electric car. He told me that it was less polluting than the diesel-powered car that we have.*

**(c) Name any two specific research resources that you used during your investigation.**

*The word specific is important. You must give precise details of research resources. For example, instead of saying 'I searched the internet', give details of the actual website that you visited.*

*Examples of some specific research resources that I used:*

- *I used the internet to find out about the benefits of electric cars to the environment.*
- *I studied the information given on the Sustainable Energy Authority of Ireland website (www.seai.ie/sustainable-solutions/electric-vehicles/).*
- *I watched a YouTube video comparing electric cars and petrol cars (www.youtube.com/watch?v=ewcWN-rHQ6Q).*

**EXAM TIP!**

Other research resources that you could use are:

- A named newspaper article
- A named article in a science journal or a magazine
- A named TV programme that you viewed
- A named podcast that you listened to.

### Section B: Knowledge, Reliability and Bias

**Question 2**

**(a) Outline some scientific knowledge you learned during your investigation.**

*In this section, give some factual knowledge that you learned. Make sure that you use scientific language or terminology. You should write a minimum of two sentences.*

*In the YouTube video, I learned that combustion of petrol provides pressure inside a piston in the engine. This transfers energy to a transmission unit, which turns the wheels and causes the car to move.*

*In an electric car, the power source is a battery pack. An inverter converts the direct current into alternating current. This causes an induction motor to turn the wheels of the car.*

*Burning petrol produces $CO_2$, which harms the environment. The batteries in an electric car do not produce $CO_2$ since the energy comes from a battery and no fuel is burned. Therefore, I concluded that electric cars make a positive contribution to improving the quality of air.*

**(b) Do you think this knowledge is reliable? Explain your answer.**

*In this section, give reasons why you feel the knowledge you have gained can be trusted. Does the person giving the information have a qualification in the subject? Have you checked the knowledge supplied by comparing it to other sources or to information supplied by other experts in the area? Is the material up to date?*

*Yes, I think that the knowledge is reliable because the video was produced by the Learn Engineering organisation. The person who presented it is a qualified engineer with a degree in engineering. Also, the video received very good comments from other engineers around the world who viewed it.*

*Also, I compared the knowledge that I gained about electric cars in the video with information that I found on the Sustainable Energy Authority of Ireland website. This website is an official website set up by the Irish government to inform citizens about sustainability. Both sources gave similar information, so I feel that the knowledge that I gained can be trusted and is therefore reliable.*

**Question 3**

**(a) Name one research resource which you found to be reliable (or unbiased). Explain why.**

*In this section, find a research resource in which the material is written by professional people who are not trying to sell you something. In other words, it is unbiased. The views given should be balanced views and should outline both sides of an argument.*

*One research resource that I found to be unbiased was the Sustainable Energy Authority of Ireland website. This was unbiased because the website gave good advice about buying an electric car but did not recommend any particular brand of electric car. The website was giving information about electric cars in general. It was left to the individual to choose the electric car that he or she felt was the best.*

**(b) Name one research resource which you found to be unreliable (or biased). Explain why.**

*In this section, refer to a research resource that may be biased, is trying to sell you something or just gives one side of an argument. Does the person giving the information have any expertise or qualification in the subject? Do they refer you to other sources to back up their views? Is the person in the video or blog being paid by the manufacturer of the product to influence you?*

*I searched the DoneDeal website (www.donedeal.ie) to learn about the distance that different brands of electric cars can travel on one charge.*

*Some of the people selling cars were giving ranges of electric cars that were very high. I feel that the information was biased, as they were trying to sell their own cars.*

*When I compared the ranges in the adverts with the ranges on the official website of the car manufacturers, I found that some of the ranges quoted on the adverts were incorrect and therefore are unreliable.*

### Section C: Communicating

**Question 4**

As you conducted your research, you may have come across information presented using methods that did not use words alone. Such methods include diagrams, photographs, tables, graphs, charts and audio/visual recordings.

**(a) Did any of these communication methods help you understand the information presented? Explain your answer using a relevant example.**

*In this section, refer to any diagrams, photos, tables, charts or audio/visual aids that helped you to understand the knowledge being provided.*

*I found the Learn Engineering YouTube video of great help in understanding the differences between petrol-driven cars and electric cars. The video showed lots of simple diagrams to explain how each type of car worked. It also included animations showing what happens inside the engine of the petrol-driven car and showed how the combustion of the petrol caused the car to move.*

*When explaining how the electric car worked, I found the diagram of the rotating magnetic field a great help to me in understanding how the wheels of the car turn.*

# 40 Science in Society Assessment Task

Study carefully the copy of the booklet provided by the State Examinations Commission to examine your Science in Society Assessment Task. Make sure that you understand what each question means. Studying the worked example in the textbook will help you to decide the length of your response to each question.

Junior Cycle Assessment Task 2019

## Science

40 marks

| Examination number | | | | |
|---|---|---|---|---|
| | | | | |

**Instructions**

The questions in this booklet relate to your Science in Society Investigation, which you completed as part of your second Classroom Based Assessment in Science.

Answer all questions.

Write your answers in the spaces provided in this booklet. Do not enclose or attach any other work, as this will not be marked.

This 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.

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| Section A | Investigation and Research | 10 marks |
|---|---|---|

**Question 1** **(10 marks)**

**(a)** State your research question.

**(b)** Why did you choose this research question?

**(c)** Name any two specific research resources that you used during your investigation.

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# Classroom Based Assessment: Extended Experimental Investigations (Chapter 41)

Essential SCIENCE

FOLENS

## **Extended Experimental Investigations** (CBA1).

- A new chapter (Chapter 41) has been included to bring students through each step needed to carry out and write up the Extended Experimental Investigation.
- A blank template for writing up the Extended Experimental Investigation is included in the Student Laboratory Notebook.

# 41 Extended Experimental Investigations

**THE NATURE OF SCIENCE** Understanding about Science; Investigating in science; Communicating in Science

**Objectives:**

- To make students familiar with the concept of an investigation in science
- To give students an understanding of the different categories of variables
- To ensure that students know the steps needed to carry out an Extended Experimental Investigation

**Keywords in this chapter:**

Investigation
Quantitative
Independent variable
Dependent variable
Controlled variable
Fair test

## 41.1 Carrying out investigations in science

When studying this science course, you will carry out two types of laboratory practical work. In the first type, you learn to follow instructions to perform various tasks, such as using a microscope, making new substances and setting up electrical circuits. These experiments help you to develop important laboratory skills, such as handling apparatus, measuring, observing and drawing conclusions from results of experiments.

In addition to the above type of experiments, you will now carry out experiments where you will not have a set of instructions. You yourself will have to plan how to carry out the experiment. Also, you will not know the 'right' answer before you begin the experiment. This type of experiment is called an **investigation**.

An **investigation** is a task for which the student cannot immediately see an answer or recall a routine method for finding it.

There are two types of investigation in science:

- **Exploratory-type investigation:** This type of investigation involves an exploratory-type activity. A scientific study of a particular situation is carried out, then a report is written based on the study's findings. An example of an exploratory-type investigation is a survey of the plant species in a local habitat. In this investigation, you would be expected to study a local habitat and write an account of the work under various headings.
- **Variable-type investigation:** The word variable refers to something that can be changed. An example of a variable-type investigation could involve studying how well sound is absorbed by different types of materials. We will now study this investigation in detail to help you learn how a variable-type investigation is carried out.

A **variable** is anything that can be changed.

The investigation that you will carry out in this chapter is called a Classroom-Based Assessment (CBA). This means that the investigation will be marked by your own teacher rather than being sent to the State Examinations Commission.

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**WORKED EXAMPLE 41.1**

**To investigate and compare the quantitative effects of changing material type on the level of sound insulation provided by a range of materials**

We apply the scientific method to carry out this investigation.

### 1. Identify the research question

- How does the type of material affect the amount of sound absorbed by that material?

### 2. Carry out background research

In your background research, you might learn that:

- The decibel scale is used to compare the loudness of different sounds.
- The sound level of various sounds can be measured using a sound-level meter (Figure 41.1).

**Figure 41.1** A sound-level meter is used to compare the loudness of different sounds.

### 3. Construct a hypothesis

- You might make an 'educated guess' that some materials are good absorbers of sound. For example, you may have observed that closing a window helps to lessen the noise from traffic outside your house. Therefore, your hypothesis might be: 'If I put a sheet of glass in front of something giving out sound, then the glass will absorb some of the sound.'
- Based on other everyday experiences, you could choose other materials through which you will pass sound. For example, you may have noticed that the sound coming from your ringing mobile phone is not as loud when it is in the pocket of your jeans as when it is held in your hand. Therefore, you may wish to test how easily sound passes through denim.

When writing a hypothesis, always use a sentence with an IF THEN statement: I think that IF I do something, THEN something else will happen.

An example of a hypothesis for this investigation might be:

I think that IF I pass sound through various materials, THEN denim will absorb the most sound compared to other materials.

Other examples of research questions and hypotheses are:

- **Research question:** How does physical exercise affect heart rate?
- **Hypothesis:** I think that IF I carry out physical exercise such as running, THEN my heart rate will increase.
- **Research question:** How does the temperature of a coil of wire depend on the electric current flowing through the wire?
- **Hypothesis:** I think that IF I increase the electric current flowing through the wire, THEN the temperature will increase.
- **Research question:** How does the rate of reaction of hydrogen peroxide to form water and oxygen depend on the amount of catalyst added?
- **Hypothesis:** I think that IF I add more catalyst, THEN the rate will increase.

**EXAM TIP!** In an examination, it does not matter whether or not your hypothesis is correct. You will only find out if your hypothesis is correct when you carry out the experiment. The important thing is that you can write a hypothesis correctly.

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## 4. Carry out an experiment to test your hypothesis

The title of the investigation contains the word **quantitative**.

**Quantitative** means that we must take measurements of quantities or amounts. In other words, we must collect data containing numbers. This should not be confused with **qualitative**, which means 'descriptive'. In other words, you do not have to collect any numbers, but simply give a description.

To collect quantitative data, you could set up an apparatus similar to that shown in Figure 41.2.

This experiment is a variable-type investigation.

In this investigation, you change one variable. The one variable that you change is the material through which you pass the sound (cardboard, plastic, denim, foam and bubble wrap). The variable that you change is called the **independent variable**.

The **independent variable** is the variable that you **change**.

You measure the second variable. The second variable is the quantity of sound that has passed through the material. The variable that you focus your attention on to see how it responds to change is called the **dependent variable**. For example, in this experiment you measure the quantity of sound that has passed through each material.

The **dependent variable** is the variable that you **measure** in order to see how it has responded to the change.

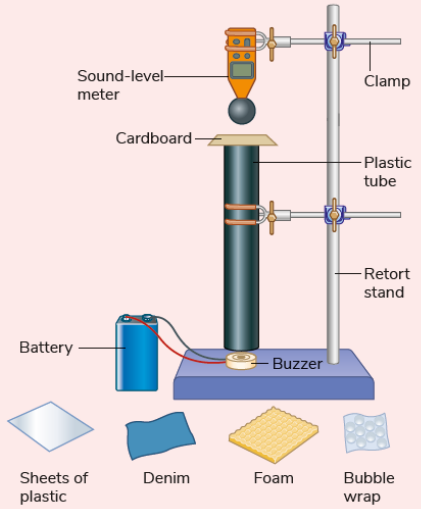


**Figure 41.2** An investigation to study how well different materials absorb sound

There is a third type of variable, called the **controlled** or **control variable**.

**Control variables** are the variables that are **not changed** by you but are kept constant.

For example, in this investigation the control variables are:

- The sound source
- The plastic tube used to channel the sound
- The size and thickness of the piece of material being tested
- The distance from the sound source to the sound-level meter
- The distance from the sound source to the material
- The room conditions.

All the above variables must be kept constant. The reason for this is because when you carry out an investigation, you must always ensure that it is a **fair test**.

A **fair test** is one in which only one variable at a time is changed while keeping all other conditions the same.

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To understand this, imagine you wished to investigate the speed of various runners. If you carried out this investigation under the conditions shown in Figure 41.3, it would not be a fair test.

- To make sure that the investigation on absorption of sound is a fair test, you must change only one variable: the type of material through which the sound is passed. You then measure the amount of sound that has passed through each material. All other variables must be controlled.
- To make sure that the results are reliable, you must repeat each experiment a few times.

**Figure 41.3** This is not a fair test to measure how fast each person can run since the conditions are not the same for all runners.

A measurement is **reliable** if you repeat the same experiment and you get the same or similar results over and over again.

In other words, reliable results are similar to each other every time an experiment is repeated. For example, in the above investigation the piece of cardboard should absorb the same amount of sound each time you test the cardboard to measure the amount of sound absorbed by it. Therefore, you should get a similar reading on the sound-level meter each time.

Reliability also means that if the experiment is repeated by other scientists, they should obtain the same results. Therefore, it is important that we ensure that experiments are reliable by repeating them to make sure that we get similar results each time. This is why scientific research should never be published until the experiments described have been repeated many times to check the reliability of the results.

In addition to reliability, remember that we have already learned (Chapter 29) that when measurements are repeated, the **accuracy** of an experiment is improved by taking an average of the measurements that are close to each other. Measurements that are clearly not accurate are ignored.

When carrying out laboratory practical work, you must ensure that all **safety precautions** are implemented. For example, in this investigation you would need to use ear protection to avoid damage to your hearing. Also, you should not leave items on the floor in case somebody trips over them.

Also, when carrying out an investigation, you need to try to avoid sources of error. For example, in this investigation you need to choose a room in which noise from outside does not interfere with the results of your experiment.

## 5. Analyse the data and draw conclusions

The results of the experiment could be summarised as shown in Table 41.1.

The results could also be summarised in the form of a bar chart (Figure 41.4). Note that the type of material (the independent variable) is placed on the x-axis. Note also that the dependent variable is placed on the y-axis.

| Material | Average sound detected when each experiment is repeated three times (dB) |
|---|---|
| None | 93.1 |
| Denim cloth | 74.9 |
| Cardboard | 73.3 |
| Bubble wrap | 86.9 |
| Plastic sheet | 83.3 |
| Foam | 92.1 |

**Table 41.1** Results obtained from the investigation

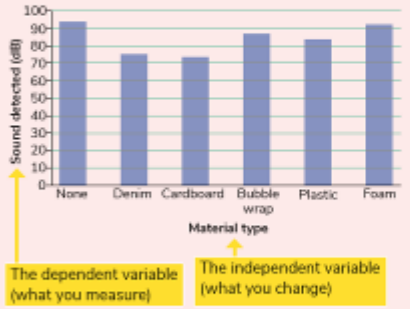



**Figure 41.4** This bar chart summarises the data obtained in the investigation of the abilities of various materials to absorb sound.

p. 425

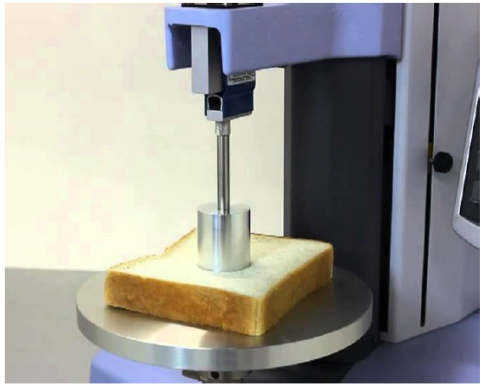

Students need practice in dealing with independent and dependent variables

**Question 14** **(45 marks)**

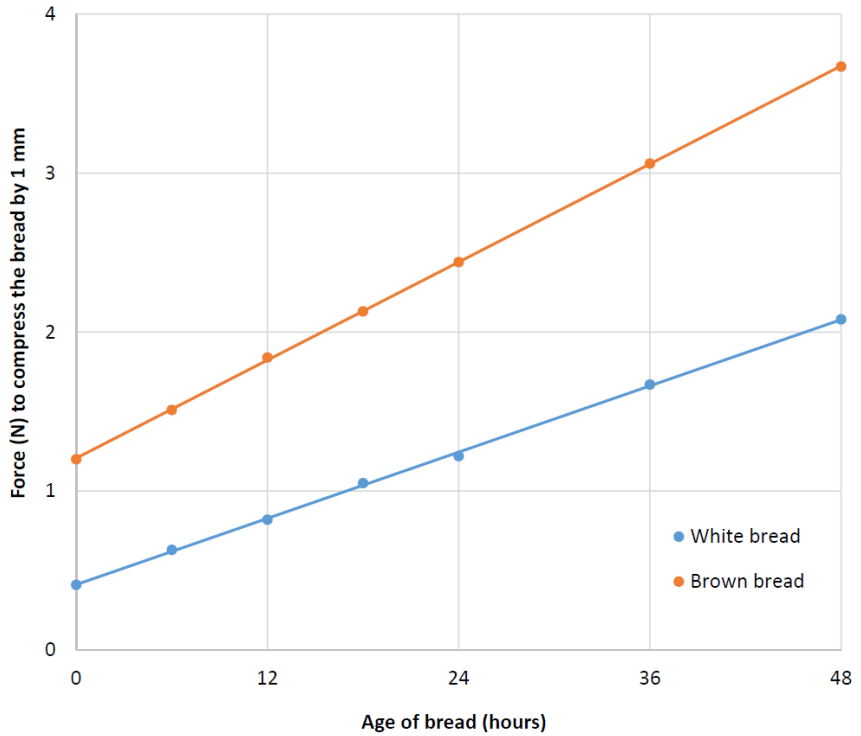
Bakers and food scientists are interested in the physical properties of bread.

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).




# Section B

## Question 14 (45 marks)

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

| |
|---|
| |
| |

**(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. | |

Time alone/ age of bread accepted.
'Keep the bread same' →0

**(c): 5 + 1**

**(c)** Thickness of bread // temperature // humidity // air pressure // where (area) force applied // depth of compression // other valid variable ***Any two***

**(d): 7 + 2(2) + 1**

**(d)**

| 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. | × |

(c) Presence or absence of air (oxygen)/baked for the same amount of time/ height or width or depth instead of thickness/ all slices of each bread type made with the same ingredients/ same samples of each bread type made with the same ingredients

(c) Repetition/ mass or density or volume or brand or length of bread/ time alone/age of bread/ same equipment – 0m

2023 Q14

# 41 Extended Experimental Investigations

The report template below may be downloaded from folenshive.ie as a Word document and modified by the teacher if necessary.

**Name of student:** _____

**Period during which the investigation was carried out**: _____

**Title of investigation:** _____

**Introduction** (what the investigation is all about, why it is being carried out, etc.):

**Background research carried out in preparation for the investigation** (sources of relevant information consulted, e.g. books, websites, etc.):

**Preparation and planning**

Indicate the type of investigation:

Exploration-type investigation ☐ Variable-type investigation ☐

In the case of variable-type investigations, please complete the following:

The variable that I will change (independent variable) is: _____

The variable that I will measure (dependent variable) is: _____

The variables that I will ensure do not change during the investigation (control variables) are:

p. 132





**Items required for the investigation** (list the items of equipment, chemicals and any other items that you will use in the investigation):

**Safety precautions required by this investigation** (carry out a risk assessment, identify sources of any possible accidents, explain what action you will take to avoid accidents, etc.):

**Your prediction** (state what sort of findings you think you might obtain when you carry out the investigation):

**Procedure followed in the investigation** (step-by-step description of how you carried out the investigation):

p. 133

Understanding of hypothesis: “moderate-to-poor levels of understanding” Chief Examiner’s Report (p. 5)

## SEC examination question

A student was asked to investigate what effect adding salt has on the boiling point of water.

**(a)** Write a suitable hypothesis for this investigation.

*I think that if I add salt to water, then the boiling point of the water will increase.*

**EXAM TIP!**

Your hypothesis does not need to be correct to get full marks. The main thing is that you show you understand the meaning of the word *hypothesis*. When writing the hypothesis, it is important that you state what you think and **do not ask a question**.

**(b)** Suggest a reason why the student repeated the investigation five times for each mass of salt used.

*The student repeated the investigation five times for reliability. In other words, they wanted to check that they would get the same or very similar results each time the experiment was performed.*

**EXAM TIP!**

You had to mention the word **reliability** in order to get full marks. To remember that **r**eliability is about **r**epeating, think of the two Rs: **r**eliability **r**epeating.

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FOLENS p. 426

When writing a hypothesis, always use a sentence with an IF THEN statement: I think that IF I do something, THEN something else will happen.

An example of a hypothesis for this investigation might be:

I think that IF I pass sound through various materials, THEN denim will absorb the most sound compared to other materials.

Other examples of research questions and hypotheses are:

- **Research question:** How does physical exercise affect heart rate?
- **Hypothesis:** I think that IF I carry out physical exercise such as running, THEN my heart rate will increase.
- **Research question:** How does the temperature of a coil of wire depend on the electric current flowing through the wire?
- **Hypothesis:** I think that IF I increase the electric current flowing through the wire, THEN the temperature will increase.
- **Research question:** How does the rate of reaction of hydrogen peroxide to form water and oxygen depend on the amount of catalyst added?
- **Hypothesis:** I think that IF I add more catalyst, THEN the rate will increase.

**EXAM TIP!**

In an examination, it does not matter whether or not your hypothesis is correct. You will only find out if your hypothesis is correct when you carry out the experiment. The important thing is that you can write a hypothesis correctly.

(p.423)

## 41.3

For each of the examples of Extended Experimental Investigations listed in Table 41.2, complete the following five statements in your homework copybook:

**(a)** My hypothesis is that ...

**(b)** The independent variable is ...

**(c)** The dependent variable is ...

**(d)** The control variables are ...

**(e)** To ensure that this is a fair test, I will ...

| No. | Extended Experimental Investigation |
|---|---|
| 1 | A gardener suggests that the length of time taken for marrowfat peas to germinate is decreased if they are soaked in water in advance. Carry out a quantitative investigation of this suggestion. |
| 2 | Investigate the effectiveness of a method of preventing an object containing iron from corroding. |
| 3 | Investigate a factor that determines the rate at which heat is lost from different types of drinking cups that contain hot liquid. |
| 4 | Florists often supply a sachet of flower food/preservative with bunches of cut flowers. Carry out an investigation to compare the effectiveness of using a commercially supplied flower food/preservative with two other household substances as additives to prolong the life of cut flowers in a container of water. |
| 5 | Compare by way of investigation the abilities of different indigestion remedies to neutralise excess stomach acid. |
| 6 | Investigate a factor that affects the distance taken for a toy car to stop after rolling down a ramp. |
| 7 | Compare by means of investigation the vitamin C content of a number of commercial and fresh fruit juices. |
| 8 | Compare by means of investigation methanol, propan-1-ol and candle wax in terms of their effectiveness as fuels. |
| 9 | Investigate and compare how the rates of flow of powdered or granulated solids through a funnel are affected by the size of the solid particles. |
| 10 | Investigate and compare the quantitative effects of changing the duration of light physical exercise on the pulse rate of a person. |

**Table 41.2** Examples of Extended Experimental Investigations

(p. 428)

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# Videos and Online Materials – FolensHIVE

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FolensHIVE
Your hive of learning activity

# More Folens Videos!

- An expanded set of videos specifically made for Junior Cycle Science
- A full suite of additional videos to backup the experiments covered in the textbook and Laboratory Notebook
- In addition, videos of teacher demonstration experiments are also included in the Essential Science Teaching package.
- Ideal for online and in-class learning, showing students the laboratory practical techniques and revising for the examination. Data from Folens website clearly shows the huge demand for these videos. Other related videos are also available.
- Before students can carry out investigations in the lab they must build up the key laboratory skills.
- Videos are linked to the Essential Science Laboratory Notebook

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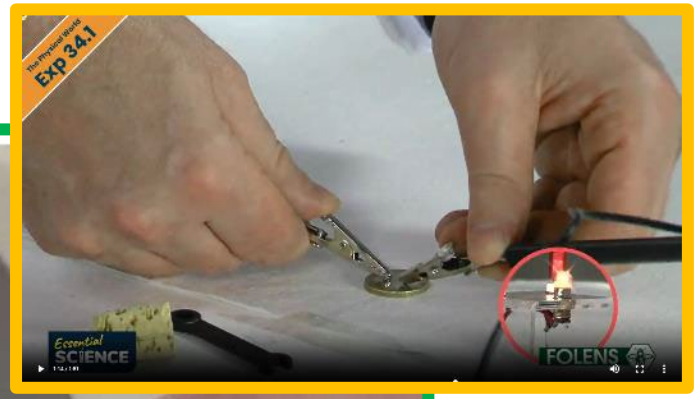
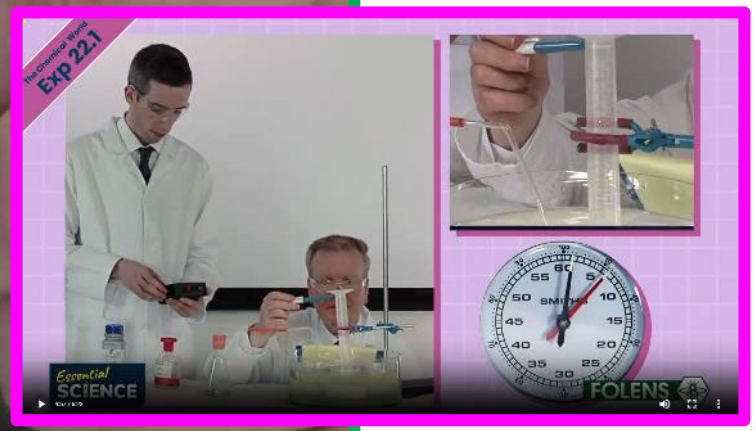
Navigation menu

FolensHIVE
Your hive of learning activity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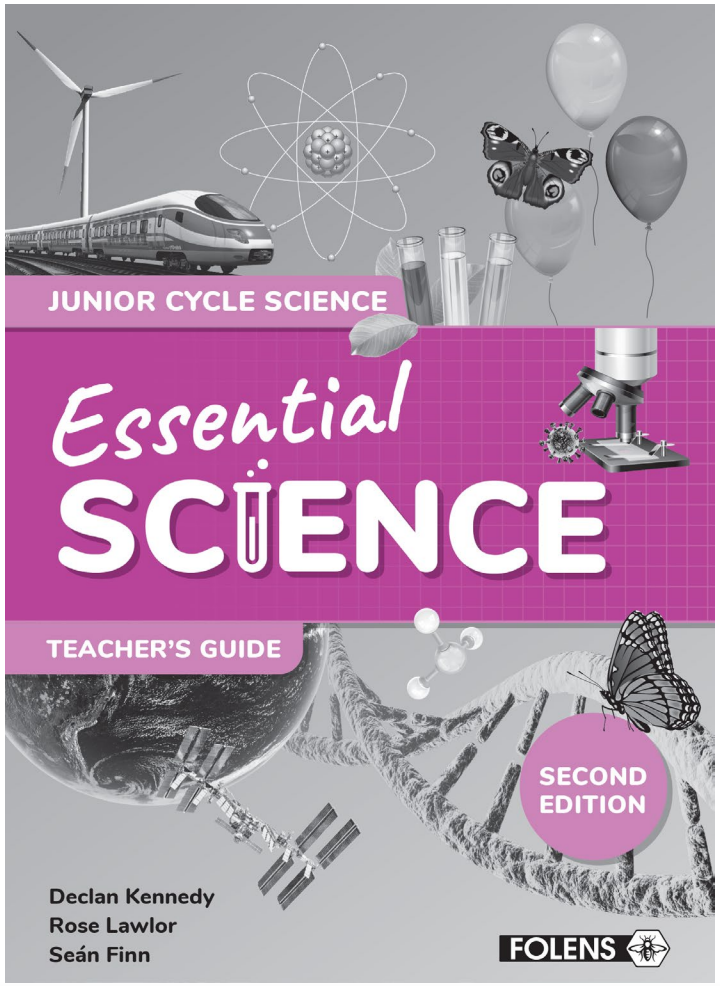


1. Introduction
2. The *Nature of Science* strand
3. The *Biological World* strand
4. The *Chemical World* strand
5. The *Physical World* strand
6. The *Earth and Space* strand
7. Laboratory Organisation and Management
8. Apparatus required for Junior Cycle Science
9. Chemicals required for Junior Cycle Science
10. Preparation of Laboratory reagents
11. Worked Solutions and Answers to numerical problems in textbook and workbook.
12. Examples of Open-Ended Investigations / Extended Experimental Investigations.
13. Scheme of Work and Units of Work

Essential SCIENCE SECOND EDITION

# Junior Cycle Science Yearly Schemes of Work: Units of Work

We are aware that Science teachers have different allocations of time available to teach Science depending on local arrangements in each school. Hence, instead of devising yearly schemes of work based on number of weeks, we have divided the entire Science curriculum specification (syllabus) into **Units of Work**, as detailed in the schemes of work summarised in the form of tables for Years 1, 2 and 3 of Junior Cycle Science. Each unit is based on two hours of class contact time.

The order in which the Units of Work is presented is based on the teaching experience of the authors. However, teachers may prefer to adapt the table below to their own preferred sequence of topics from each of the five strands of the Junior Cycle Science specification.

The suggested student practical work included in the yearly schemes is based on the experiments described in the *Essential Science* textbook and Laboratory Notebook. These experiments have been chosen to help students achieve the learning outcomes in the specification and to ensure that students acquire fundamental laboratory skills. Teachers may wish to carry out additional investigations that utilise these fundamental laboratory skills.

Teachers who wish to teach Science by following a thematic approach (rather than following the structure of the five strands in the specification) can rearrange the units of work in whatever order they wish.

We hope that you will find these yearly schemes of work and Units of Work helpful in planning your teaching of the Junior Cycle Science curriculum (syllabus).

*Declan Kennedy, Rose Lawlor, Seán Finn*

Junior Cycle Science | Teacher's Planner | Units of Work

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## YEAR 1

| Unit no. | Unit of work (2 hours' class contact time) | Topic | *Essential Science* 2nd edition (chapter & pages) | Link with Nature of Science | Suggested student lab practical work |
|---|---|---|---|---|---|
| 1 | Introduction to science | • Lab safety<br>• Lab rules<br>• Safety symbols<br>• Lab equipment | Introduction (pp. viii–x) | • Select suitable equipment<br>• Safety in the lab | |
| 2 | The cell – part 1 | • Cells<br>• The characteristics of life<br>• The microscope<br>• The animal cell<br>• The plant cell | Chapter 3 (pp. 20–25) | | To use a light microscope |
| 3 | The cell – part 2 | • Preparing and viewing slides with aid of microscope | Chapter 3 (pp. 23–24) | • How to write up a laboratory experiment: Apparatus, Procedure, Observation, Conclusion<br>• Labelled diagram | • To prepare a sample of cheek cells<br>• To prepare a sample of onion cells |
| 4 | The nature of science | • The scientific method<br>• Science in society<br>• Communicating in science | Chapter 1 (pp. 2–7) | • How scientists work<br>• The scientific method<br>• Science in society<br>• Communicating in science | |
| 5 | Measurement in science – part 1 | • Measurement of length<br>• Measurement of length of a curved line<br>• Measuring larger distances<br>• Measuring area | Chapter 29 (pp. 276–280) | • Selection of suitable equipment<br>• Data collection and recording in a table<br>• Showing calculations | • To measure the length of a curved line<br>• To estimate the area of an irregular shape |
| 6 | Measurement in science – part 2 | • Measurement of volume, time, mass and temperature<br>• Units<br>• Accuracy and precision | Chapter 29 (pp. 281–288) | • Accuracy and precision<br>• Units used in measurement | |
| 7 | Density | • Density<br>• Calculating density<br>• Measuring density<br>• Density and flotation | Chapter 30 (pp. 292–297) | • Select suitable equipment<br>• Produce and record data<br>• Select data from a table to predict floatation | To measure the density of regular- and irregular-shaped objects and liquids |

## Additional Teachers' Resources.

An expanded suite of resources to help the busy teacher has already been provided in the first edition. In addition to these comprehensive resources, we now have an expanded Teacher's Guide to include:

- More detailed units of work spanning the three years of the course to help teachers plan and navigate their way through the specification.
- Updated materials on Extended Expt Investigations (CBA1) with lots of examples.
- Detailed editable online Powerpoints for each chapter,
- Online Worksheets to be used for class tests and school examinations,
- Updated references to short, relevant and succinct YouTube videos listed in Teachers' Guide to assist teachers use these in classroom and remote learning.

# New online Worksheets for all chapters in textbook

## 3.5

To observe a slide under a light microscope, certain steps must be taken. These are listed below, but not in the correct order. Using the letters given for each step, place them in the order in which they should occur. The letter of the first step is written for you.

**(a)** Using the coarse focus wheel, the slide is brought into focus.
**(b)** What you see can be observed and drawn.
**(c)** Next, the medium power objective lens is put in place.
**(d)** The microscope is plugged in and the light is turned on.
**(e)** The iris diaphragm, under the stage, is used to adjust the light coming through.
**(f)** Now the fine focus wheel is used to make the slight adjustment needed to bring the object into clear focus.
**(g)** A slide is placed on the stage.
**(h)** The stage is raised to its highest position.
**(i)** The rotating nosepiece is turned to fix the low power objective lens in place.

Correct order: (d), _____

## 3.6

All plants and animals are composed of cells. In Table 3.3 write the letter **B** beside two cell parts that are found in both animal and plant cells.

| | |
|---|---|
| | Cell wall |
| | Nucleus |
| | Cell membrane |
| | Chloroplast |

Table 3.3

## 3.7

Figure 3.2 shows a sketch of a cell.

**(a)** Is this a plant cell or an animal cell?

_____

**(b)** Give a reason for your answer.

_____

Figure 3.2

## 16.9

The three states of matter are **solid**, **liquid** and **gas**. Figure 16.3 shows the arrangement of particles in the three states of matter. In Figure 16.3, write the letter **L** beside the arrangement of particles in a **liquid**. Write the letter **G** beside the arrangement of particles in a **gas**.

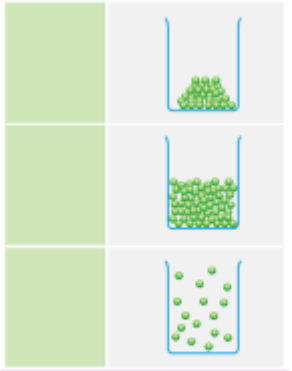

Figure 16.3

## 16.10

Water exists in the three states of **solid**, **liquid** and **gas**. In Figure 16.4, write **S** opposite the solid. What word describes the change of state from a solid to a liquid?

_____

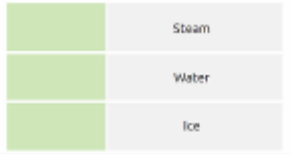


Figure 16.4

## 16.11

**(a)** Complete this sentence: When iron is heated to 1540 °C, it _____, i.e. it changes into a liquid. This means that it can be poured into moulds.

**(b)** Define the melting point of a solid. _____

_____

**(c)** What do you call the changing of a liquid to a vapour? _____

**(d)** Complete this sentence: When evaporation begins to occur throughout the liquid, the _____ of the liquid has been reached.

## 34.8

Name (from left to right) the instruments represented by the symbols shown in Figure 34.4.

**(a)** _____
**(b)** _____
**(c)** _____
**(d)** _____


Figure 34.4

## 34.9

**(a)** Name a meter that can measure current. _____

**(b)** Name the unit used to measure current. _____

## 34.10

When green light is shone into a red solution, such as blood, some of the light is absorbed, some is reflected, and some passes straight through.

A student set up the apparatus shown below to investigate the relationship between the concentration of a red solution and how much green light passes through it.

On one side of the test tube of red solution, green light was emitted from a light-emitting diode (LED). On the other side of the test tube, a light-dependent resistor (LDR) was used to detect how much green light passed through the solution.

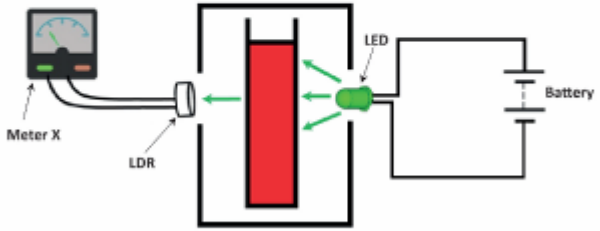


Figure 34.5

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# Conclusions

- Full chapter on Drawing and Analysing Graphs. (Chapter 2)
- Full chapter on the Science in Society Assessment Task. (Chapter 40) = 10% of SEC examination (+ CBA2)
- Full chapter on Extended Experimental Investigations – Chapter 41. (CBA1)
- Student Laboratory Notebook with all the key experiments needed to achieve the learning outcomes.
- Custom-made videos produced by Folens specifically for the new specification and to aid online learning.
- Online resources and videos for teachers on the Extended Experimental Investigations.
- Exam Tips based on marking schemes, Chief Examiner's report and common student misconceptions.
- Blue boxes summarising all the key points for the visual learners (Integrated Instructions to lower cognitive load).

Thanks for all the very helpful feedback on the first edition of *Essential Science* and for making it such a popular publication in very many schools throughout Ireland.

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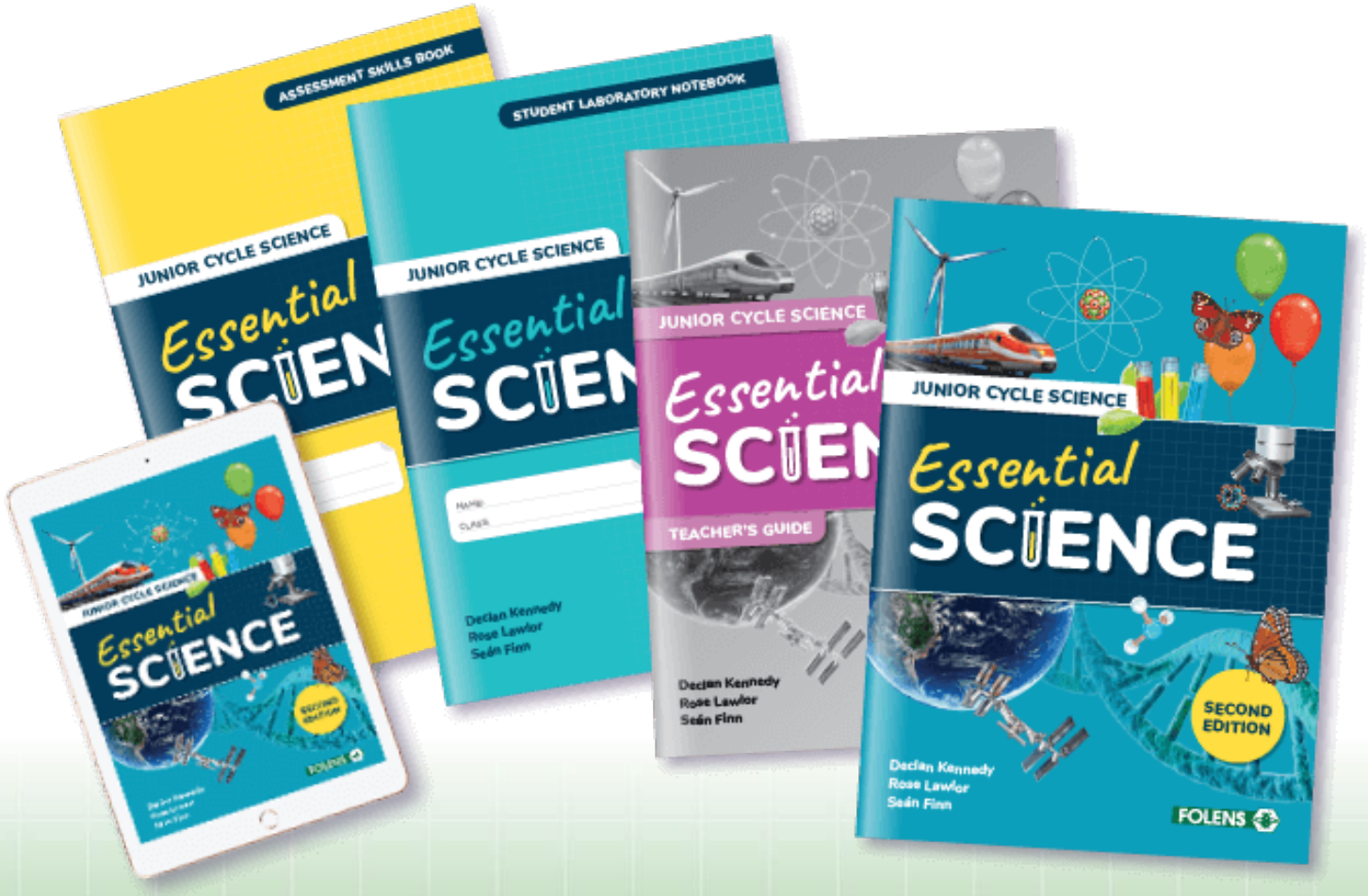
# Find out more about Essential Science at Folens.ie

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