



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

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**COMBINED SCIENCE**

**0653/21**

Paper 2 (Core)

**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	
<b>Total</b>	

This document consists of **22** printed pages and **2** blank pages.



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

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

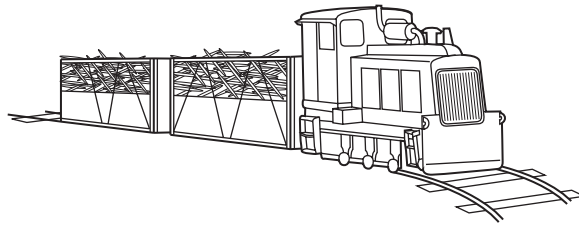


Fig. 1.1

- (a) The train travels a distance of 25 kilometres in 2 hours.

Calculate the average speed of the train.

State the formula that you use and show your working.

formula used

working

..... km/h [2]

- (b) The train engine is powered by oil. The oil is burned to change water into steam. The steam is used to make parts of the engine move.

- (i) What kind of energy is stored in the oil?

..... [1]

- (ii) The engine is 30% efficient in converting the energy stored in the oil into movement energy. The rest of the stored energy is lost in different ways.

State **one** of these ways.

..... [1]

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

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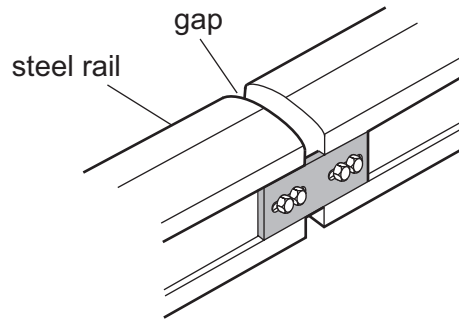


Fig. 1.2

Suggest a reason for leaving these small gaps.

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

- (d) Sugar can be fermented and turned into ethanol. Ethanol is now used as a fuel for cars.

Give **one** reason, other than cost, why people might use ethanol rather than petrol in their cars.

..... [1]

- (e) The farm on which the sugar cane is grown uses a wind turbine to produce electrical power. Table 1.1 shows the electrical power generated for different wind speeds.

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**Table 1.1**

<b>wind speed / km per hour</b>	0	3	5	8	10	12	15	20
<b>power generated / W</b>	0	0	150	500	1000	1100	1200	1200

- (i) Suggest the lowest wind speed needed to generate power.

..... km/h [1]

- (ii) State the maximum power that this wind turbine can produce.

..... W [1]

- (iii) State **one** disadvantage of using only a wind turbine as the source of electrical power.

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

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

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The elements are shown in the Periodic Table.

- (a) The chemical symbol of an atom of the element chlorine is shown below.



The nucleon number of this atom is 35.

- (i) Name the part of an atom that contains the protons and neutrons.

..... [1]

- (ii) State the number of neutrons in this chlorine atom.

Explain your answer.

number of neutrons .....

explanation .....

..... [2]

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

..... [1]

- (b) Table 2.1 shows Period 2 of the Periodic Table.

**Table 2.1**

	I	II	III	IV	V	VI	VII	0
Period 2	<b>X</b>						<b>Y</b>	<b>Z</b>

The element represented by **X** is a solid at room temperature and the elements represented by **Y** and **Z** are gases.

- (i) Suggest **one** difference, other than physical state at room temperature, between the properties of elements **X** and **Y**.

.....

..... [1]

- (ii) Suggest **one** difference between the chemical properties of elements **Y** and **Z**.

.....

..... [1]

- (c) Fig. 2.1 shows a simple lime kiln which is used to produce lime (calcium oxide) from limestone (calcium carbonate).

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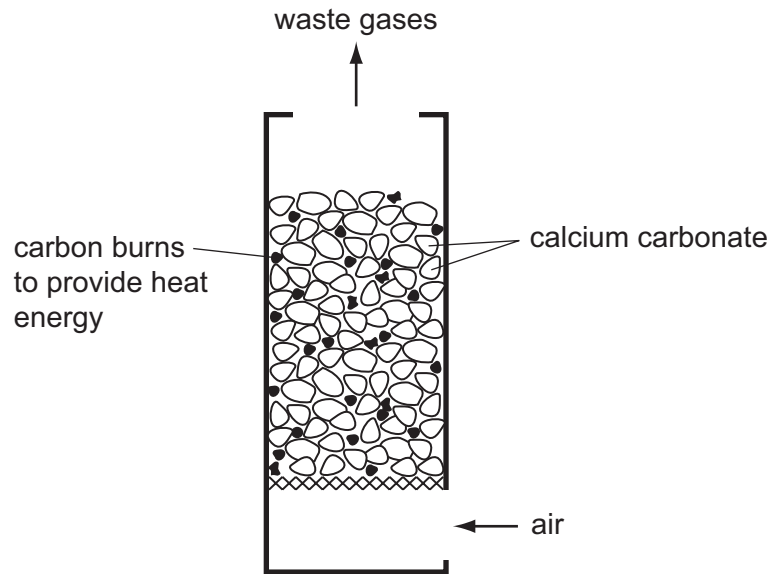


Fig. 2.1

In the lime kiln, the pieces of carbon are burnt to provide heat energy.

- (i) Explain why the burning of carbon is described as an oxidation reaction.

.....

.....

..... [2]

- (ii) Both calcium oxide and calcium carbonate are sometimes added to the soil by farmers.

Suggest and explain why this is done.

.....

.....

..... [2]

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

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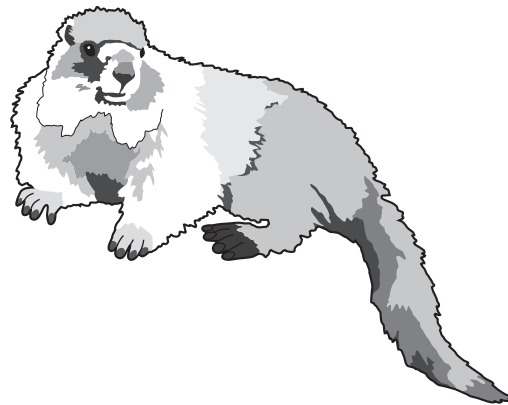


Fig. 3.1

(a) Define the term *herbivore*.

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

(b) A study has been carried out on the marmots living in Colorado, USA.

The winters in this part of Colorado are very cold. The marmots hibernate (sleep) in burrows in winter. They do not eat while they are hibernating. They wake up in spring.

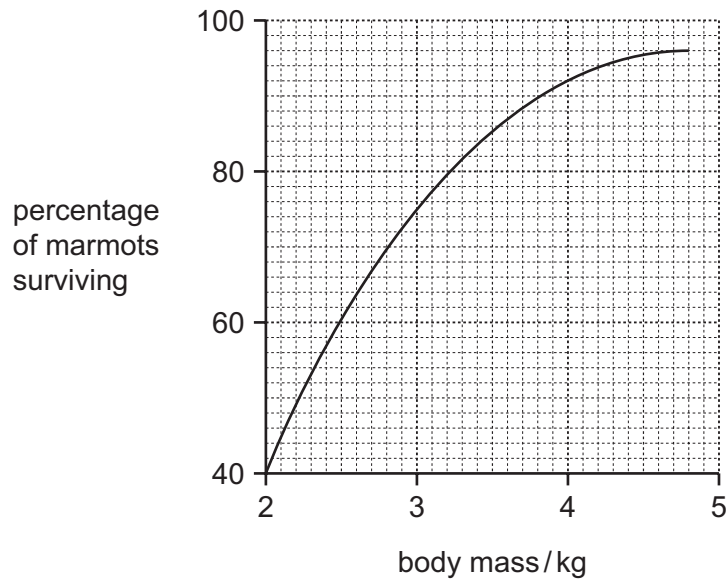
Before they hibernate, marmots build up large fat stores beneath their skin.

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

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

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

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**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 help a marmot to keep warm during cold weather.

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

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

Name **two** gases that contribute to global warming.

- 1 .....  
 2 .....

[2]



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

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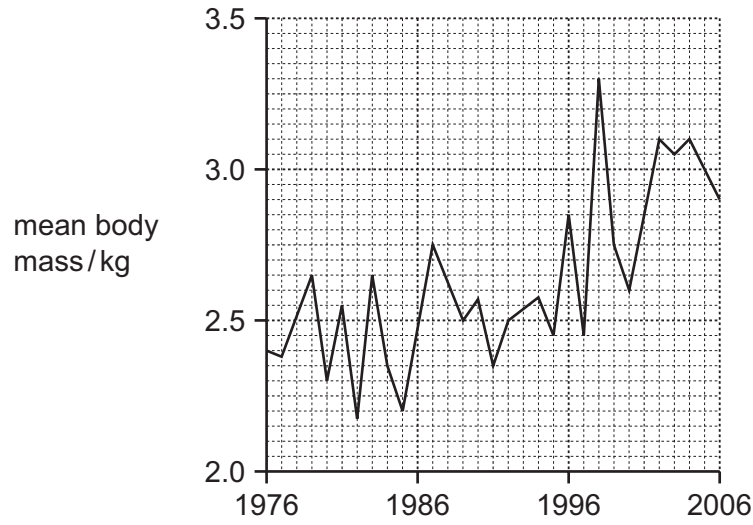


Fig. 3.3

(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 some of the apparatus and substances a student used to investigate the rate of reaction between magnesium and dilute hydrochloric acid. In this reaction a gas is given off and bubbles up into the measuring cylinder.

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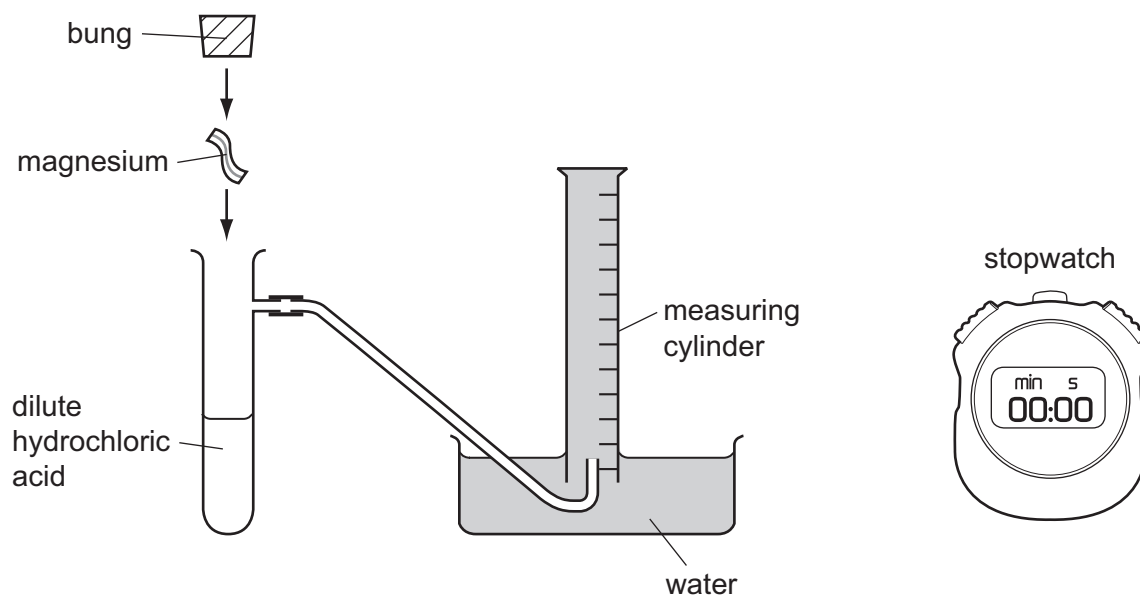


Fig. 4.1

- (a) Fig. 4.1 shows the apparatus just before the student started his experiment to measure the rate of reaction.

Describe briefly the method the student should use and the measurements he should make.

.....

.....

.....

..... [3]

(b) The student carried out a second experiment using hydrochloric acid which had a **higher** concentration. All of the other variables which could affect the rate were kept the same as in the first experiment.

(i) State **one** of the other variables that the student kept constant.

..... [1]

(ii) Predict and explain briefly how the results the student obtained in the second experiment would be different from the first experiment.

.....

.....

..... [2]

(c) The reaction between magnesium and dilute hydrochloric acid also produces the ionic compound magnesium chloride.

In crystals of this compound, **two** chloride ions combine with **one** magnesium ion.

(i) State **one** difference between a magnesium atom and a magnesium ion.

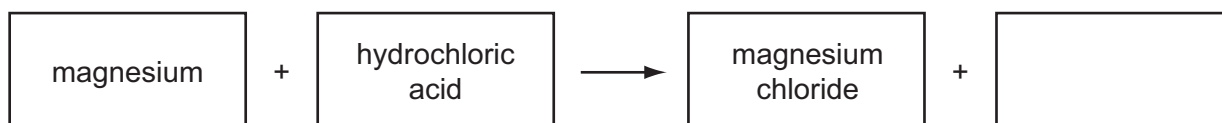
.....

..... [1]

(ii) State the chemical formula of magnesium chloride.

..... [1]

(iii) Complete the **word** chemical equation for the reaction between magnesium and hydrochloric acid.



[1]

5 (a) A bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.0016 m.

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

State the approximate audible frequency range for humans.

..... Hz [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]

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

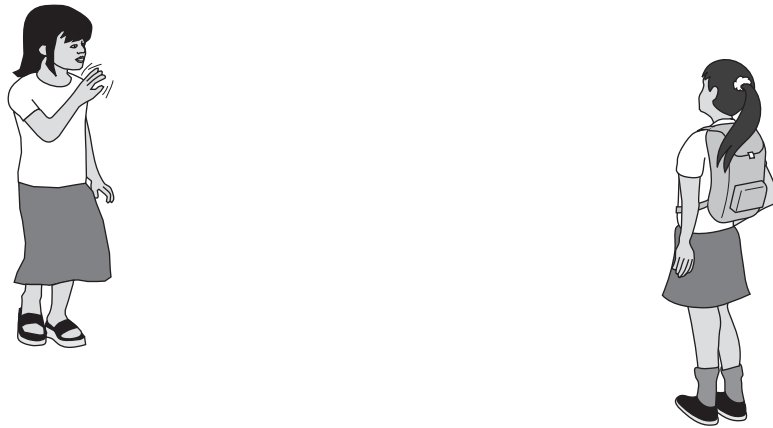


Fig. 5.1

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

(i) Explain why sound waves will **not** travel through a vacuum.

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

(ii) If the first girl now makes another sound with a smaller amplitude, what change would the second girl notice?

..... [1]

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

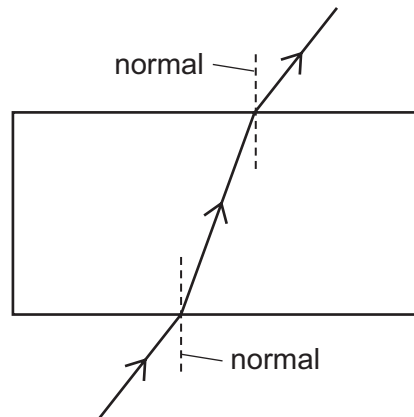
Name the type of electromagnetic wave used to communicate between mobile phones.

..... [1]

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(c) Fig. 5.2 shows a ray of light passing through a rectangular glass block.

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**Fig. 5.2**

**On Fig. 5.2,** label an angle of incidence,  $i$ , and an angle of refraction,  $r$ .

[2]

**Please turn over for Question 6.**

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

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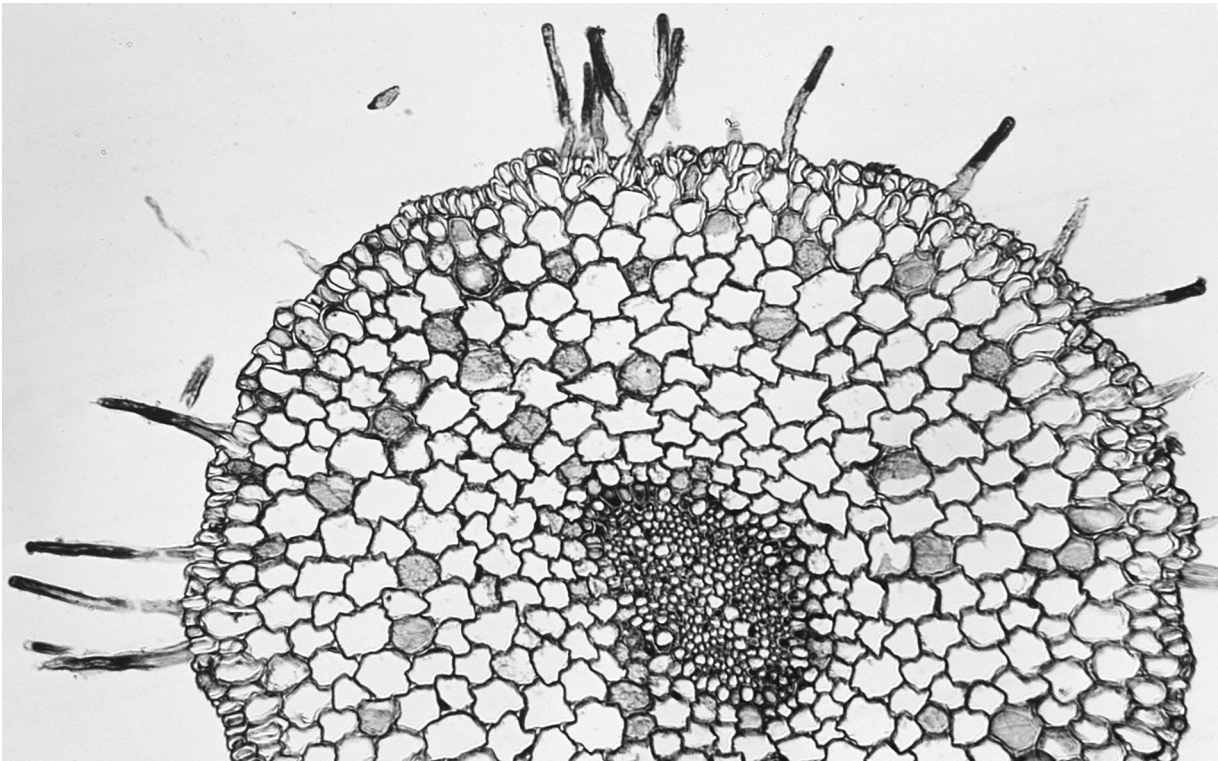


Fig. 6.1

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

- (b) Root hair cells absorb substances from the soil.

Name **two** substances that root hair cells absorb from the soil.

1 .....

2 ..... [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]



- (d) (i) The cells in the radish root are plant cells.

Complete Table 6.1 to show which structures are present in plant cells and which are present in animal cells.

Use a tick (✓) to show that the structure is present. Use a cross (X) to show that the structure is not present.

You should place either a tick or a cross in every space in the table.

**Table 6.1**

structure	plant cells	animal cells
cell membrane		
cell wall		
nucleus		
vacuole containing sap		

[4]

- (ii) Would you expect the cells in the radish root to contain chloroplasts?

Explain your answer.

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

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- 7 (a) A student investigated how the change in potential difference across a lamp affected the current flowing through it.

She used wires to connect the components shown in Fig. 7.1 to make a suitable circuit.

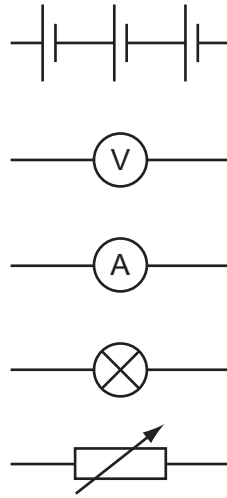


Fig. 7.1

- (i) Using the correct symbols from Fig. 7.1, draw a diagram to show the circuit she made.

[3]

- (ii) Explain why a variable resistor is used in this circuit.

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

(b) 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 types of charge.

1 .....

2 .....

[1]

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

Name the charged particles transferred. .... [1]

(iii) Plastic is an example of an electrical insulator.

Name **one** material which is an electrical conductor.

..... [1]

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- 8 The bar chart in Fig. 8.1 shows the approximate composition of unpolluted air.

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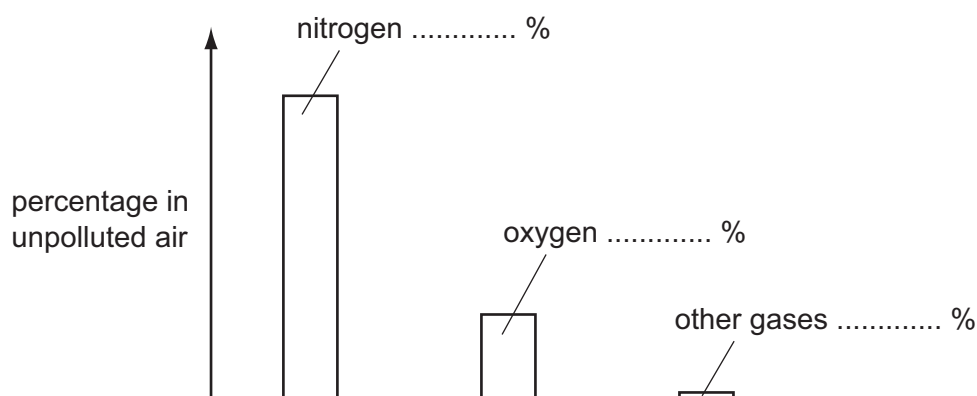


Fig. 8.1

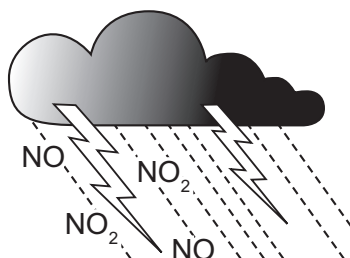
- (a) (i) Complete the bar chart in Fig. 8.1 by labelling the percentages of nitrogen, oxygen and other gases. [2]

- (ii) Name **one** of the **other gases** in Fig. 8.1 that exists in unpolluted air.

..... [1]

- (b) Nitrogen and oxygen exist in the air in the form of the diatomic molecules,  $N_2$  and  $O_2$ .

When lightning passes through the air, the gaseous compounds nitric oxide, NO, and nitrogen dioxide,  $NO_2$ , are formed.



- (i) Explain why nitrogen and oxygen are described as chemical elements, but nitric oxide and nitrogen dioxide are described as compounds.

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

- (ii) Suggest the type of chemical bonding in nitric oxide and nitrogen dioxide.

Explain your answer briefly.

type of bonding .....

explanation .....

..... [2]

- (iii) Nitrogen dioxide dissolves and reacts with rainwater.

A student carried out an experiment to investigate what happened to the acidity of rainwater during a thunderstorm.

His results are shown in Table 8.1.

**Table 8.1**

description of sample	pH
pure water obtained in a science laboratory	7
rainwater collected when no thunderstorm was occurring	5
rainwater collected during a thunderstorm	4

What conclusions can the student make from these results?

.....

.....

.....

..... [2]

- 9 (a) One of the characteristics of living organisms is sensitivity. This is the ability to respond to changes in the environment.

List **four** other characteristics of all living things.

- 1 .....
- 2 .....
- 3 .....
- 4 .....

[2]

- (b) Hormones help organisms to respond to changes in their environment.

(i) Name the hormone that is produced when a person is frightened.

..... [1]

(ii) State **two** effects of this hormone.

- 1 .....
- .....
- 2 .....
- .....

[2]

- (c) How are hormones transported around the body?

..... [1]

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*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	VIII	IX	X	XI
		1 <b>H</b> Hydrogen 1										4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											19 <b>F</b> Fluorine 9
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	18 <b>Ar</b> Argon 18	20 <b>Ne</b> Neon 10	35.5 <b>Br</b> Bromine 35	80 <b>Kr</b> Krypton 36
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	52 <b>Te</b> Tellurium 52	84 <b>Xe</b> Xenon 54
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	57 <b>Co</b> Cobalt 27	58 <b>Ni</b> Nickel 28	59 <b>Cu</b> Copper 29	60 <b>Zn</b> Zinc 30	61 <b>Ga</b> Gallium 31	62 <b>Ge</b> Germanium 32	63 <b>As</b> Arsenic 33	64 <b>Se</b> Selenium 34	65 <b>Br</b> Bromine 35
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	91 <b>Zr</b> Zirconium 40	92 <b>Nb</b> Niobium 41	93 <b>Mo</b> Molybdenum 42	94 <b>Tc</b> Technetium 43	95 <b>Ru</b> Ruthenium 44	96 <b>Rh</b> Rhodium 45	97 <b>Pd</b> Palladium 46	98 <b>Ag</b> Silver 47	99 <b>Cd</b> Cadmium 48	100 <b>In</b> Indium 49	101 <b>Sn</b> Tin 50
226 <b>Fr</b> Francium 87	227 <b>Ra</b> Radium 88	140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	142 <b>Nd</b> Neodymium 60	143 <b>Pm</b> Promethium 61	144 <b>Sm</b> Samarium 62	145 <b>Eu</b> Europium 63	146 <b>Gd</b> Gadolinium 64	147 <b>Tb</b> Terbium 65	148 <b>Dy</b> Dysprosium 66	149 <b>Ho</b> Holmium 67	150 <b>Er</b> Erbium 68
		150 <b>Sm</b> Samarium 62	151 <b>Eu</b> Europium 63	152 <b>Gd</b> Gadolinium 64	153 <b>Tb</b> Terbium 65	154 <b>Dy</b> Dysprosium 66	155 <b>Ho</b> Holmium 67	156 <b>Er</b> Erbium 68	157 <b>Tm</b> Thulium 69	158 <b>Yb</b> Ytterbium 70	159 <b>Lu</b> Lutetium 71	160 <b>Lr</b> Lawrencium 103
		140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	142 <b>Nd</b> Neodymium 60	143 <b>Pm</b> Promethium 61	144 <b>Sm</b> Samarium 62	145 <b>Eu</b> Europium 63	146 <b>Gd</b> Gadolinium 64	147 <b>Tb</b> Terbium 65	148 <b>Dy</b> Dysprosium 66	149 <b>Ho</b> Holmium 67	150 <b>Er</b> Erbium 68
		232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92

\*58-71 Lanthanoid series  
†90-103 Actinoid series

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

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).