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CAMBRIDGE
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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0223445822

COMBINED SCIENCE **0653/42**

Paper 4 Theory (Extended) **February/March 2026**

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. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

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.

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1 Figure 1.1 is a diagram of the human digestive system.

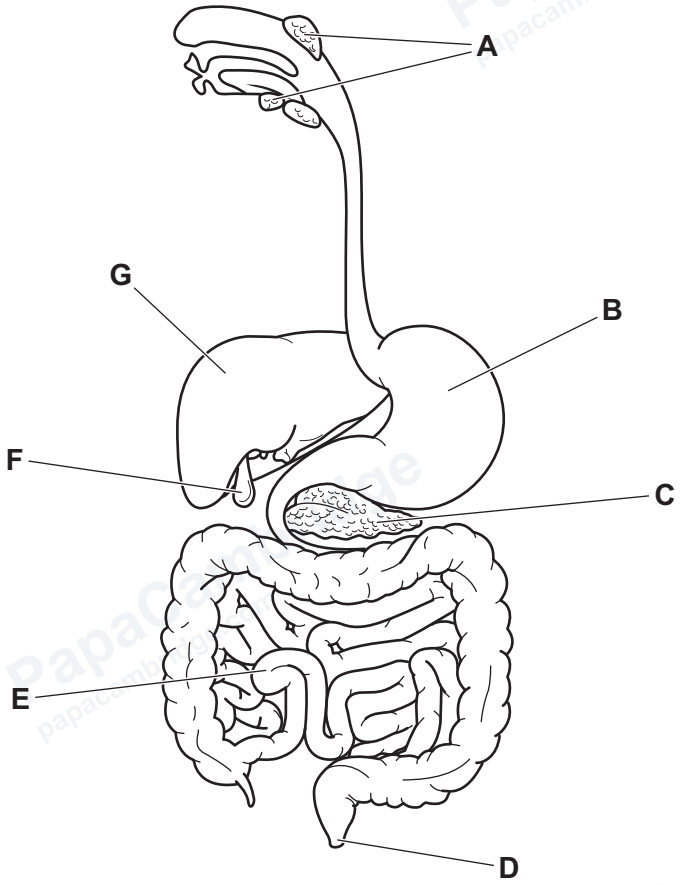


Figure 1.1

(a) State **one** letter from Figure 1.1 that identifies a part where:

absorption occurs .....

egestion occurs. .....

[2]

(b) State **all** the letters from Figure 1.1 that identify the parts of the digestive system that are part of the alimentary canal.

..... [1]

(c) The part labelled **B** in Figure 1.1 contains hydrochloric acid.

Hydrochloric acid provides the optimum pH for protease enzymes.

(i) Describe the **other** function of hydrochloric acid in the part labelled **B** in Figure 1.1.

.....

..... [1]

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(ii) Complete the sentences to explain why the enzyme amylase does **not** function in part **B** in Figure 1.1.

The acidic pH changes the shape of the ..... of the enzyme.

Amylase is no longer complementary to its substrate, which is called ..... .

Enzyme–substrate ..... can no longer form.

This process is called ..... .

[4]

(iii) Describe **one** other environmental condition that causes the same process explained in **1(c)(ii)**.

..... [1]

[Total: 9]

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2 **(a)** Figure 2.1 is a photograph of a wind-pollinated grass flower.



Figure 2.1

(i) Describe **two visible** pieces of evidence in Figure 2.1 that show the stigma is adapted to wind-pollination.

1 .....

.....

2 .....

.....

[2]

(ii) State the part of the flower where fertilisation occurs.

..... [1]

(iii) Grass is part of a food chain. State the position of grass in a food chain.

..... [1]

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(b) Deforestation causes species extinction and an increase of carbon dioxide in the atmosphere.

(i) State the balanced symbol equation for the process in plants that removes carbon dioxide from the atmosphere.

..... [2]

(ii) Describe ways to prevent the extinction of plant species.

.....

.....

.....

.....

..... [3]

[Total: 9]

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3 **(a)** The aorta is the main artery from the heart and the vena cava is the main vein to the heart.

Table 3.1 shows some information about the features of the aorta and vena cava.

Table 3.1

name of blood vessel	type of blood vessel	cross-sectional area of the lumen / cm^2
aorta	artery	3.5
vena cava	vein	8.0

(i) Calculate how many times greater the cross-sectional area of the vena cava lumen is compared to the cross-sectional area of the aorta lumen in Table 3.1.

..... [1]

(ii) Explain the difference in size of the cross-sectional area of the aorta lumen and the vena cava lumen in Table 3.1.

.....

.....

.....

..... [2]

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(b) Blood vessels transport red blood cells.

(i) State the name of the chemical that combines with oxygen in red blood cells.

..... [1]

(ii) Describe how oxygen moves through the membrane of a red blood cell.

.....

.....

.....

.....

..... [3]

(iii) Describe **two** factors that increase the rate of oxygen moving through the cell membrane.

1 .....

2 .....

[2]

[Total: 9]

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4 **(a)** The electrolysis of molten magnesium chloride, $MgCl_2$, is investigated.

The apparatus used is shown in Figure 4.1.

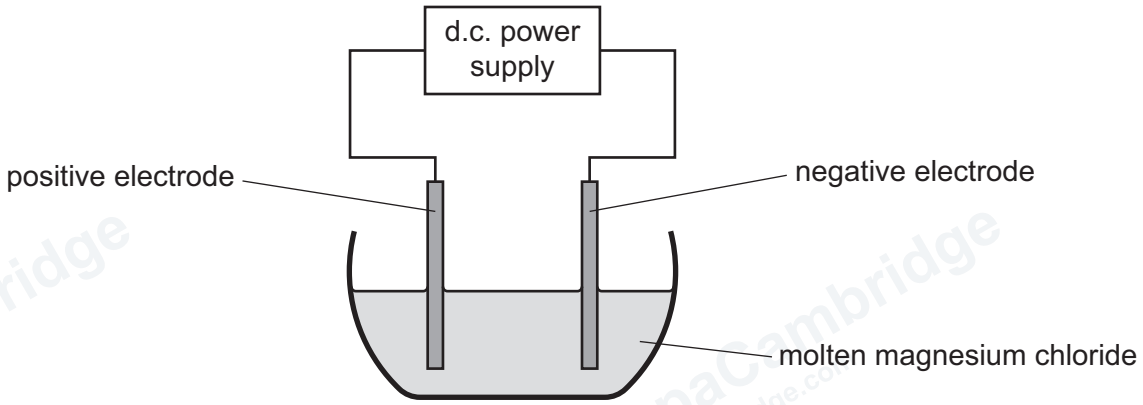


Figure 4.1

(i) State the name of the negative electrode.

..... [1]

(ii) Complete Table 4.1 to show information about the products formed at each electrode.

Table 4.1

	name of product	**formula of product**	**appearance of product**
negative electrode			
positive electrode			

[2]

(iii) Solid magnesium chloride **cannot** be electrolysed.

The magnesium chloride shown in Figure 4.1 is molten.

State **one** other way that magnesium chloride can be electrolysed.

..... [1]

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(b) Electrolysis is an endothermic process.

(i) Complete Figure 4.2 to show the reaction pathway diagram for an endothermic process.

Include:

- the products
- an arrow labelled E_a to show the activation energy
- an arrow labelled **X** to show the overall energy change of reaction.

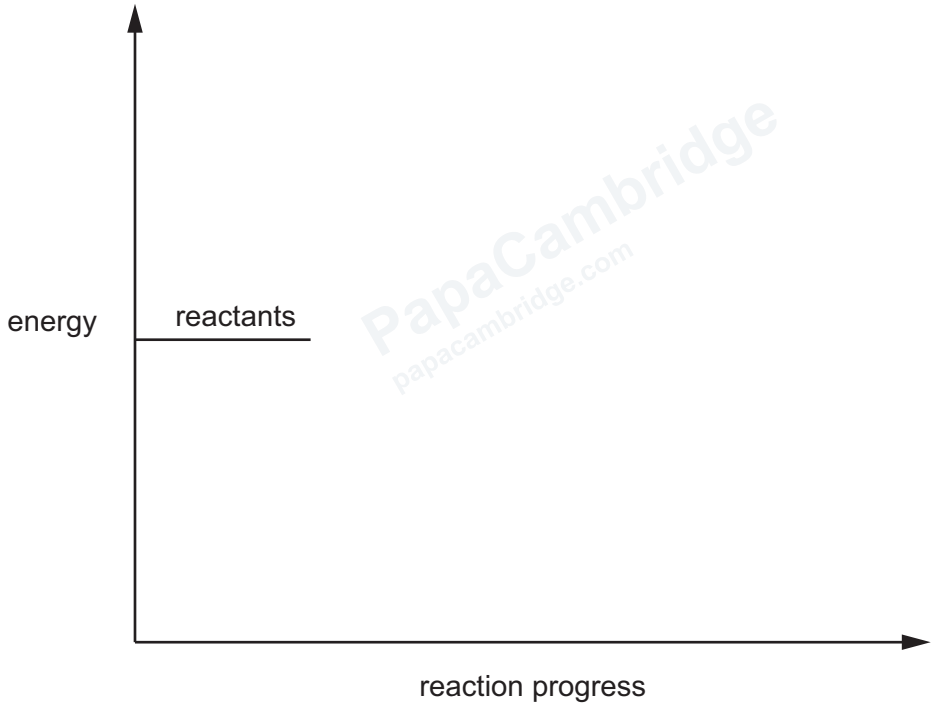


Figure 4.2

[3]

(ii) Define activation energy, E_a.

.....

..... [2]

(iii) Give **one** conclusion about the energy involved in bond breaking compared with bond making in endothermic reactions.

.....

..... [1]

[Total: 10]

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5 **(a)** A student adds drops of aqueous chlorine to three separate test-tubes containing aqueous halide compounds as shown in Figure 5.1.

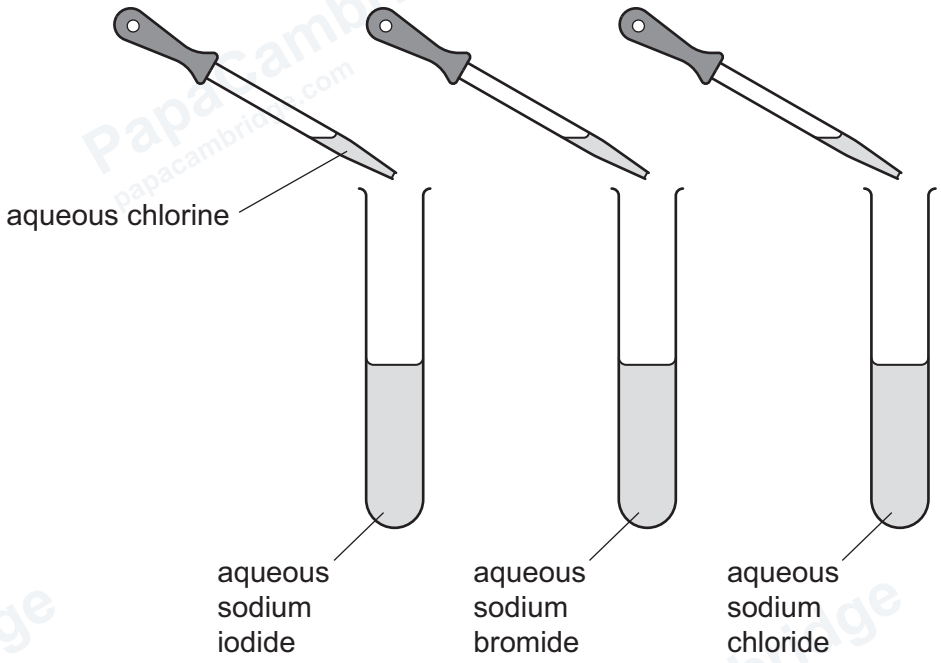


Figure 5.1

(i) Complete Table 5.1 to show the observations in each test-tube.

Table 5.1

	aqueous sodium iodide	**aqueous sodium bromide**	**aqueous sodium chloride**
aqueous chlorine			

[3]

(ii) Each aqueous halide compound contains a different halide ion. State the type of chemical reaction that occurs between halogens and other halide ions.

..... [1]

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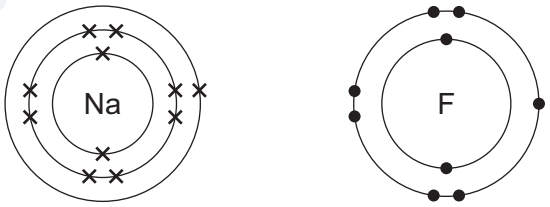
(b) Aqueous bromine reacts with aqueous sodium iodide.

Give the balanced symbol equation for this reaction.

..... [2]

(c) Fluorine is a Group VII halogen.

Figure 5.2 shows the electronic configuration for an atom of sodium and an atom of fluorine.



sodium atom fluorine atom

Figure 5.2

Complete the dot-and-cross diagram in Figure 5.3 to show the ionic bonding in sodium fluoride, NaF.

Show **only** the outer-shell electrons and include the charges on the ions.

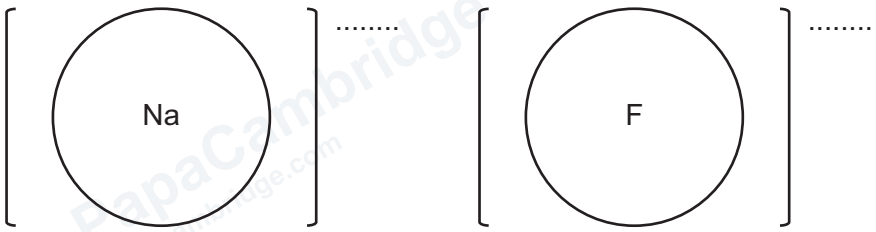


Figure 5.3

[3]

[Total: 9]

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6 **(a)** Figure 6.1 shows the structure of pentane.

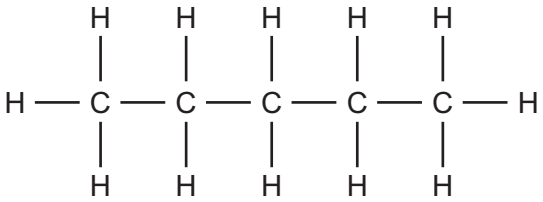


Figure 6.1

(i) Deduce the molecular formula for pentane.

..... [1]

(ii) Name the homologous series to which pentane belongs.

..... [1]

(iii) Tick (✓) **all** the statements in Table 6.1 that are true for pentane.

Table 6.1

statement	true
It forms air pollutants during combustion.	
It contains covalent bonds.	
It is generally unreactive.	
It is a saturated hydrocarbon.	
It reacts with hydrogen in the presence of a nickel catalyst.	

[3]

(b) Pentane is used to make smaller hydrocarbons.

Name this process and describe **two** conditions required.

process .....

condition 1 .....

condition 2 .....

[2]

[Total: 7]

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7 The Sun is a stable star.

(a) Figure 7.1 shows two planets, **J** and **K**, orbiting a stable star.

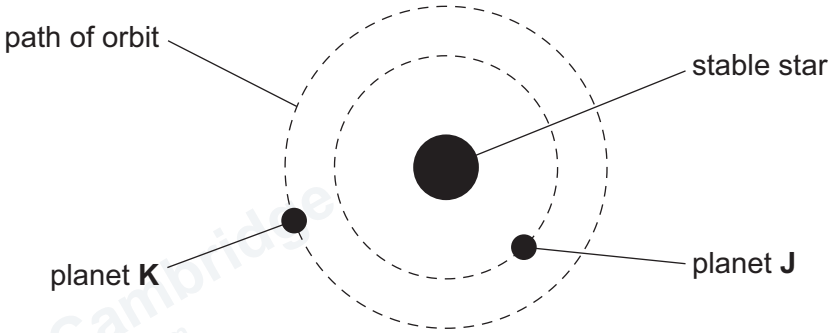


Figure 7.1

State which planet has the greater orbital speed.

Explain your answer in terms of forces.

planet .....

explanation .....

.....

[2]

(b) The Sun is a small mass star.

Complete Figure 7.2 to show the next stages in the lifecycle of the Sun.

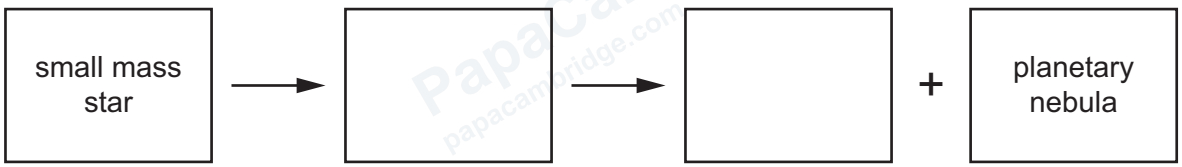


Figure 7.2

[2]

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(c) There is a region of gases in the Sun called the convection zone.

Thermal energy is transferred from the hotter interior to the cooler exterior of the Sun by convection.

Describe the process of convection in a gas.

.....

.....

..... [2]

(d) Table 7.1 shows data for two of the planets in the Solar System.

Table 7.1

planet	gravitational field strength / N/kg
Mercury	3.7
Mars	3.7

Student **A** says: 'I will have a smaller mass and a smaller weight on Mercury than on Mars.'

Student **B** says: 'I will have the same mass and weight on Mercury as on Mars.'

Explain which student is correct.

student .....

explanation .....

.....

.....

[2]

[Total: 8]

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8 **(a)** Figure 8.1 shows a distance–time graph for a car on a journey.

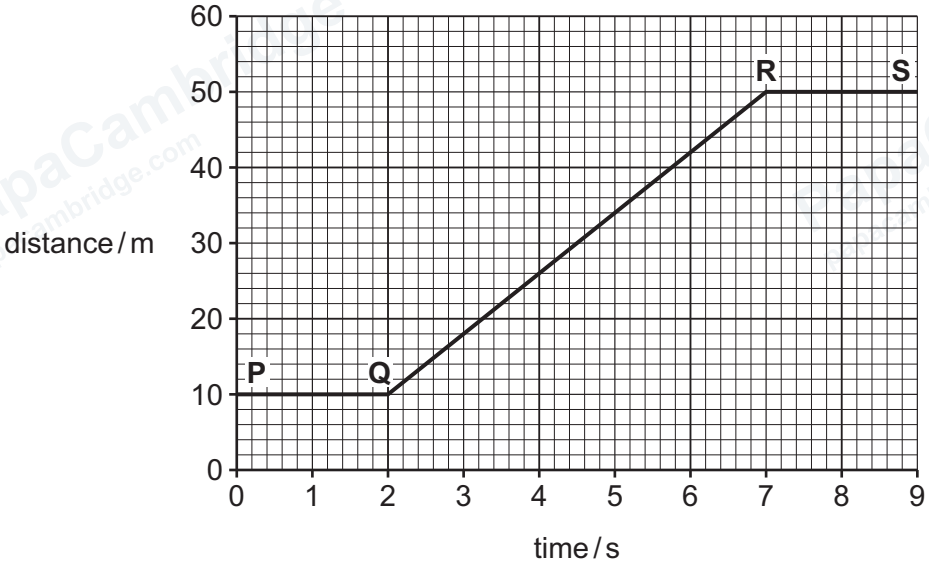


Figure 8.1

Calculate the speed of the car between point **Q** and point **R**.

speed = ... m / s [2]

(b) A different car is moving at a constant speed with a kinetic energy of 61 000 J.

The mass of the car is 850 kg.

Calculate the speed of the car.

speed = ... m / s [2]

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(c) The rear lamps of the car contain light emitting diodes (LEDs) that emit red light.

(i) Draw the circuit symbol for a light emitting diode (LED).

[1]

(ii) The red light has a frequency of 4.0×10^{14} Hz.

Calculate the wavelength of the red light.

wavelength = ... m [3]

(iii) Light is a transverse wave.

Describe the difference between a transverse wave and a longitudinal wave.

Use ideas about direction of vibrations in your answer.

.....

.....

.....

..... [2]

[Total: 10]

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9 **(a)** A car battery is charged using a 120 V, 30 kW charger.

The battery is charged for 1.5 hours.

(i) Calculate the energy, in kW h, transferred to the battery.

energy transferred = ... kW h [2]

(ii) Calculate the charge that flows while the battery is charging.

charge = ... C [5]

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(b) Table 9.1 shows data for three wires, **W**, **X** and **Y**.

The wires are all made of the same metal.

The wires all have the same length.

Table 9.1

wire	cross-sectional area / cm^2	resistance / Ω
W	1.0	12
X	2.0	6
Y	3.0	4

Wire **Z** is made from the same metal and has the same length as wires **W**, **X** and **Y**.

Wire **Z** has a resistance of 5 Ω.

Determine the cross-sectional area of wire **Z**.

Show your working.

cross-sectional area of wire **Z** = ... cm^2 [2]

[Total: 9]

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).

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