Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2179611717

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.

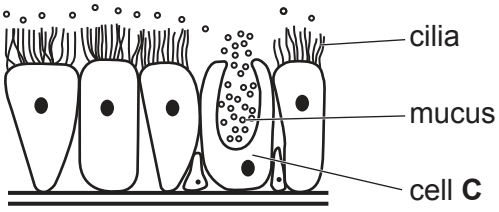

Fig. 1.1

(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.

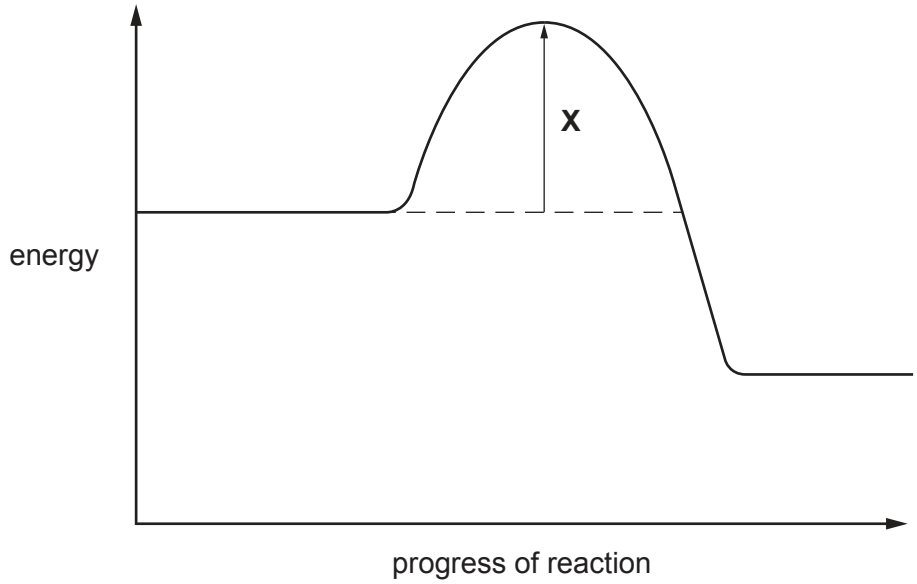

Fig. 2.1

(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.

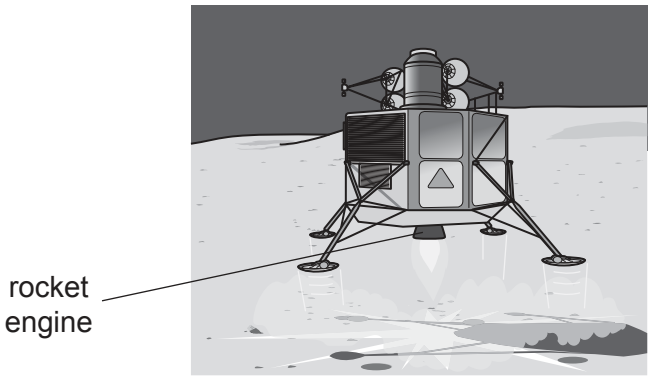

Fig. 3.1

(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.

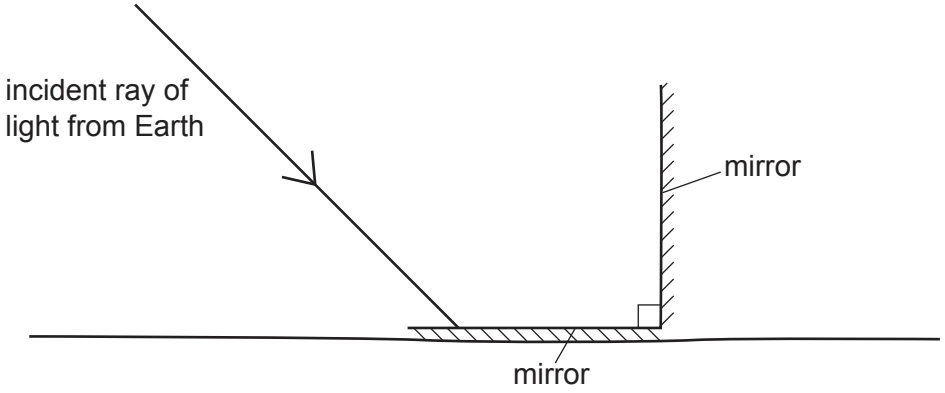

Fig. 3.2

(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 3.00×10^5 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.

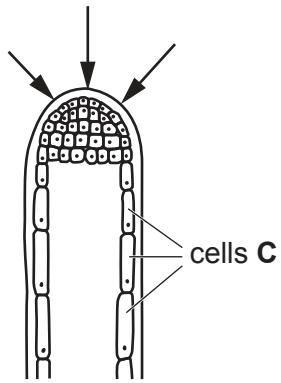

Fig. 4.1

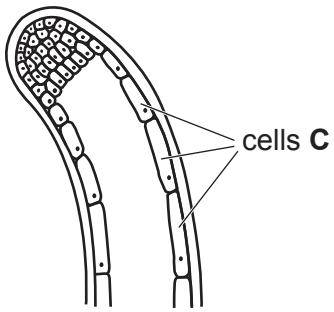

Fig. 4.2

(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.

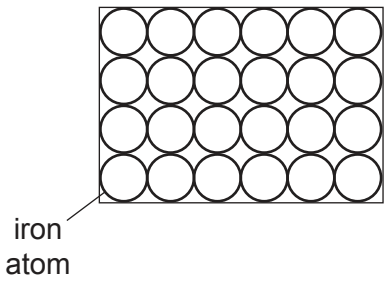

Fig. 5.1

(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.

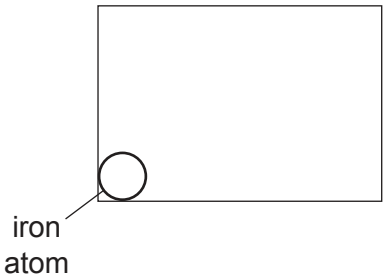

Fig. 5.2

[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 → 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.

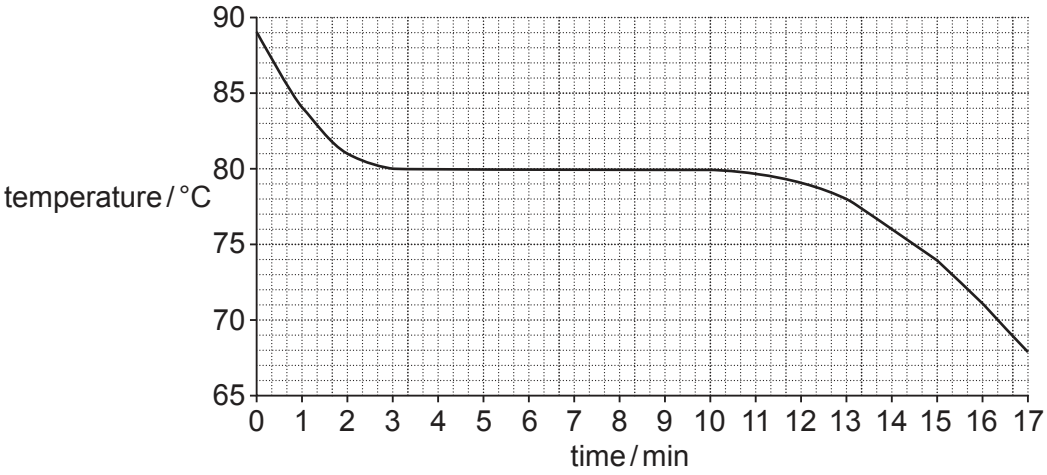

Fig. 6.1

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.

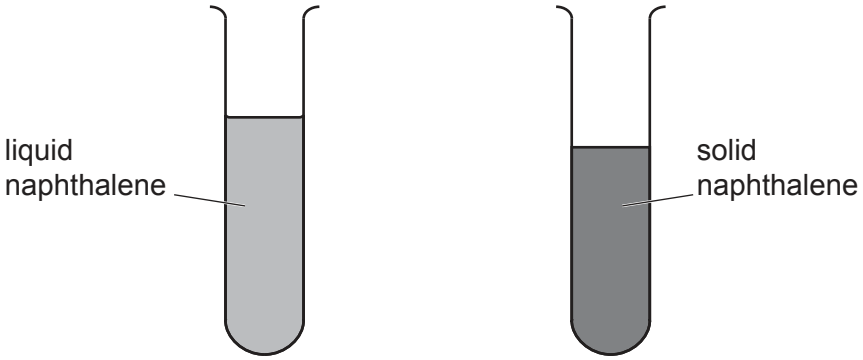

Fig. 6.2 **Fig. 6.3**

(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**.

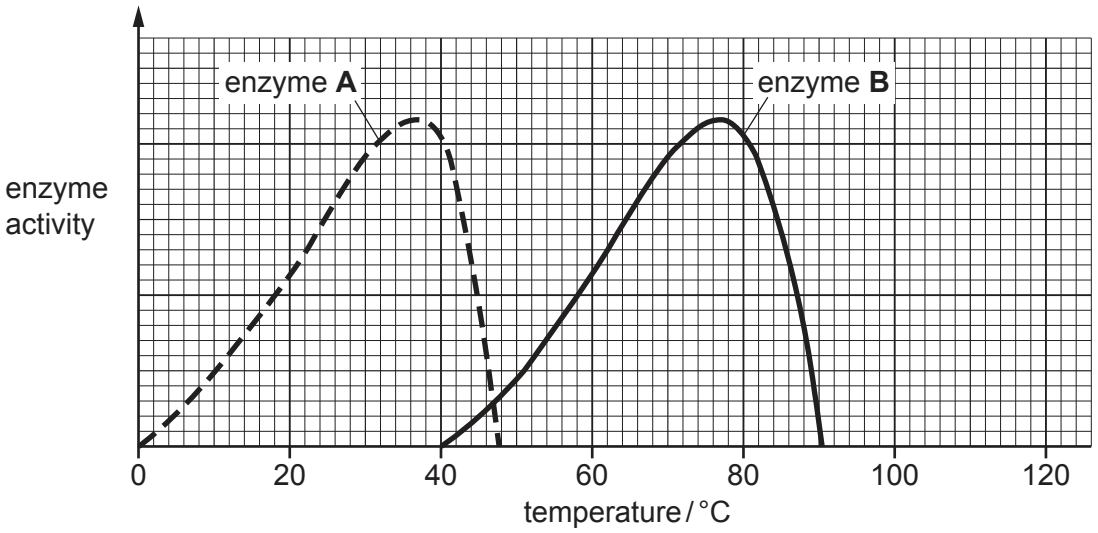

Fig. 7.1

(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.

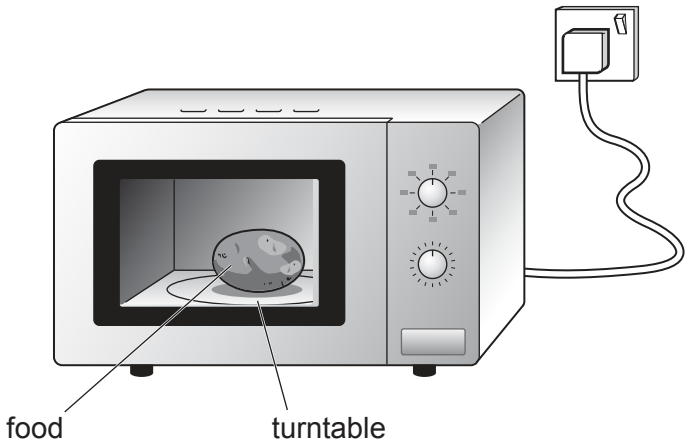

Fig. 9.1

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 2.45×10^9 Hz.

The speed of microwave radiation is 3.00×10^8 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.

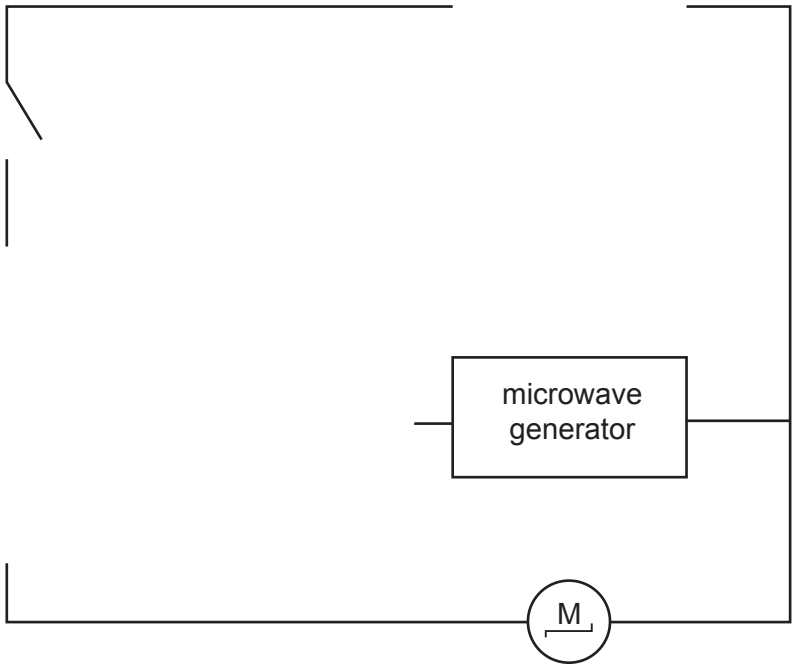

Fig. 9.2

[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	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.).