Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

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| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | |

*0123456789*

**CO-ORDINATED SCIENCES** **0654/03**

Paper 3 Theory (Core) **For Examination from 2019**

SPECIMEN PAPER

**2 hours**

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 an HB pencil for any diagrams or graphs.
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 you working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 31.

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 **30** printed pages and **2** blank pages.



CAMBRIDGE International Examinations

**1 (a) (i)** A torch (flashlight) contains three cells, a lamp and a switch connected in series. Using the correct circuit symbols, draw the electrical circuit for the torch.

[2]

**(ii)** The resistance of the lamp is 5.0 Ω when the potential difference across the lamp is 4.5 V.

Calculate the current through the lamp.

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

formula

working

current = ..... unit ..... [3]

**(iii)** The resistance of the lamp is 5.0 Ω when lit.

Two identical lamps are connected together in series.

State the combined resistance of the two lamps when connected in series.

..... Ω [1]

**(b)** Fig. 1.1 shows a ray of light from the torch incident on a plane mirror.

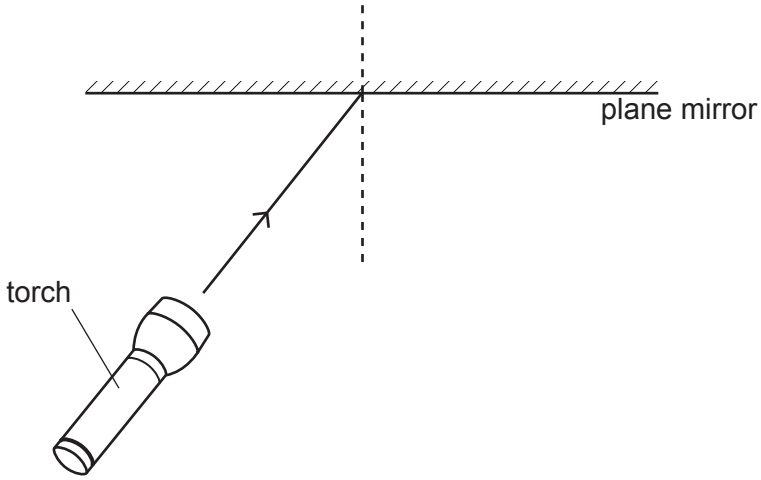


**Fig. 1.1**

**(i)** On Fig. 1.1 draw the reflected ray. [1]

**(ii)** On Fig. 1.1 label the angle of incidence with the letter *i*. [1]

**(iii)** State what happens to the value of the angle of reflection when the angle of incidence is doubled.

..... [1]

[Total: 9]

**2** Petroleum (crude oil) is separated at an oil refinery.

**(a)** Fig. 2.1 shows the industrial apparatus used to obtain gasoline and diesel oil from petroleum.

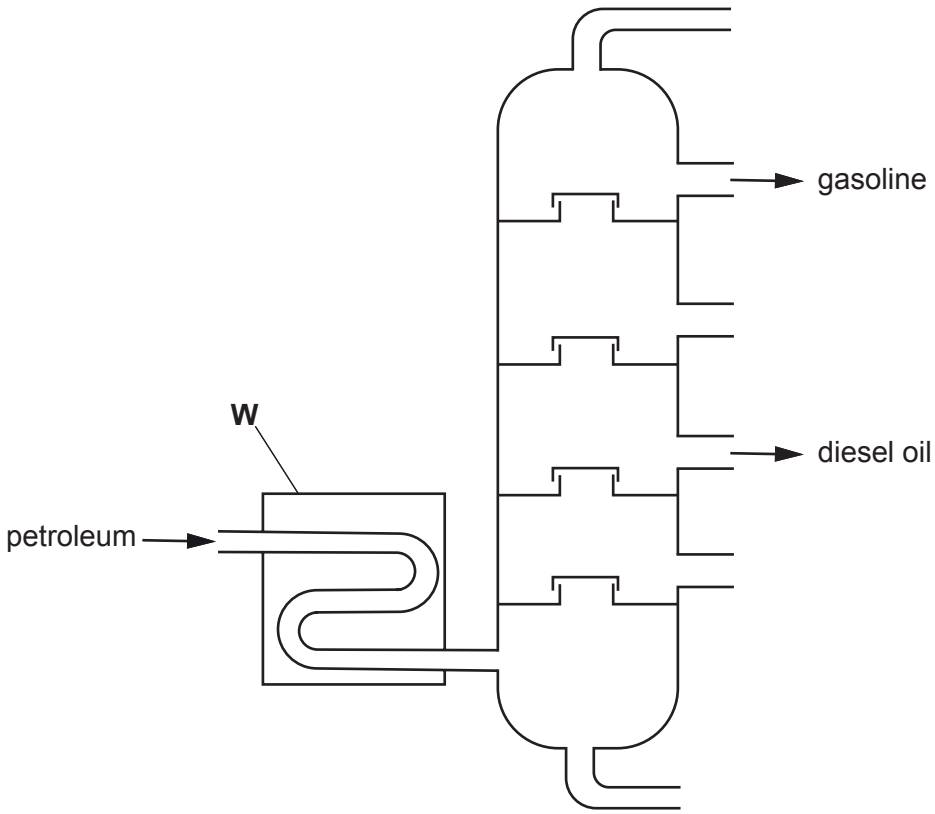


**Fig. 2.1**

**(i)** Name the process shown in Fig. 2.1.

..... [1]

**(ii)** State what happens to petroleum in the part of the apparatus labelled **W**.

..... [1]

**(b)** Fig. 2.2 shows the molecular structure of a compound found in gasoline and diesel oil.

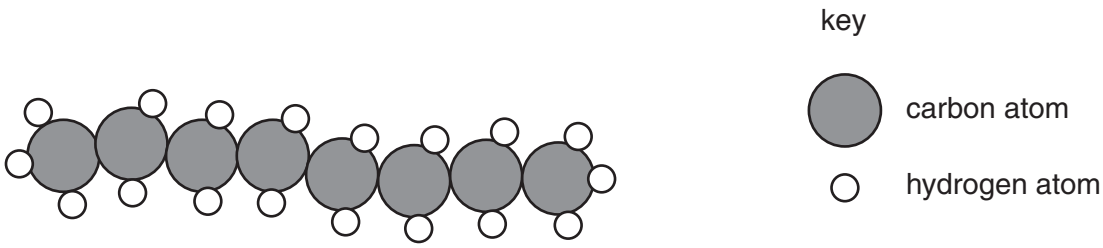


**Fig. 2.2**

**(i)** State the type of compound shown in Fig. 2.2.

..... [1]

**(ii)** Give the formula of the molecule shown in Fig. 2.2.

..... [1]

**(c)** Gasoline is used as a fuel in car engines. Gasoline contains sulfur compounds.

**(i)** The sulfur compounds in the gasoline burn in the car engine.

Name the pollutant gas that forms when sulfur burns.

..... [1]

**(ii)** State an adverse effect of the pollutant gas in **(i)**.

..... [1]

[Total: 6]

**3** Fig. 3.1 shows part of a leaf in section, as it appears under a microscope.

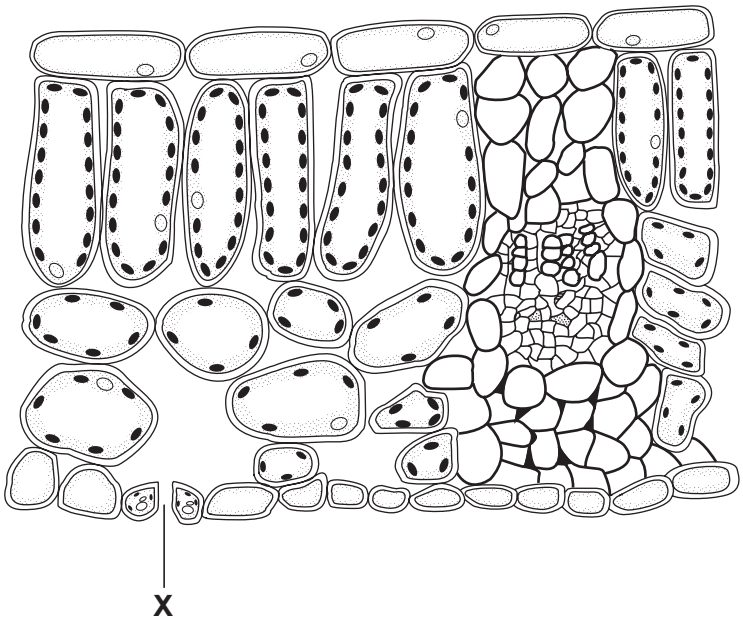


**Fig. 3.1**

**(a)** Plants lose water from their leaves in the form of water vapour.

**(i)** State the name for the loss of water from leaves.

..... [1]

**(ii)** Water inside the leaf evaporates and the water vapour then diffuses through pores in the leaf.

On Fig. 3.1, use a label line with the letter **E** to show a place inside the leaf where water evaporates. [1]

**(iii)** Name the pore in the leaf labelled **X**.

..... [1]

**(iv)** State two environmental conditions that would increase the rate of water loss from a leaf.

1. .....

2. .....
[2]

**(b)** Water is transported through the plant from the root to the leaf.

Complete the sequence to show the pathway of water through the plant.

root hair → ..... → xylem → cells in the leaf [1]

**(c)** State the products of photosynthesis.

1. .....

2. .....
[2]

**(d)** The leaf is the area where most photosynthesis occurs in a plant. The flower is the part of the plant involved in reproduction.

Fig. 3.2 shows a section through a flower.

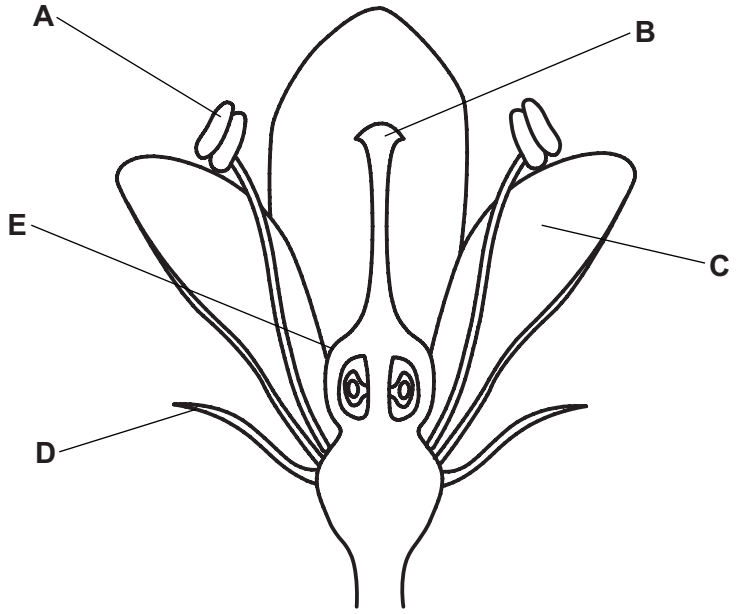


**Fig. 3.2**

Write **one** letter from Fig. 3.2 to identify **each** of the following.

petal .....

anther .....

stigma .....

sepal .....

[4]

[Total: 12]

**4** **(a)** Fig. 4.1 shows a speed-time graph for a police car.

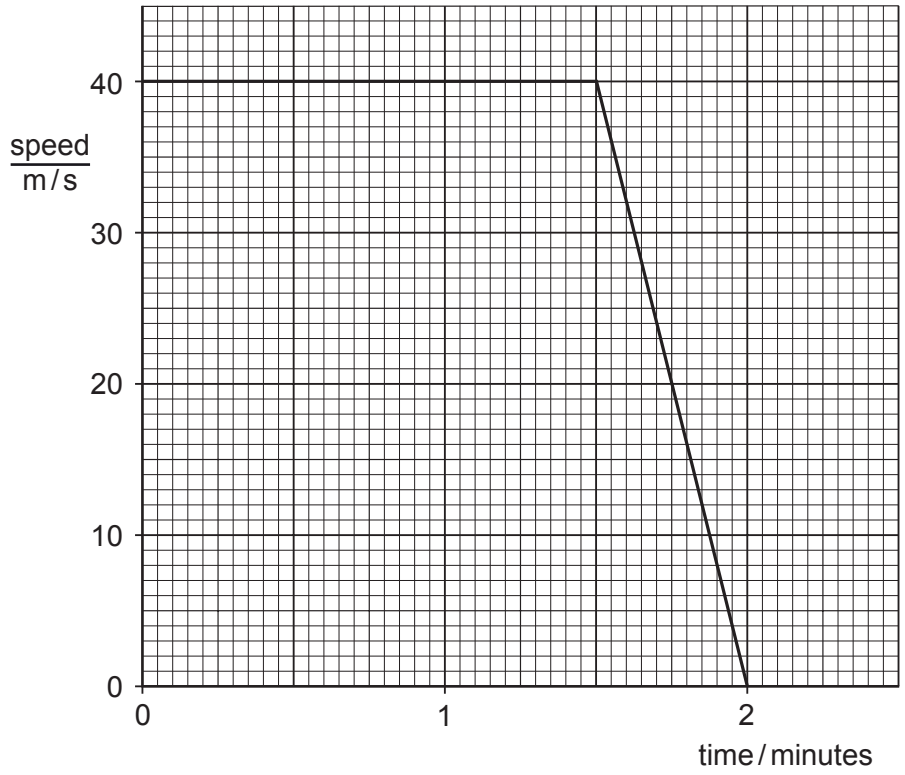


**Fig. 4.1**

**(i)** Label with the letter **X** a point on the graph when the police car is not moving. [1]

**(ii)** Label with the letter **D** a point on the graph where the car is decelerating. [1]

**(iii)** Label with the letter **K** a point on the graph where the car has the most kinetic energy. [1]

**(b)** The police car communicates with the police station using radio waves. The police car uses a flashing light to alert people.

**(i)** Radio waves and visible light are both parts of the electromagnetic spectrum.

Place radio waves and visible light in the correct boxes of the incomplete electromagnetic spectrum below.

| | | | | | | |
|---|---|---|---|---|---|---|
| | microwaves | infra-red | | | X-rays | |

[2]

**(ii)** Microwaves are used for heating and cooking food.

State **one** other use for microwaves.

..... [1]

**(iii)** State **one** difference between the wave properties of radio waves and visible light.

.....

..... [1]

**(iv)** Fig. 4.2 represents a wave.

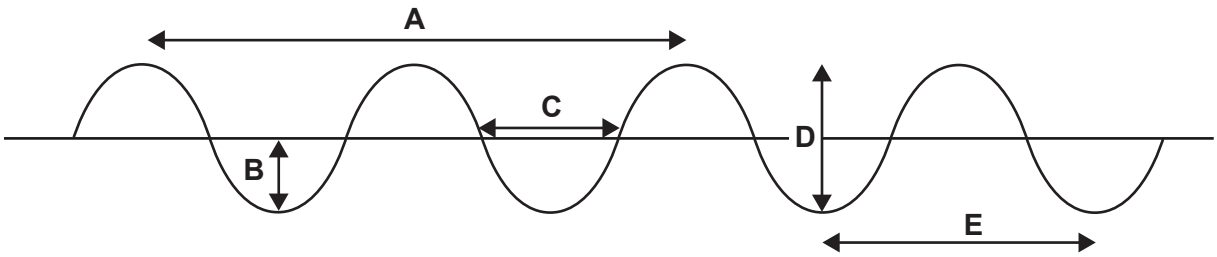


**Fig. 4.2**

State which measurement, **A**, **B**, **C**, **D** or **E**, is

the amplitude of the wave .....

the wavelength of the wave .....
[2]

**(c)** The bodywork of the police car is made from steel.

The bodywork of some vehicles is made from aluminium.

Suggest a simple way of deciding whether the bodywork of a vehicle is made from steel or aluminium.

.....

..... [1]

[Total: 10]

**5** Sea water contains dissolved salt (sodium chloride).

**(a)** Describe how sodium chloride crystals can be obtained from sea water.

.....

.....

..... [2]

**(b)** Sodium chloride is formed when sodium metal reacts with chlorine gas.

In this reaction, sodium atoms are changed into sodium ions.

**(i)** Complete the sentences to explain the difference between a sodium atom, Na, and a sodium ion, $Na^+$.

A sodium **atom** has no overall charge because .....

.....

.....

A sodium **ion** has one positive charge because .....

.....

.....
[2]

**(ii)** Name the type of bonding in sodium chloride.

..... [1]

**(c)** Fig. 5.1 shows laboratory apparatus that is used to obtain chlorine from sodium chloride solution.

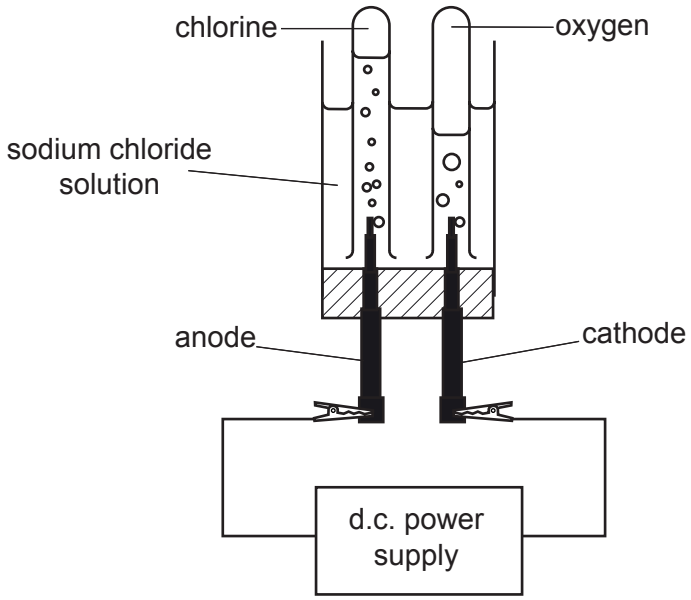


**Fig. 5.1**

**(i)** Name the process shown in Fig. 5.1.

..... [1]

**(ii)** State the charge on the anode.

..... [1]

**(iii)** The anode and cathodes are inert electrodes.

State the meaning of the term *inert*.

..... [1]

[Total: 8]

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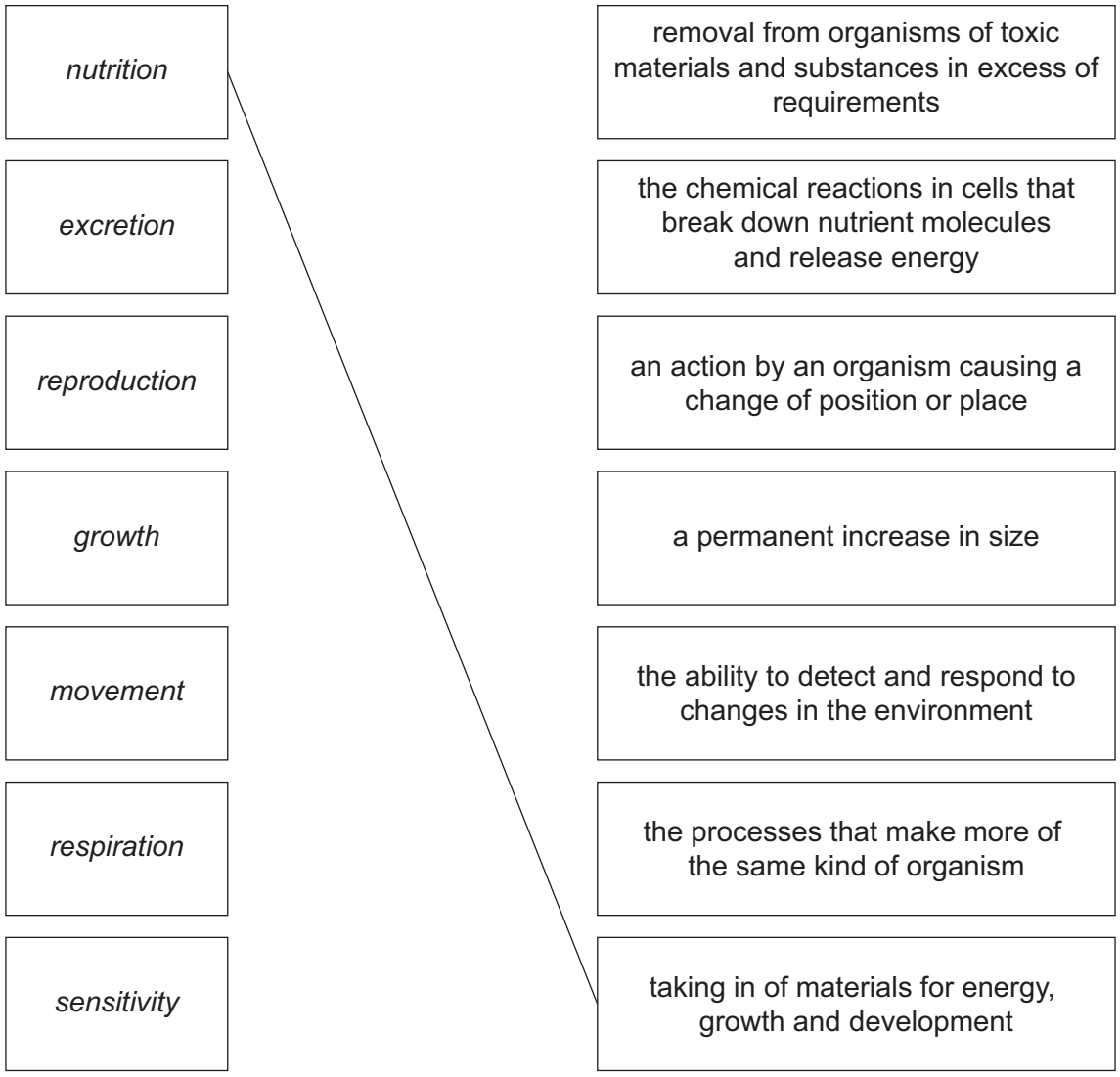
**6** Nutrition is one of the seven characteristics of living organisms.

The characteristics of living organisms are listed on the left hand side.

The definitions are on the right hand side.

**(a)** Match the characteristics and definitions by drawing lines between them on the diagram below. One has been done for you.




[3]

**(b)** A scientist investigates the effect of diet on the growth of mice.

The scientist feeds two groups of mice different diets. Table 6.1 shows the diets fed to the mice.

**Table 6.1**

| group | type of diet | contents of diet |
|---|---|---|
| 1 | basic | protein, carbohydrate, fat, mineral ions and plenty of water |
| 2 | supplemented | protein, carbohydrate, fat, mineral ions, plenty of water and some milk. |

The scientist measures the average mass of the mice in each group every day for 18 days.

After 18 days he changes over the diets given to the groups of mice and continues the investigation.

The results of the investigation are shown in Fig. 6.1.

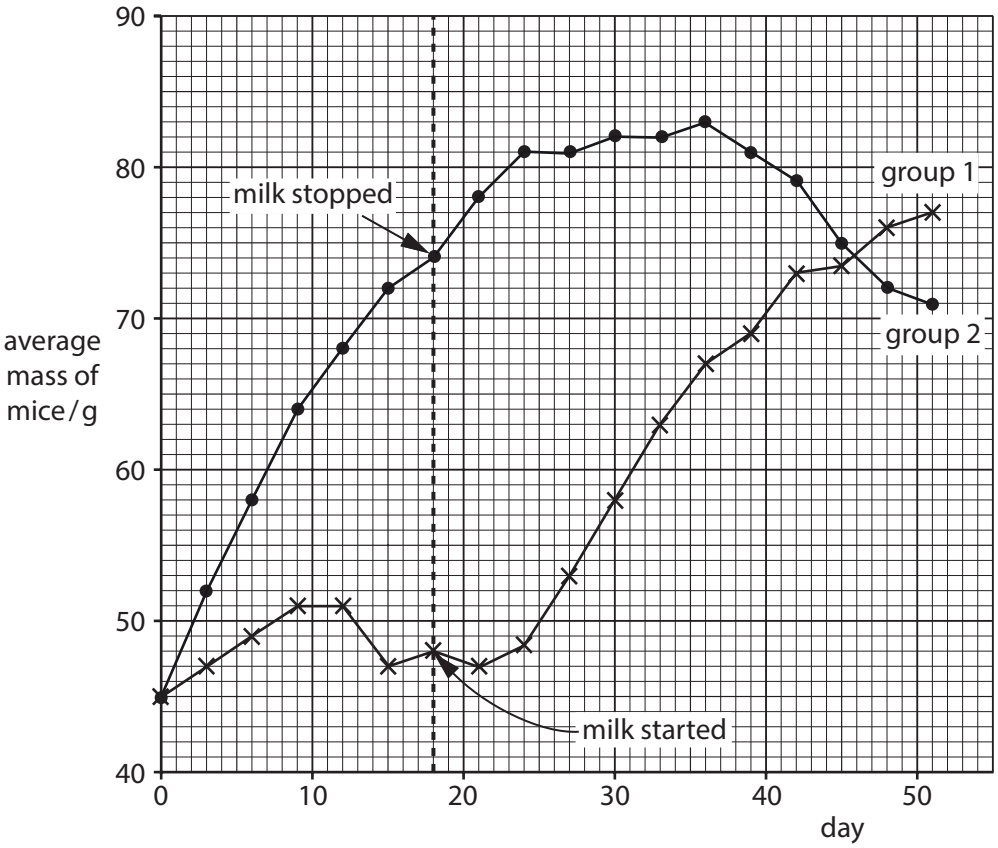



**Fig. 6.1**

**(i)** Describe one similarity and one difference in the pattern of growth of the two groups of mice between day 0 and day 9.

similarity .....

.....

difference .....

..... [2]

**(ii)** In the experiment, a third control group were also used, which did not have any milk in their diet for 50 days.

Suggest how the average mass of the mice would differ from the mice in group 1 and 2 at day 50.

Give a reason for your answer.

.....

.....

..... [1]

**(c)** State **one** function, in a diet, of

**(i)** protein,

..... [1]

**(ii)** carbohydrate.

..... [1]

**(d)** Name **one** mineral ion that the mice in **(b)** would need in their diet, and state its function.

mineral ion .....

function .....

..... [2]

**(e)** The milk in the supplemented diet in **(b)** contained vitamin D.

Suggest how a lack of vitamin D would have affected the mice on the basic diet.

.....

..... [1]

[Total: 11]



**[Turn over**

**7** **(a)** A student rubs a balloon on his sweater. Charged particles move from the sweater to the balloon which becomes negatively charged.

**(i)** Name the charged particles.

..... [1]

**(ii)** The student charges a second balloon in the same way.

Fig. 7.1 shows the two charged balloons next to each other.

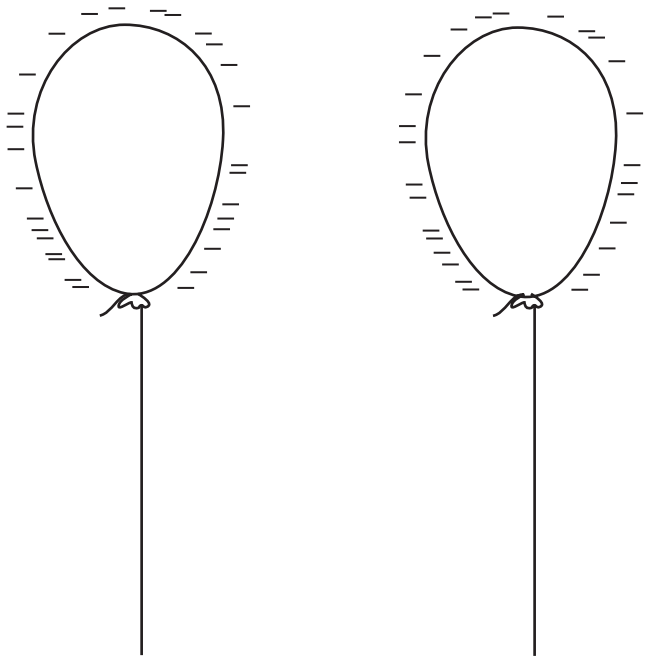


**Fig. 7.1**

State what happens to the balloons when the student brings the balloons very close together.

Explain your answer.

.....

.....

..... [2]

**(b)** The student stands 83 m from a brick wall when one of the balloons bursts.

This is shown in Fig. 7.2.

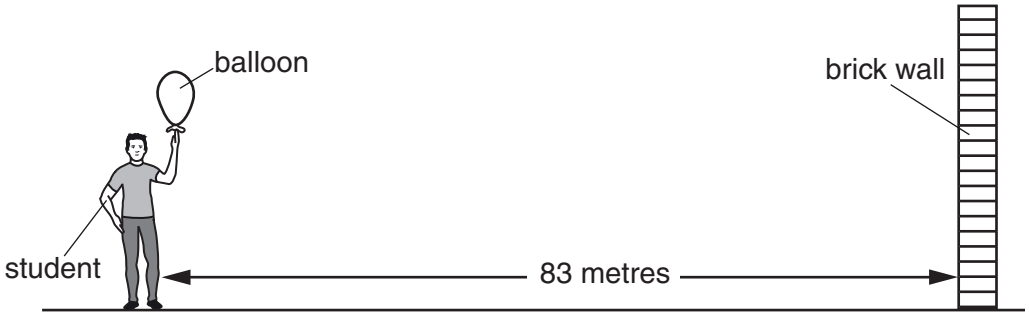



**Fig. 7.2**

The noise the balloon makes when it bursts travels through the air as a sound wave.

The student hears an echo.

**(i)** State why the student hears an echo.

.....

..... [1]

**(ii)** The balloon bursts and 0.50 s later the student hears the echo.

Determine the distance travelled by the sound wave in this time.

distance = ..... m [1]

**(iii)** Use your answer to **(ii)** to calculate the speed of sound in air.

Show your working.

speed = ..... m/s [2]

**(c)** Fig. 7.3 shows the forces acting on a hot air balloon.

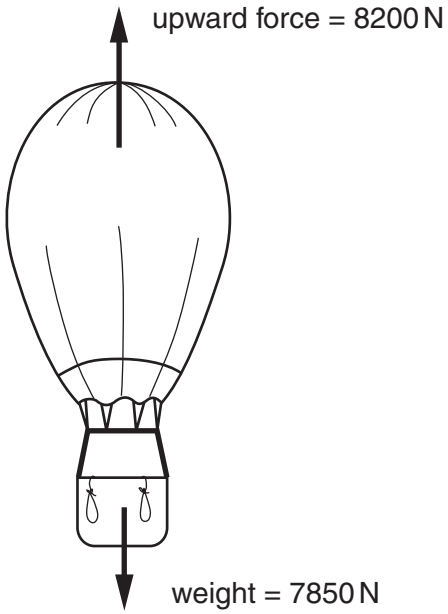



**Fig. 7.3**

**(i)** Calculate the resultant force of the weight and the upward force acting on the balloon.

resultant force = ..... N [1]

**(ii)** Explain how the resultant force affects the movement of the balloon.

.....

..... [1]

**(iii)** The mass of the air in the hot air balloon is 2660 kg. The volume of the air in the hot air balloon is 2800 $m^3$.

Calculate the density of the air in the hot air balloon in kg / $m^3$.

Show your working.

density = ..... kg / $m^3$ [2]

[Total: 11]

**Question 8 starts on page 20**

**8** **(a)** State how the structure of the nucleus of an atom is used to place the elements in order in the Periodic Table.

..... [1]

**(b)** Atoms of the same element can have different nucleon numbers.

Table 8.1 shows information about two different atoms, **X** and **Y**, of the element boron.

**Table 8.1**

| atom | proton number | nucleon number |
|---|---|---|
| **X** | 5 | 10 |
| **Y** | 5 | 11 |

**(i)** State and explain which of the atoms, **X** or **Y**, contains the same number of neutrons as protons.

atom .....

explanation .....

.....
[1]

**(ii)** State the word used to describe atoms of the same element that have different nucleon numbers.

..... [1]

**(c)** Fig. 8.1 shows sodium reacting with water. The water contains a few drops of Universal Indicator.

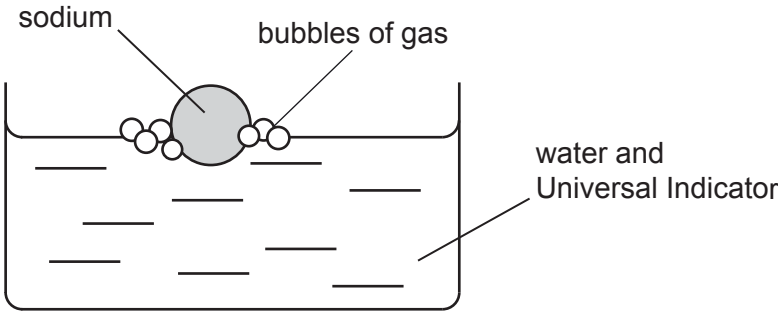



**Fig. 8.1**

**(i)** Name the gas formed when sodium reacts with water.

..... [1]

**(ii)** State how the pH of the solution changes during the reaction.

Explain your answer.

.....

.....

..... [2]

**(iii)** The experiment was repeated using lithium instead of sodium.

State **one** change in the observations made when lithium reacts with water instead of sodium.

Explain your answer.

.....

.....

..... [2]

[Total: 8]

**9** Fig. 9.1 shows, for one country, the number of people recorded as newly infected with HIV each year from 2000 to 2010.

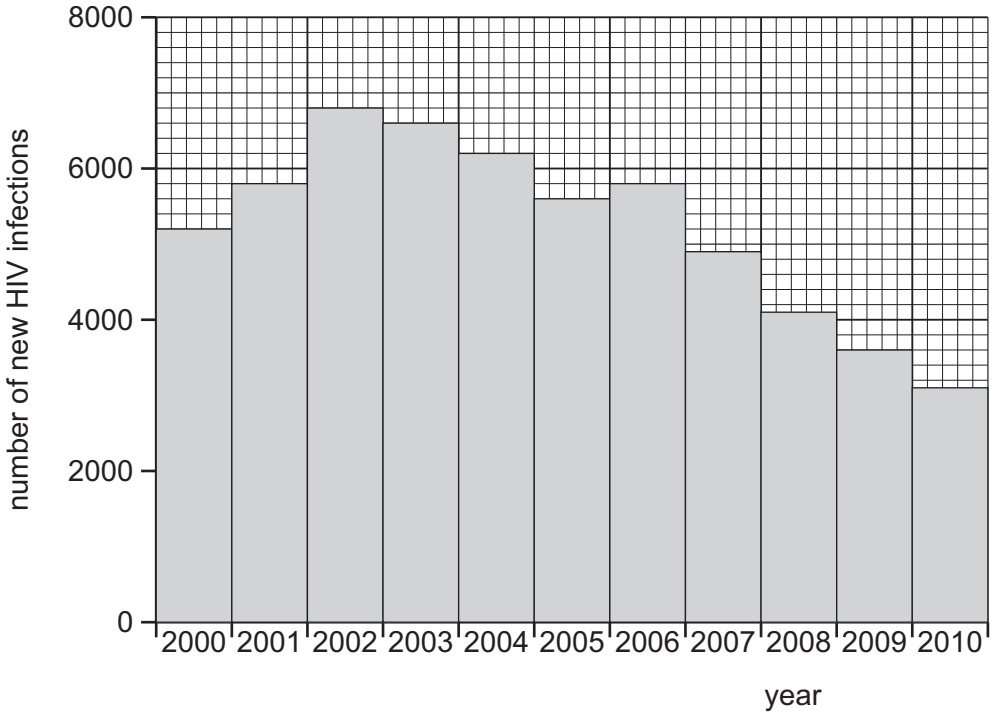



**Fig 9.1**

**(a) (i)** State the year in which the number of new HIV infections was greatest.

year ..... [1]

**(ii)** Suggest **one** reason why the actual number of new HIV infections may have been greater than this.

.....

..... [1]

**(b)** State two ways in which HIV can be transmitted.

1. .....

2. ..... [2]

**(c) (i)** Use data from Fig. 9.1 to describe how the number of new HIV infections changed between 2006 and 2010.

.....

.....

..... [2]

**(ii)** Suggest two ways in which a government can reduce the number of new HIV infections.

1. .....

2. ..... [2]

[Total: 8]

**10 (a)** Coal is burned in a power station to generate electricity.

Fig. 10.1 shows the energy transfers in a coal burning power station.

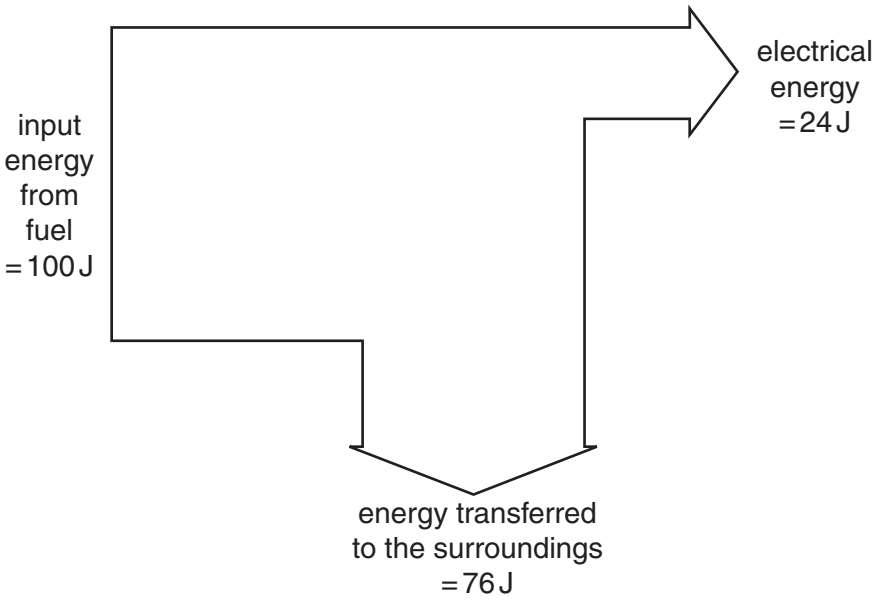



**Fig. 10.1**

**(i)** State the form of energy in a fuel such as coal.

..... [1]

**(ii)** State the form in which most energy is transferred to the surroundings.

..... [1]

**(iii)** Explain how information in Fig. 10.1 shows that the energy transfer from the fuel to electrical energy is not 100% efficient.

.....

..... [1]

**(b)** The workers in a nuclear power station take safety precautions to protect themselves from radioactive materials.

**(i)** Explain why working with radioactive materials is dangerous to humans.

.....

.....

..... [2]

**(ii)** Describe how enclosing the nuclear reactor in thick concrete protects the workers.

.....

..... [1]

**(c) (i)** The nuclide notations for magnesium-28 and aluminium-28 are

$$^{28}_{12}Mg \qquad ^{28}_{13}Al$$

Magnesium-28 is a radioactive isotope. It decays to form aluminium-28.

Complete the sentences below using words from the list below.

Each word may be used once, more than once or not at all.

**electron** **neutron** **nucleon** **nucleus** **proton**

The elements magnesium and aluminium both have the same ..... number.

An atom of magnesium-28 has an unstable ..... [2]

**(ii)** For **each** statement below put a tick (✓) in **one** correct box.

| | alpha | beta | gamma |
|---|---|---|---|
| negatively charged | ☐ | ☐ | ☐ |
| positively charged | ☐ | ☐ | ☐ |
| neutral | ☐ | ☐ | ☐ |

[2]

[Total: 10]

**11** Fig. 11.1 shows the structures of diamond and graphite.

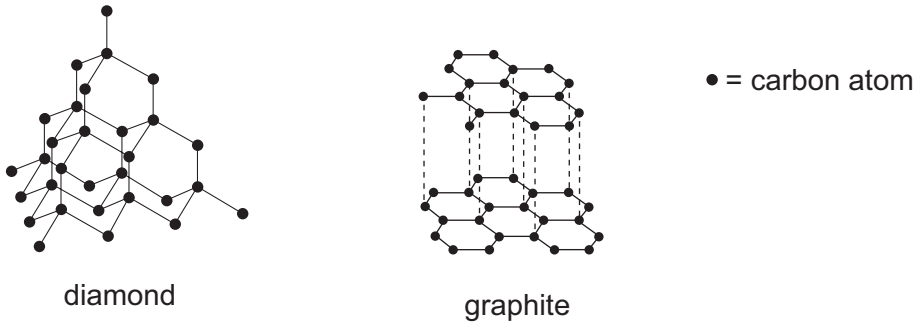



**Fig. 11.1**

**(a)** Describe the similarities and differences between these structures.

.....

.....

.....

.....

.....

..... [4]

**(b)** Graphite burns in air to form carbon dioxide.

Describe a test for carbon dioxide.

test .....

result .....

[2]

**(c)** Carbon dioxide and calcium oxide are produced from calcium carbonate in the reaction shown.

$$\text{calcium carbonate} \rightarrow \text{calcium oxide} + \text{carbon dioxide}$$

Give the name of this type of reaction.

..... [1]

[Total: 7]

**12** Fig. 12.1 represents the carbon cycle.

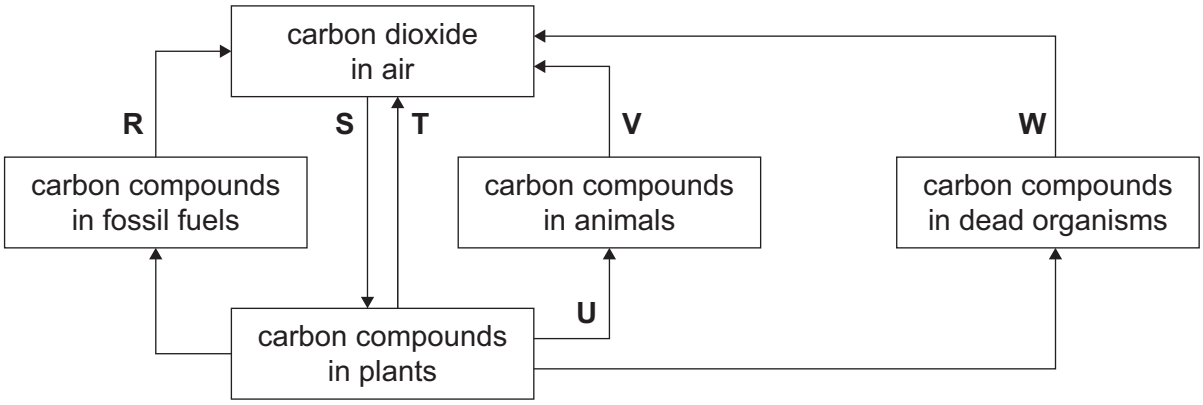



**Fig. 12.1**

**(a)** Use Fig. 12.1 to answer the following questions.

**(i)** Name the process labelled **R**.

..... [1]

**(ii)** Name a group of organisms that are responsible for the process labelled **W**.

..... [1]

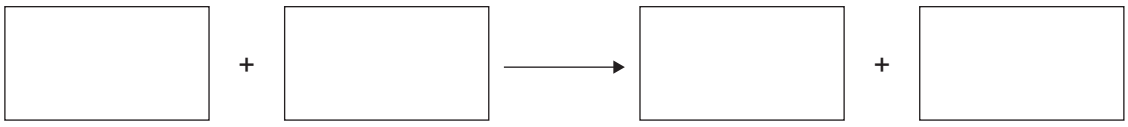
**(iii)** Give **two** letters that identify respiration.

..... [2]

**(iv)** Give **one** letter that identifies photosynthesis.

..... [1]

**(b)** State the **word** equation for respiration.




[2]

**(c)** Describe the role of the Sun in the carbon cycle.

.....

.....

..... [2]

[Total: 9]

**13** **(a)** Fig. 13.1 shows an experiment to investigate the conditions needed for iron to rust.

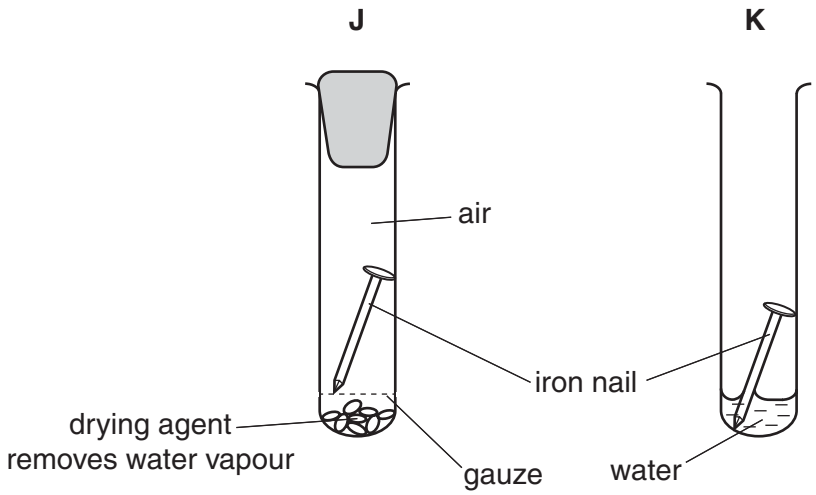



**Fig. 13.1**

**(i)** Predict and explain in which test-tube, **J** or **K**, the nail rusted.

Your explanation should include why the iron rusted in one of the test-tubes and not in the other.

test-tube in which rust forms .....

explanation .....

.....

.....

.....

[2]

**(ii)** Mild steel is used to make bicycle frames and car bodies.

Mild steel contains iron.

Describe how rusting is prevented on bicycle frames and car bodies.

.....

..... [1]

**(iii)** Explain why the method you have described in **(ii)** prevents rust forming.

.....

..... [1]

**(b)** Table 13.1 shows some of the physical and chemical properties of five oxides **V** to **Z**.

**Table 13.1**

| oxide | physical state at 20 °C | colour | pH after shaking with water |
|---|---|---|---|
| **V** | solid | white | 7 |
| **W** | solid | red | 7 |
| **X** | solid | white | 13 |
| **Y** | solid | white | 1 |
| **Z** | gas | colourless | 2 |

**(i)** State and explain which of the oxides do **not** affect the pH of water.

oxides .....

explanation .....

.....

[2]

**(ii)** State which of the oxides contains a transition element.

Give a reason for your answer.

oxide .....

reason .....

.....

[1]

**(iii)** The elements calcium and phosphorus both form solid, white oxides.

Use the information in Table 13.1 to state whether oxide **Y** is calcium oxide or phosphorus oxide.

Explain your answer.

oxide **Y** is .....

explanation .....

.....

..... [2]



**[Turn over**

**(c)** Magnesium burns in air to form magnesium oxide.

This is an exothermic reaction.

**(i)** Write the **word** equation for this reaction.

[ ] **+** [ ] → [ ]

[1]

**(ii)** State what happens to the temperature during an exothermic reaction.

.....

..... [1]

[Total: 11]

## The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | VIII |
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89–103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

atomic number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium – | 62 Sm samarium 150 | 63 Eu europium 152 | 64 Gd gadolinium 157 | 65 Tb terbium 159 | 66 Dy dysprosium 163 | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 |
| actinoids | 89 Ac actinium – | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium – | 94 Pu plutonium – | 95 Am americium – | 96 Cm curium – | 97 Bk berkelium – | 98 Cf californium – | 99 Es einsteinium – | 100 Fm fermium – | 101 Md mendelevium – | 102 No nobelium – | 103 Lr lawrencium – |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).

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