



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

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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.

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

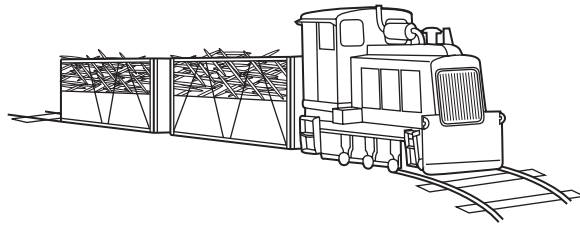


Fig. 1.1

- (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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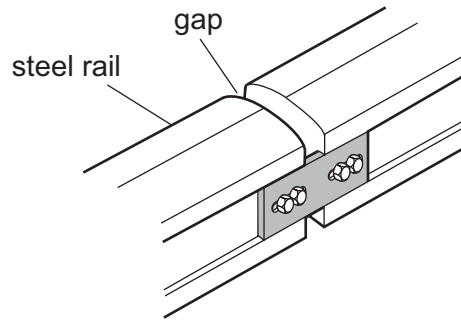


Fig. 1.2

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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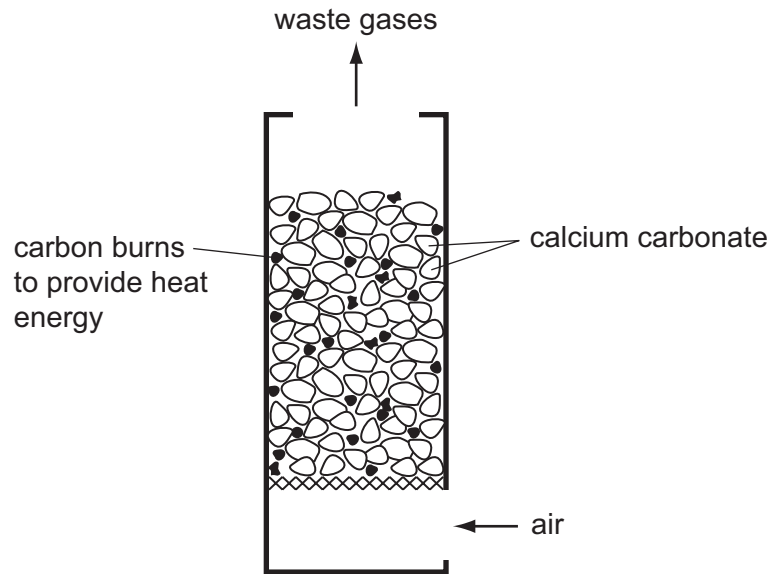


Fig. 2.1

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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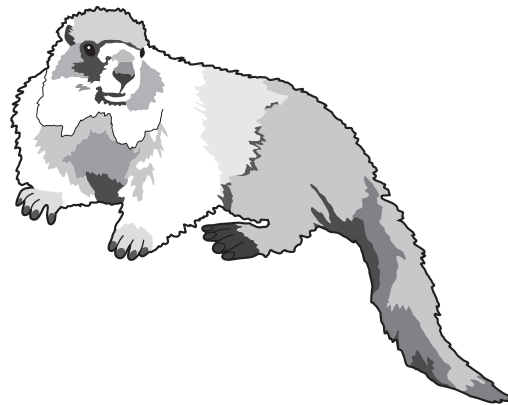


Fig. 3.1

(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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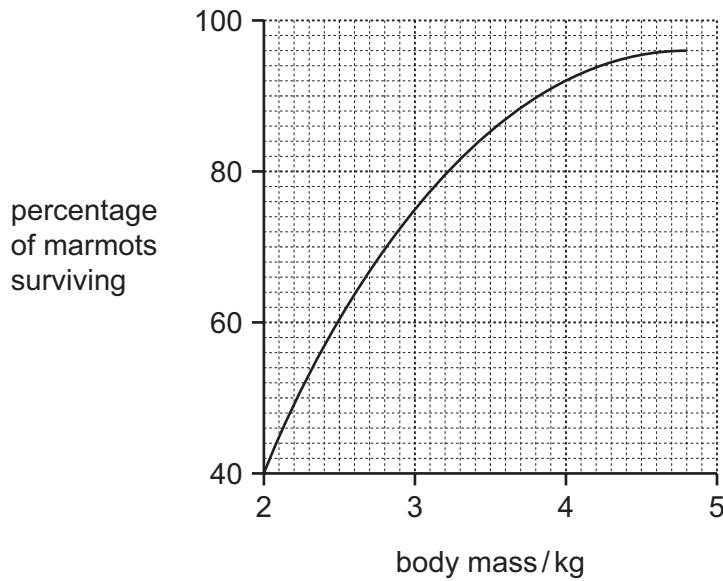


Fig. 3.2

(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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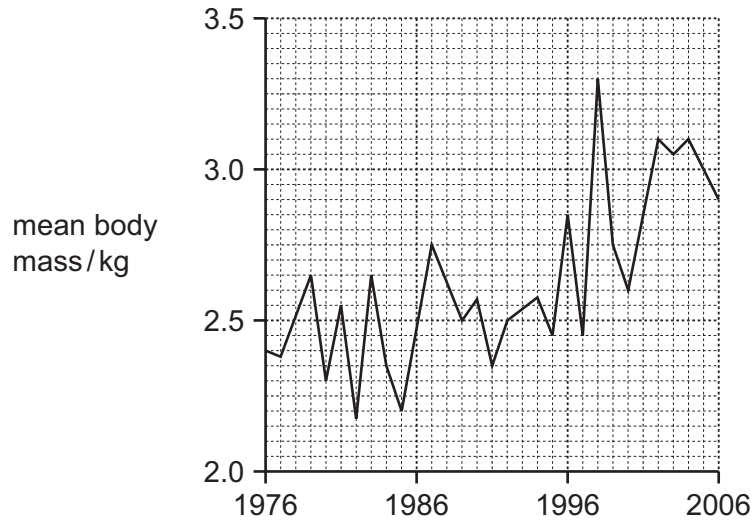


Fig. 3.3

(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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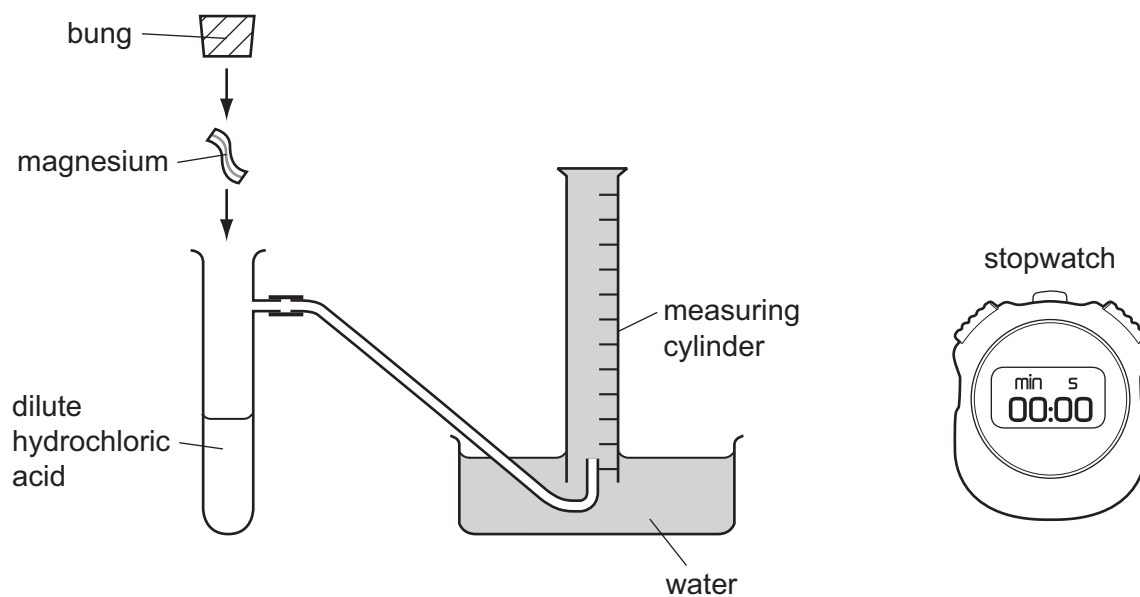


Fig. 4.1

- (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.

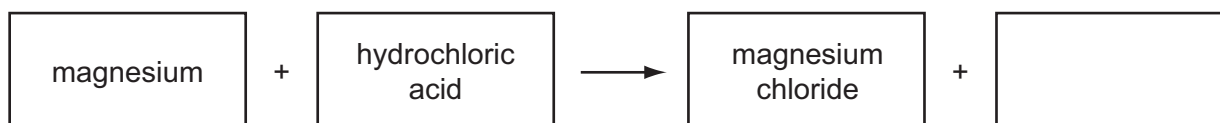
.....

..... [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).

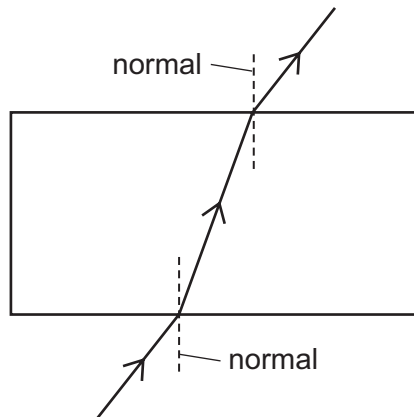
Name the type of electromagnetic wave used to communicate between mobile phones.

..... [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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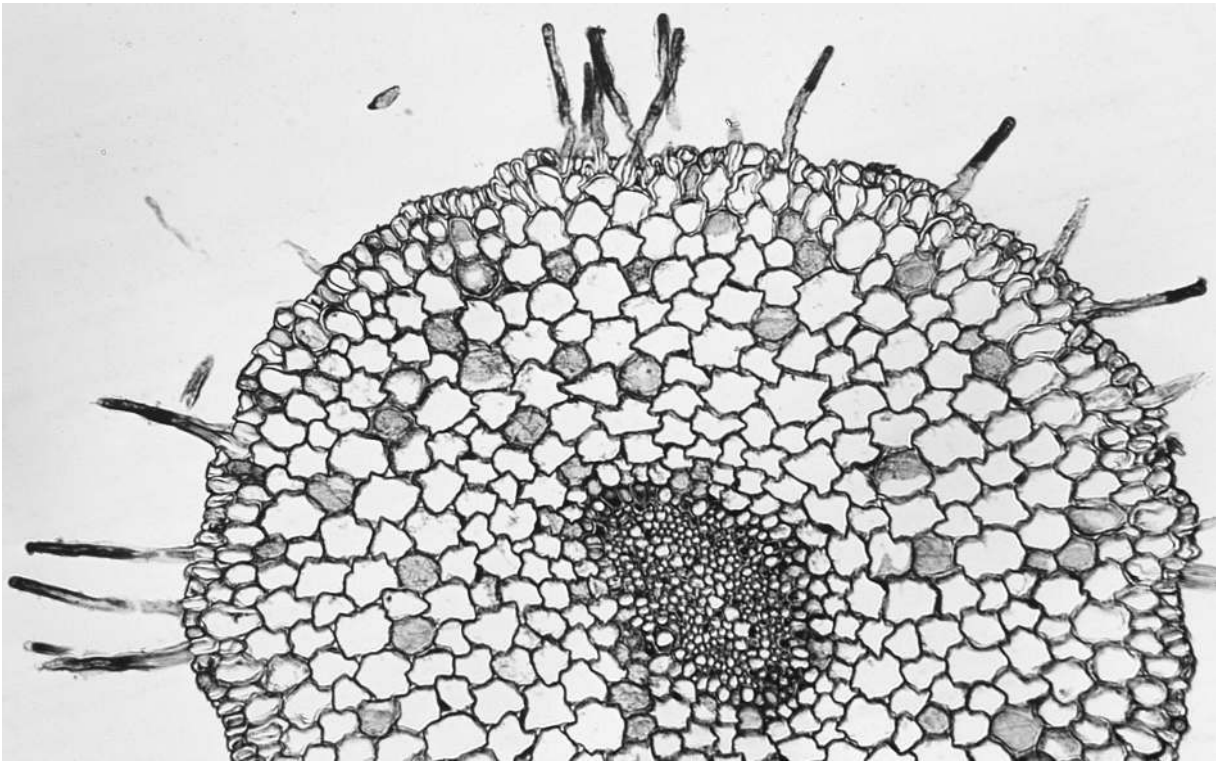


Fig. 6.1

- (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.

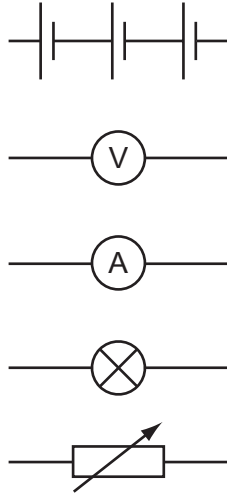


Fig. 7.1

- (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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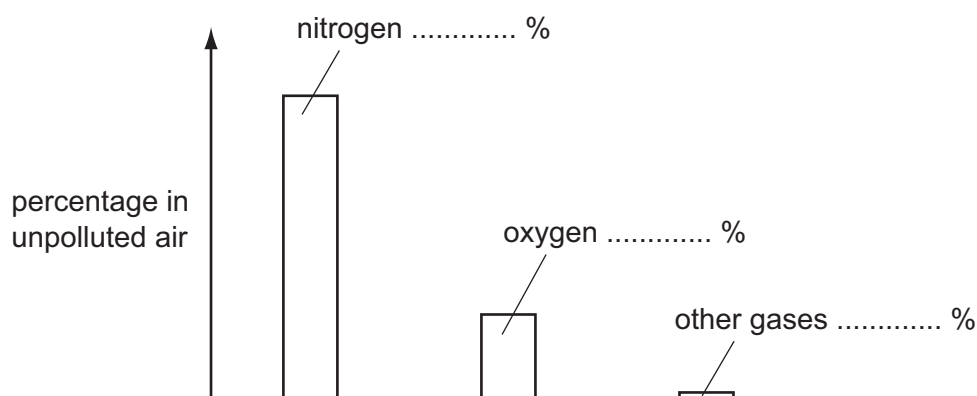


Fig. 8.1

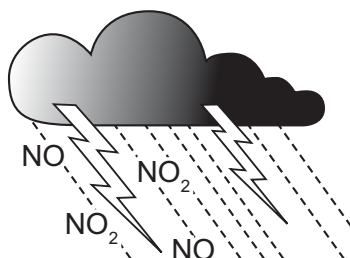
- (a) (i) Complete the bar chart in Fig. 8.1 by labelling the percentages of nitrogen, oxygen and other gases. [2]

- (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	0					0																																			
		1 <b>H</b> Hydrogen 1											4 <b>He</b> Helium 2																																		
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											20 <b>Ne</b> Neon 10																																			
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18					18																																			
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36					36																																			
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	101 <b>Ru</b> Ruthenium 44	106 <b>Pd</b> Palladium 46	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54					54																																			
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	190 <b>Os</b> Osmium 76	195 <b>Pt</b> Platinum 78	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	210 <b>Rn</b> Radon 86																																					
226 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89											86																																		
*58-71 Lanthanoid series																																															
†90-103 Actinoid series																																															
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%;"></td> <td style="width: 5%; text-align: center;">a</td> <td style="width: 5%; text-align: center;"><b>X</b></td> <td style="width: 5%; text-align: center;">b</td> <td style="width: 5%;"></td> <td style="width: 5%; text-align: center;">140 <b>Ce</b> Cerium 58</td> <td style="width: 5%; text-align: center;">141 <b>Pr</b> Praseodymium 59</td> <td style="width: 5%; text-align: center;">144 <b>Nd</b> Neodymium 60</td> <td style="width: 5%; text-align: center;">150 <b>Sm</b> Samarium 62</td> <td style="width: 5%; text-align: center;">152 <b>Eu</b> Europium 63</td> <td style="width: 5%; text-align: center;">157 <b>Gd</b> Gadolinium 64</td> <td style="width: 5%; text-align: center;">162 <b>Dy</b> Dysprosium 66</td> <td style="width: 5%; text-align: center;">165 <b>Ho</b> Holmium 67</td> <td style="width: 5%; text-align: center;">167 <b>Er</b> Erbium 68</td> <td style="width: 5%; text-align: center;">169 <b>Tm</b> Thulium 69</td> <td style="width: 5%; text-align: center;">173 <b>Yb</b> Ytterbium 70</td> <td style="width: 5%; text-align: center;">175 <b>Lu</b> Lutetium 71</td> </tr> <tr> <td style="text-align: right;"><b>Key</b></td> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">232 <b>Th</b> Thorium 90</td> <td style="text-align: center;">238 <b>U</b> Uranium 92</td> <td style="text-align: center;">238 <b>Np</b> Neptunium 93</td> <td style="text-align: center;">238 <b>Pu</b> Plutonium 94</td> <td style="text-align: center;">238 <b>Am</b> Americium 95</td> <td style="text-align: center;">238 <b>Cm</b> Curium 96</td> <td style="text-align: center;">238 <b>Bk</b> Berkelium 97</td> <td style="text-align: center;">238 <b>Cf</b> Californium 98</td> <td style="text-align: center;">238 <b>Es</b> Einsteinium 99</td> <td style="text-align: center;">238 <b>Fm</b> Fermium 100</td> <td style="text-align: center;">238 <b>Md</b> Mendelevium 101</td> <td style="text-align: center;">238 <b>No</b> Nobelium 102</td> <td style="text-align: center;">238 <b>Lr</b> Lawrencium 103</td> </tr> </table>														a	<b>X</b>	b		140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	<b>Key</b>					232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <b>Lr</b> Lawrencium 103
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<p style="text-align: right;">a = relative atomic mass  <b>X</b> = atomic symbol  b = proton (atomic) number</p>																																															

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