



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

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COMBINED SCIENCE

0653/31

Paper 3 (Extended)

May/June 2012

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **23** printed pages and **1** blank page.



- 1 Sugar cane is a food crop grown in Australia. It is harvested and then transported on trains to the processing plant.

Fig. 1.1 shows one of the trains carrying sugar cane.

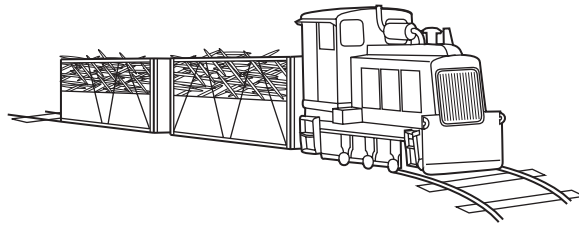


Fig. 1.1

- (a) The mass of the engine and empty trucks is 20 000 kg and the mass of the sugar cane transported is 10 000 kg.

The train travels at a speed of 0.5 m/s.

- (i) Calculate the kinetic energy of the loaded train.

State the formula that you use and show your working.

formula used

working

..... [2]

- (ii) To travel at this speed, a driving force of 1 000 000 N is needed.

Calculate the work done by the engine of the train when it travels 1 km.

State the formula that you use and show your working.

formula used

working

..... [2]

- (iii) It takes the train 5 minutes to travel 1 km. Calculate the power output of the engine. For
miner's

State the formula that you use and show your working.

formula used

working

..... [2]

- (b) The track for the train is composed of short lengths of steel rail with small gaps left between them as shown in Fig. 1.2.

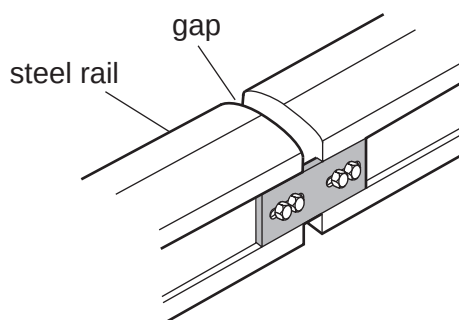


Fig. 1.2

Suggest a reason for leaving these small gaps.

.....

 [2]

- 2 An element is a substance that is made of atoms which have the same proton number. Most atoms contain protons, neutrons and electrons.

(a) Name the element whose atoms do **not** usually contain any neutrons.

..... [1]

- (b) The electronic structures (configurations) of atoms of three elements, **P**, **Q** and **R** are shown below.

P 2,8,1

Q 2,8

R 2,7

- (i) Use the electronic structures to state and explain the group numbers in the Periodic Table that contain elements **P**, **Q** and **R**.

P Group

Q Group

R Group

explanation

..... [2]

- (ii) State and explain which of the elements, **P**, **Q** or **R**, is the least reactive.

element

explanation

..... [1]

- (iii) State and explain which **one** of the elements, **P**, **Q** or **R**, is a good conductor of electricity.

element

explanation

..... [1]

- (c) Most metallic elements occur combined with non-metals in the Earth's crust. For thousands of years, humans have carried out chemical reactions to extract metals from their ores.

Fig. 2.1 shows a cross-section through a shaft furnace which was a simple reaction vessel used by ancient civilisations to extract iron.

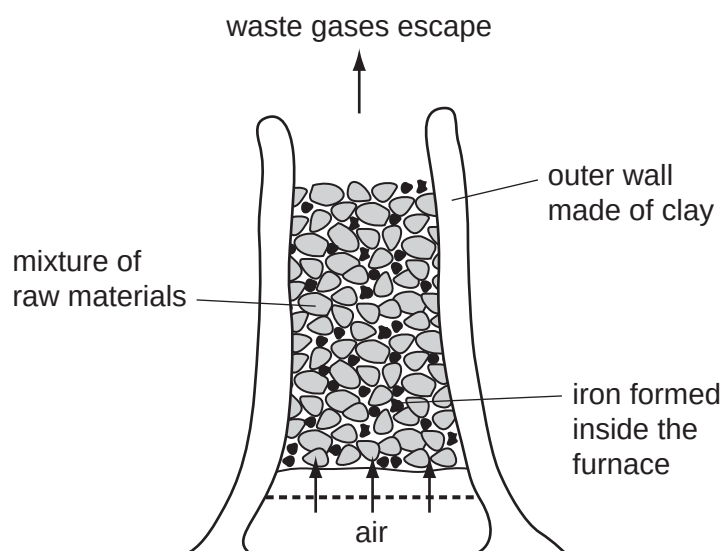


Fig. 2.1

In this shaft furnace the mixture of raw materials consisted of charcoal and iron ore. Charcoal contains mainly carbon, and iron ore contains iron oxide.

Nowadays iron is extracted from iron ore in a blast furnace.

- (i) Name another raw material, which is added to a modern blast furnace but which is **not** present in the shaft furnace in Fig. 2.1.

Explain briefly why this material is used.

name of material

reason this material is used

[2]

- (ii) Iron is extracted from iron ore when a gaseous oxide of carbon reacts with iron oxide.

Write a **word** chemical equation for this reaction.

[2]

- (d) (i) Suggest, in terms of relative reactivity, why a mixture of aluminium oxide and carbon does **not** produce any metallic aluminium in a blast furnace.

.....
.....
..... [2]

- (ii) Name the process that is used to extract aluminium from aluminium oxide.

..... [1]

- 3 Marmots are herbivorous mammals. Fig. 3.1 shows a marmot.

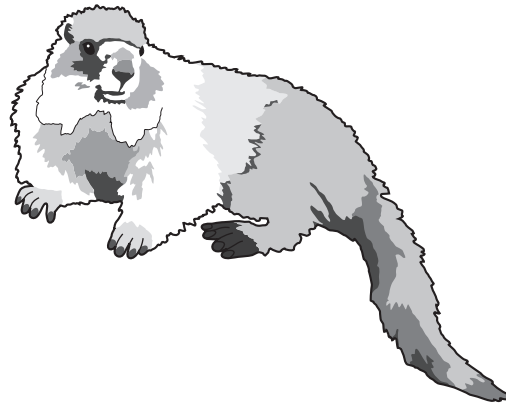


Fig. 3.1

A study has been carried out into the marmots living in Colorado, USA.

The winters in this part of Colorado are so cold that the marmots would not be able to find enough food to eat. Instead, they allow their body temperature to drop much lower than normal and stay inactive for many months. This is called hibernation. They do not eat while they are hibernating. They emerge from hibernation in spring.

- (a)** Before they hibernate, marmots build up large fat stores beneath their skin.

Suggest and explain what marmots must do in order to build up large fat stores in their bodies.

.....

.....

..... [2]

- (b) Fig. 3.2 shows the percentage of marmots with different body masses that survive through the winter.

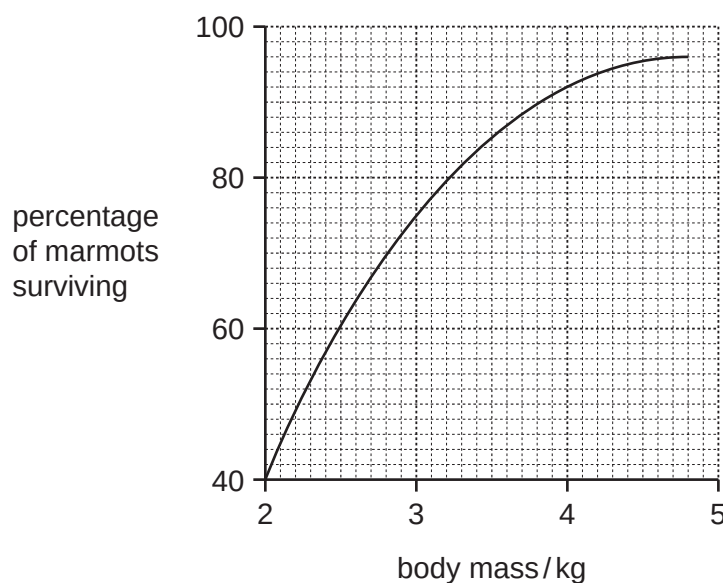


Fig. 3.2

- (i) Describe the relationship between a marmot's body mass and its chance of surviving the winter.

.....

 [2]

- (ii) Suggest how a layer of fat beneath the skin can reduce heat transfer from a hibernating marmot's body to its surroundings.

.....
 [1]

- (c) In the last twenty years, spring has been arriving earlier in the year in Colorado. This is a result of global warming.

Explain how human activities, other than the combustion of fossil fuels, are thought to contribute to global warming.

.....

 [3]

- (d) Fig. 3.3 shows the mean body mass of the marmots on the first day of August (summer) between 1976 and 2006.

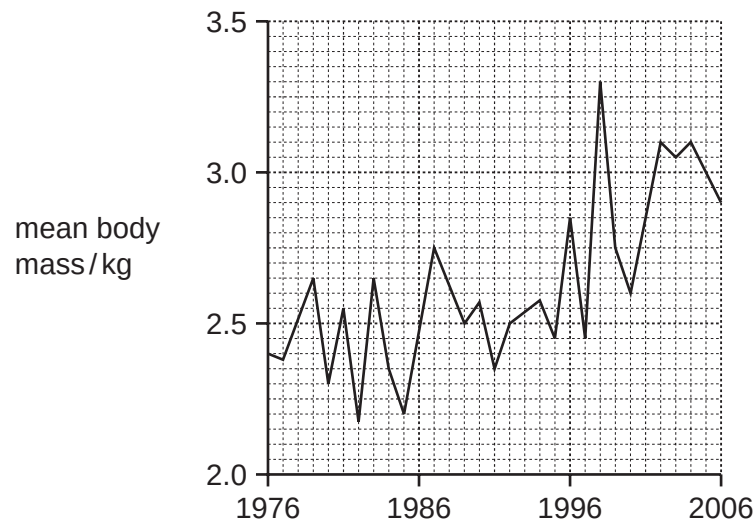


Fig. 3.3

- (i) Describe the general trend shown in Fig. 3.3.

.....
 [1]

- (ii) Suggest how the earlier arrival of spring could be responsible for this trend.

.....
 [1]

- 4 Fig. 4.1 shows the apparatus a student used to investigate the effect of changing the concentration on the rate of reaction between excess dilute hydrochloric acid and magnesium. At the start of the experiment the measuring cylinder contained no gas and was full of water.

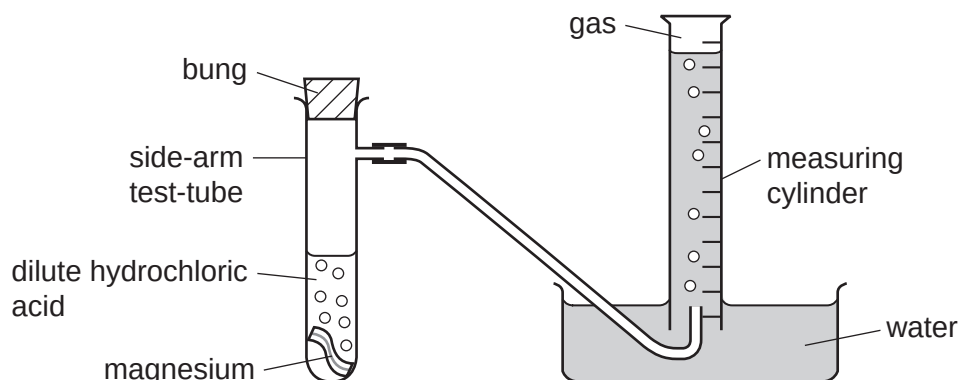


Fig. 4.1

To carry out his investigation the student used the following method.

- He dropped the magnesium into the dilute acid.
- He immediately placed the bung into the side-arm test-tube and started a stopclock.
- He measured the volume of gas in the measuring cylinder every half minute, for eight minutes.

He carried out two experiments, **A** and **B**, in which the only variable that he changed was the concentration of the hydrochloric acid.

- (a) State **two** other variables that the student needed to keep the same in experiments **A** and **B**.

- 1
- 2 [1]

(b) Fig. 4.2 shows the results the student obtained for experiments **A** and **B**.

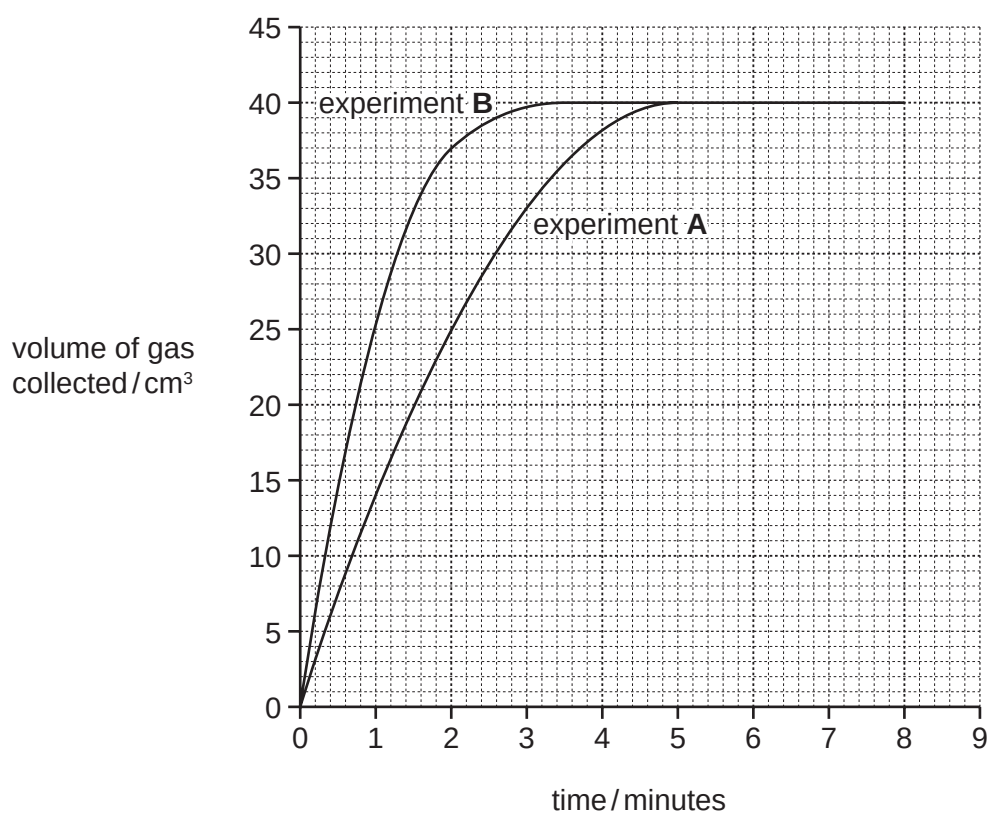


Fig. 4.2

- (i) In which experiment, **A** or **B**, did the student use hydrochloric acid which had the higher concentration?

Explain your answer.

experiment

explanation

.....

..... [1]

- (ii) The student was told that he could calculate the average rate of reaction using

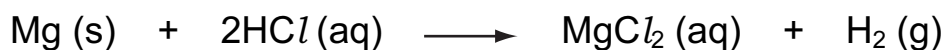
$$\text{average rate of reaction} = \frac{\text{maximum volume of gas collected}}{\text{minimum time taken to collect maximum volume}}$$

Use the information in Fig. 4.2 to calculate the average rate of reaction for experiment **A**.

Show your working and state the units.

..... [3]

- (c) The balanced symbolic equation for the reaction between hydrochloric acid and magnesium is shown below.



- (i) What is meant by the state symbol (aq) in this equation?

..... [1]

- (ii) Suggest why the reaction in both experiments **A** and **B** above produced the same volume of gas.

.....

.....

..... [2]

Please turn over for Question 5.

- 5 (a) A bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.003 m.

- (i) This sound is outside the audible frequency range for humans.

State the approximate audible frequency range for humans.

..... [1]

- (ii) State the meaning of the terms *frequency* and *wavelength*, when describing a wave. You may use a diagram if it helps your explanation.

frequency

.....
.....
.....

wavelength

.....
.....
.....

[2]

- (iii) Calculate the speed of the sound wave produced by the bat.

State the formula that you use and show your working.

formula used

working

..... [2]

- (iv) Sound travels through the air by a series of compressions and rarefactions.

Describe what this means in terms of air particles.

.....

.....

..... [2]

- (b) A girl shouts and waves to another girl in the school playground as shown in Fig. 5.1.



Fig. 5.1

The sound energy and the light energy both travel from one girl to the other by wave motion.

- (i) State whether sound waves and light waves are transverse or longitudinal.

Sound waves are

Light waves are [2]

- (ii) The girls could have communicated with each other using their mobile phones (cell phones).

Name the type of electromagnetic wave used to communicate between mobile phones.

..... [1]

- 6 Fig. 6.1 shows part of a section across a root from a radish plant, photographed through a microscope.

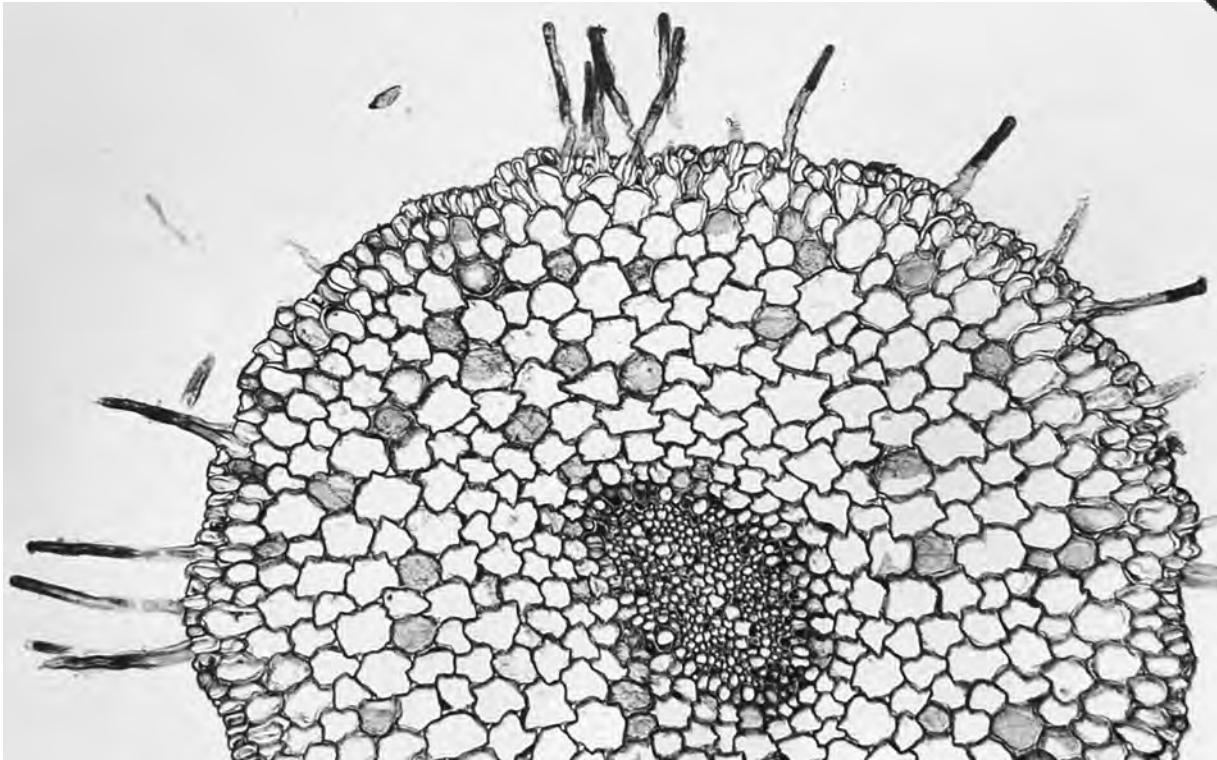


Fig. 6.1

(a) On Fig. 6.1, use a label line to label a root hair cell. [1]

(b) Root hair cells absorb water from the soil.

(i) State **one** other function of root hair cells.

..... [1]

(ii) Explain how root hair cells are adapted for their functions.

.....

.....

..... [2]

- (c) A complete radish plant was placed with the lower part of the root standing in water. A soluble red dye was added to the water. After a while, the veins in the leaves of the radish plant became red.

- (i) Name the tissue in the radish plant through which the coloured water was transported from the roots to the leaves.

..... [1]

- (ii) On Fig. 6.1, write the letter **A** to show the position of this tissue in the root. [1]

- (iii) Water was drawn up through the radish plant because water vapour was constantly escaping from its leaves. A plastic bag was placed over the leaves of the radish plant, and the water vapour formed colourless droplets of liquid water on the bag as it condensed.

Explain why these water droplets were not red.

.....
.....
..... [2]

- 7 (a) (i) Draw a circuit diagram that a student could use to investigate how the change in potential difference across a lamp affects the current flowing through it.

[3]

- (ii) During his investigations, the student measured the voltage across the lamp as 3.0 V and the current passing through the lamp as 0.3 A.

Calculate the resistance of the lamp.

State the formula that you use and show your working.

formula used

working

[2]

- (b) Table 7.1 shows some information about six pieces of wire, all at room temperature (20 °C).

Table 7.1

wire	metal composition	length / cm	cross-sectional area / mm ²
A	copper	10	0.5
B	nichrome	10	0.5
C	copper	20	0.5
D	nichrome	20	0.5
E	copper	10	1.0
F	copper	20	1.0

- (i) Which wire, **B** or **D**, will have the greater resistance?

Explain your answer.

wire

..... [1]

- (ii) Which wire, **A** or **E**, will have the greater resistance?

Explain your answer.

wire

..... [1]

- (c) A plastic rod is rubbed with a cloth.

The rod becomes charged.

There are two types of electric charge.

- (i) State the names of these charges.

1

2 [1]

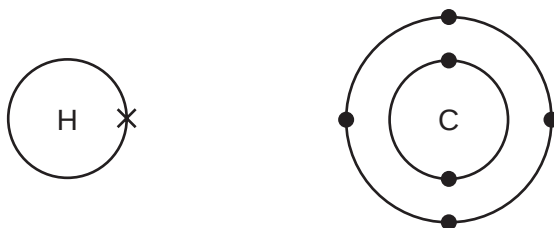
- (ii) Charged particles are transferred between the rod and cloth.

Name the charged particles transferred. [1]

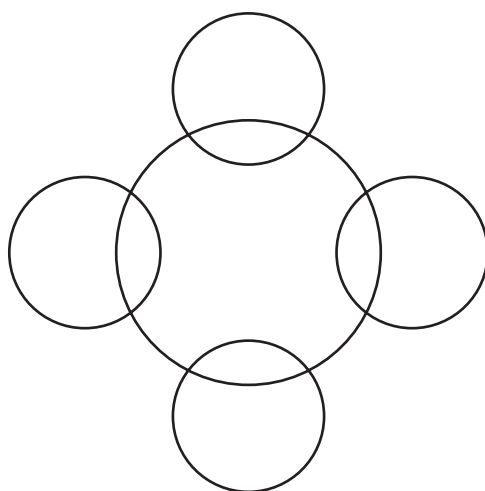
- 8 Hydrocarbons are compounds that contain carbon and hydrogen only.

The hydrocarbon that contains the simplest molecules is methane.

- (a) (i) The diagrams below show an atom of carbon and an atom of hydrogen.



Complete the covalent bonding diagram of a molecule of methane to show how the bonding electrons are arranged.



[2]

- (ii) Complete the molecular structure diagrams below to show molecules of the hydrocarbons ethane and ethene.

ethane	$\text{H}-\text{C}$
ethene	$\begin{array}{c} \text{C} \\ \\ \text{H} \end{array}$

[2]

- (b) In many countries, ethanol, $\text{C}_2\text{H}_5\text{O}$, is added to hydrocarbon fuels such as gasoline.

The products of complete combustion of ethanol are the same as those of hydrocarbons such as methane.

Suggest the **word** chemical equation for the complete combustion of ethanol.

..... [2]

- 9 (a) Define the term *hormone*.

.....

.....

.....

.....

..... [3]

- (b) Adrenaline is sometimes called the 'fright, flight or fight' hormone. It is produced when a person is frightened.

One effect of adrenaline is to increase a person's pulse rate.

Explain how this could help a person to run away from the thing that has frightened them.

.....

.....

.....

..... [2]

- (c) Plants also produce hormones. One plant hormone is auxin. Auxin helps plant shoots to respond to light coming from only one direction.

- (i) State the correct term for the growth response of a plant to light coming from only one direction.

..... [1]

- (ii) Explain how auxin helps a plant shoot respond to light coming from one direction. You may use a diagram as part of your explanation.

.....

.....

.....

.....

..... [3]

Copyright Acknowledgements:

Question 6 Photograph

© B23WP8 cross section of a radish root; Biodisc/Visuals Unlimited/Alamy.

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DATA SHEET
The Periodic Table of the Elements

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COMBINED SCIENCE

0653/32

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This document consists of **19** printed pages and **1** blank page.



- 1 (a) Most atoms of metallic elements found in the Earth's crust exist in compounds in ores which are contained in rocks.

The chemical formulae of some metal compounds found in ores together with the names of the ores are shown below.

argentite	Ag_2S
chromite	FeCr_2O_4
galena	PbS
scheelite	CaWO_4

- (i) A binary compound is one that contains only two different elements.

State which of the compounds in the list above are binary compounds.

..... [1]

- (ii) State the ore from which the metallic element tungsten could be extracted.

..... [1]

- (b) Fig. 1.1 shows an incomplete diagram of an atom of an element **Q** in which only the outer shell electrons are shown.

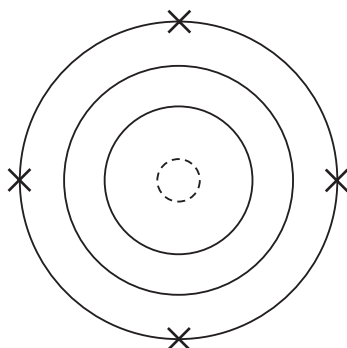


Fig. 1.1

- (i) Name element **Q** and explain your answer.

name

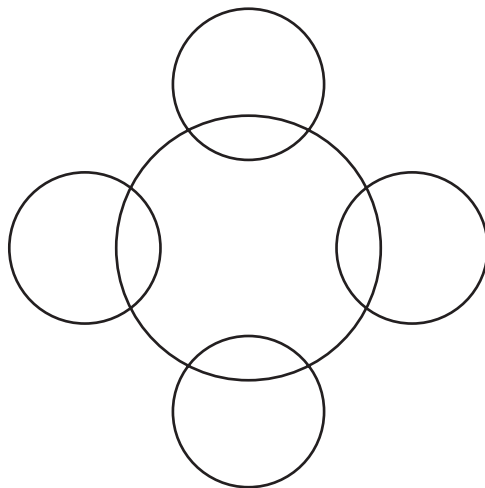
explanation

.....

..... [3]

- (ii) Element **Q** combines with hydrogen to form covalent molecules which have the formula QH_4 .

Complete the bonding diagram below to show how the bonding electrons are arranged.



[2]

- (iii) Element **Q** may be extracted from its oxide, QO_2 , in a reaction with carbon, C .

In this reaction, the compound carbon monoxide, CO , is formed in addition to the free element **Q**.

Suggest a balanced symbol equation for this reaction.

..... [2]

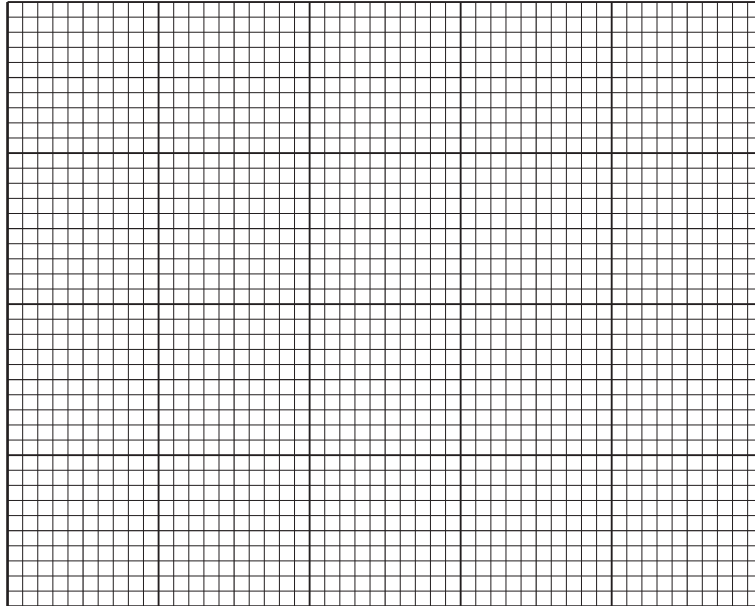
2 An athlete warms up by running along a race track.

(a) He accelerates from rest and after 10 seconds reaches a maximum speed of 7 m/s.

He continues at this speed for another 10 seconds.

During the next 5 seconds, he steadily slows down and stops.

Draw a speed-time graph to show the motion of the athlete.



[3]

(b) He then competes in a 200 m running race.

(i) He completes the race in 25 seconds.

Calculate his average speed.

State the formula that you use and show your working.

formula used

working

..... [2]

- (ii) The mass of the athlete is 70 kg.

Calculate the kinetic energy of the athlete when he is travelling at 6 m/s.

State the formula that you use and show your working.

formula used

working

..... [2]

- (c) During a race the athlete cools down by sweating.

- (i) Describe and explain, in terms of the movement of water molecules, how evaporation cools down the athlete.

.....
.....
.....
.....
..... [3]

- (ii) State **two** factors which would increase the rate of evaporation.

..... and [1]

3 (a) Define the term *respiration*.

.....
.....
..... [2]

(b) State the balanced symbolic equation for aerobic respiration.

..... [2]

(c) Outline how oxygen is transported to a respiring cell in a muscle.

.....
.....
..... [2]

- 4 (a) Radio waves are electromagnetic waves. Sound waves are not.

State **two** other ways in which radio waves differ from sound waves.

1

.....

2

.....

[2]

- (b) Draw lines to connect each type of radiation to its use.

radiation

use

gamma	examining bones and teeth
microwave	remote controls for television sets
infra-red	satellite communications
X-rays	sterilising surgical instruments

[2]

- (c) Visible light is another type of electromagnetic wave.

The frequency of green light is 5×10^{14} Hz.

The wavelength of green light is 6×10^{-7} m.

Calculate the speed of green light.

State the formula that you use and show your working.

formula used

working

..... [2]

(d) Describe how to find the density of a small irregular object such as a tooth.

.....

.....

.....

.....

.....

..... [3]

- 5 Water supplies are often impure and have to be purified to make them safe for human drink.

(a) State **one** way that harmful bacteria may be removed from water during purification.

..... [1]

(b) Water is a compound which contains the elements hydrogen and oxygen.

Describe **one** difference, other than physical state, between the **compound** water and a **mixture** of the elements hydrogen and oxygen.

.....
.....
..... [2]

(c) Table 5.1 shows information about water and three compounds that can form mixtures with water.

Table 5.1

compound	melting point/°C	boiling point/°C	solubility in water
water	0	100	—
sodium chloride	801	1413	soluble
silicon dioxide	1650	2230	insoluble
hexane	−95	69	insoluble

(i) State which compound in Table 5.1 could be separated from a mixture with water by filtration.

..... [1]

(ii) Explain why the other two compounds **cannot** be separated from a mixture with water by filtration.

.....
.....
.....
..... [2]

- (d) (i) A student was asked to use the reaction between the insoluble compound zinc carbonate and dilute sulfuric acid to make a solution that contained only the soluble compound zinc sulfate.

Describe the main steps of a method the student should use to carry out this task.

You may draw labelled diagrams if it helps you to answer this question.

.....

.....

.....

.....

.....

..... [3]

- (ii) Suggest the word chemical equation for the reaction between zinc carbonate and dilute sulfuric acid.

..... [2]

- 6 (a) A car tyre is inflated with air using a footpump. The mechanic using the footpump notices that the pump gets hot.

The air going into the tyre is warmed up by the pumping. Describe what happens to the motion of the air molecules as the air warms up.

.....
..... [1]

- (b) Many forces act on a car tyre during a car journey.

State **three** effects that forces can have on an object.

1
2
3

[2]

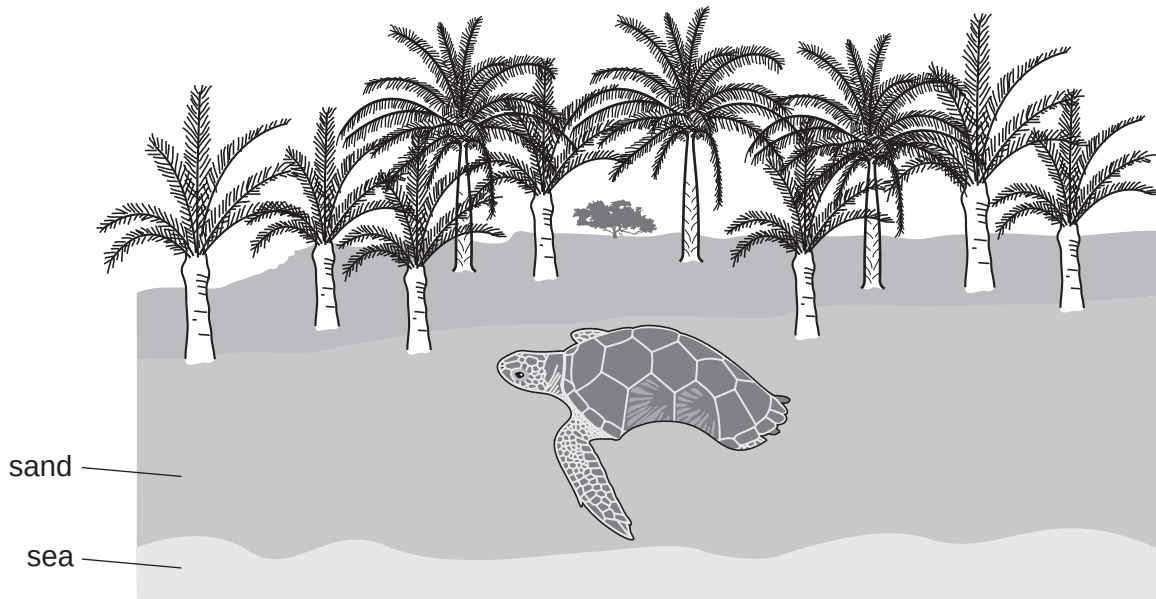
- (c) Car brake lights (stop lights) light up when the driver presses on the footbrake pedal. The pedal acts as a switch.

Draw a circuit diagram including a battery to show how this works.

Design your circuit so that, if one brake light fails, the other still lights up.

[4]

- 7 Hawksbill turtles are an endangered species. Adults spend most of their lives at sea, but the females come ashore to lay their eggs. They bury their eggs in nests in the sand, either on a beach or in the vegetation that grows just behind the beach.



The sex of hawksbill turtles is determined by the temperature of the sand in which the eggs develop.

- At 29 °C, equal numbers of males and females develop.
- Higher temperatures produce more females.
- Lower temperatures produce more males.

There is concern that in recent years too many female turtles have been produced, and not enough males.

- (a) Researchers measured the temperature, at a depth of 30 cm, in four different parts of a beach, on Antigua, where hawksbill turtles lay their eggs. The results are shown in Fig. 7.1. The tops of the bars represent the mean temperature.

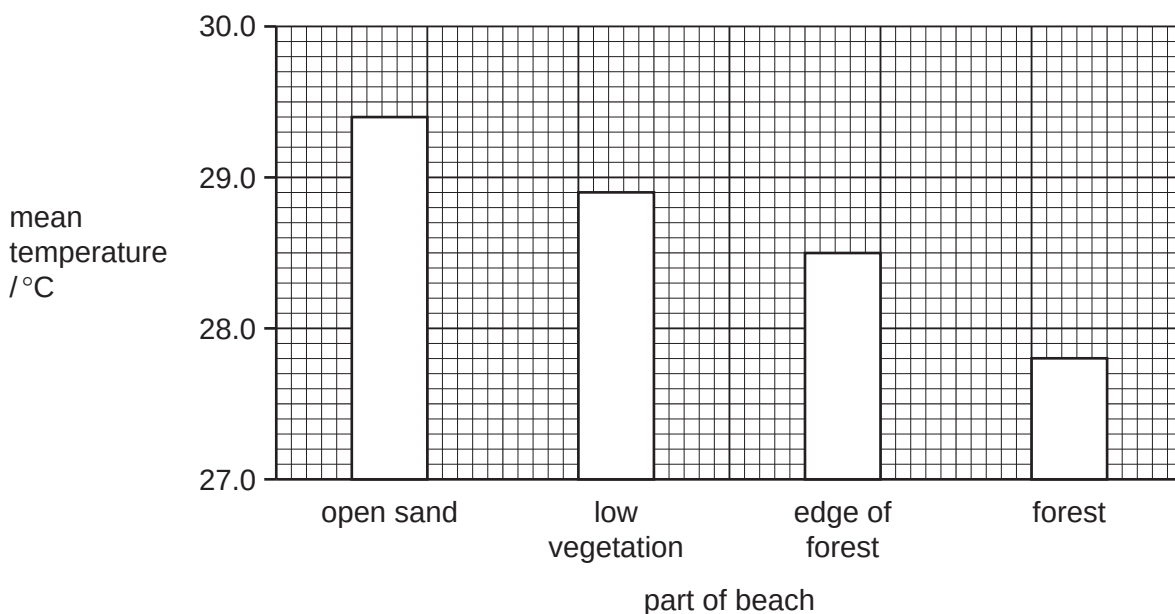


Fig. 7.1

With reference to Fig. 7.1, describe the effect of the presence of trees on the temperature of the sand.

.....

.....

..... [2]

- (b) The researchers counted the proportion of male and female turtles hatching from nests in the four different parts of the beach. The results are shown in Table 7.1.

Table 7.1

part of beach	nests producing more males than females	nests producing more females than males	nests producing equal numbers of females and males
open sand	0	16	0
low vegetation	31	24	6
edge of forest	61	0	11
in forest	36	0	0

- (i) State the part of the beach in which most female hawksbill turtles chose to lay their eggs.

..... [1]

- (ii) Use the information in Fig. 7.1 to explain the results for nests in open sand and in forest, shown in Table 7.1.

.....

.....

..... [2]

- (c) Tourism is an important industry in Antigua. The vegetation on many beaches has been cut down to make the beaches more attractive to tourists.

With reference to the results of this research, suggest how deforestation of beaches could affect hawksbill turtle populations.

.....

.....

..... [2]

- (d) Describe **two** harmful effects to the environment, other than extinction of species, that may result from deforestation.

1

.....

.....

2

.....

.....

[4]

Please turn over for Question 8.

- 8 Fig. 8.1 shows apparatus a student used to investigate temperature changes that occur during chemical reactions.

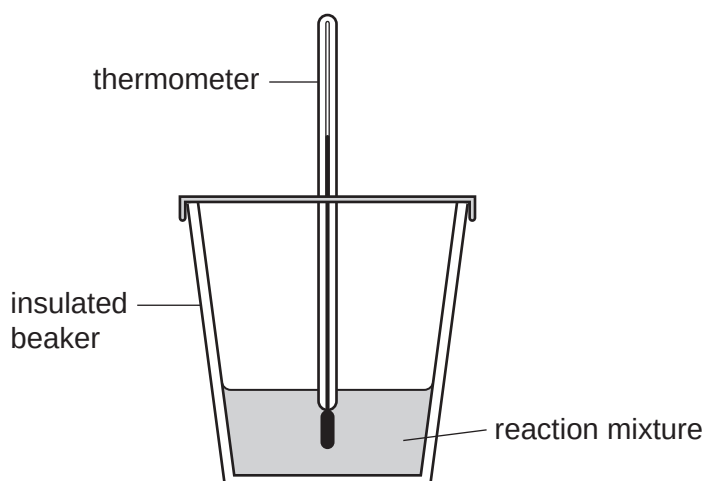


Fig. 8.1

The student added reactants to the insulated beaker and stirred the mixture. She recorded the final temperature of each mixture.

At the start of each experiment, the temperature of the reactants was 22 °C.

Table 8.1 contains the results the student obtained.

Table 8.1

experiment	reactant A	reactant B	final temperature / °C
1	dilute hydrochloric acid	sodium hydrogencarbonate	16
2	dilute hydrochloric acid	potassium hydroxide solution	26
3	magnesium	copper sulfate solution	43
4	copper	magnesium sulfate solution	22

- (a) Explain which experiment, 1, 2, 3 or 4, was a neutralisation reaction between an acid and an alkali.

experiment

explanation

..... [1]

- (b) State and explain which experiment, **1**, **2**, **3** or **4**, was an endothermic reaction.

experiment

explanation

[1]

- (c) Apart from the change in temperature, state **one** other observation the student could make when she carried out experiment **3**.

.....

[1]

- (d) Explain, in terms of reactivity, why a reaction occurred in experiment **3**.

.....

[1]

- (e) Suggest and explain a reason for the result obtained in experiment **4**.

.....

[2]

- 9 (a) Fig. 9.1 shows the effect of pH on the activity of an enzyme.

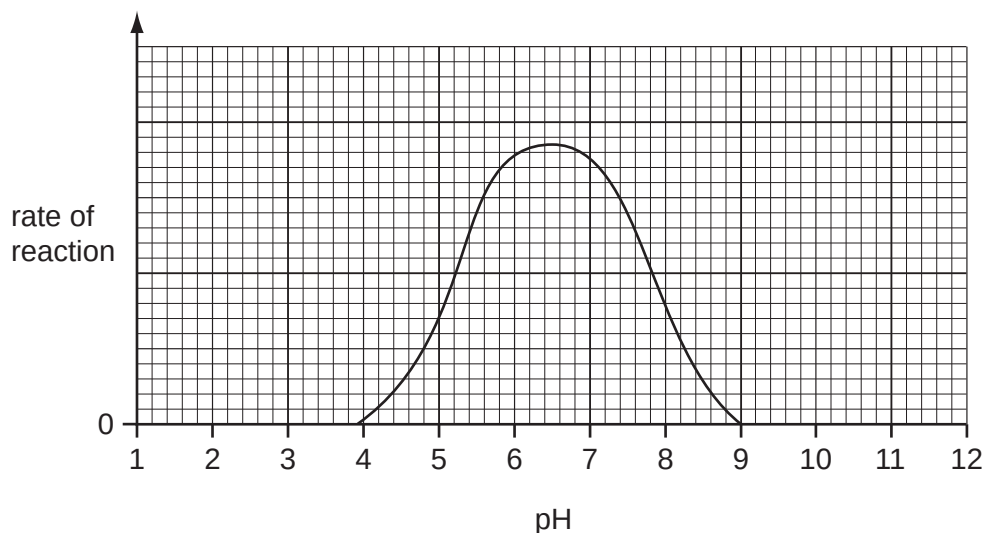


Fig. 9.1

- (i) Describe the effect of pH on the activity of this enzyme.

.....

 [2]

- (ii) Explain why pH affects the enzyme in this way.

.....

 [2]

- (iii) An enzyme digests food in the human stomach, where hydrochloric acid is secreted. This enzyme is adapted to work best in these conditions.

On Fig. 9.1, sketch a curve to show how pH affects the activity of this stomach enzyme. [1]

- (iv) After the food has been in the stomach for a while, it passes into the duodenum. Pancreatic juice, which contains sodium hydrogencarbonate, is mixed with the food in the duodenum.

Explain why this stomach enzyme stops working when it enters the duodenum.

.....

 [2]

(b) Explain how chemical digestion enables body cells to obtain nutrients.

.....

.....

.....

..... [3]

Group

a	a = relative atomic mass
X	X = atomic symbol
b	b = proton (atomic) number

*58-71 Lanthanoid series
90-103 Actinoid series

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COMBINED SCIENCE

0653/33

Paper 3 (Extended)

May/June 2012

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **23** printed pages and **1** blank page.



- 1 Sugar cane is a food crop grown in Australia. It is harvested and then transported on trains to the processing plant.

Fig. 1.1 shows one of the trains carrying sugar cane.

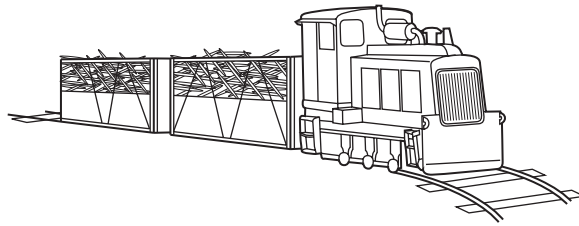


Fig. 1.1

- (a) The mass of the engine and empty trucks is 20 000 kg and the mass of the sugar cane transported is 10 000 kg.

The train travels at a speed of 0.5 m/s.

- (i) Calculate the kinetic energy of the loaded train.

State the formula that you use and show your working.

formula used

working

..... [2]

- (ii) To travel at this speed, a driving force of 1 000 000 N is needed.

Calculate the work done by the engine of the train when it travels 1 km.

State the formula that you use and show your working.

formula used

working

..... [2]

- (iii) It takes the train 5 minutes to travel 1 km. Calculate the power output of the engine. For
miner's

State the formula that you use and show your working.

formula used

working

..... [2]

- (b) The track for the train is composed of short lengths of steel rail with small gaps left between them as shown in Fig. 1.2.

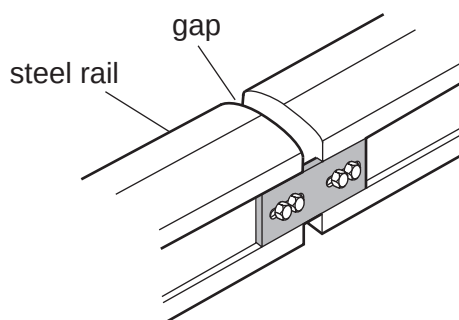


Fig. 1.2

Suggest a reason for leaving these small gaps.

.....

.....

..... [2]

- 2 An element is a substance that is made of atoms which have the same proton number. Most atoms contain protons, neutrons and electrons.

(a) Name the element whose atoms do **not** usually contain any neutrons.

..... [1]

- (b) The electronic structures (configurations) of atoms of three elements, **P**, **Q** and **R** are shown below.

P 2,8,1

Q 2,8

R 2,7

- (i) Use the electronic structures to state and explain the group numbers in the Periodic Table that contain elements **P**, **Q** and **R**.

P Group

Q Group

R Group

explanation

..... [2]

- (ii) State and explain which of the elements, **P**, **Q** or **R**, is the least reactive.

element

explanation

..... [1]

- (iii) State and explain which **one** of the elements, **P**, **Q** or **R**, is a good conductor of electricity.

element

explanation

..... [1]

- (c) Most metallic elements occur combined with non-metals in the Earth's crust. For thousands of years, humans have carried out chemical reactions to extract metals from their ores.

Fig. 2.1 shows a cross-section through a shaft furnace which was a simple reaction vessel used by ancient civilisations to extract iron.

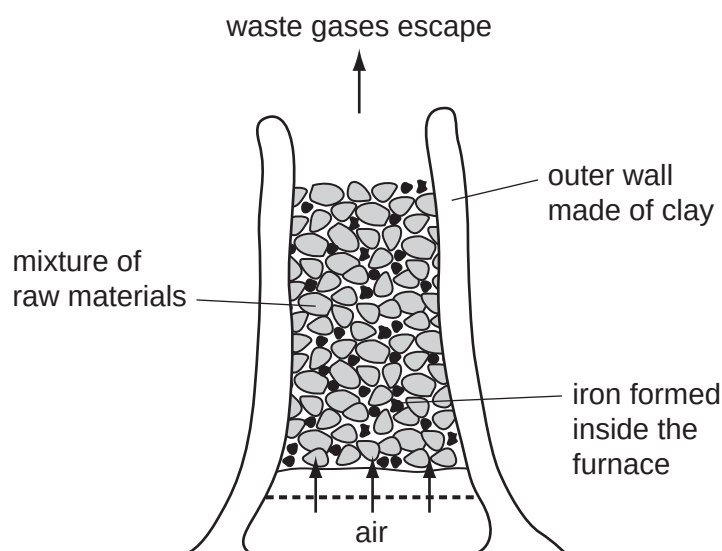


Fig. 2.1

In this shaft furnace the mixture of raw materials consisted of charcoal and iron ore. Charcoal contains mainly carbon, and iron ore contains iron oxide.

Nowadays iron is extracted from iron ore in a blast furnace.

- (i) Name another raw material, which is added to a modern blast furnace but which is **not** present in the shaft furnace in Fig. 2.1.

Explain briefly why this material is used.

name of material

reason this material is used

[2]

- (ii) Iron is extracted from iron ore when a gaseous oxide of carbon reacts with iron oxide.

Write a **word** chemical equation for this reaction.

[2]

- (d) (i) Suggest, in terms of relative reactivity, why a mixture of aluminium oxide and carbon does **not** produce any metallic aluminium in a blast furnace.

.....
.....
..... [2]

- (ii) Name the process that is used to extract aluminium from aluminium oxide.

..... [1]

- 3 Marmots are herbivorous mammals. Fig. 3.1 shows a marmot.

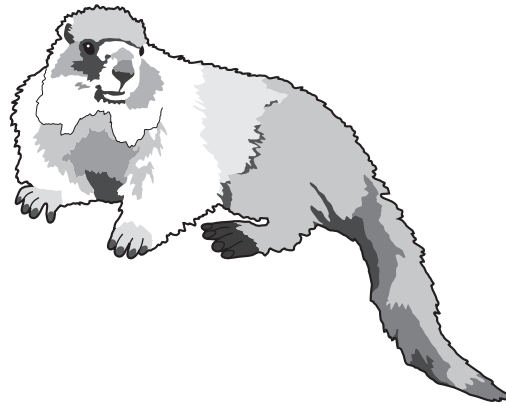


Fig. 3.1

A study has been carried out into the marmots living in Colorado, USA.

The winters in this part of Colorado are so cold that the marmots would not be able to find enough food to eat. Instead, they allow their body temperature to drop much lower than normal and stay inactive for many months. This is called hibernation. They do not eat while they are hibernating. They emerge from hibernation in spring.

- (a)** Before they hibernate, marmots build up large fat stores beneath their skin.

Suggest and explain what marmots must do in order to build up large fat stores in their bodies.

.....

.....

..... [2]

- (b) Fig. 3.2 shows the percentage of marmots with different body masses that survive through the winter.

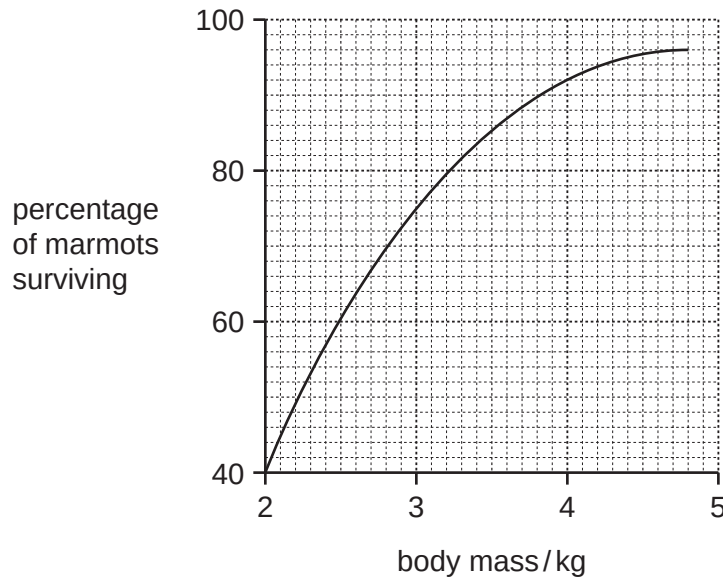


Fig. 3.2

- (i) Describe the relationship between a marmot's body mass and its chance of surviving the winter.

.....

 [2]

- (ii) Suggest how a layer of fat beneath the skin can reduce heat transfer from a hibernating marmot's body to its surroundings.

.....
 [1]

- (c) In the last twenty years, spring has been arriving earlier in the year in Colorado. This is a result of global warming.

Explain how human activities, other than the combustion of fossil fuels, are thought to contribute to global warming.

.....

 [3]

- (d) Fig. 3.3 shows the mean body mass of the marmots on the first day of August (summer) between 1976 and 2006.

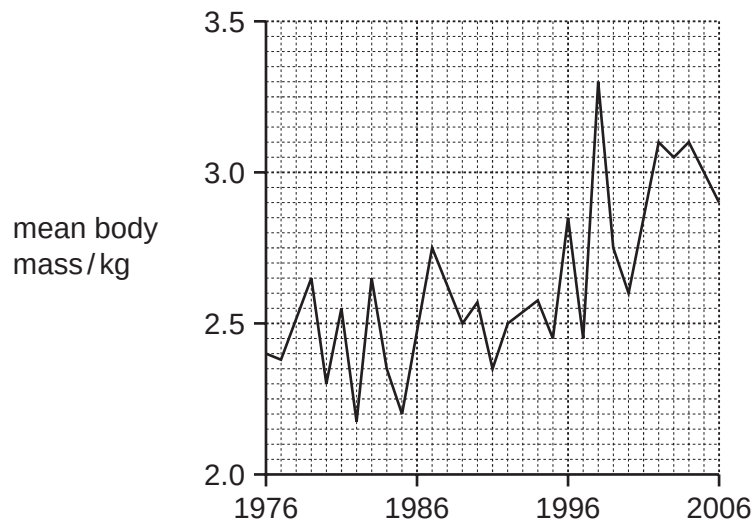


Fig. 3.3

- (i) Describe the general trend shown in Fig. 3.3.

.....
 [1]

- (ii) Suggest how the earlier arrival of spring could be responsible for this trend.

.....
 [1]

- 4 Fig. 4.1 shows the apparatus a student used to investigate the effect of changing the concentration on the rate of reaction between excess dilute hydrochloric acid and magnesium. At the start of the experiment the measuring cylinder contained no gas and was full of water.

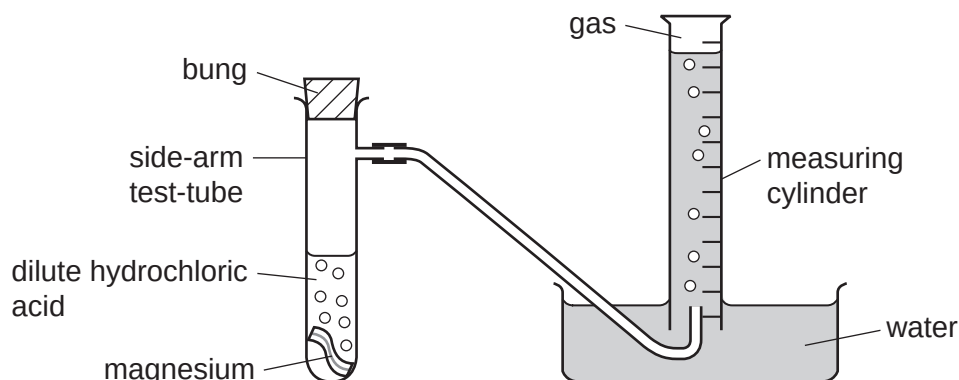


Fig. 4.1

To carry out his investigation the student used the following method.

- He dropped the magnesium into the dilute acid.
- He immediately placed the bung into the side-arm test-tube and started a stopclock.
- He measured the volume of gas in the measuring cylinder every half minute, for eight minutes.

He carried out two experiments, **A** and **B**, in which the only variable that he changed was the concentration of the hydrochloric acid.

- (a) State **two** other variables that the student needed to keep the same in experiments **A** and **B**.

- 1
- 2 [1]

(b) Fig. 4.2 shows the results the student obtained for experiments **A** and **B**.

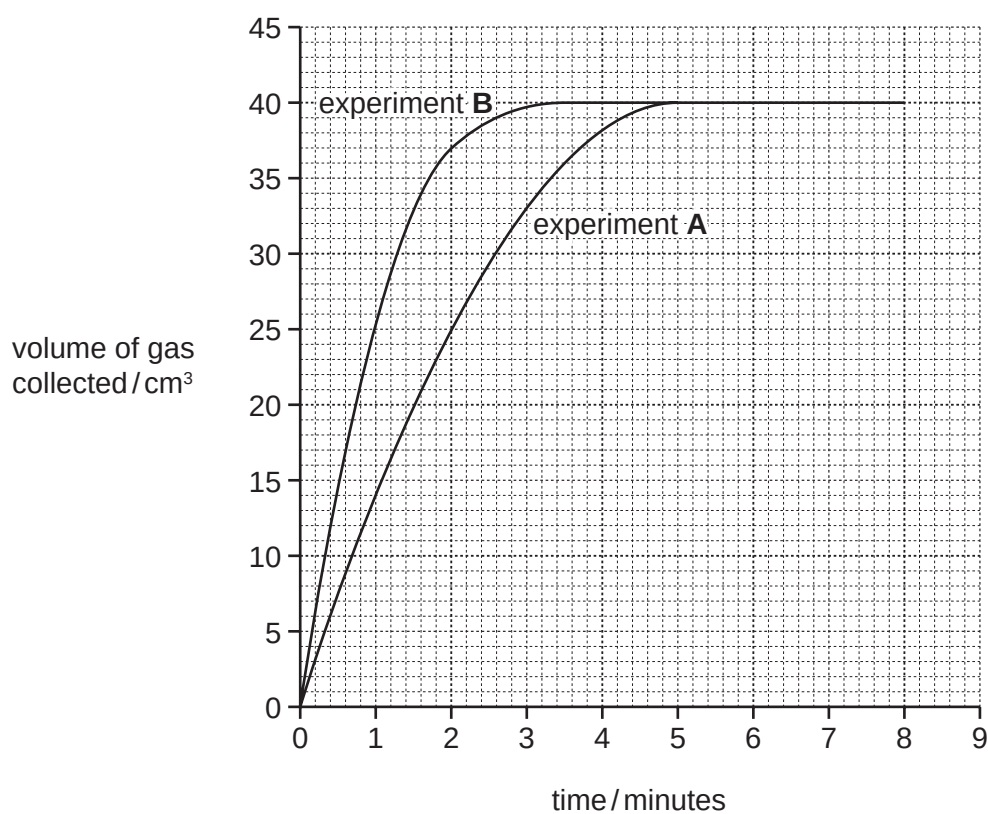


Fig. 4.2

- (i) In which experiment, **A** or **B**, did the student use hydrochloric acid which had the higher concentration?

Explain your answer.

experiment

explanation

.....

..... [1]

- (ii) The student was told that he could calculate the average rate of reaction using

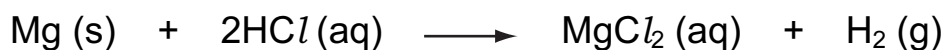
$$\text{average rate of reaction} = \frac{\text{maximum volume of gas collected}}{\text{minimum time taken to collect maximum volume}}$$

Use the information in Fig. 4.2 to calculate the average rate of reaction for experiment **A**.

Show your working and state the units.

..... [3]

- (c) The balanced symbolic equation for the reaction between hydrochloric acid and magnesium is shown below.



- (i) What is meant by the state symbol (aq) in this equation?

..... [1]

- (ii) Suggest why the reaction in both experiments **A** and **B** above produced the same volume of gas.

.....

.....

..... [2]

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Please turn over for Question 5.

- 5 (a) A bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.003 m.

- (i) This sound is outside the audible frequency range for humans.

State the approximate audible frequency range for humans.

..... [1]

- (ii) State the meaning of the terms *frequency* and *wavelength*, when describing a wave. You may use a diagram if it helps your explanation.

frequency

.....
.....
.....

wavelength

.....
.....
.....

[2]

- (iii) Calculate the speed of the sound wave produced by the bat.

State the formula that you use and show your working.

formula used

working

..... [2]

- (iv) Sound travels through the air by a series of compressions and rarefactions.

Describe what this means in terms of air particles.

.....

.....

..... [2]

- (b) A girl shouts and waves to another girl in the school playground as shown in Fig. 5.1.



Fig. 5.1

The sound energy and the light energy both travel from one girl to the other by wave motion.

- (i) State whether sound waves and light waves are transverse or longitudinal.

Sound waves are

Light waves are [2]

- (ii) The girls could have communicated with each other using their mobile phones (cell phones).

Name the type of electromagnetic wave used to communicate between mobile phones.

..... [1]

- 6 Fig. 6.1 shows part of a section across a root from a radish plant, photographed through a microscope.

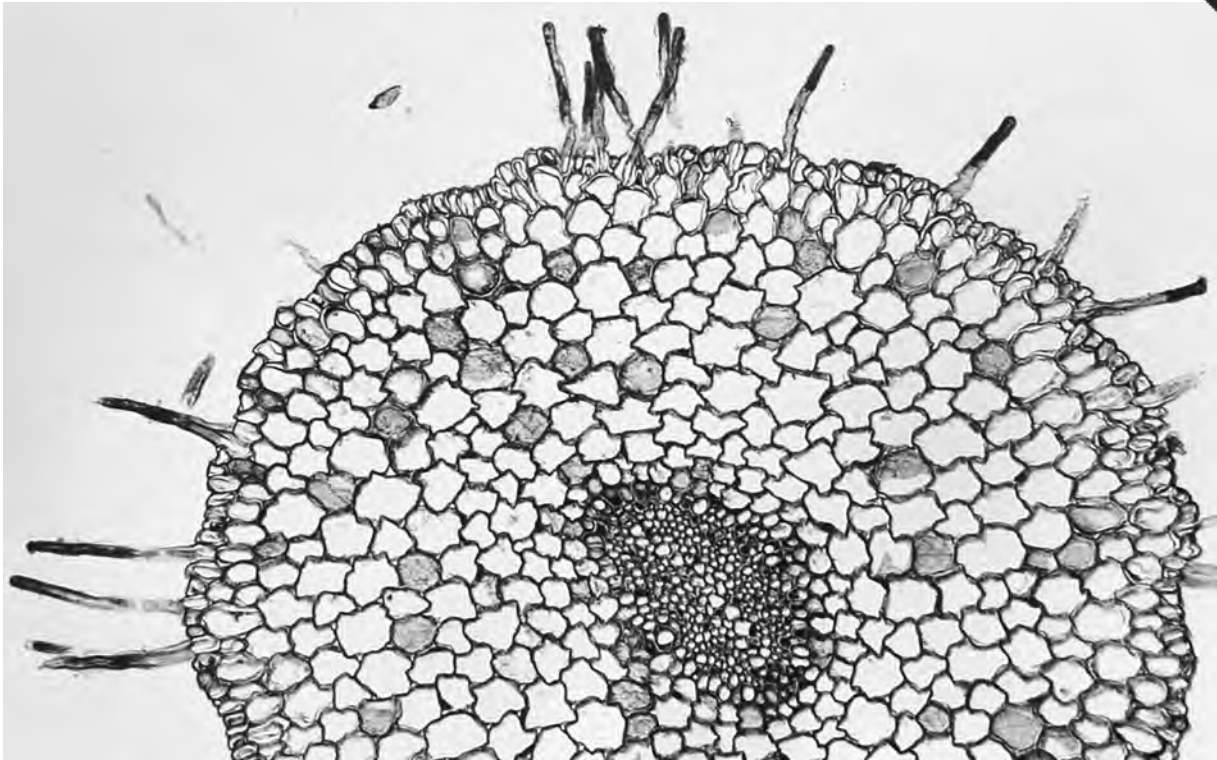


Fig. 6.1

(a) On Fig. 6.1, use a label line to label a root hair cell. [1]

(b) Root hair cells absorb water from the soil.

(i) State **one** other function of root hair cells.

..... [1]

(ii) Explain how root hair cells are adapted for their functions.

.....

 [2]

- (c) A complete radish plant was placed with the lower part of the root standing in water. A soluble red dye was added to the water. After a while, the veins in the leaves of the radish plant became red.

- (i) Name the tissue in the radish plant through which the coloured water was transported from the roots to the leaves.

..... [1]

- (ii) On Fig. 6.1, write the letter **A** to show the position of this tissue in the root. [1]

- (iii) Water was drawn up through the radish plant because water vapour was constantly escaping from its leaves. A plastic bag was placed over the leaves of the radish plant, and the water vapour formed colourless droplets of liquid water on the bag as it condensed.

Explain why these water droplets were not red.

.....
.....
..... [2]

- 7 (a) (i) Draw a circuit diagram that a student could use to investigate how the change in potential difference across a lamp affects the current flowing through it.

[3]

- (ii) During his investigations, the student measured the voltage across the lamp as 3.0 V and the current passing through the lamp as 0.3 A.

Calculate the resistance of the lamp.

State the formula that you use and show your working.

formula used

working

[2]

- (b) Table 7.1 shows some information about six pieces of wire, all at room temperature (20 °C).

Table 7.1

wire	metal composition	length / cm	cross-sectional area / mm ²
A	copper	10	0.5
B	nichrome	10	0.5
C	copper	20	0.5
D	nichrome	20	0.5
E	copper	10	1.0
F	copper	20	1.0

- (i) Which wire, **B** or **D**, will have the greater resistance?

Explain your answer.

wire

..... [1]

- (ii) Which wire, **A** or **E**, will have the greater resistance?

Explain your answer.

wire

..... [1]

- (c) A plastic rod is rubbed with a cloth.

The rod becomes charged.

There are two types of electric charge.

- (i) State the names of these charges.

1

2 [1]

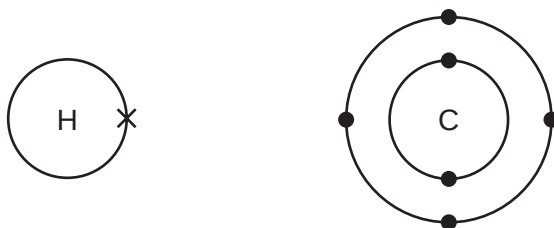
- (ii) Charged particles are transferred between the rod and cloth.

Name the charged particles transferred. [1]

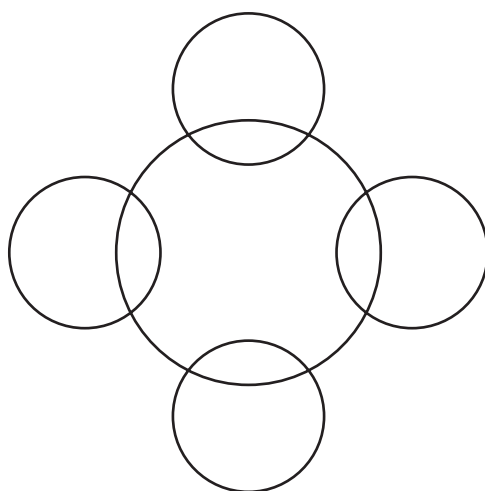
- 8 Hydrocarbons are compounds that contain carbon and hydrogen only.

The hydrocarbon that contains the simplest molecules is methane.

- (a) (i) The diagrams below show an atom of carbon and an atom of hydrogen.



Complete the covalent bonding diagram of a molecule of methane to show how the bonding electrons are arranged.



[2]

- (ii) Complete the molecular structure diagrams below to show molecules of the hydrocarbons ethane and ethene.

ethane	$\text{H}-\text{C}$
ethene	$\begin{array}{c} \text{C} \\ \\ \text{H} \end{array}$

[2]

- (b) In many countries, ethanol, $\text{C}_2\text{H}_5\text{O}$, is added to hydrocarbon fuels such as gasoline.

The products of complete combustion of ethanol are the same as those of hydrocarbons such as methane.

Suggest the **word** chemical equation for the complete combustion of ethanol.

..... [2]

- 9 (a) Define the term *hormone*.

.....

.....

.....

.....

..... [3]

- (b) Adrenaline is sometimes called the 'fright, flight or fight' hormone. It is produced when a person is frightened.

One effect of adrenaline is to increase a person's pulse rate.

Explain how this could help a person to run away from the thing that has frightened them.

.....

.....

.....

..... [2]

- (c) Plants also produce hormones. One plant hormone is auxin. Auxin helps plant shoots to respond to light coming from only one direction.

- (i) State the correct term for the growth response of a plant to light coming from only one direction.

..... [1]

- (ii) Explain how auxin helps a plant shoot respond to light coming from one direction. You may use a diagram as part of your explanation.

.....

.....

.....

.....

..... [3]

Copyright Acknowledgements:

Question 6 Photograph

© B23WP8 cross section of a radish root; Biodisc/Visuals Unlimited/Alamy.

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DATA SHEET
The Periodic Table of the Elements

Group																			
I	II											III	IV	V	VI	VII	0		
												1 H Hydrogen 1							4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4												11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	
	23 Na Sodium 11	24 Mg Magnesium 12												27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20		45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	
85 Rb Rubidium 37	88 Sr Strontium 38		89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	127 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54			
133 Cs Caesium 55	137 Ba Barium 56		139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86	
226 Fr Francium 87	227 Ra Radium 88		227 Ac Actinium 89																
*58-71 Lanthanoid series †90-103 Actinoid series																			
a X b a = relative atomic mass X = atomic symbol b = proton (atomic) number																			

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).