Cambridge IGCSE

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

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

*7445844604*

**COMBINED SCIENCE** **0653/41**

Paper 4 (Extended) **October/November 2019**

**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 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 your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 20.

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 **19** printed pages and **1** blank page.




Cambridge Assessment International Education

**[Turn over**

**1** Fig. 1.1 shows some cells. The diagrams are not to scale.

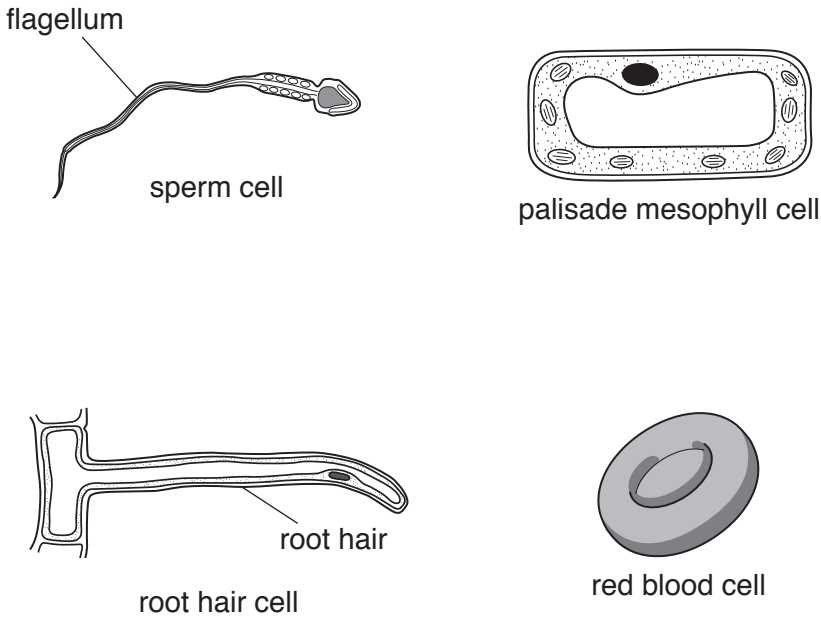


**Fig. 1.1**

**(a)** On Fig. 1.1 use label lines to name **two** structures in the palisade mesophyll cell which are absent from the red blood cell. [2]

**(b)** Describe the function of the root hair shown in Fig. 1.1.

.....

..... [1]

**(c)** **(i)** The flagellum is one of the adaptive features of a sperm cell.

Suggest the function of the flagellum.

.....

..... [1]

**(ii)** State **one other** adaptive feature of a sperm cell.

.....

..... [1]

**(d)** Fig. 1.2 is a diagram of some body cells surrounded by capillaries.

Substances in the blood can reach the body cells by moving out of the capillaries.

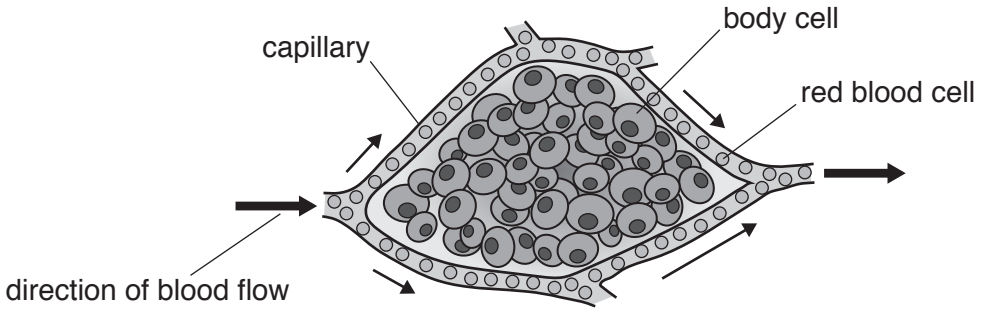


**Fig. 1.2**

**(i)** Circle **one** substance in the list that leaves the capillaries to enter the body cells.

**amylase** **carbon dioxide** **glucose** **glycogen** **starch**

[1]

**(ii)** Use words or phrases from the list to complete the following sentences about oxygen in the blood.

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

**diffusion** **dissolving** **fat** **haemoglobin** **osmosis**

**platelets** **red blood cells** **white blood cells**

Oxygen is carried in the blood by the ..... molecules which are contained in the ..... .

Oxygen moves out of the capillary by the process of ..... .

[3]

**(iii)** Describe how the structure of capillaries enables some substances to pass through their walls.

..... [1]

[Total: 10]



**[Turn over**

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**2** Hydrocarbons are composed of the two elements carbon and hydrogen.

**(a)** State the type of chemical bond that forms between these two elements.

Explain your answer.

type of chemical bond .....

explanation .....

.....

.....

[2]

**(b)** Cracking is a process used to make smaller alkene molecules from larger alkane molecules.

**(i)** State **two** reaction conditions needed for cracking hydrocarbons.

1. .....

2. .....

[2]

**(ii)** During cracking, one molecule of decane, $C_{10}H_{22}$, breaks down to form one molecule of ethane, $C_2H_6$, and four molecules of another hydrocarbon.

Complete the balanced symbol equation for the cracking of decane.

$$C_{10}H_{22} \longrightarrow C_2H_6 + 4 \text{ .....}$$ [1]

**(c)** During the complete combustion of hydrocarbons, carbon dioxide and water are produced.

**(i)** Draw a dot-and-cross diagram to show all of the outer shell electrons in the atoms in one molecule of carbon dioxide.

[2]

**(ii)** State **one** effect of an increase in the amount of carbon dioxide in the atmosphere.

.....

..... [1]

[Total: 8]

**3** Fig. 3.1 shows how a small hydroelectric power station is used to supply electricity.

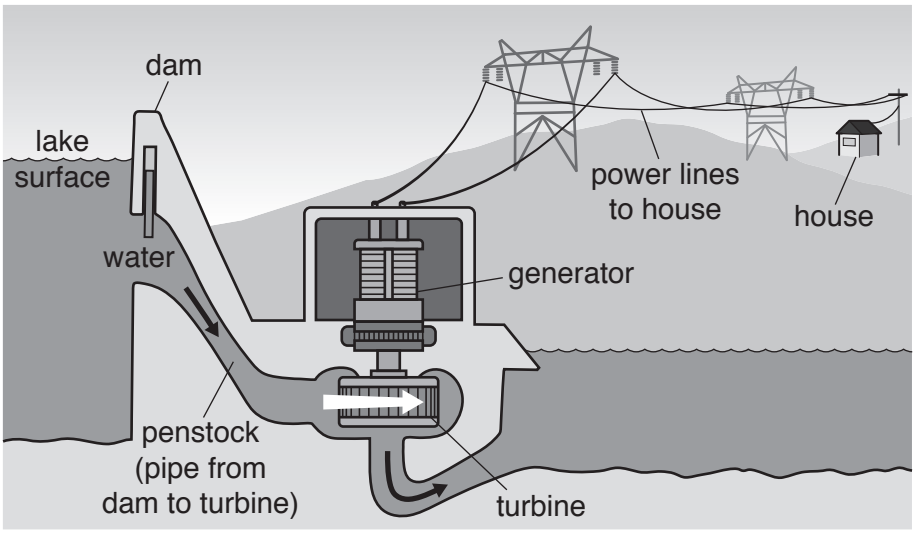


**Fig. 3.1**

**(a)** The flowing water turns the turbine which then turns the generator.

Identify, using the names on Fig. 3.1:

**(i)** **one** place where the gravitational potential energy of the water is at a maximum

..... [1]

**(ii)** **two** places where kinetic energy is part of the sequence of energy transfers.

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

**(b)** Hydroelectric power is an example of a renewable source of energy.

State **one** advantage and **one** disadvantage of hydroelectric power in terms of its environmental impact.

advantage .....

.....

disadvantage .....

.....

[2]

**(c)** In a house, electricity is used to power a television set.

An aerial for the television set receives signals in the radio wave region of the electromagnetic spectrum with a frequency of $600 \times 10^6$ Hz (600 MHz).

**(i)** State the speed at which these signals travel.

..... [1]

**(ii)** Use your answer to **(i)** to calculate the wavelength of the signal.

Show your working.

wavelength = ..... m [2]

**(iii)** Fig. 3.2 shows the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| gamma radiation | X-rays | ultraviolet | visible light | infrared | microwaves | radio waves |

**Fig. 3.2**

State the part of the electromagnetic spectrum used in television transmissions from satellites.

..... [1]

**(d)** The television set emits sound waves.

Describe how sound waves are transmitted in air.

You may wish to draw a diagram as part of your answer.

.....

.....

.....

[2]

[Total: 10]



**[Turn over**

**4** **(a)** Plants make glucose by the process of photosynthesis.

Complete the balanced symbol equation for photosynthesis.

**(i)** .....$CO_2$ + 6..... $\xrightarrow[\text{chlorophyll}]{\text{light}}$ $C_6H_{12}O_6$ + ..... [2]

**(ii)** State **two** uses of the glucose made by photosynthesis.

1. .....

2. .....
[2]

**(b)** Fig. 4.1 shows a diagram of the cross-section of a leaf. The letters refer to the layers of cells in the leaf.

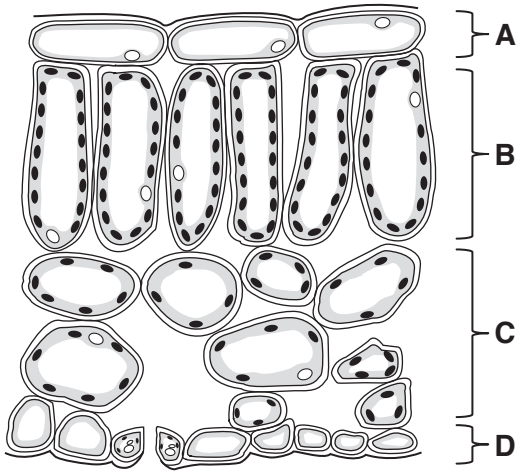


**Fig. 4.1**

**(i)** State the **letter** of the layer of the leaf where the greatest amount of photosynthesis takes place.

..... [1]

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

.....

.....

..... [2]

**(c)** During transpiration water vapour is lost from leaves through the stomata.

When the air surrounding the leaves becomes more humid, the rate of transpiration decreases.

Explain why the rate of transpiration decreases.

.....

.....

..... [2]

[Total: 9]

**5** **(a)** Aluminium is a Group III metal. It is **not** a transition metal.

Copper is a transition metal. It forms coloured compounds.

State **one other** property of copper that is not a property of aluminium.

..... [1]

**(b)** Fig. 5.1 shows the apparatus used to extract copper from aqueous copper(II) chloride by electrolysis.

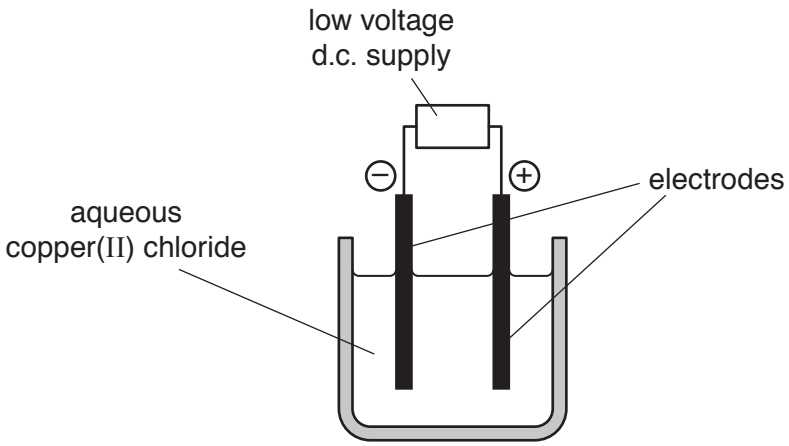


**Fig. 5.1**

**(i)** During this process copper forms at the negative electrode.

State the name of the negative electrode.

..... [1]

**(ii)** Explain how copper(II) ions change into copper atoms.

.....

..... [2]

**(c)** Copper is also extracted by heating copper oxide with carbon.

The word equation for the reaction is:

carbon + copper oxide ⟶ copper + carbon dioxide

**(i)** Name the reducing agent in this redox reaction.

..... [1]

**(ii)** Explain why aluminium **cannot** be extracted from aluminium oxide by heating with carbon.

.....

..... [1]

**(d)** At a water treatment works, a scientist thinks that the water is contaminated with a soluble copper compound containing copper(II) ions.

Describe a test that is used to detect the presence of aqueous copper(II) ions.

Give the positive result for this test.

test .....

.....

result .....

.....
[2]

[Total: 8]

**6** Table 6.1 gives some data about the planets Earth, Mars, Mercury and Venus.

**Table 6.1**

| | Earth | Mars | Mercury | Venus |
|---|---|---|---|---|
| mass | $5.97 \times 10^{24}$ kg | $6.42 \times 10^{23}$ kg | $3.29 \times 10^{23}$ kg | $4.87 \times 10^{24}$ kg |
| volume | $1.08 \times 10^{21}$ m$^3$ | $1.63 \times 10^{20}$ m$^3$ | $6.08 \times 10^{19}$ m$^3$ | $9.28 \times 10^{20}$ m$^3$ |
| gravitational field strength *g* | 9.81 N/kg | 3.71 N/kg | 3.70 N/kg | 8.87 N/kg |
| mean temperature at surface | 15 °C | –63 °C | 167 °C | 462 °C |
| pressure of atmosphere | 101 000 N/m$^2$ | 600 N/m$^2$ | 0 | 9 300 000 N/m$^2$ |
| percentage of Sun's radiation reflected | 31% | 25% | 7% | 69% |

**(a)** Use data from Table 6.1 to state which planet has the greatest volume.

..... [1]

**(b)** Use data from Table 6.1 to calculate the density of Mercury.

Show your working and give the units of your answer.

density = ..... units ..... [3]

**(c)** A mass of 5 kg is placed on each planet, 10 m above the planet's surface.

State on which planet this mass has the greatest gravitational potential energy.

Give a reason for your answer.

planet .....

reason .....

.....
[2]

**(d)** The surface of a planet reflects a percentage of the Sun's radiation back into space. The rest of the radiation is absorbed by the planet.

Suggest **one** reason why the percentage of the Sun's radiation reflected by the surface of Mercury is so low.

..... [1]

**(e)** A space probe of mass 50 kg descends through the atmosphere on Venus. The probe is slowed down by the atmosphere much more than it would be by the resistance of the Earth's atmosphere.

Use data from Table 6.1 to explain this in terms of difference in the arrangement of the molecules in the atmosphere.

.....

.....

.....

..... [2]

[Total: 9]



**[Turn over**

**7** Fig. 7.1 shows the flow of energy through a forest ecosystem.

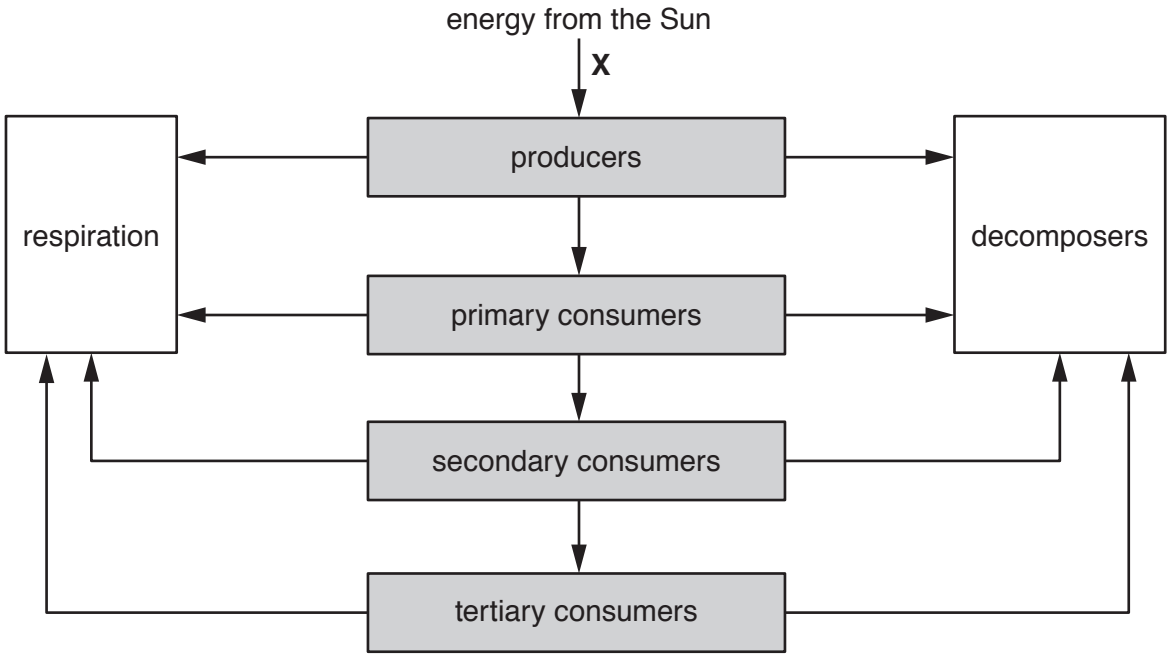


**Fig. 7.1**

**(a)** **(i)** Define the term *ecosystem*.

.....

.....

..... [2]

**(ii)** Complete the sentence about the energy transfer at **X**.

At **X** ..... energy is transferred to

..... energy. [2]

**(b)** The shaded boxes in Fig. 7.1 show the trophic levels in the ecosystem.

Energy is lost from the organisms at each trophic level.

State **two** ways in which energy is lost from the organisms at each trophic level.

1. .....

.....

2. .....

.....

[2]

**(c)** The trees are the main producers in the forest. They are cut down and taken away from the ecosystem.

Suggest what happens to the primary consumers in the forest.

Explain your answer.

.....

.....

..... [2]

[Total: 8]

**8** Table 8.1 shows data about Group I metals.

The data for rubidium is missing.

**Table 8.1**

| element | melting point / °C | rate of reaction with water |
|---|---|---|
| lithium | 181 | slow |
| sodium | 98 | moderate |
| potassium | 64 | fast |
| rubidium | | |
| caesium | 29 | very violent |

**(a) (i)** Suggest the melting point of rubidium.

..... °C [1]

**(ii)** Predict the rate of reaction of rubidium with water.

..... [1]

**(b)** Rubidium reacts with water to form rubidium hydroxide solution and hydrogen.

**(i)** Suggest the formula of rubidium hydroxide.

..... [1]

**(ii)** Suggest the pH of rubidium hydroxide solution.

Explain your answer.

pH .....

explanation .....

.....

[2]

**(c)** Rubidium hydroxide has a higher melting point than water.

Explain the difference in the melting point of rubidium hydroxide and of water.

In your answer refer to the type of bonds and the attractive forces.

.....

.....

.....

.....

.....

..... [3]

**(d)** The reaction between rubidium and water is exothermic.

Describe what happens during an exothermic reaction. Use ideas about chemical energy and thermal energy in your answer.

.....

.....

.....

..... [2]

[Total: 10]

**9** **(a)** Fig. 9.1 shows a circuit containing three resistors, $R_1$, $R_2$ and $R_3$.

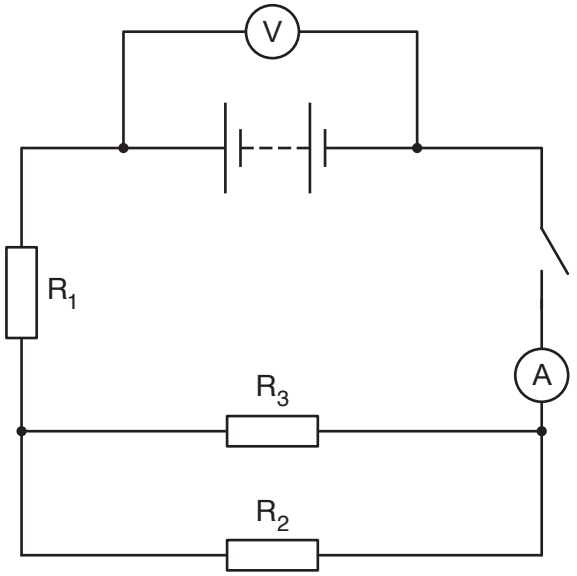


**Fig. 9.1**

**(i)** $R_1$ has a value of 8.0 Ω.

$R_2$ has a value of 3.0 Ω.

$R_3$ has a value of 6.0 Ω.

Complete steps **1** and **2** to calculate the value of the combined resistance of the three resistors in this circuit.

Show your working.

Step **1**: Calculate the combined resistance of $R_2$ and $R_3$.

combined resistance of $R_2$ and $R_3$ = ..... Ω

Step **2**: Calculate the total resistance of the three resistors.

total resistance = ..... Ω

[3]

**(ii)** The reading on the ammeter is 2.7 A.

The current in $R_2$ is 1.8 A

Determine the current in $R_3$.

Show your working.

current = ..... A [1]

**(iii)** Explain your answer to **(a)(ii)**.

.....

..... [1]

**(iv)** With the switch closed and the current flowing in the circuit, the reading on the voltmeter is 27 V.

The switch is opened, so no current flows in the circuit. The reading on the voltmeter increases to 30 V.

Suggest an explanation for this observation.

.....

..... [1]

**(b)** A circuit with a total resistance of 5.0 Ω has a current of 9.0 A.

Calculate the power consumed in the circuit.

Show your working.

power = ..... W [2]

[Total: 8]

## The Periodic Table of Elements

| Group I | Group II | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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.).