Cambridge Assessment International Education

# Cambridge IGCSE™

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

Paper 4 Theory (Extended) **May/June 2020**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

**INFORMATION**

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Blank pages are indicated.

DC (CJ/JG) 191904/2


**[Turn over**

**1** **(a)** Table 1.1 shows the percentage composition of the gases in inspired air and in expired air.

**Table 1.1**

| gas | percentage composition of inspired air | percentage composition of expired air |
|---|---|---|
| carbon dioxide | 0.04 | 4 |
| nitrogen | 78 | 78 |
| oxygen | 21 | 16 |

Explain why the percentage of carbon dioxide is greater in expired air than in inspired air.

.....

.....

..... [2]

**(b)** State **two** features of alveoli that make them efficient gas exchange surfaces.

1. .....

2. .....

[2]

**(c)** Fig. 1.1 shows some cells which line the trachea.

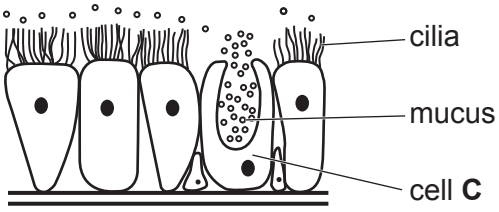


**Fig. 1.1**

**(i)** State the name of cell **C** as shown in Fig. 1.1.

..... [1]

**(ii)** Describe the roles of cilia and mucus in the protection of the gas exchange system.

cilia .....

.....

mucus .....

.....

[2]

**(iii)** Describe **one** effect of tar in tobacco smoke on the gas exchange system.

.....

..... [1]

[Total: 8]

**2** The formula of methanol is $CH_3OH$.

**(a)** Explain why methanol is **not** a hydrocarbon.

.....

..... [1]

**(b)** **(i)** Complete the dot-and-cross diagram for a molecule of methanol.

C O

[2]

**(ii)** Explain why a molecule of methanol contains only covalent bonds.

.....

..... [1]

**(c)** Methanol is used as a fuel because it burns in oxygen.

Complete the equation for the complete combustion of methanol.

$2CH_3OH$ + ..... → ..... + .....

[2]

**(d)** Fig. 2.1 shows the energy level diagram for the complete combustion of methanol.

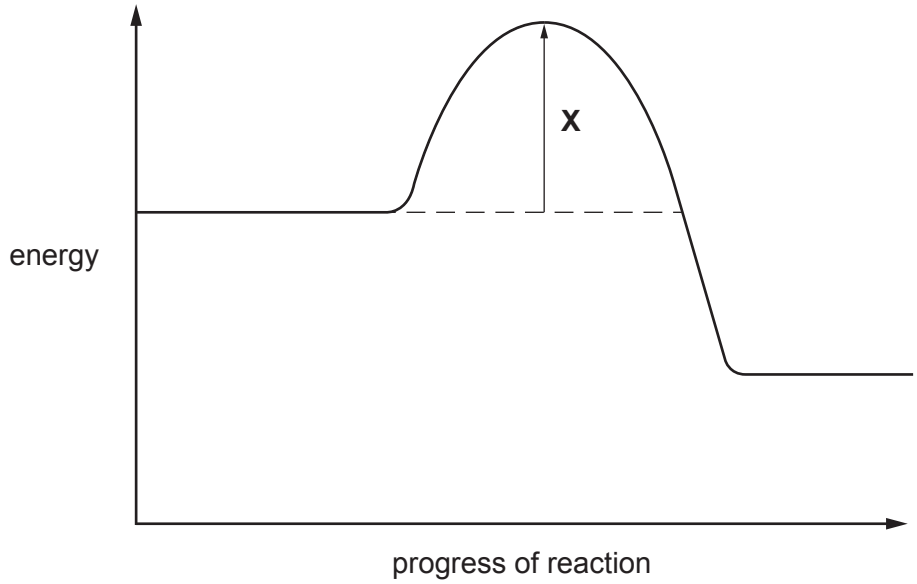


**Fig. 2.1**

**(i)** On Fig. 2.1, write the words *reactants* and *products* in suitable places. [1]

**(ii)** State what the energy value **X** on Fig. 2.1 represents.

..... [1]

**(e)** During the combustion of methanol, the amount of carbon dioxide in the atmosphere increases.

Suggest one effect of this increase.

.....

..... [1]

[Total: 9]

**3** Fig. 3.1 shows a spacecraft taking off from the Moon.

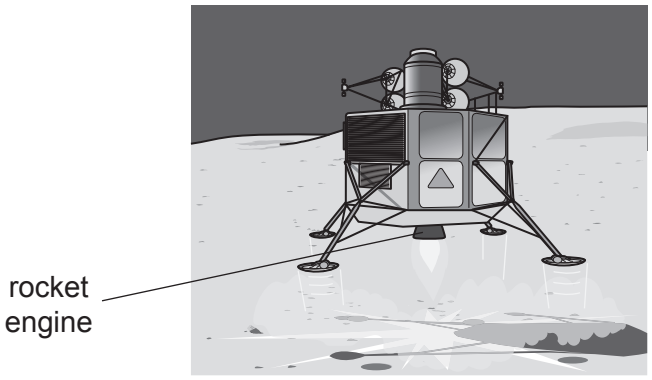


**Fig. 3.1**

**(a)** The total mass of the spacecraft is 5000 kg.

**(i)** The gravitational field strength on the Moon is 1.6 N / kg.

Calculate the weight of the spacecraft on the Moon.

weight = ..... N [1]

**(ii)** The rocket engine pushes the spacecraft vertically upwards with a constant force of 15 000 N.

Calculate the work done by the rocket engine to move the spacecraft to a height of 500 m.

work done = ..... J [2]

**(iii)** Use your answer to **(a)(i)** to calculate the gravitational potential energy gained by the spacecraft at 500 m above the Moon's surface.

gravitational potential energy = ..... J [2]

**(iv)** Explain the difference between your answers to **(a)(ii)** and **(a)(iii)**.

.....

..... [1]

**(b)** Fig. 3.2 shows two large mirrors left behind on the Moon's surface.

The two mirrors are arranged at 90° to each other.

A laser light beam from the Earth can be reflected back to the Earth by the mirrors. This enables the distance between the Earth and the Moon to be measured.

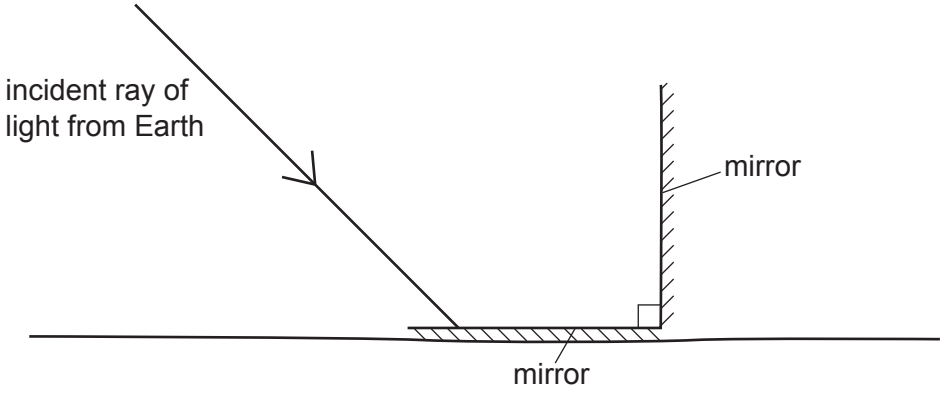


**Fig. 3.2**

**(i)** On Fig. 3.2 complete the ray diagram to show how the ray of light is reflected back parallel to the incident ray. [2]

**(ii)** Light takes 2.56 s to travel from the Earth to the Moon and back again.

The speed of electromagnetic waves in space is $3.00 \times 10^5$ km / s.

Calculate the distance from the Earth to the Moon.

distance = ..... km [2]

[Total: 10]

**4** **(a)** If the light shining on a shoot tip is more intense on one side, the shoot shows a growth response.

Name the response of the shoot to light.

..... [1]

**(b)** Fig. 4.1 shows a shoot which is evenly illuminated.
Fig. 4.2 shows how the same shoot grows when light shines from one side.

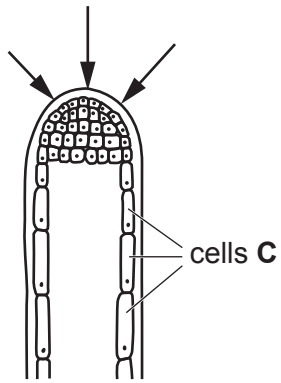


**Fig. 4.1**

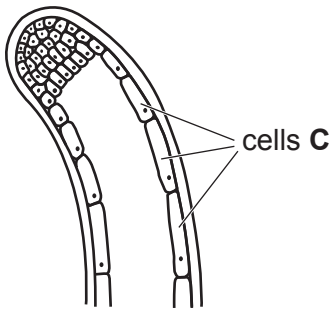


**Fig. 4.2**

**(i)** On Fig. 4.2, draw an arrow to show the direction of the light shining on the shoot. [1]

**(ii)** The response by the shoot in Fig. 4.2 is shown by most plants.

Describe the advantage of this response.

.....

.....

..... [2]

**(iii)** Describe how cells **C** are different in Fig. 4.1 compared with Fig. 4.2.

..... [1]

**(iv)** Describe the role of the hormone auxin in the response of the shoot shown in Fig. 4.2.

.....

.....

..... [2]

**(c)** The hormone adrenaline is secreted in humans. Table 4.1 shows some statements about adrenaline.

In Table 4.1 place a tick (✓) to show **two** correct statements about adrenaline.

**Table 4.1**

| statement about adrenaline | tick (✓) if correct |
|---|---|
| causes pupils of the eye to get smaller | |
| increases the blood glucose concentration | |
| increases the pulse rate | |
| less is secreted when a person is scared | |
| slows the rate of breathing | |

[2]

[Total: 9]

**5** **(a)** Iron is a transition element.

State **one** property of iron that is common to all transition elements but not to other metals.

..... [1]

**(b)** Fig. 5.1 shows the arrangement of particles in pure solid iron.

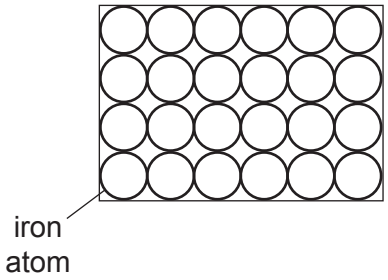


**Fig. 5.1**

**(i)** Explain why a high temperature is needed to melt solid iron.

.....

.....

..... [2]

**(ii)** Steel is an alloy of iron. It contains iron atoms and smaller carbon atoms.

Complete Fig. 5.2 to show the arrangement of atoms in solid steel.

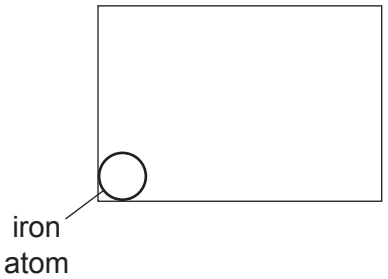


**Fig. 5.2**

[1]

**(c)** Iron is extracted from iron oxide in the blast furnace.

**(i)** The word equation for one of the reactions in the blast furnace is shown.

iron oxide + carbon monoxide $\longrightarrow$ iron + carbon dioxide

State why this is a redox reaction.

.....

.....

..... [2]

**(ii)** Iron(III) oxide contains iron(III) ions, $Fe^{3+}$, and oxide ions, $O^{2-}$.

Deduce the formula of iron(III) oxide.

..... [1]

**(iii)** Magnesium can be extracted from magnesium oxide by electrolysis.

Explain why magnesium **cannot** be extracted from magnesium oxide in a blast furnace.

.....

..... [2]

[Total: 9]

**6** Naphthalene is a solid that melts at 80 °C to form a liquid.

**(a)** Some solid naphthalene is heated until it has all melted. The liquid is then allowed to cool slowly.

The temperature is measured every minute as the liquid cools and becomes solid again.

Fig. 6.1 shows a graph of the results.

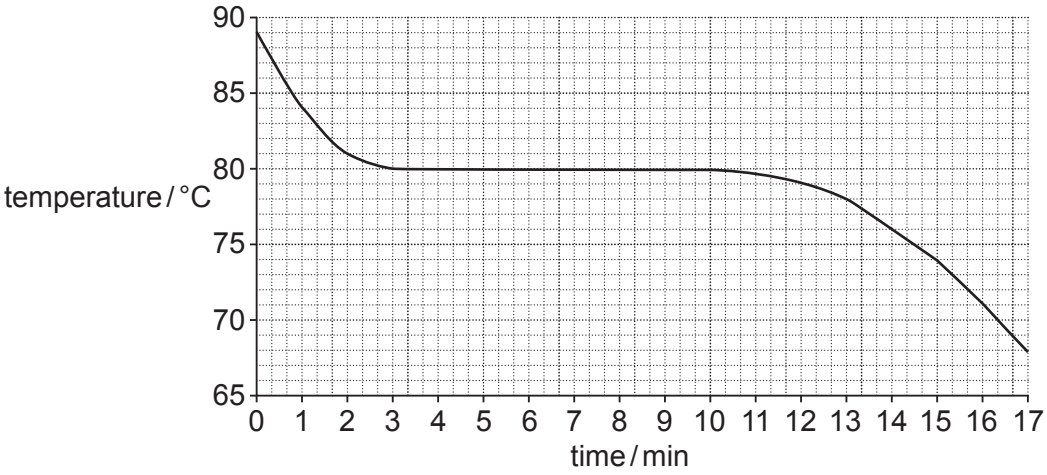


**Fig. 6.1**

On Fig. 6.1, draw an **X** to show a part of the graph at which all of the naphthalene is liquid. [1]

**(b)** Fig. 6.2 shows a test-tube with liquid naphthalene at its melting point.

Fig. 6.3 shows the same test-tube with the same mass of naphthalene when it has all turned solid.

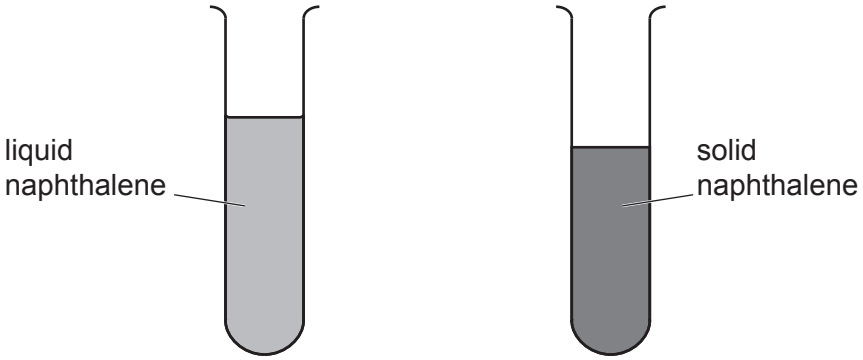


**Fig. 6.2** **Fig. 6.3**

**(i)** Suggest how the distances between the molecules in liquid naphthalene and in solid naphthalene compare.

Give a reason for your answer.

.....

.....

..... [2]

**(ii)** Suggest how the motions of the molecules in liquid naphthalene and in solid naphthalene compare.

Give a reason for your answer.

.....

.....

..... [2]

**(c)** The solid naphthalene cools very slowly, as the vibrations of the large molecules do not conduct thermal energy well and there are no mobile electrons.

Predict whether solid naphthalene will be a good or poor conductor of electricity.

Give a reason for your answer.

.....

..... [1]

[Total: 6]

**7** **(a)** The substrates and products of three digestive enzymes are shown in Table 7.1.

Complete Table 7.1.

**Table 7.1**

| substrate | digestive enzyme | product |
|---|---|---|
| ..... | amylase | sugars |
| fat | ..... | ..... and fatty acids |
| protein | protease | ..... |

[3]

**(b)** State **two** functions of the hydrochloric acid in gastric juice in the stomach.

1. .....

.....

2. .....

.....

[2]

**(c)** Fig. 7.1 shows a graph of activity against temperature for two enzymes, **A** and **B**.

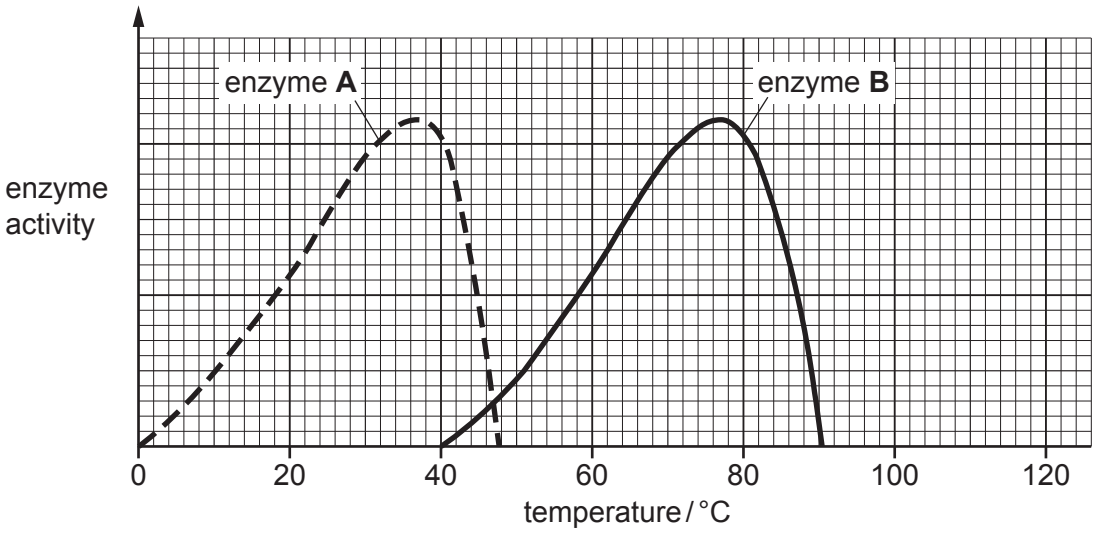


**Fig. 7.1**

**(i)** Identify the temperature of maximum activity of enzyme **B**.

temperature = ..... °C [1]

**(ii)** The enzyme activity of both enzymes is the same at 47 °C.

The temperature is increased to 50 °C.

State and explain the effects of this temperature increase on the activity of enzyme **A**.

.....

.....

.....

.....

..... [3]

**(iii)** Amylase is a digestive enzyme secreted in parts of the alimentary canal.

Suggest which enzyme, **A** or **B**, is amylase. Give a reason for your answer.

enzyme .....

reason .....

.....

[1]

[Total: 10]

**8** **(a)** When dilute sulfuric acid is electrolysed, hydrogen forms at the cathode.

**(i)** Describe, in terms of electrons, what happens to one hydrogen ion at the cathode.

.....

..... [2]

**(ii)** State the test for hydrogen gas and give the positive result.

test .....

result .....
[2]

**(iii)** Name the product at the anode.

..... [1]

**(b)** Magnesium reacts with dilute sulfuric acid to produce magnesium sulfate.

Explain why the rate of this reaction increases when the temperature of the acid is higher.

Use ideas about particles in your answer.

.....

.....

.....

..... [2]

**(c)** Name **one** other substance that reacts with dilute sulfuric acid to produce magnesium sulfate.

..... [1]

[Total: 8]

**9** Fig. 9.1 shows a microwave oven connected to a mains electricity supply.

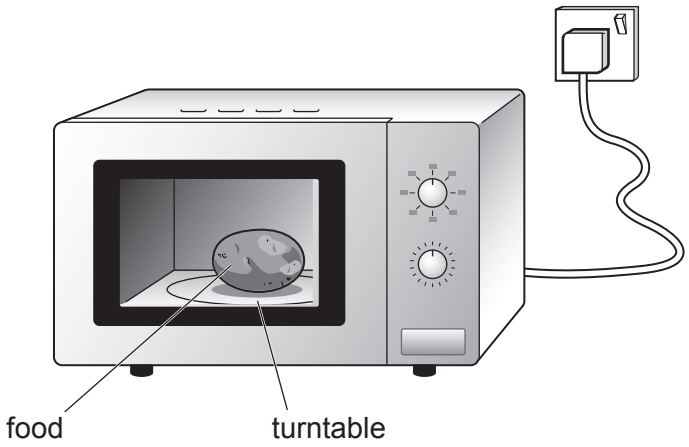


**Fig. 9.1**

When the door is closed, the oven can be switched on and the food gets hot.

**(a)** State the main useful energy transfer that results in the food getting hot.

..... energy → ..... energy [2]

**(b)** Microwave radiation is generated inside the oven and absorbed by the food.

The microwave radiation has a frequency of $2.45 \times 10^9$ Hz.

The speed of microwave radiation is $3.00 \times 10^8$ m/s.

Calculate the wavelength of the microwaves.

wavelength = ..... m [2]

**(c)** When the oven is switched on, the food is rotated on a turntable turned by an electric motor. This ensures the food is heated completely.

All the circuit components of the microwave oven are connected in parallel. These components are the microwave generator, the turntable motor and a lamp.

**(i)** The microwave oven has two switches.

- the main switch operates all the components,
- the other switch operates only the microwave generator and turntable motor.

On Fig. 9.2 complete the circuit diagram for the microwave oven, including the symbol for the mains electricity supply (a.c. power supply), the second switch and the lamp.

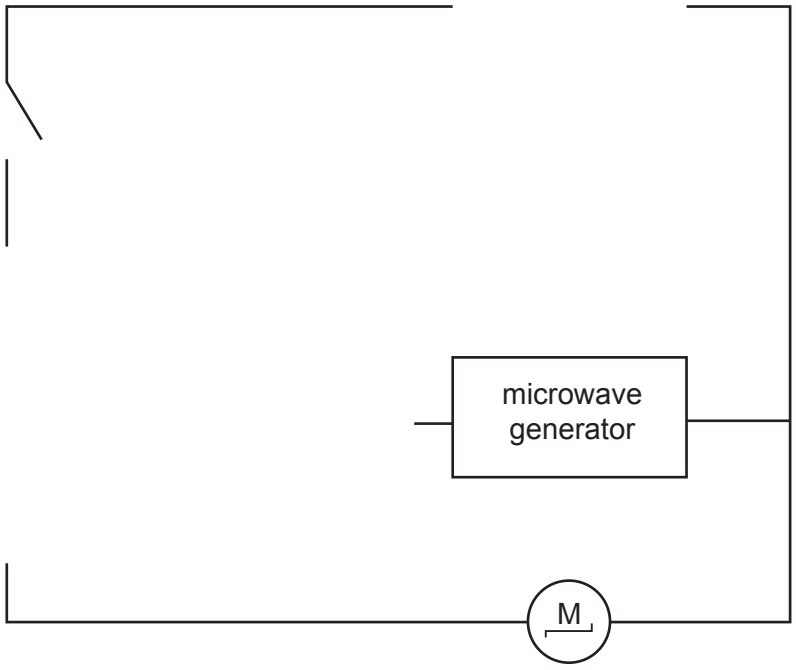


**Fig. 9.2**

[3]

**(ii)** The current in each of the three components is shown.

lamp 0.1A microwave generator 2.5A turntable motor 0.2A

Calculate the current supplied from the mains supply.

current = ..... A [1]

**(iii)** The mains electricity supply is 230 V.

Calculate the power used by the microwave generator.

State the unit of your answer.

power = ..... unit ..... [3]

[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.).