

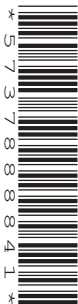
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**CO-ORDINATED SCIENCES (DOUBLE) (US)**

**0442/23**

Paper 2 (Core)

**October/November 2014**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

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

Write in dark blue or black pen.

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

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

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

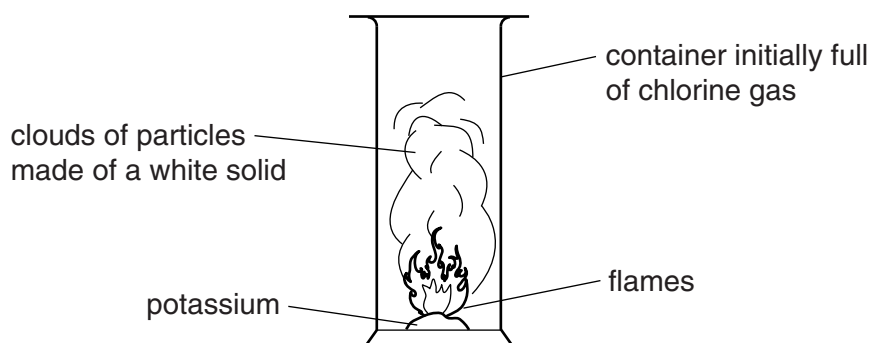
A copy of the Periodic Table is printed on page 32.

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.

This document consists of **31** printed pages and **1** blank page.

- 1 Fig. 1.1 shows what happens when a small piece of potassium metal reacts with chlorine gas inside a container.



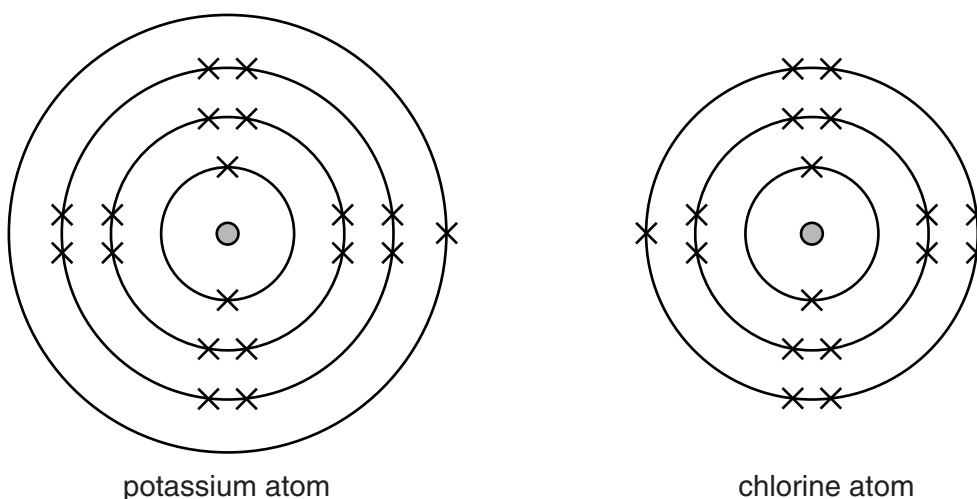
**Fig. 1.1**

When the reaction has finished, particles of a white solid compound are left in the container.

- (a) (i) Suggest the name of the white solid compound.

.....[1]

- (ii) Fig. 1.2 shows diagrams of a potassium atom and a chlorine atom.



**Fig. 1.2**

Describe what happens to these atoms when they change into ions.

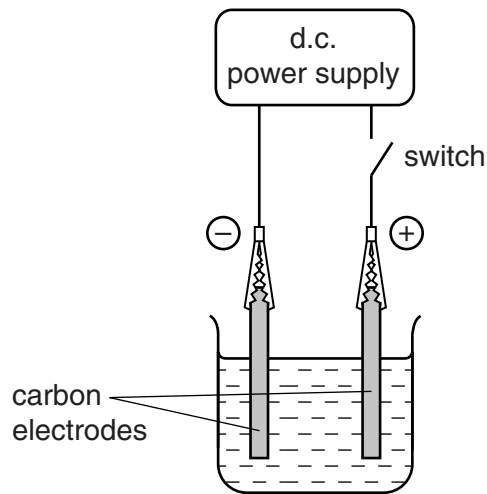
.....

.....

.....[2]

- (b) A chemical change occurs when an electrical current passes through a solution of a compound copper chloride.

Fig. 1.3 shows apparatus that can be used to investigate this chemical change.



**Fig. 1.3**

- (i) Name the process which occurs in the apparatus shown in Fig. 1.3 when the switch is closed. [1]
- .....[1]
- (ii) On Fig. 1.3 use label lines to label the cathode and the electrolyte. [2]
- (iii) When the switch is closed, bubbles of chlorine appear on the surface of the anode.

Describe a safe chemical test for chlorine.

.....

.....[2]

- (c) A student investigates whether there is any change in the mass of the electrodes during the electrolysis process shown in Fig. 1.3.

She uses the apparatus shown in Fig. 1.3 and her results are shown in Table 1.1.

**Table 1.1**

| electrode | mass before the switch is closed /g | mass after the switch has been closed for some time /g |
|-----------|-------------------------------------|--|
| anode     | 48.3                                | 48.3   |
| cathode   | 47.6                                | 47.9   |

- (i) State the changes in mass of the electrodes during the experiment.

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

- (ii) Explain the results obtained for the cathode.

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

2 Fig. 2.1 shows the chromosomes from the nucleus of a single cell of a human male.

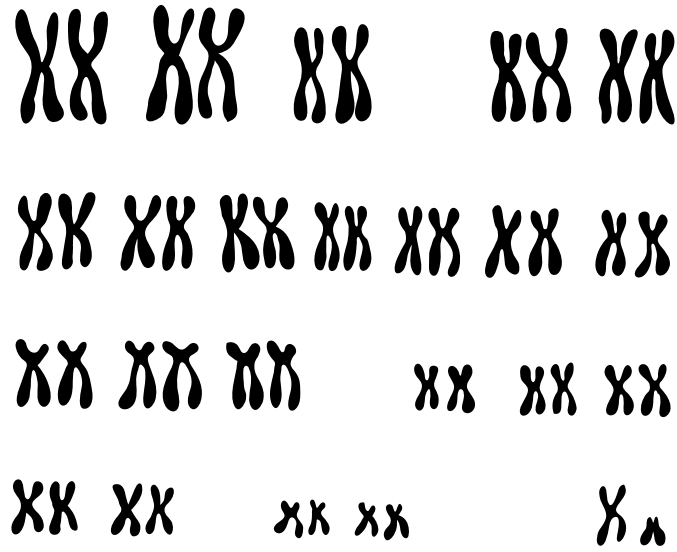


Fig. 2.1

(a) (i) State the number of chromosomes that can be seen in Fig. 2.1.

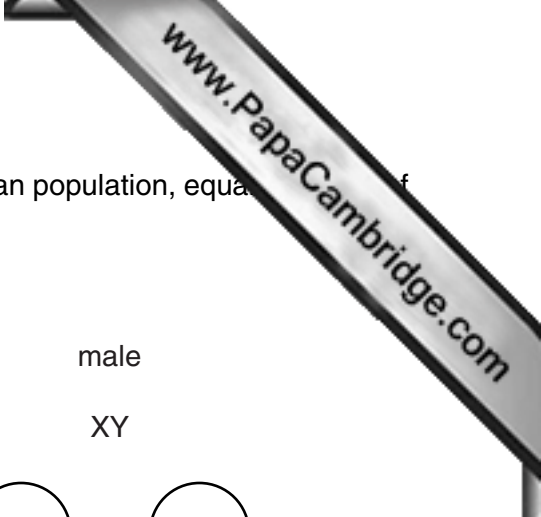
.....[1]

(ii) On Fig. 2.1, draw a circle around the Y chromosome.

[1]

(b) Chromosomes carry genes. Define a *gene*.

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



(c) Complete the genetic diagram below to explain why, in a human population, equal numbers of male and female babies should be expected.

**parents**

phenotypes

female

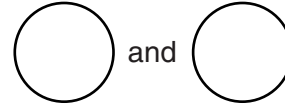
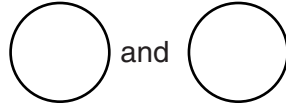
male

sex chromosomes

XX

XY

gametes



**chromosomes and phenotypes of offspring**

|                |  | male gametes |  |
|----------------|--|--------------|--|
|                |  |              |  |
| female gametes |  |              |  |
|                |  |              |  |

ratio of male to female .....

[4]

(d) In sea turtles, the sexes of the offspring are not determined by chromosomes. It depends on the temperature at which the eggs are incubated. Fig. 2.2 shows this effect.

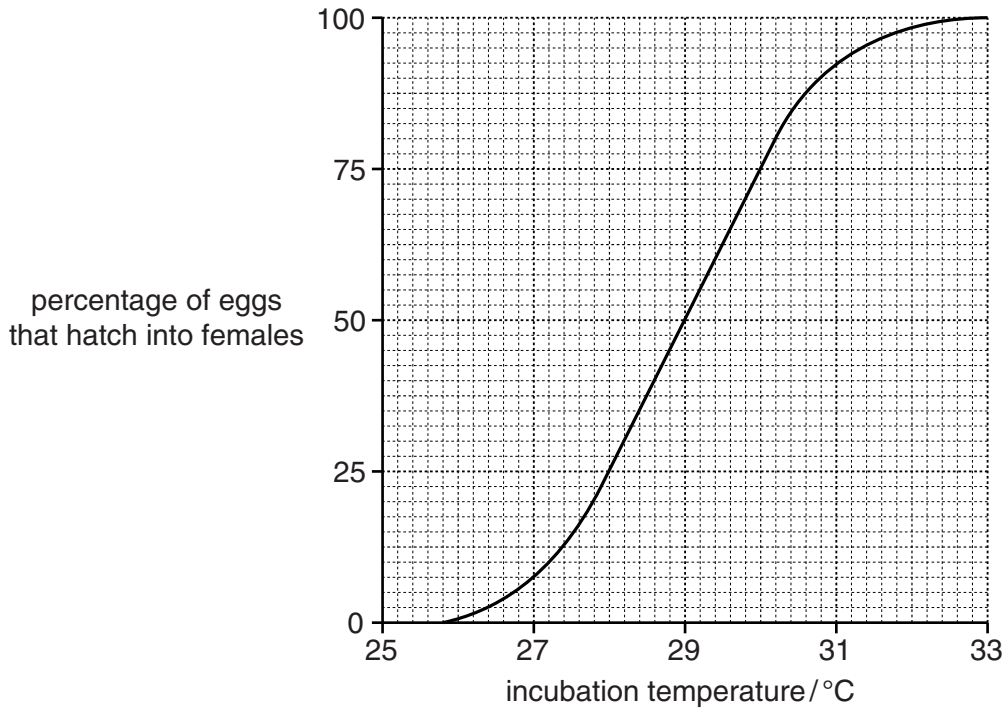


Fig. 2.2

(i) Describe the effect of temperature on the percentage of eggs that hatch into females.

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

(ii) State the temperature at which equal numbers of male and female offspring are produced.

.....°C [1]

(iii) Use the information in Fig. 2.2 to predict how global warming will affect the sea turtle population. Explain your answer.

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

- 3 (a) A motorcycle is driven along a straight road. Fig. 3.1 shows a speed/time graph for the motorcycle from the time the rider sees a car approaching and gradually slowing down.

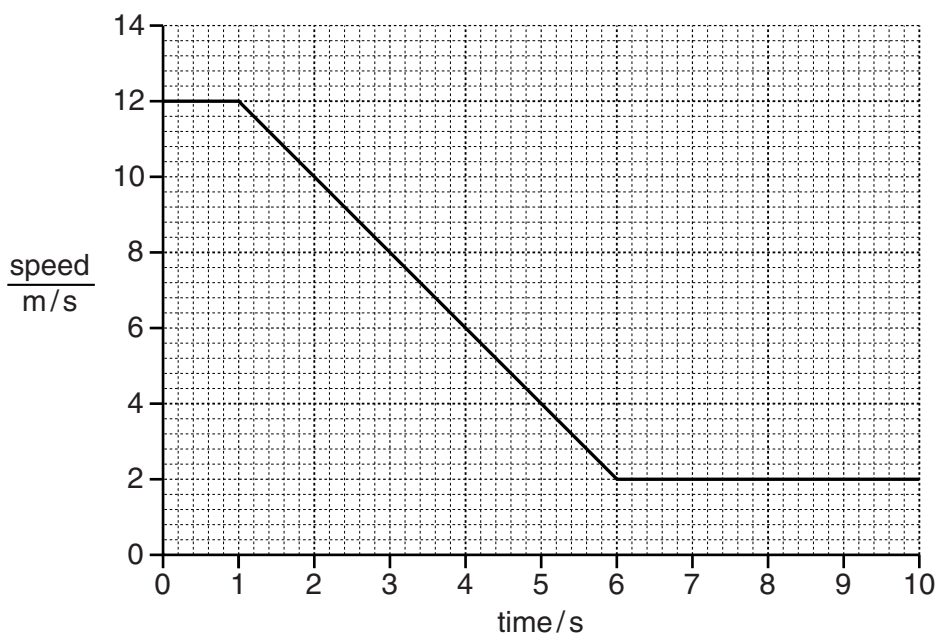


Fig. 3.1

- (i) State the speed at which the driver was traveling before he slowed down.  
 ..... m/s [1]

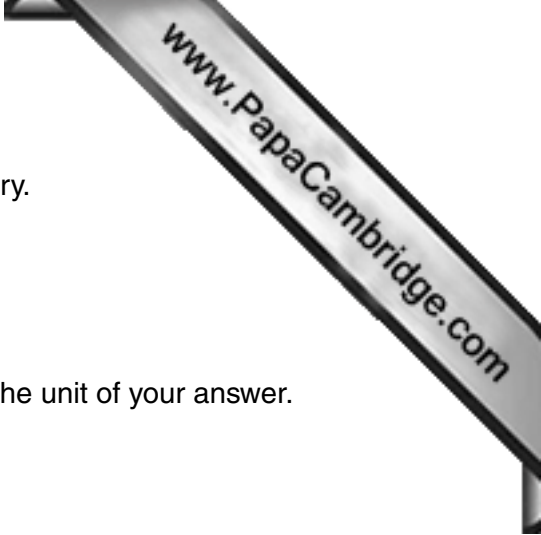
- (ii) State whether the motorcycle stopped during the period of ten seconds shown in Fig. 3.1.  
 Explain your answer.

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

- (b) The motorcycle rider notices that the sound from a car's engine becomes louder as the car approaches and drops in pitch as the car passes.

Describe these changes in terms of the frequency and amplitude of sound waves released.  
 becomes louder .....  
 .....  
 has a lower pitch .....  
 ..... [2]





(c) The motorcycle has one headlamp, connected to a 12V battery.

The headlamp takes a current of 4 A.

Calculate the resistance of the headlamp.

State the formula that you use, show your working and state the unit of your answer.

formula

working

resistance = ..... unit ..... [3]

(d) As the motorcycle drives along, the temperature of the air in the tires increases.

By referring to the motion of molecules in air, explain why this results in an increased tire pressure.

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

- (e) The metal bodywork of the motorcycle can be painted using electrostatic painting. In electrostatic paint spraying, the surface being painted is given a negative electric charge.

The paint particles emerge from the paint sprayer carrying a positive charge.

Fig. 3.2 shows part of a motorcycle frame being painted.

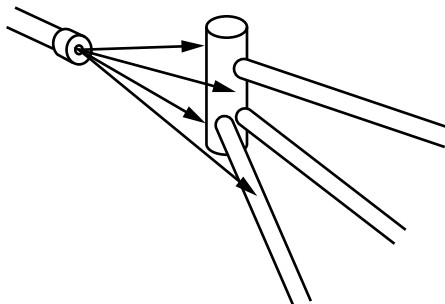


Fig. 3.2

- (i) Suggest why more paint sticks to the charged frame than to an uncharged frame.

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

- (ii) The motorcycle is painted evenly. An even coat of paint is achieved because the paint particles repel each other.

Explain why the particles repel each other.

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



**Please turn over for Question 4.**

4 (a) Define the term *transpiration*.

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

(b) Fig. 4.1 shows xylem vessels from the stem of a plant as seen in longitudinal section.

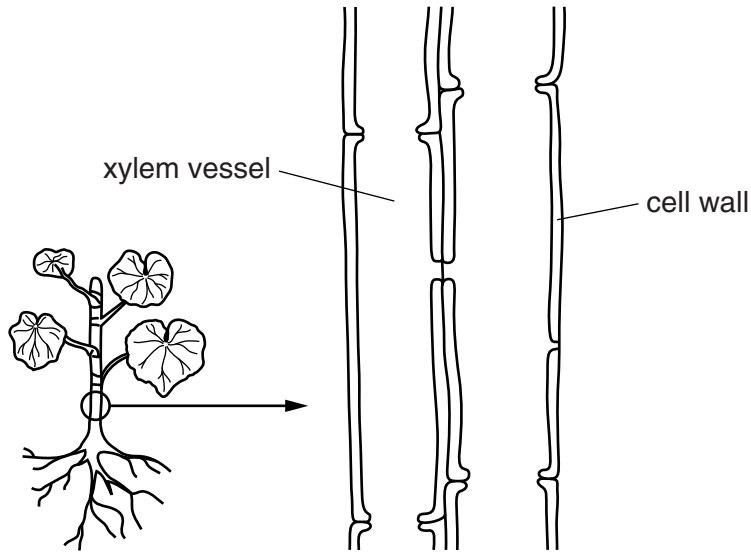


Fig. 4.1

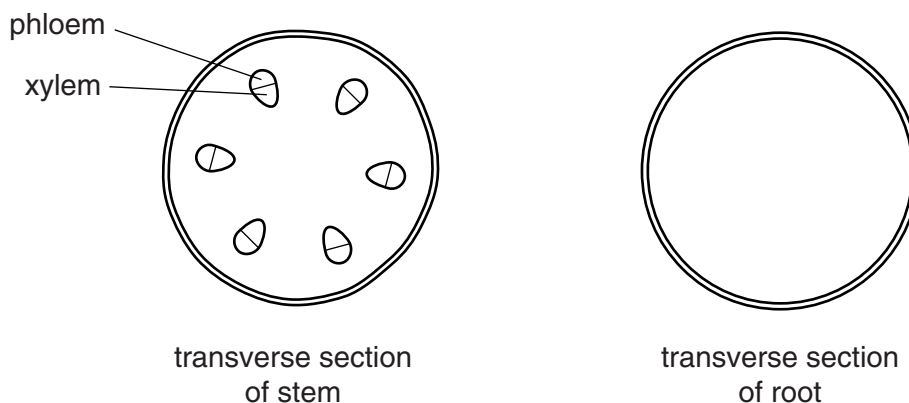
(i) On Fig. 4.1 draw an arrow to show the direction in which water flows through the xylem vessel. [1]

(ii) Name **one** other substance, apart from water, that is transported through xylem vessels.

.....[1]

(c) Fig. 4.2 shows a stem and a root in transverse section.

On the stem, the positions of the xylem and the phloem tissues have been labeled.



**Fig. 4.2**

(i) Complete the diagram of the root by drawing in the positions of the xylem and the phloem tissues and labeling them. [3]

(ii) State the function of the phloem.

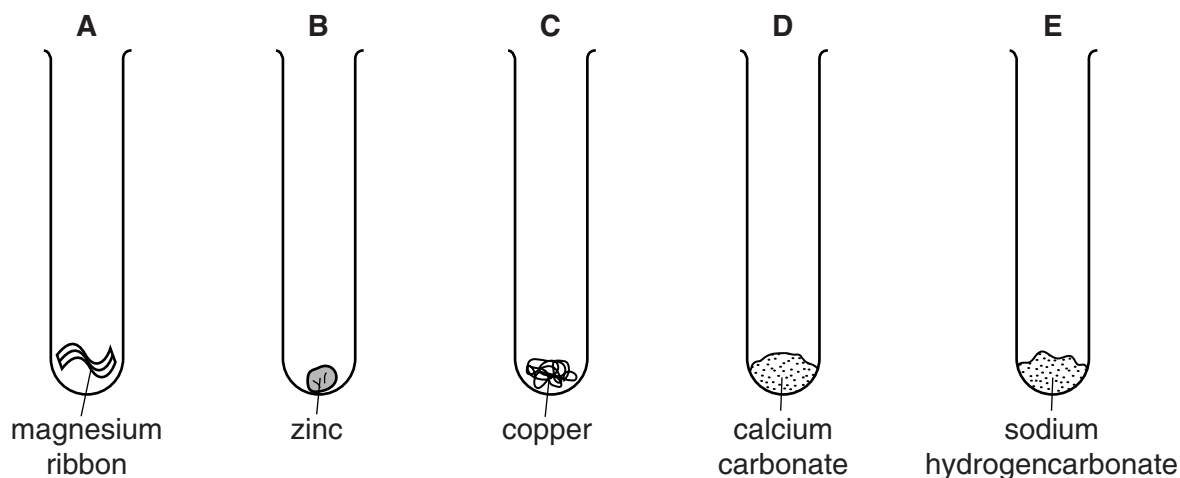
.....[1]

(d) Plants absorb water from the soil. Name the plant cells that take up most of this water.

..... [1]

- 5 A student investigates the reactions between dilute hydrochloric acid and five substances.

Fig. 5.1 shows the five substances contained in test-tubes **A** to **E**.



**Fig. 5.1**

She adds dilute hydrochloric acid to each tube.

Her observations and temperature measurements are shown in Table 5.1.

**Table 5.1**

| test-tube | observations          | temperature of the reactants before reaction/ $^{\circ}\text{C}$ | temperature of the mixture in the test-tube after a short time/ $^{\circ}\text{C}$ |
|-----------|-----------------------|--|--|
| <b>A</b>  | gas given off quickly | 18   | 45   |
| <b>B</b>  | gas given off slowly  | 18   | 19   |
| <b>C</b>  | no gas produced       | 18   |  |
| <b>D</b>  | gas given off quickly | 18   | 20   |
| <b>E</b>  | gas given off quickly | 18   | 11   |

- (a) (i) Name the gas given off when dilute hydrochloric acid is added to test-tubes **A** and **B**.

.....[1]

- (ii) Describe a test and its result for the gas you have named in (a)(i).

test .....

result .....[1]



(iii) The pH of the dilute hydrochloric acid before reacting is 2.

Predict the pH of the solution in test-tube **D** after reaction.

Explain your answer.

prediction .....

explanation .....

.....

.....[2]

(b) When substances are mixed together, a change in temperature is evidence that a chemical reaction occurs.

(i) Suggest the temperature of the mixture in test-tube **C** after a short time.

Write your answer in Table 5.1. [1]

(ii) Explain your answer to (b)(i).

.....

.....[1]

(iii) State and explain in which test-tube, **A**, **B**, **C**, **D** or **E**, an endothermic reaction occurs.

test-tube .....

explanation .....

.....[1]

(c) Suggest **two** possible reasons why gas is given off more quickly in test-tube **A** than in **B**.

1 .....

.....

2 .....

.....[2]

- 6 (a) Infrared waves can pass through optical fibers.

Fig. 6.1 shows a length of optical fiber.

An infrared ray goes in at one end and emerges at the other end.

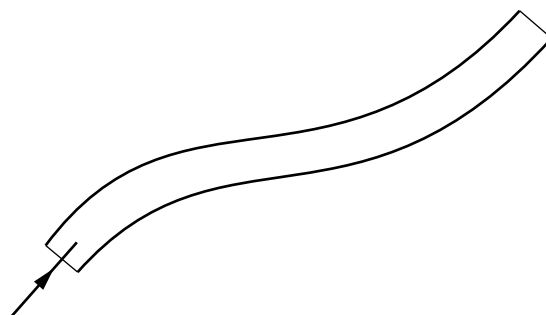


Fig. 6.1

On Fig. 6.1, use a ruler to draw its path along the optical fiber. [2]

- (b) (i) State what is transferred by all electromagnetic waves.

.....[1]

- (ii)  $\gamma$ -radiation is also part of the spectrum of electromagnetic waves.

State **one** difference between  $\gamma$ -radiation and infrared radiation.

.....[1]

- (c) Fig. 6.2 shows an experiment to investigate infrared radiation.

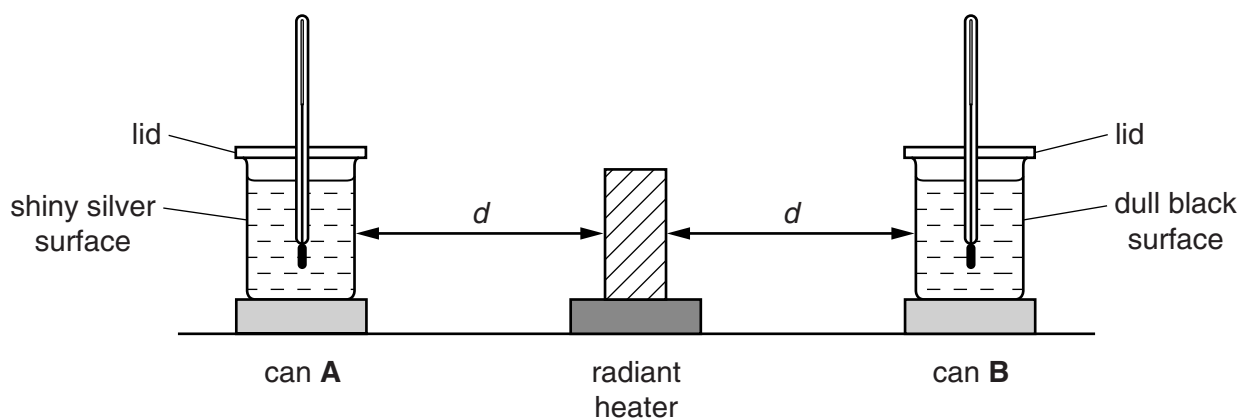


Fig. 6.2

Two similar cans **A** and **B** contain equal amounts of water which start off at the same temperature.

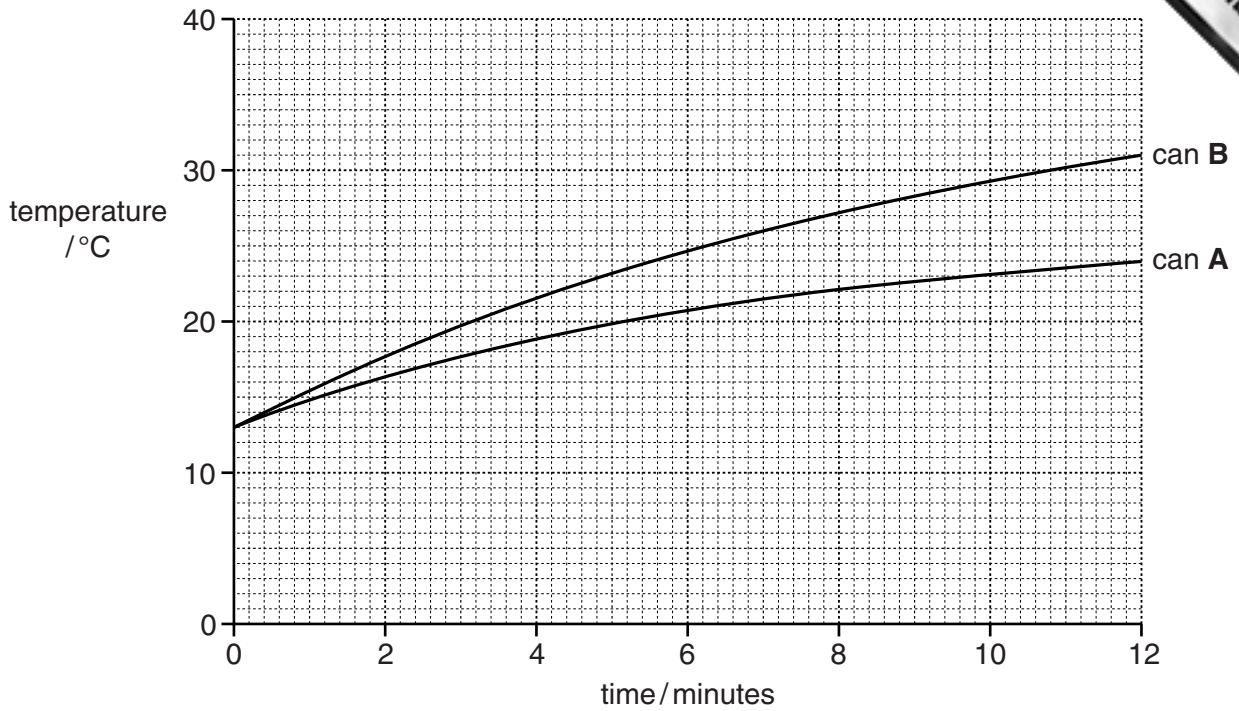
Can **A** has a shiny silver surface and can **B** has a dull black surface.

A thermometer is placed into each can. The cans stand on cork mats and are placed at the same distance  $d$  from a radiant heater emitting infrared radiation.

The temperature of the water is measured every minute for twelve minutes.



Fig. 6.3 shows how the temperature of the water changes for the two cans.



**Fig. 6.3**

(i) State the starting temperature of the water in both cans.

.....°C [1]

(ii) Explain why the two cans are placed on cork mats.

.....[1]

(iii) Describe how the temperature changes are different for the two cans.

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

(iv) Suggest reasons for your answer to (c)(iii).

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

7 Fig. 7.1 shows the concentration of carbon dioxide in a muscle cell of an athlete before and after a period of exercise.

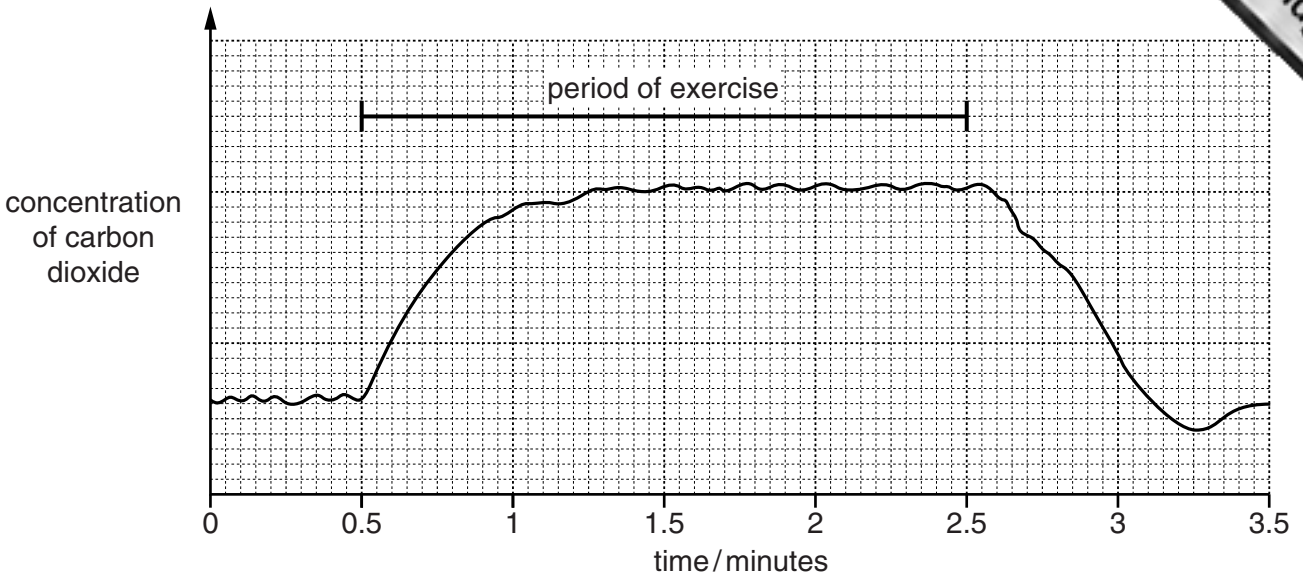
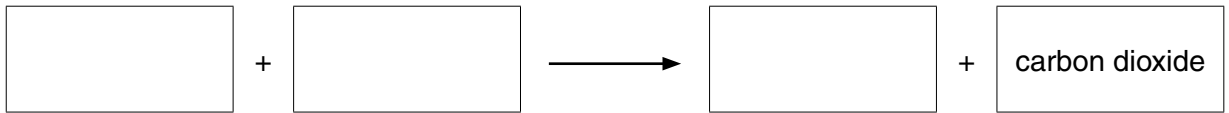


Fig. 7.1

(a) (i) Name the process that produces carbon dioxide in cells.

.....[1]

(ii) Complete the word equation for this process.



[2]

(b) State the time in Fig. 7.1 at which the carbon dioxide concentration is lowest.

.....min [1]

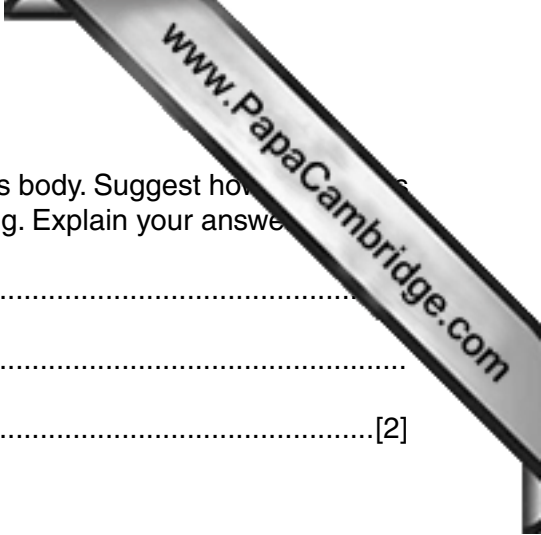
(c) During exercise, the blood flow to the muscles increases. Explain why this increased blood flow is important during exercise.

.....

.....

.....

.....[2]



(d) Training increases the number of red blood cells in an athlete's body. Suggest how this affects the amount of lactic acid produced when an athlete is sprinting. Explain your answer.

.....

.....

.....[2]

- 8 (a) A spillage of a radioactive substance occurs in a store for radioactive materials.

The activity due to normal background radiation is 100 counts per minute.

After the spillage, the activity in the store rises to 900 counts per minute.

- (i) State the meaning of the term *background radiation*.

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

- (ii) Write down the increase in activity produced by the spilled material.

..... counts per minute [1]

- (iii) The pie chart in Fig. 8.1 shows the proportion of the average background radiation that comes from all sources in the United Kingdom.

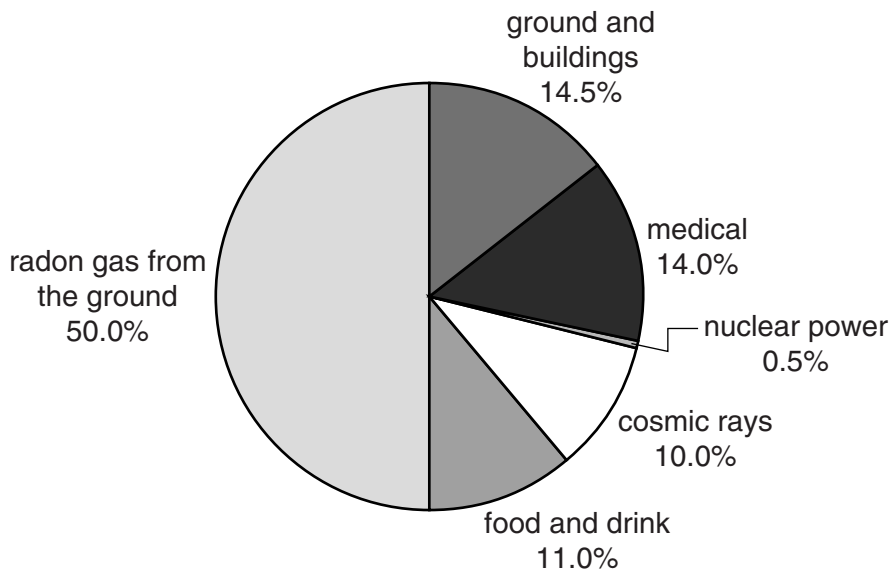


Fig. 8.1

Use the pie chart to explain why doubling the amount of power generated from nuclear sources would only produce a relatively small increase in background radiation.

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

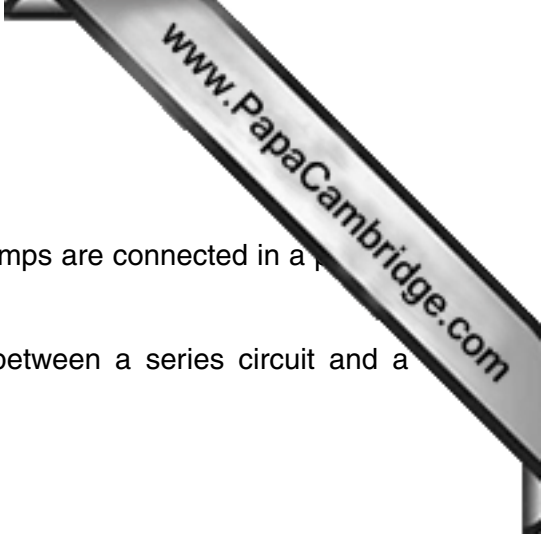
- (b) Apart from cost, give **one** advantage and **one** disadvantage of an oil-fired power station compared to a nuclear power station.

advantage .....

.....

disadvantage .....

.....[2]



(c) Electricity supplied to a house is used to produce light.

The lighting circuits in a house are constructed so that the lamps are connected in a parallel circuit and not a series circuit.

(i) Draw simple circuit diagrams to show the difference between a series circuit and a parallel circuit.

Each circuit should include a power source (a cell).

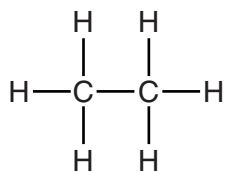
[2]

(ii) State **two** advantages of connecting lamps in parallel in a lighting circuit.

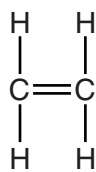
1 .....

2 ..... [2]

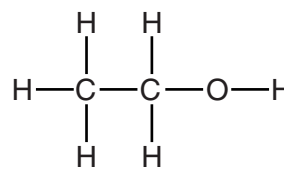
- 9 Fig. 9.1 shows molecules of ethane, ethene and ethanol.



ethane



ethene



ethanol

**Fig. 9.1**

- (a) (i) State and explain which of these compounds are hydrocarbons.

compounds .....

explanation .....

.....[2]

- (ii) State and explain which **one** of the three compounds named above is an unsaturated compound.

compounds .....

explanation .....

.....[1]

- (b) (i) State **one** use of ethanol.

.....[1]

- (ii) In industry, ethanol is made in a chemical reaction involving ethene.

Name the substance that reacts with ethene to produce ethanol.

.....[1]

- (iii) The reaction in (b)(ii) needs a catalyst.

State the meaning of the term *catalyst*.

.....

.....

.....[2]

(c) Ethene is a colorless gas that reacts to form poly(ethene) which is a white solid.

(i) Describe what happens when ethene molecules react to form poly(ethene) molecules.

Draw a diagram to help you answer this question.

Use the symbol  $\text{---} \bigcirc \text{E} \text{---}$  to show an ethene molecule.

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

(ii) State the full name of the type of chemical reaction that occurs in (c)(i).

.....[2]

10 (a) Fig. 10.1 represents some waves on water.

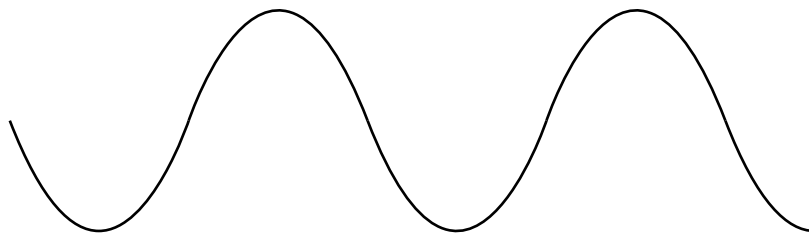


Fig. 10.1

(i) On Fig. 10.1 label with an arrow ( ←————→ ) one wavelength.

[1]

(ii) The waves have a frequency of 0.2 Hz.

Explain what is meant by a *frequency of 0.2 Hz*.

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

(iii) Water waves are transverse waves and sound waves are longitudinal waves.

Describe how a transverse wave is different from a longitudinal wave.

You may draw a labeled diagram if it helps your answer.

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



(b) A large meteorite falls into the sea.

(i) The meteorite produces a wave which travels at a speed of 5.6 m/s.

Calculate the time taken by the wave to travel 33 600 m.

State the formula that you use and show your working.

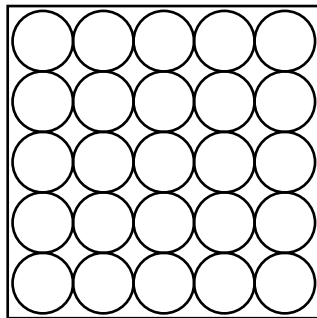
formula

working

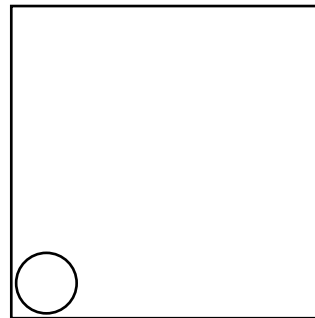
time = ..... s [2]

(ii) The meteorite is a solid and the sea water is a liquid.

Complete Fig. 10.2 to show the arrangement of particles in a liquid. The diagram for a solid has been done for you.



solid



liquid

[2]

Fig. 10.2

(iii) The mass of the meteorite is 32 000 kg and its volume is 4 m<sup>3</sup>.

Calculate the density of the meteorite in kg/m<sup>3</sup>.

State the formula that you use and show your working.

formula

working

density = ..... kg/m<sup>3</sup> [2]

11 Fig. 11.1 shows two liver cells, as seen under a light microscope.

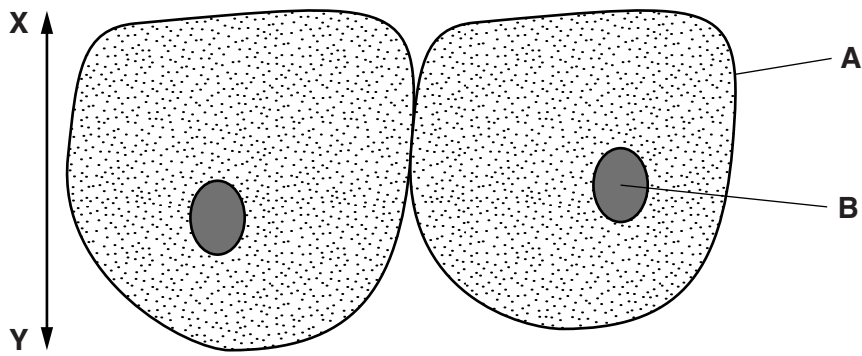


Fig. 11.1

(a) Name the structures labeled **A** and **B**.

**A** .....

**B** .....

[2]

(b) State **two** functions of liver cells.

1 .....

2 ..... [2]

(c) Give **three** ways in which a plant palisade cell differs from a liver cell.

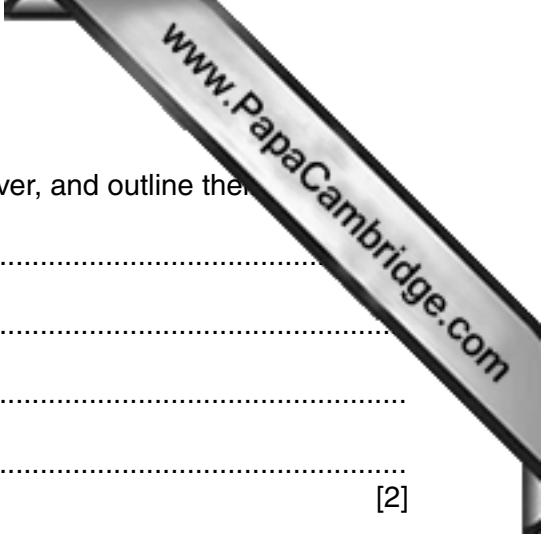
1 .....

2 .....

3 ..... [3]

(d) In Fig. 11.1, the actual height of the cells along the line **X–Y** is 0.03mm. Calculate the magnification of the drawing.

magnification = ..... [2]



(e) Name **two** of the blood vessels that are associated with the liver, and outline their

vessel 1 .....

function .....

vessel 2 .....

function .....

[2]

- 12 (a) The Periodic Table lists the elements in order of their proton numbers.

Fig. 12.1 shows the positions of the first eighteen elements.

The letters are **not** the chemical symbols of the elements.

|   |    |     |    |   |    |     |   |
|---|----|-----|----|---|----|-----|---|
| I | II | III | IV | V | VI | VII | 0 |
|   |    |     |    |   |    |     |   |
|   |    |     |    |   |    | L   | M |
| N |    |     |    |   |    | O   | P |

Fig. 12.1

- (i) State the meaning of the terms *proton number* and *nucleon number (mass number)*.

proton number .....

.....

nucleon number .....

.....[2]

- (ii) Predict and explain whether element **N** has a higher or lower melting point than element **P**.

.....

.....[1]

- (iii) State and explain which other element in Fig. 12.1 has chemical properties that are very similar to those of element **O**.

element .....

explanation .....

.....[2]

- (b) Carbon dioxide is a gas at room temperature and contains molecules that have the chemical formula  $\text{CO}_2$ .

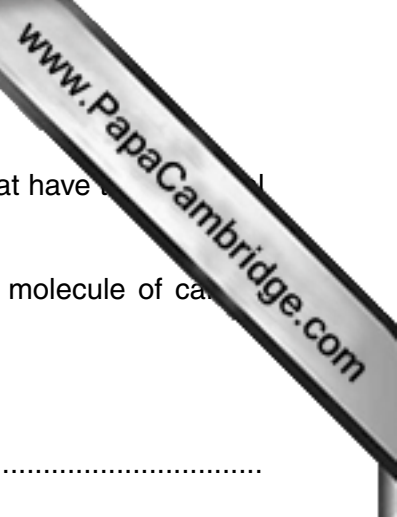
State the type of chemical bonding that joins the atoms together in a molecule of carbon dioxide.

Give a reason for your choice.

type of bonding .....

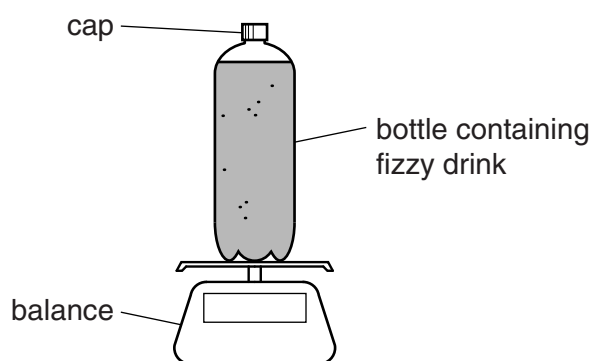
reason .....

.....[2]



- (c) A student investigates how much carbon dioxide gas is contained in a carbonated drink.

He measures the mass of a full bottle of fizzy drink.



He shakes the bottle. He releases the carbon dioxide by carefully unscrewing the cap.

He measures the mass of the bottle and cap, and liquid without the carbon dioxide.

His results are shown in Table 12.1.

**Table 12.1**

| mass of bottle filled with fizzy drink /g | mass of bottle and cap, and liquid without carbon dioxide /g | volume of the liquid /cm <sup>3</sup> |
|---|--|---------------------------------------|
| 526.2                                     | 524.0  | 500.0                                 |

- (i) State the mass of carbon dioxide that was released from the fizzy drink.

Show your working.

mass = .....g [1]

- (ii) Calculate the mass of carbon dioxide that is dissolved in 1.0 dm<sup>3</sup> of the fizzy drink.

Show your working.

mass = .....g [2]



**DATA SHEET**  
**The Periodic Table of the Elements**

| Group                              |                                    | I                                   | II                                 | III                                    | IV                                     | V                                    | VI                                  | VII                                | 0                                    |                                       |                                       |                                      |  |                                     |                                       |                                     |                                    |
|------------------------------------|------------------------------------|-------------------------------------|------------------------------------|--|--|--------------------------------------|-------------------------------------|------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|--|-------------------------------------|---------------------------------------|-------------------------------------|------------------------------------|
|                                    |                                    | 1<br><b>H</b><br>Hydrogen<br>1      |                                    |  |  |                                      |                                     |                                    | 4<br><b>He</b><br>Helium<br>2        |                                       |                                       |                                      |  |                                     |                                       |                                     |                                    |
| 7<br><b>Li</b><br>Lithium<br>3     | 9<br><b>Be</b><br>Beryllium<br>4   |                                     |                                    |  |  |                                      |                                     | 16<br><b>O</b><br>Oxygen<br>8      | 19<br><b>F</b><br>Fluorine<br>9      | 20<br><b>Ne</b><br>Neon<br>10         |                                       |                                      |  |                                     |                                       |                                     |                                    |
| 23<br><b>Na</b><br>Sodium<br>11    | 24<br><b>Mg</b><br>Magnesium<br>12 | 27<br><b>Al</b><br>Aluminum<br>13   | 28<br><b>Si</b><br>Silicon<br>14   | 31<br><b>P</b><br>Phosphorus<br>15     | 32<br><b>S</b><br>Sulfur<br>16         | 35<br><b>Cl</b><br>Chlorine<br>17    | 36<br><b>Ar</b><br>Argon<br>18      |                                    |                                      |                                       |                                       |                                      |  |                                     |                                       |                                     |                                    |
| 39<br><b>K</b><br>Potassium<br>19  | 40<br><b>Ca</b><br>Calcium<br>20   | 45<br><b>Sc</b><br>Scandium<br>21   | 48<br><b>Ti</b><br>Titanium<br>22  | 51<br><b>V</b><br>Vanadium<br>23       | 52<br><b>Cr</b><br>Chromium<br>24      | 55<br><b>Mn</b><br>Manganese<br>25   | 56<br><b>Fe</b><br>Iron<br>26       | 59<br><b>Co</b><br>Cobalt<br>27    | 64<br><b>Cu</b><br>Copper<br>29      | 65<br><b>Zn</b><br>Zinc<br>30         | 70<br><b>Ga</b><br>Gallium<br>31      | 73<br><b>Ge</b><br>Germanium<br>32   | 75<br><b>As</b><br>Arsenic<br>33       | 76<br><b>Se</b><br>Selenium<br>34   | 79<br><b>Br</b><br>Bromine<br>35      | 84<br><b>Kr</b><br>Krypton<br>36    |                                    |
| 85<br><b>Rb</b><br>Rubidium<br>37  | 88<br><b>Sr</b><br>Strontium<br>38 | 89<br><b>Y</b><br>Yttrium<br>39     | 91<br><b>Zr</b><br>Zirconium<br>40 | 93<br><b>Nb</b><br>Niobium<br>41       | 96<br><b>Mo</b><br>Molybdenum<br>42    | 101<br><b>Ru</b><br>Ruthenium<br>44  | 106<br><b>Pd</b><br>Palladium<br>46 | 108<br><b>Ag</b><br>Silver<br>47   | 112<br><b>Cd</b><br>Cadmium<br>48    | 115<br><b>In</b><br>Indium<br>49      | 119<br><b>Sn</b><br>Tin<br>50         | 122<br><b>Sb</b><br>Antimony<br>51   | 127<br><b>I</b><br>Iodine<br>53        | 128<br><b>Te</b><br>Tellurium<br>52 | 131<br><b>Xe</b><br>Xenon<br>54       | 222<br><b>Rn</b><br>Radon<br>86     |                                    |
| 133<br><b>Cs</b><br>Caesium<br>55  | 137<br><b>Ba</b><br>Barium<br>56   | 139<br><b>La</b><br>Lanthanum<br>57 | 178<br><b>Hf</b><br>Hafnium<br>72  | 181<br><b>Ta</b><br>Tantalum<br>73     | 184<br><b>W</b><br>Tungsten<br>74      | 190<br><b>Os</b><br>Osmium<br>76     | 195<br><b>Pt</b><br>Platinum<br>78  | 197<br><b>Au</b><br>Gold<br>79     | 201<br><b>Hg</b><br>Mercury<br>80    | 204<br><b>Tl</b><br>Thallium<br>81    | 207<br><b>Pb</b><br>Lead<br>82        | 209<br><b>Bi</b><br>Bismuth<br>83    | 210<br><b>At</b><br>Astatine<br>85     | 209<br><b>Po</b><br>Polonium<br>84  | 222<br><b>Rn</b><br>Radon<br>86       |                                     |                                    |
| 223<br><b>Fr</b><br>Francium<br>87 | 226<br><b>Ra</b><br>Radium<br>88   | 227<br><b>Ac</b><br>Actinium<br>89  |                                    |  |  |                                      |                                     |                                    | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64  | 159<br><b>Tb</b><br>Terbium<br>65     | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67      | 167<br><b>Er</b><br>Erbium<br>68    | 169<br><b>Tm</b><br>Thulium<br>69     | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71 |
|                                    |                                    |                                     |                                    | 144<br><b>Nd</b><br>Neodymium<br>60    | 141<br><b>Pr</b><br>Praseodymium<br>59 | 147<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 159<br><b>Tb</b><br>Terbium<br>65     | 162<br><b>Dy</b><br>Dysprosium<br>66  | 165<br><b>Ho</b><br>Holmium<br>67    | 167<br><b>Er</b><br>Erbium<br>68       | 169<br><b>Tm</b><br>Thulium<br>69   | 173<br><b>Yb</b><br>Ytterbium<br>70   | 175<br><b>Lu</b><br>Lutetium<br>71  |                                    |
|                                    |                                    | 232<br><b>Th</b><br>Thorium<br>90   | 238<br><b>U</b><br>Uranium<br>92   | 231<br><b>Pa</b><br>Protactinium<br>91 | 237<br><b>Np</b><br>Neptunium<br>93    | 244<br><b>Pu</b><br>Plutonium<br>94  | 243<br><b>Am</b><br>Americium<br>95 | 247<br><b>Cm</b><br>Curium<br>96   | 247<br><b>Bk</b><br>Berkelium<br>97  | 251<br><b>Cf</b><br>Californium<br>98 | 252<br><b>Es</b><br>Einsteinium<br>99 | 257<br><b>Fm</b><br>Fermium<br>100   | 258<br><b>Md</b><br>Mendelevium<br>101 | 259<br><b>No</b><br>Nobelium<br>102 | 260<br><b>Lr</b><br>Lawrencium<br>103 |                                     |                                    |

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

**Key**

|   |          |
|---|----------|
| a | <b>X</b> |
| b |          |

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

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