Cambridge O Level

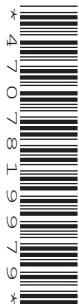| CANDIDATE NAME	

CENTRE NUMBER			CANDIDATE NUMBER	

COMBINED SCIENCE **5129/21**

Paper 2 Theory **May/June 2023**

1 hour 45 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. Any blank pages are indicated.

[Turn over

1 Fig. 1.1 shows the effect of exercise on two students, **A** and **B**.

Both students did the same exercise for the same length of time.
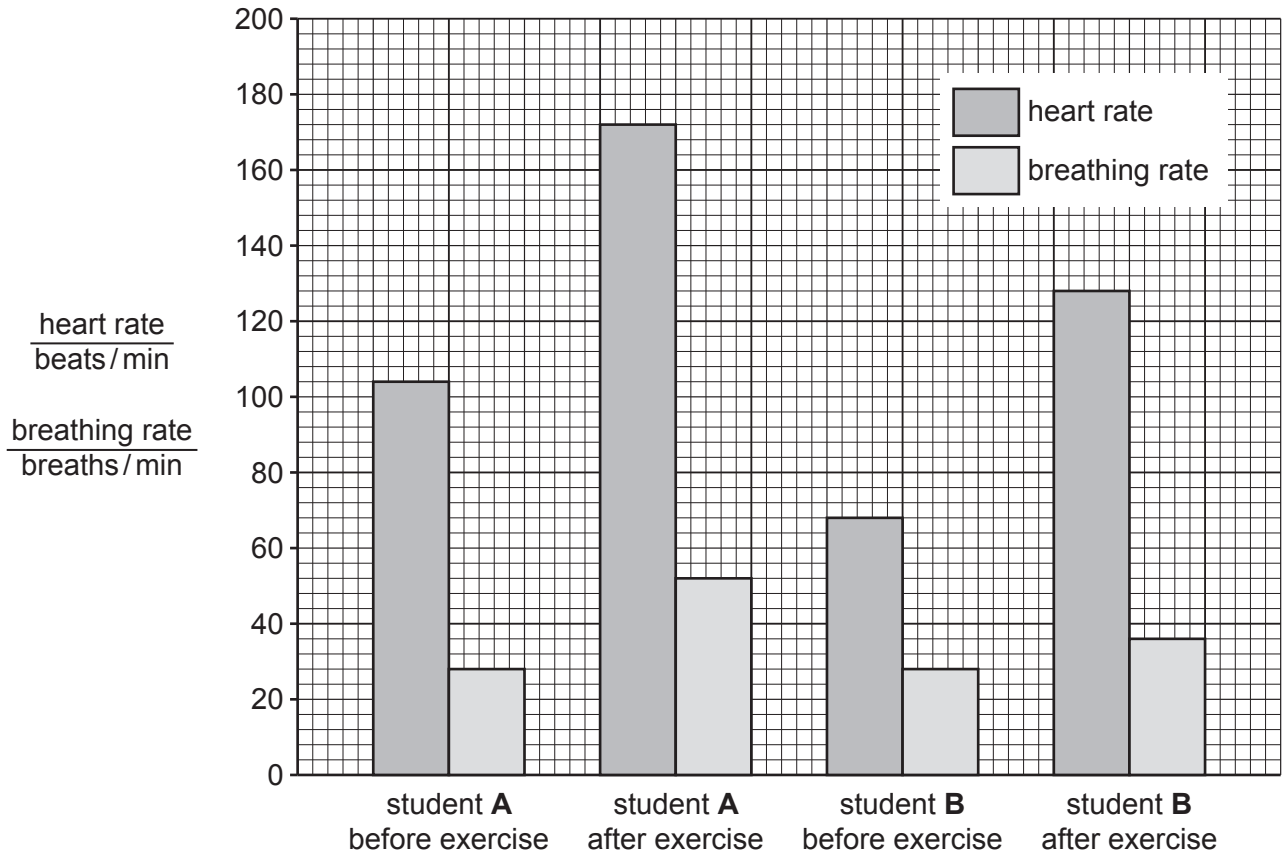
Fig. 1.1

(a) (i) Determine the heart rate of student **B** after exercise.

heart rate = ... beats per min. [1]

(ii) State **two** conclusions about the effect of exercise on the students.

1 ....

....

....

2 ....

....

....
[2]

(b) Use words or phrases from the list to complete the sentences about aerobic respiration in humans.

<div align="center">

carbon dioxide   **carbon monoxide**   **lactic acid**

less   **liver**   **lungs**   **more**

</div>

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

During aerobic respiration, ... energy is transferred from the chemical

energy store in glucose than during anaerobic respiration.

In humans, aerobic respiration produces .... that is passed out of the

body by the ....

[3]

[Total: 6]

2 A horse has a maximum speed of 88 km/h.

(a) Calculate the horse's maximum speed in metres per second.

Show your working.

Give your answer to 2 significant figures.

maximum speed = ... m/s [3]

(b) The horse runs at maximum speed for one minute.

Calculate the distance travelled by the horse and state the unit.

distance travelled = ... unit .... [2]

[Total: 5]

3 Titanium metal is obtained from the reaction between titanium chloride and magnesium.

The equation for the reaction is:

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$
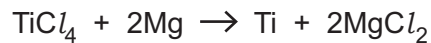
[A_r: Cl, 35.5; Mg, 24; Ti, 48]

(a) (i) Calculate the relative molecular mass M_r of titanium chloride.

M_r = ... [1]

(ii) Complete the following sentences.

19 g of titanium chloride reacts with .... g of magnesium and

produces .... g of titanium.

[2]

(b) Titanium chloride is a compound.

State what is meant by 'a compound'.

....

.... [1]

(c) Titanium has similar physical properties to aluminium.

Suggest a property of titanium which makes it suitable for use in the manufacture of aircraft.

....

.... [1]

[Total: 5]

4 Fig. 4.1 shows the direction of three forces **A**, **B** and **C** acting on a parachutist and his parachute as he falls towards the ground.
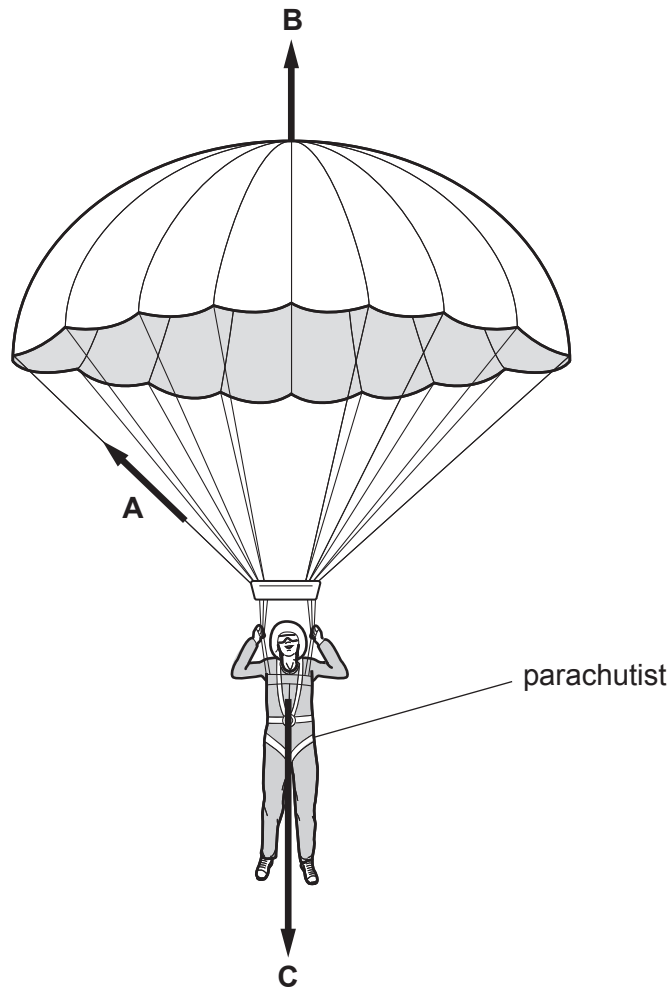
Fig. 4.1

(a) Complete Table 4.1 to identify the forces **A**, **B** and **C** shown in Fig. 4.1 by writing **one** letter next to each type of force.

Table 4.1

type of force	letter
drag	....
tension	....
weight	....

[2]

(b) As the parachutist falls towards the ground, approximately 3.5 MJ of energy is transferred between energy stores in a time of 40 s.

(i) State the name of the energy store that decreases as the kinetic energy store increases.

.... [1]

(ii) Describe how energy is transferred to **one** other energy store as the parachutist falls and name this store.

name of store ....

how the energy is transferred ....

.... [2]
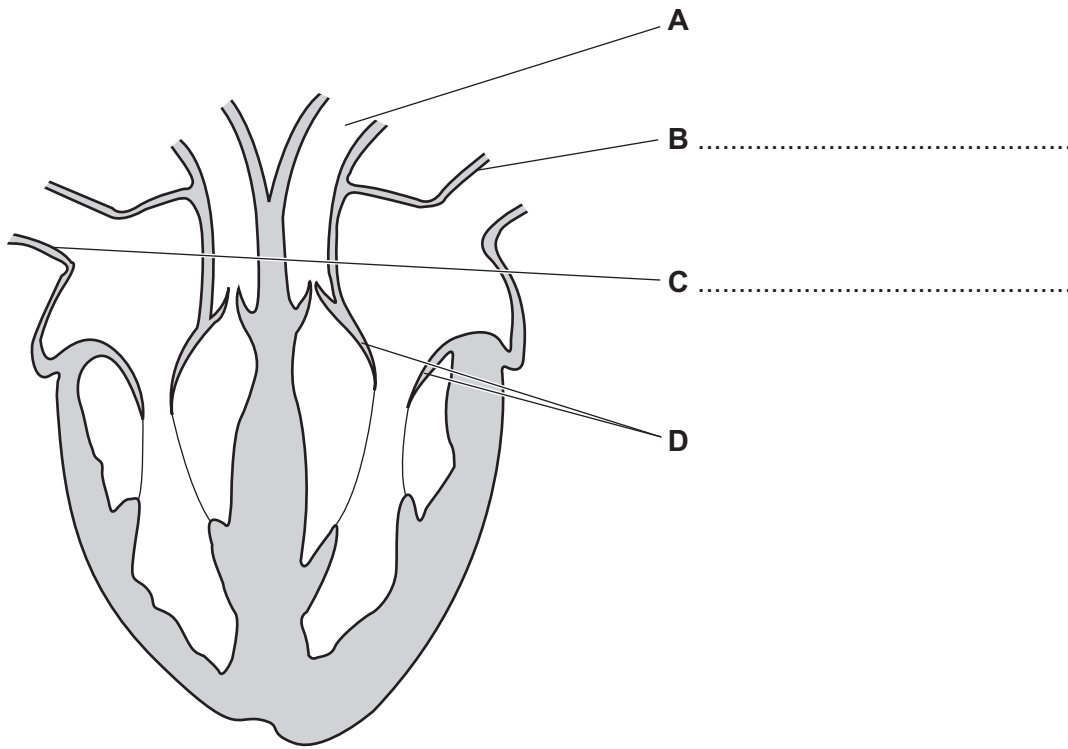
(iii) Energy is conserved.

Determine the total amount of energy transferred to all the energy stores in 40 s.

total amount of energy transferred = ... MJ [1]

[Total: 6]

5 Fig. 5.1 shows a section through a human heart.

Fig. 5.1

(a) Name the blood vessels labelled **B** and **C** on Fig. 5.1.

Write your answers on Fig. 5.1. [2]

(b) Draw an arrow in blood vessel **A** on Fig. 5.1 to show the direction of blood flow. [1]

(c) Describe and explain how valve **D** maintains a one-way flow of blood when the left ventricle contracts.

....

....

....

....

....

.... [3]

[Total: 6]

6 Use the words in the list to complete the sentences.

<div align="center">

chemical   **chromatography**   **cracking**

decreases   **filtration**   **increases**   **methane**

neutralisation   **oxygen**   **physical**

</div>

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

.... is produced by the decomposition of vegetation.

Melting is an example of a .... change.

.... is an example of an exothermic reaction.

The reactivity of Group I metals with water .... down the group.

.... can be used to identify pure substances.

[5]

7 Fig. 7.1 shows a lighted candle made from wax.

The solid wax becomes liquid near the flame.
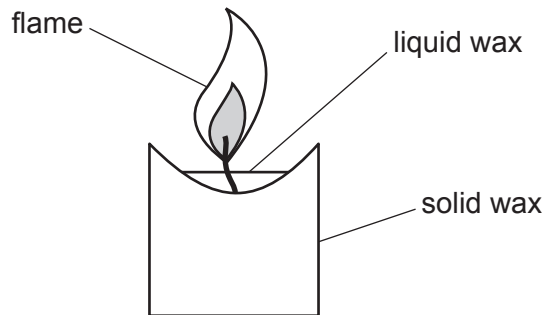
Fig. 7.1

(a) Use ideas about particles to explain how the solid wax becomes liquid wax.

....

....

....

.... [3]

(b) State the name of the process by which the air around the flame transfers thermal energy to the surroundings.

.... [1]

[Total: 4]

8 Petroleum is a fossil fuel.

(a) Name **one** other fossil fuel that is **not** petroleum and is **not** obtained from petroleum.

.... [1]

(b) Petroleum contains a mixture of hydrocarbons.

Fig. 8.1 shows some fractions obtained by the separation of petroleum in a fractionating column.
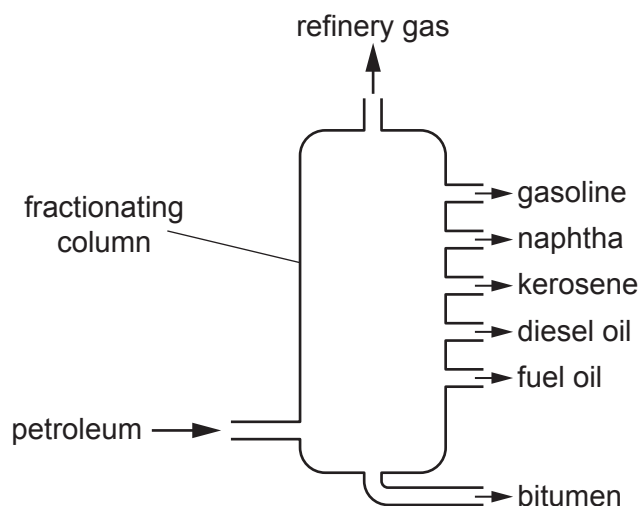
Fig. 8.1

(i) State the physical property of hydrocarbons that is used in the separation of petroleum.

.... [1]

(ii) Name a fraction that is more viscous than diesel oil.

.... [1]

(iii) State a use of the naphtha fraction.

.... [1]

(c) Fig. 8.2 shows a hydrocarbon found in petroleum.
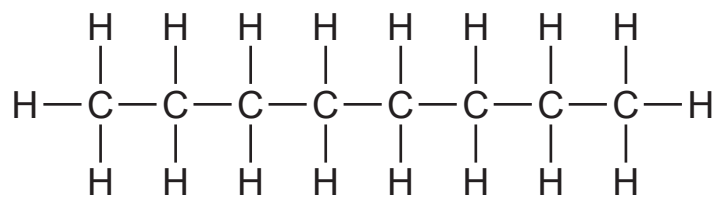
Fig. 8.2

Explain how the structure of this hydrocarbon shows that it is an alkane.

....

....

.... [1]

[Total: 5]

9 Fig. 9.1 shows a diagram of a plant cell.

Some structures in the cell are identified by letters.
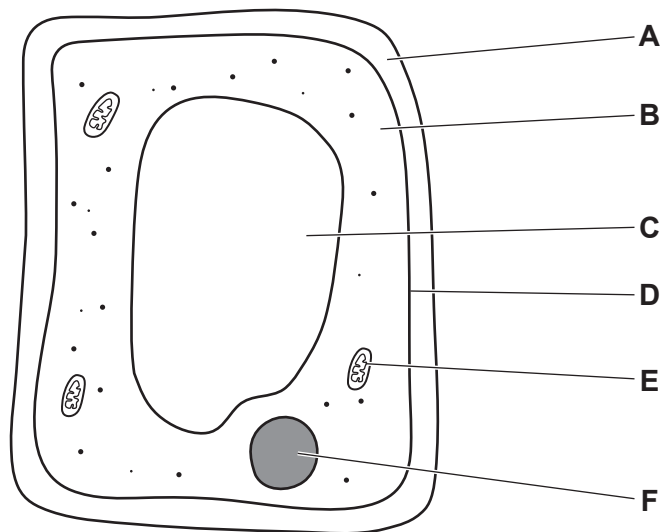
Fig. 9.1

(a) Table 9.1 describes three of the structures in the cell in Fig. 9.1.

Complete Table 9.1 by matching the letters in Fig. 9.1 with the descriptions.

Table 9.1

description of structure	letter of structure
made of cellulose	
contains chromosomes	
releases energy from glucose	

[3]

(b) (i) Name the chemical which causes the energy transferred from the sun by sunlight to be stored as chemical energy.

.... [1]

(ii) The word equation for photosynthesis is:

water + carbon dioxide $\longrightarrow$ glucose + oxygen

State the balanced chemical equation for photosynthesis.

.... [2]

[Total: 6]

10 A student produces a wave in a rope as shown in Fig. 10.1.

rope

4.8 m
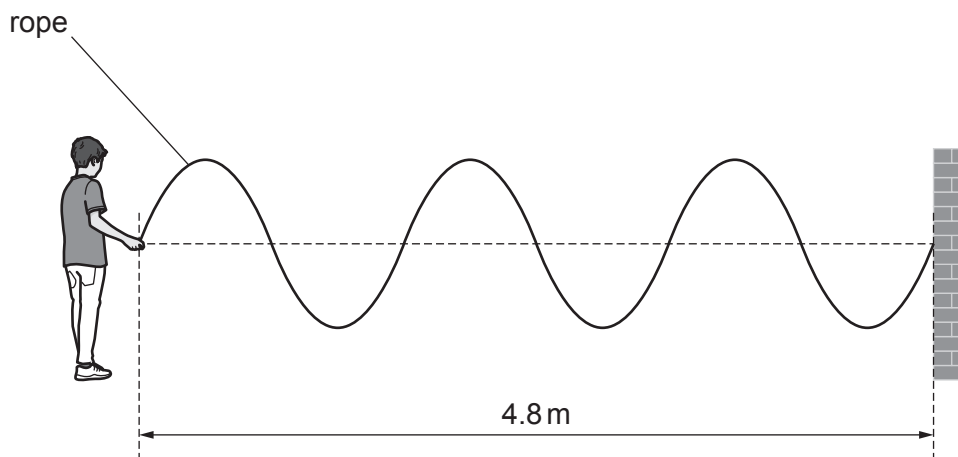
Fig. 10.1

(a) Choose **two** words from the list to complete the sentence about waves.

amplitude   **energy**   **light**   **matter**   **sound**

Waves transfer .... without transferring .... [2]

(b) (i) Use information in Fig. 10.1 to calculate the wavelength of the wave.

wavelength = ... m [1]

(ii) The student produces 1.2 waves per second.

Calculate the speed of the wave in the rope.

speed = ... m / s [2]

[Total: 5]

11 The boxes on the left contain the names of small biological structures.

The boxes on the right contain the names of larger biological structures where the small structures are found.

Draw **one** straight line from each box on the left to link the small structure to the larger structure where it is found.

small structure   **larger structure**

| alveoli | | ileum |

| | | leaf |

| gene | | stomach |

| guard cell | | chromosome |

| villi | | lung |

[4]

12 (a) An atom of calcium has a nucleon number of 40 and an atomic number of 20.

Deduce the number of electrons and the number of neutrons in the atom of calcium.

number of electrons = ...

number of neutrons = ...

[2]

(b) Powdered calcium metal reacts with water to produce an alkaline solution.

(i) State the formula of the ion that causes the solution to be alkaline.

.... [1]

(ii) Suggest a pH value of the alkaline solution.

.... [1]

(iii) Describe **one** way to decrease the rate of reaction between calcium metal and water.

....

.... [1]

[Total: 5]

13 A battery is used to start the engine of a car.

The initial current is very high but only lasts for a fraction of a second.

(a) Calculate the amount of charge transferred in a time of 0.20 s by a current of 250 A.

charge = ... C [2]

(b) The cable that carries the large current is wide.

Suggest **one** electrical safety hazard that is reduced by using a wide cable.

.... [1]

[Total: 3]

14 (a) Name **two** types of neurone present in the nervous system.

1 ....

2 ....

[2]

(b) State what is described as 'a rapid and automatic response to a stimulus'.

.... [1]

(c) Name the type of structure that produces a hormone.

.... [1]

(d) Name **one** human hormone.

.... [1]

[Total: 5]

15 (a) Potassium, K, reacts with chlorine, Cl_2, to form potassium chloride, KCl.

(i) Construct a balanced symbol equation, including state symbols, for the reaction.

.... [2]

(ii) Potassium chloride contains K^+ and Cl^- ions.

Fig. 15.1 shows part of the giant ionic lattice of potassium chloride.
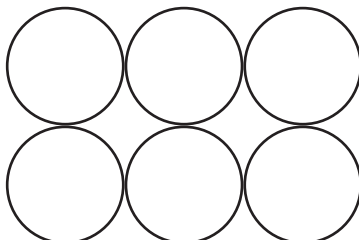
Fig. 15.1

Complete Fig. 15.1 to show the arrangement of ions in the lattice. [1]

(iii) Calculate the concentration of the solution formed when 2 g of potassium chloride dissolves in 100 cm^3 of distilled water.

[1 dm^3 = 1000 cm^3]

concentration = ... g / dm^3 [1]

(iv) Describe a test and the result of the test that shows the presence of chloride ions in the solution.

test ....

result ....
[2]

(b) State the difference between tap water and distilled water.

....

.... [1]

[Total: 7]

16 An unstable isotope decays by beta emission.

(a) Describe the particle that is emitted from the nucleus when the isotope decays.

.... [1]

(b) Emitters of beta radiation are used in medical treatments inside the human body.

(i) Suggest why emitters used inside the body have a short half-life.

....

.... [1]

(ii) Suggest **one** other type of emission that can be used safely inside the body.

.... [1]

[Total: 3]

19

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The Periodic Table of Elements

Group

Key

atomic number
atomic symbol
name
relative atomic mass

I	II		III	IV	V	VI	VII	VIII
								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

1
H
hydrogen
1

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
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
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
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 –

III	IV	V	VI	VII	
31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).