Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2763952449

COMBINED SCIENCE **0653/42**

Paper 4 (Extended) **May/June 2017**

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.

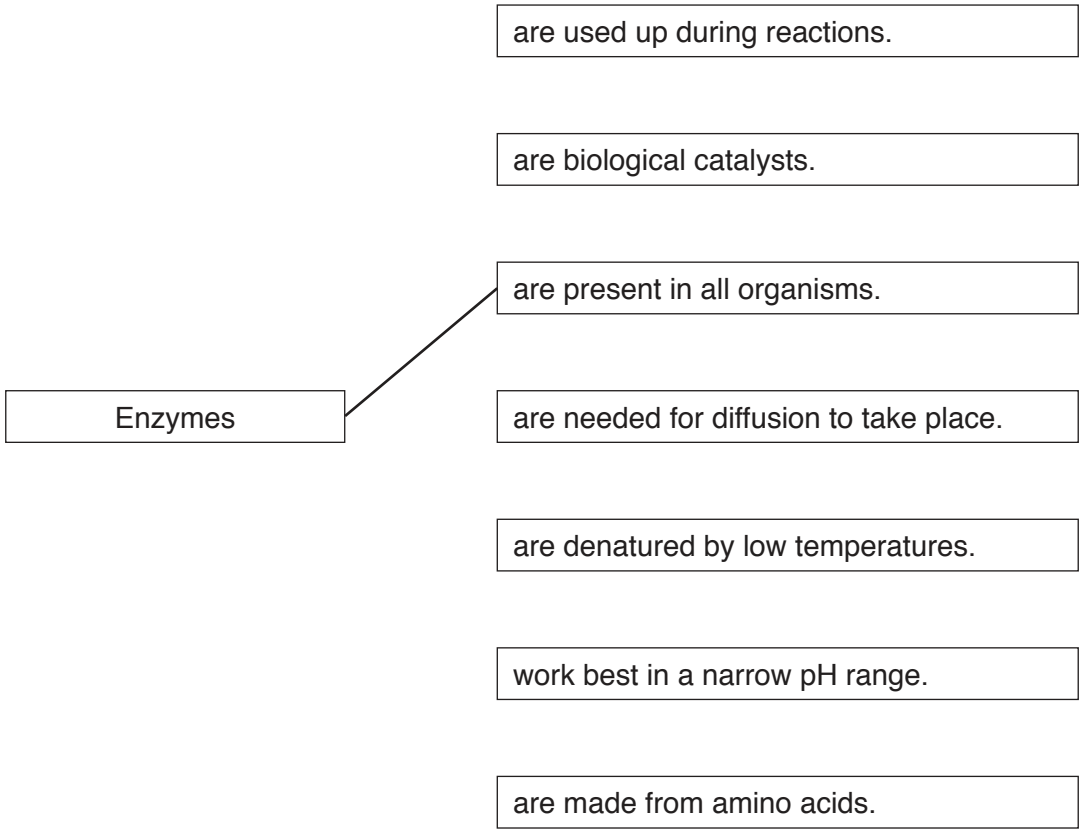
This document consists of **20** printed pages.

CAMBRIDGE International Examinations

1 **(a)** Use lines to connect the box on the left to different boxes on the right to make correct sentences.

One is done for you. The sentence reads 'Enzymes are present in all organisms'.

Draw **three** more lines to make three more correct sentences.



[3]

(b) Microorganisms are used in the production of yoghurt.

If the temperature increases the rate of yoghurt production also increases until 46 °C is reached. As the temperature increases further, the rate of yoghurt production rapidly decreases.

A student thinks that enzymes in the microorganisms are involved in making yoghurt.

Suggest whether the student is correct. Explain your answer.

.....

.....

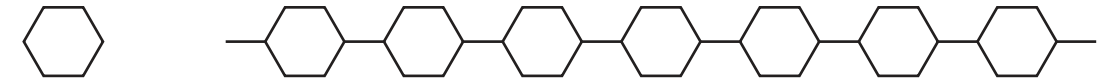
.....

.....

..... [2]

(c) Fig. 1.1 shows a small section of a starch molecule.

Starch is a very large molecule, made up from many basic units which are joined together.



basic unit part of a starch molecule

Fig. 1.1

(i) Name the basic unit shown in Fig. 1.1.

..... [1]

(ii) Name another **large** molecule, found in some living organisms, which could be made up from the same basic unit as shown in Fig. 1.1.

..... [1]

(iii) Name the element found in a protein molecule which is absent from a starch molecule.

..... [1]

2 **(a)** A teacher places the first three metals of Group I in the Periodic Table into separate beakers of water. This is shown in Fig. 2.1.

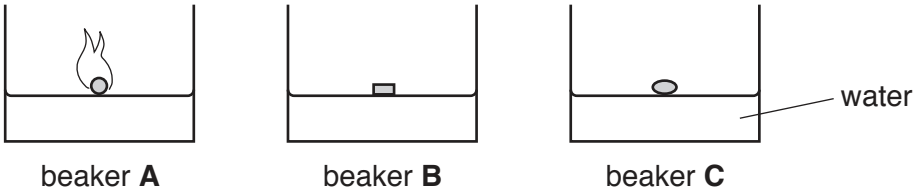


Fig. 2.1

The three pieces of metal are the same size.

A student records her observations in Table 2.1.

Table 2.1

beaker	the metal floats	the metal melts	time for metal to fully react in seconds	flames are seen
A	yes	yes	15	yes
B	yes	no	60	no
C	yes	yes	40	no

(i) Use the information in Table 2.1 to identify the three metals in beakers **A**, **B** and **C**.

beaker **A** .....

beaker **B** .....

beaker **C** .....

[2]

(ii) Complete the sentences about the reaction in beaker **A** using suitable words or phrases.

The temperature in the beaker increases because this is an

..... reaction.

During this reaction ..... energy is changed into

..... and ..... energy.

[3]

(iii) The fourth metal in Group I is rubidium, Rb.

The student observes the reaction between a piece of rubidium and water. The piece of rubidium is the same size as the other metals.

Suggest how long it takes for the piece of rubidium to react completely.

..... seconds [1]

(b) Suggest why Group I metals **must not** be added to dilute hydrochloric acid.

.....

..... [1]

(c) Saucepans are usually made from an iron alloy rather than from pure iron.

Some coins are made from a copper alloy rather than from pure copper.

Explain why these alloys are used instead of the pure metals.

(i) iron alloy for saucepans

.....

..... [1]

(ii) copper alloy for coins

.....

..... [1]

[Turn over

3 **(a)** Fig. 3.1 shows an aircraft flying at a constant height and constant speed above the Earth's surface. The arrows labelled **A**, **B**, **C** and **D** show the forces acting on the aircraft.

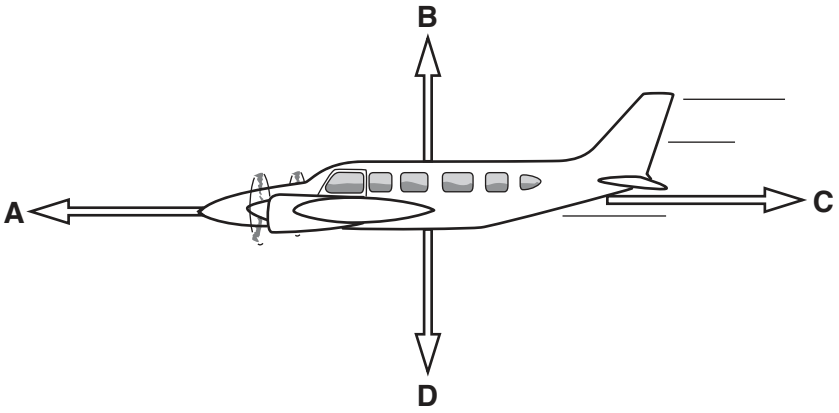


Fig. 3.1

(i) State which letter, **A**, **B**, **C** or **D**, corresponds to:

1. frictional force, ...

2. lifting force. .....

[1]

(ii) Force **D** is measured and found to be 500 000 N.

State whether force **B** is 500 000 N or has a different value.

Give a reason for your answer.

.....

..... [1]

(iii) During the flight, the aircraft burns 1000 kg of fuel.

State the effect this has on force **D**.

Explain why this happens.

effect on force **D** .....

explanation .....

.....

[1]

(b) The speed of the aircraft increases steadily in 30 s from 100 m / s to 160 m / s.

(i) Calculate the acceleration of the aircraft.

Show your working and state the unit of your answer.

acceleration = ... unit ..... [2]

(ii) As the speed increases, the aircraft loses height from 10 000 m to 8000 m.

The aircraft has a mass of 50 000 kg.

Calculate the loss in gravitational potential energy of the aircraft.

State the formula you use and show your working.

(g = 10 N / kg)

formula

working

potential energy lost = ... J [2]

4 **(a)** Fig. 4.1 shows a diagram of the internal structure of the heart.

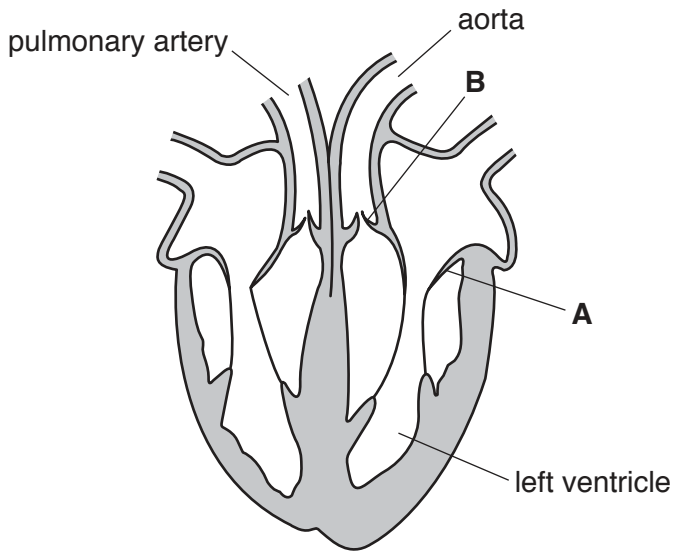


Fig. 4.1

(i) The ventricles contract to send blood out of the heart.

State what happens to the valves at **A** and **B** when the ventricles contract.

A .....

B .....
[1]

(ii) There is a difference in pressure of the blood travelling in the aorta compared with the blood travelling in the pulmonary artery.

Explain why it is important for blood to have different pressures in these arteries.

.....

.....

.....

..... [2]

(b) **(i)** The heart muscle must be supplied with blood.

Explain how coronary heart disease affects the blood supply to the heart muscle.

.....

.....

..... [2]

(ii) State **one** way in which sufferers of coronary heart disease can improve their lifestyle.

..... [1]

(c) The hormone adrenaline is secreted into the blood by the adrenal glands which are above the kidneys. One of the effects of adrenaline is to increase the heart rate.

(i) Describe **one** situation when the rate of adrenaline secretion increases rapidly.

.....

..... [1]

(ii) State how the hormone adrenaline is removed from the blood.

.....

..... [1]

(d) Hormones can affect the direction of growth in plants.

Fig. 4.2 shows what happens when a plant has bright light coming from one side.

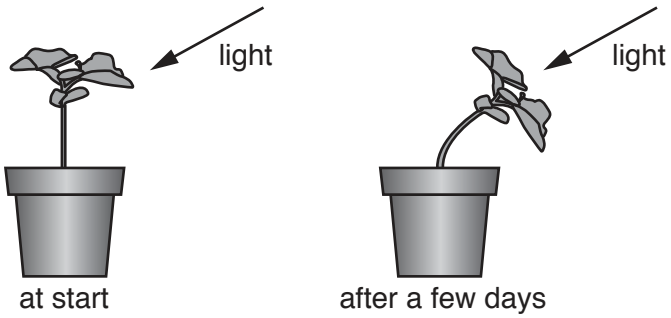


Fig. 4.2

Explain how hormones in the plant caused the phototropic response shown in Fig. 4.2.

.....

.....

.....

.....

..... [3]

5 Petroleum is a mixture of hydrocarbons.

(a) **(i)** Name the process that is used to separate liquids with different boiling points.

..... [1]

(ii) Describe the relationship between the size of hydrocarbon molecules and the size of intermolecular attractive forces.

.....

.....

..... [1]

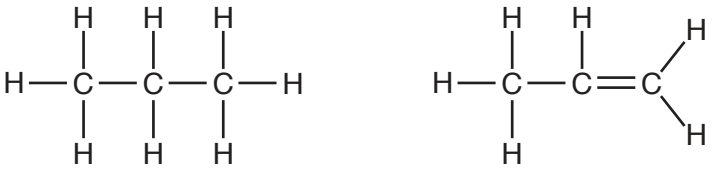
(iii) Describe the relationship between the size of the intermolecular attractive forces between hydrocarbon molecules and the boiling points of the hydrocarbons.

.....

.....

..... [1]

(b) The structures of two hydrocarbon molecules, **D** and **E**, are shown in Fig. 5.1.



D **E**

Fig. 5.1

(i) Name the **types** of hydrocarbon shown by molecules **D** and **E**.

D .....

E .....
[2]

(ii) Describe a chemical test used to distinguish between **D** and **E**.

State the observation for each.

test .....

observation with **D** .....

.....

observation with **E** .....

.....

[2]

(iii) Molecule **E** is made by heating larger hydrocarbon molecules in the presence of a catalyst.

Name this process.

..... [1]

(c) Heptane, C_7H_{16}, undergoes complete combustion in the presence of excess oxygen.

Complete the equation for this reaction.

$$C_7H_{16} + ...O_2 \rightarrow .....CO_2 + ...H_2O$$ [2]

6 An aircraft is flying at a height of 10 000 m. Outside the aircraft the temperature is –55 °C, but inside the aircraft the air temperature is kept at 21 °C.

(a) (i) State the main method of thermal energy transfer from air inside the aircraft to the air outside.

..... [1]

(ii) Describe in terms of molecular motion how thermal energy is lost from air inside the aircraft to the air outside.

.....

.....

.....

..... [2]

(b) Inside the aircraft's jet engines, the temperature reaches 1700 °C as the jet fuel burns. The combustion of the fuel forms exhaust gases containing carbon dioxide and water molecules.

(i) State which of the diagrams in Fig. 6.1, **X**, **Y** or **Z**, shows the arrangement of these molecules as they are formed in the engine.

Give a reason for your answer.

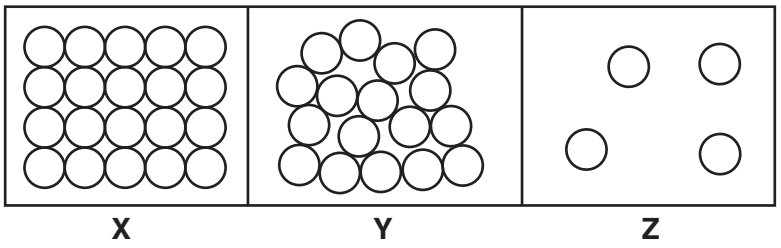


Fig. 6.1

diagram .....

reason .....

.....
[1]

(ii) Suggest how the motion of the water molecules formed in the jet engines differs from the motion of water molecules in a glass of water inside the aircraft.

Give a reason for your answer.

.....

.....

..... [2]

(c) Radar is a method of tracking aircraft from the ground using electromagnetic waves.

A radar signal is transmitted from the ground to an aircraft several kilometres away. The signal is then reflected by the aircraft back to the ground.

(i) The reflected signal is received back at the transmitting station 0.0002 s after transmission.

The speed of radar waves is 3×10^5 km / s.

Calculate the distance of the aircraft from the transmitter.

Show your working.

distance = ... km [3]

(ii) The radar signal has a frequency of 1.5×10^9 Hz.

Table 6.1 shows the range of frequencies across the electromagnetic spectrum.

Table 6.1

radiation	gamma radiation	X-rays	ultra-violet	visible light	infrared	micro-waves	radio waves
approximate frequency range	above 10^{19} Hz	10^{16} Hz to 10^{19} Hz	10^{14} Hz to 10^{16} Hz	4×10^{14} Hz to 8×10^{14} Hz	10^{11} Hz to 10^{14} Hz	10^9 Hz to 10^{11} Hz	below 10^9 Hz

Use this data to state whether the radar signal is at the short or long wavelength end of the electromagnetic spectrum.

Explain your answer.

.....

.....

.....

..... [2]

7 The lake shown in Fig. 7.1 is a balanced ecosystem. The steady flow of nutrients into the lake enables the water plants to grow and provide food for the small animals and fish.

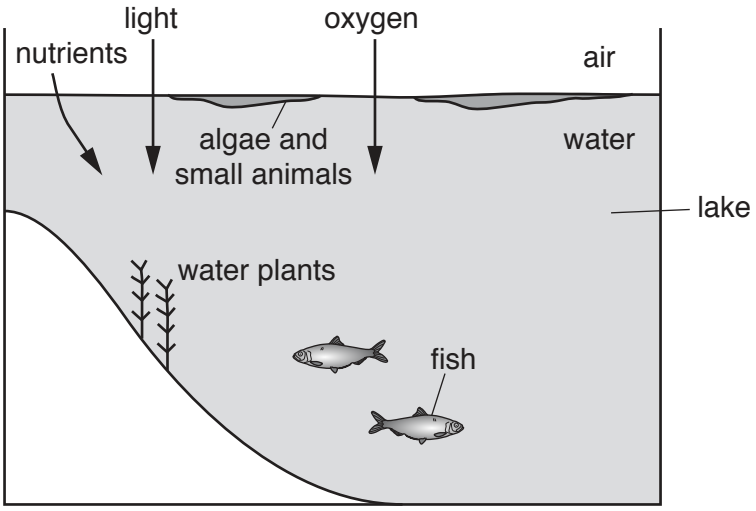


Fig. 7.1

(a) Define the term *ecosystem*.

.....

.....

..... [2]

(b) The feeding relationships of the organisms in Fig. 7.1 are as follows.

- the small animals feed on algae
- the fish feed on the algae, water plants and small animals.

Use the information provided to complete the food web which has been started below.

algae

water plants

[2]

(c) The ecosystem becomes unbalanced when fertiliser is accidentally added to the lake.

The fertiliser increases the concentration of nutrients in the lake.

Fig. 7.2 shows the lake after a few weeks.

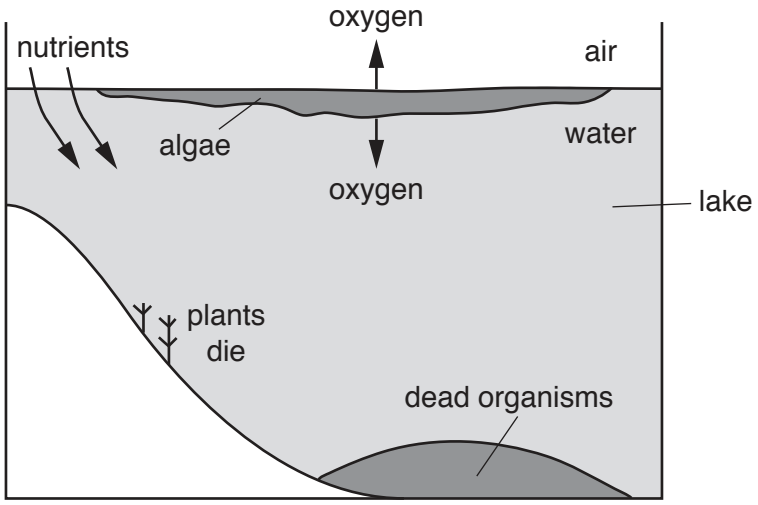


Fig. 7.2

(i) Explain why the water plants beneath the surface die.

.....

.....

.....

..... [2]

(ii) The fish die due to lack of oxygen. However, Fig. 7.2 shows the algae producing oxygen, some of which goes into the lake.

Explain what happens to the oxygen in the lake.

.....

.....

..... [2]

8 **(a)** An atom of element **X** is in Group VI of the Periodic Table.

(i) State the number of outer-shell electrons in an atom of **X**.

..... [1]

(ii) State whether element **X** is a metal or a non-metal.

Suggest **one** physical property of element **X**.

metal or non-metal .....

physical property .....
[1]

(b) Chlorine, C*l*, is in Group VII of the Periodic Table.

(i) Complete Fig. 8.1 to show the electronic structure of an atom of chlorine.

Use the Periodic Table on page 20.

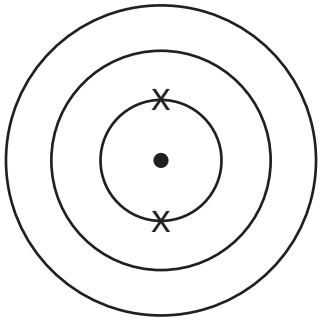


Fig. 8.1

[1]

(ii) Draw a dot-and-cross diagram to show all of the outer-shell electrons in a molecule of chlorine, Cl_2.

C*l* C*l*

[1]

(c) Chlorine reacts with sodium to form a compound.

(i) State the type of chemical bond in this compound.

..... [1]

(ii) Describe what happens to sodium atoms and to chlorine atoms when they react together to form this compound.

Use ideas about electrons in your answer.

sodium atoms .....

chlorine atoms .....
[2]

(d) Noble gases are unreactive.

Explain this observation using ideas about the electronic structure of noble gas atoms.

.....

..... [1]

9 Fig. 9.1 shows a simple circuit set up to investigate the electrical properties of a lamp.

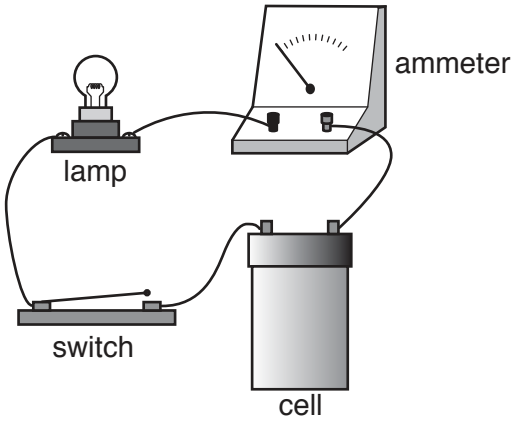


Fig. 9.1

(a) (i) On Fig. 9.2 use the correct circuit symbols to complete the circuit diagram for the circuit shown in Fig. 9.1.

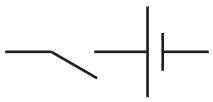


Fig. 9.2

[2]

(ii) On Fig. 9.2, using the correct circuit symbol, connect a meter into the circuit that can measure the potential difference across the lamp. [2]

(b) The cell has a voltage of 1.5 V, and the reading on the ammeter is 0.6 A for the circuit in Fig. 9.1. The lamp is brightly lit and hot to the touch.

Show by calculation that the power dissipated in the circuit is less than 1 W.

power = ... W [1]

(c) A second identical lamp is added in series with the lamp in the circuit in Fig. 9.1.

The reading on the ammeter decreases, and both lamps are now dimly lit and cool to the touch.

(i) Explain why adding the second lamp causes the current to decrease.

.....

.....

..... [1]

(ii) Explain why less light and thermal energy are emitted by the two bulbs than by one bulb on its own in the circuit.

.....

.....

.....

..... [2]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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 –		

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.)