OCR
Oxford Cambridge and RSA

Thursday 9 January 2025 – Afternoon

Level 3 Cambridge Technical in Applied Science

05847/05848/05849/05874/05879 Unit 1: Science fundamentals

Time allowed: 2 hours
C340/2501

C340/2501

You must have:
- the Data Sheet (inside this document)
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator
- an HB pencil

05847/01

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

Date of birth | D | D | M | M | Y | Y | Y | Y |

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- The Periodic Table is on the back page.
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

1 An atom is made up of protons, neutrons and electrons.

(a)

(i) Draw a straight line from each property to the correct subatomic particle.

Property	Subatomic particle
These particles reduce electrostatic repulsion in the nucleus.	Electrons
These particles are responsible for making bonds with other atoms.	Neutrons
The number of these particles is the atomic number of an element.	Protons

[3]

(ii) Complete the table to show the relative masses and charges of the subatomic particles in the atom.

	Relative mass	Relative charge
Proton	.....	.....
Neutron	.....	.....
Electron	.....	.....

[3]

(b) Phosphorus is an element in Group 5 of the Periodic Table and has an atomic number of 15.

(i) An isotope of phosphorus has a mass number of 31.

How does the mass of one atom of phosphorus-31 compare to the mass of one atom of carbon-12?

.....

..... **[2]**

(ii) Determine the electronic configuration in terms of main energy levels of:

- a phosphorus atom .....
- a phosphide ion, P^{3-} .....

[2]

(c) Phosphorus can form both ionic and covalent compounds.

(i) Explain what **ionic bond** means.

.....

.....

..... **[1]**

(ii) Sodium phosphide is an ionic compound.

What is the correct formula of sodium phosphide?

Tick (✓) **one** box.

NaP_3 ☐

Na_2PO_3 ☐

Na_3P ☐

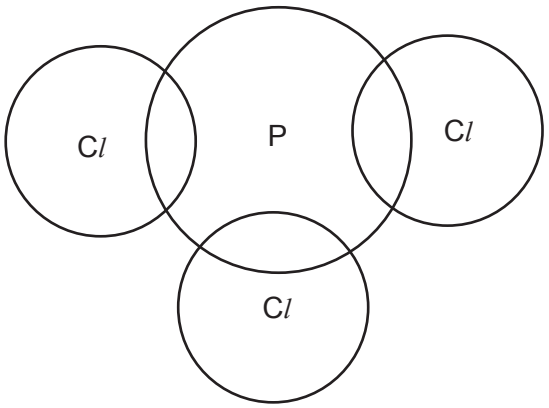
Na_3PO_4 ☐

[1]

(iii) PCl_3 is a covalent compound.

Complete the dot-and-cross diagram of PCl_3.

Only draw the outer shell electrons.



[2]

(iv) The P–C*l* bond is polar.

Explain what **polar bond** means.

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.....

..... **[1]**

(d) Chlorine reacts with potassium bromide to form bromine and potassium chloride.

(i) Complete and balance the equation for the reaction.

Cl_2 + ... KBr ⟶ ..... + 2 .....

[2]

(ii) Explain why chlorine displaces bromine from potassium bromide (KBr) but iodine does not displace bromine from potassium bromide.

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..... **[2]**

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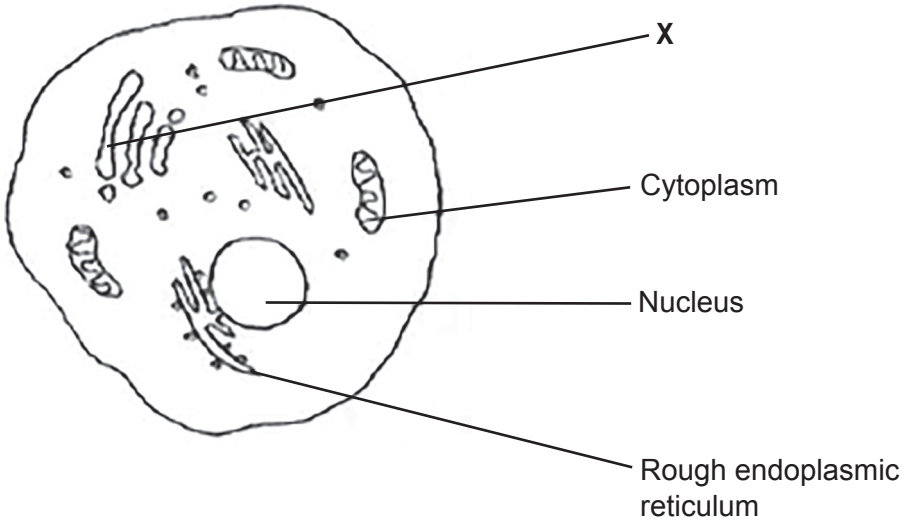
Turn over for the next question

2 A eukaryotic cell from an animal is shown in the diagram below.

The cell components are not drawn to scale.

Some of the organelles in the diagram have been labelled.



(a) Rough endoplasmic reticulum is shown in the diagram.

(i) Identify the organelles that cover the surface of rough endoplasmic reticulum.

Tick (✓) **one** box.

chromosomes ☐

ribosomes ☐

thylakoids ☐

vesicles ☐

[1]

(ii) Rough and smooth endoplasmic reticulum produce and process biological molecules in different ways.

Draw a straight line to link:

- each type of endoplasmic reticulum to the biological molecule produced.
- each biological molecule to the process at the endoplasmic reticulum.

Type of endoplasmic reticulum	Biological molecule	Process
rough	lipid	storage
smooth	protein	transportation

[2]

(b) Organelle **X** releases lysosomes.

(i) Identify the organelle labelled as **X**.

Tick (✓) **one** box.

chloroplast	☐
cytoplasm	☐
Golgi apparatus	☐
plasma membrane	☐

[1]

(ii) Describe the function of a lysosome within a eukaroytic cell.

.....

.....

..... **[2]**

(c) The eukaryotic cell contains nucleic acids with different roles.

Two types of nucleic acids are DNA and RNA.

(i) Both DNA and RNA contain the same charged functional group in their structure.

Draw a (ring) around the charged functional group found in DNA and RNA.

nitrate **phosphate** **sulfate**

[1]

(ii) State **two** structural differences between DNA and RNA.

Difference 1 .....

.....

Difference 2 .....

.....

[2]

(iii) Three types of RNA are messenger (mRNA), ribosomal (rRNA) and transfer (tRNA).

Describe how each of the types of RNA link the genetic sequence or gene held in the DNA to processes taking place at the ribosome.

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..... **[4]**

(d) Cisplatin is used in chemotherapy to treat cancer patients.

(i) Identify the metal ion in cisplatin.

..... **[1]**

(ii) Describe the action of cisplatin in the treatment of cancer patients.

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.....

.....

..... **[2]**

Turn over for the next question

3 Nitrogen is a vital element in biological organisms.

(a) The nitrogen cycle involves a series of steps.

(i) In the nitrogen-fixing step, nitrogen in the atmosphere is converted into NH_4^+ ions in the soil by nitrogen-fixing bacteria.

Identify the name of the NH_4^+ ion.

Tick (✓) **one** box.

ammonium ☐

cysteine ☐

methionine ☐

nitrate ☐

[1]

(ii) The nitrogen-fixing bacteria convert NH_4^+ ions into NO_3^- ions.

The half equation for the conversion of NH_4^+ ions into NO_3^- ions is shown below.

$NH_4^+ + \ldots\ldots\ldots\ldots H_2O \longrightarrow NO_3^- + \ldots\ldots\ldots\ldots H^+ + \ldots\ldots\ldots\ldots e^-$

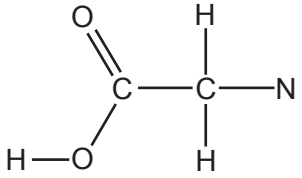
- Complete the equation so that it balances.
- Explain in terms of electrons whether the conversion of NH_4^+ ions into NO_3^- ions is oxidation or reduction.

.....

..... **[3]**

(iii) In the assimilation step NO_3^- ions are absorbed by plants and converted into amino acids such as glycine.

Complete the diagram to show the correct structural formula of glycine.



[1]

(iv) Name the type of bond that forms between amino acids to form a protein.

..... **[1]**

(b) Connective tissue is made up of protein.

(i) State the function of connective tissue.

.....

..... **[1]**

(ii) Describe the structure of connective tissue.

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..... **[3]**

4 Hydrogen peroxide is produced during amino acid metabolism in the human body.

(a) Identify the site of hydrogen peroxide synthesis in the human body.

Tick (✓) **one** box.

heart ☐

intestine ☐

liver ☐

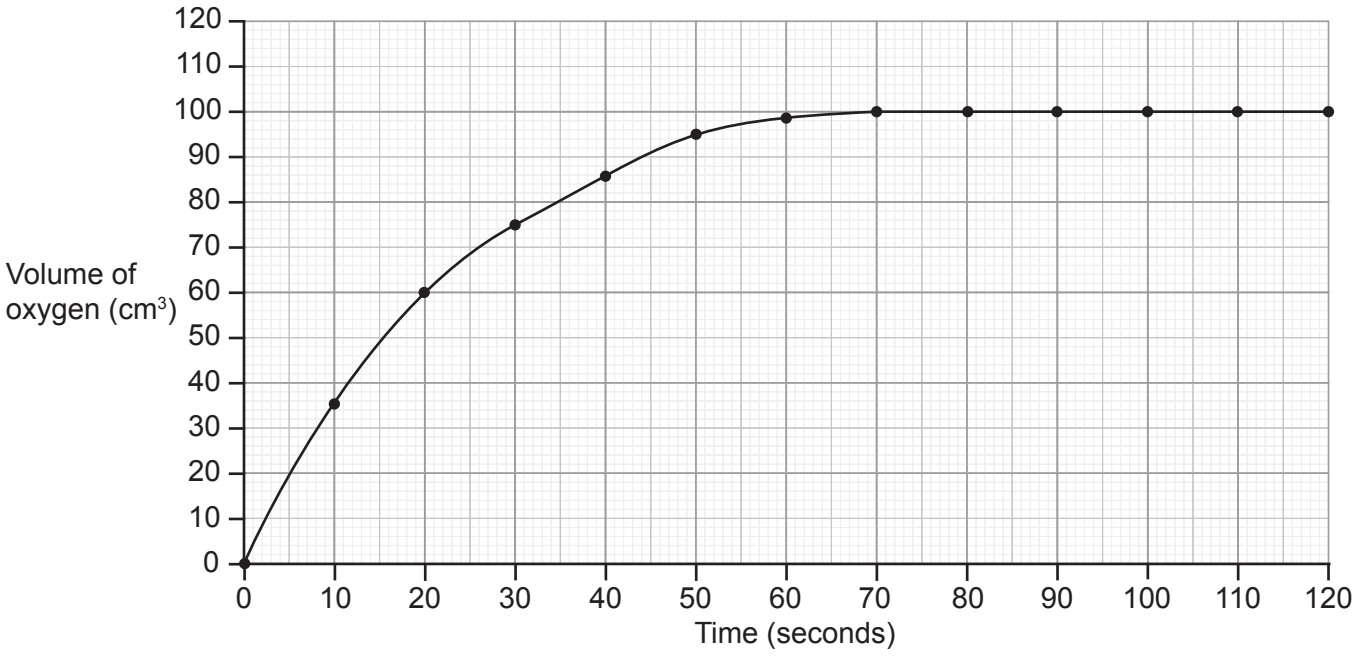
muscle ☐

[1]

(b) In the presence of a catalyst, a solution of hydrogen peroxide decomposes into water and oxygen gas.

A student investigates the rate of decomposition by measuring the volume of oxygen gas produced over time.

A graph for the decomposition of a solution of hydrogen peroxide in the presence of a catalyst is shown below.



(i) The average rate of decomposition at any given time can be determined by the equation:

$$\text{average rate } (\text{cm}^3\ \text{s}^{-1}) = \frac{\text{change in volume of oxygen gas } (\text{cm}^3)}{\text{change in time (s)}}$$

Calculate the average rate of reaction during the first 40 seconds, using the graph.

Average rate = ... $\text{cm}^3\ \text{s}^{-1}$ **[2]**

(ii) The student repeated the experiment at a lower temperature.

They used the same volume and concentration of hydrogen peroxide solution and the same catalyst.

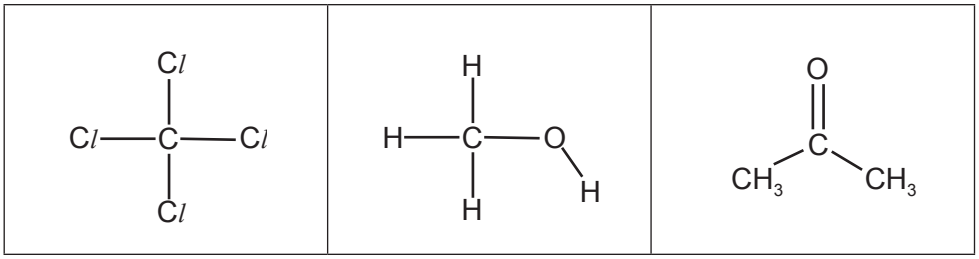
Draw a second line on the graph to show how the curve would change.

[2]

(iii) The solvent in the hydrogen peroxide solution is water.

The student makes the prediction that the rate of decomposition will decrease if the polarity of the solvent is decreased.

The diagram shows the structural formulae of three solvents.



Draw a (ring) around the solvent which would give the lowest rate of decomposition, based on the student's prediction.

[1]

(c) The catalyst used in the decomposition of hydrogen peroxide solution is a compound of manganese.

(i) Explain how a catalyst increases the rate of a reaction.

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..... **[2]**

(ii) Manganese ions are also found to have an important role within enzymes.

Identify the role of manganese ions in an enzyme.

Tick (✓) **one** box.

cofactors ☐

deactivators ☐

pH regulators ☐

receptors ☐

[1]

(iii) Enzymes containing manganese ions have different functions.

State **two** ways in which manganese-containing enzymes are involved in biological processes.

1 .....

.....

2 .....

.....

[2]

(d) Hazelnuts are a source of manganese.

100 g of hazelnuts contain 5.7 mg of manganese. A person consumes 50 g of hazelnuts.

The recommended daily intake of manganese for adults is 2.30 mg.

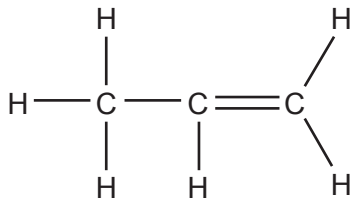
Calculate the percentage difference between the amount of manganese that the person consumes and the recommended daily intake. Express this value as a percentage of the recommended daily intake.

Percentage difference = ... % **[3]**

Turn over for the next question

5

(a) The diagram shows the structural formula of an alkene with three carbon atoms.



The molecules of the alkene react together to form a polymer.

(i) Draw the structure of the polymer formed, showing **two** repeat units.

[2]

(ii) Identify the type of polymerisation that alkenes undergo.

Tick (✓) **one** box.

addition ☐

condensation ☐

displacement ☐

substitution ☐

[1]

(b) Compounds **A** and **B** are two organic compounds which also have three carbon atoms.

A	**B**
CH_3COOCH_3	CH_3CH_2COOH

(i) Compounds **A** and **B** are isomers of each other.

Which type of isomers are **A** and **B**?

Tick (✓) **one** box.

geometric isomers ☐

optical isomers ☐

stereoisomers ☐

structural isomers ☐

[1]

(ii) Which type of compound is compound **A**?

Tick (✓) **one** box.

aldehyde ☐

alkyne ☐

ester ☐

ketone ☐

[1]

(iii) Name compound **B**.

..... **[1]**

(iv) Compound **B** reacts with sodium hydroxide.

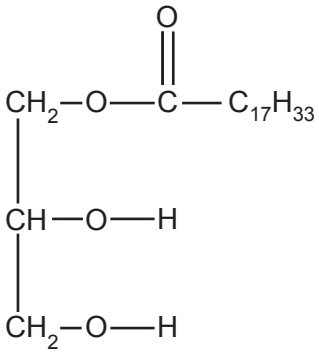
Complete the equation to show the products of this reaction.

$CH_3CH_2COOH + NaOH \longrightarrow$ ..... + ...

[2]

(c) Glycerides are large organic compounds which have the same functional group as compound **A**.

(i) The diagram shows a monoglyceride.



Monoglyceride molecules are produced when one molecule of glycerol combines with one molecule of a fatty acid.

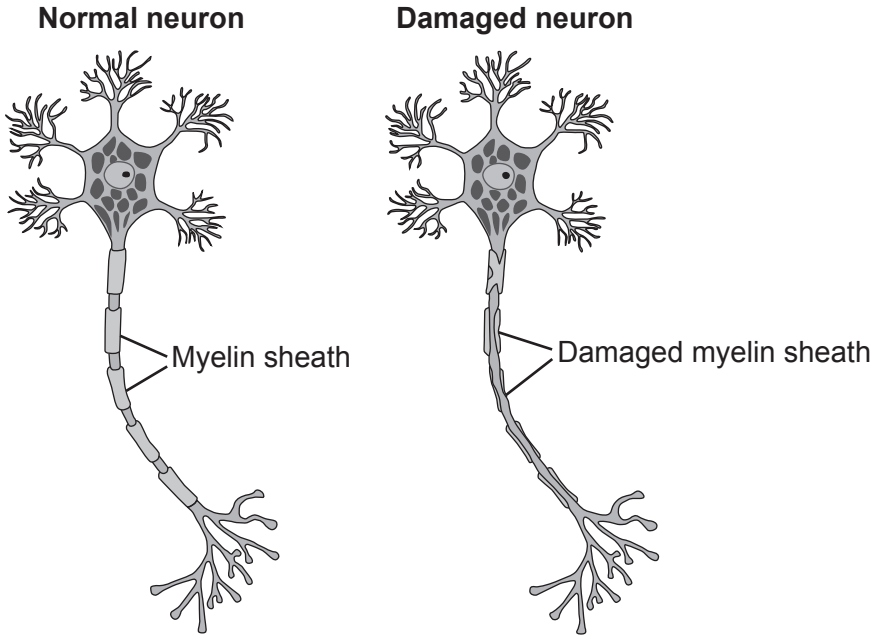
Draw the structural formulae of glycerol and of the fatty acid that make the monoglyceride.

glycerol	**fatty acid**

[2]

(ii) Triglycerides (or lipids) are important components of the myelin sheath found around the axons of some neurons.

The diagram compares a normal neuron with a damaged neuron.



Discuss the function of a neuron, the role of the myelin sheath and the impact of the damaged myelin sheath.

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..... **[6]**

6 Glycerol is a colourless, odourless liquid.

When glycerol is added to a starch-based biodegradable polymer it acts as a plasticiser. The addition of glycerol changes the mechanical properties of the polymer.

A technician tests samples of the polymer containing different percentages of glycerol. The technician uses the results to determine the elongation and Young's Modulus of each sample.

The following results are obtained when three different polymer samples are tested.

Percentage of glycerol by weight (%)	**Elongation (%)**	**Young's Modulus (MPa)**
15	47.3	279.1
20	85.0	153.1
25	195.5	77.5

(a)

(i) Suggest **one** feature of the three polymer samples that must be controlled when making this comparison.

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..... **[1]**

(ii) Percentage elongation is a measure of the ductility of a material.

Suggest how a test to measure percentage elongation could be performed.

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..... **[2]**

(iii) Explain the trend in percentage elongation shown in the table.

Use ideas about the structure of the polymer in your answer.

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..... **[2]**

(b) Describe the property of a material measured by Young's Modulus.

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..... **[1]**

Turn over for the next question

7

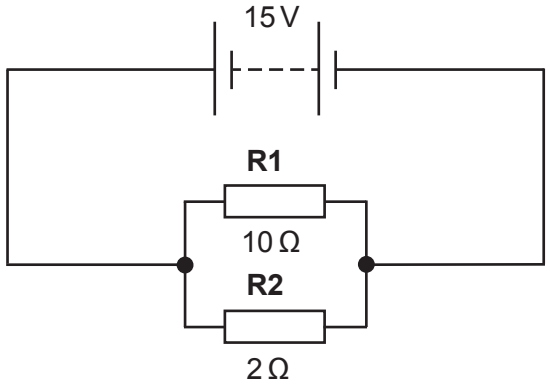
(a) An electrical current is the rate of flow of charge through a conductor.

The current in an electrical circuit is 3.0 A.

Calculate the charge, in Coulombs, that flows past a point in the circuit over a period of 10 minutes.

Charge = ... C **[2]**

(b) A 15 V battery is connected to resistors **R1** and **R2**.



Calculate the total power dissipated in the resistors.

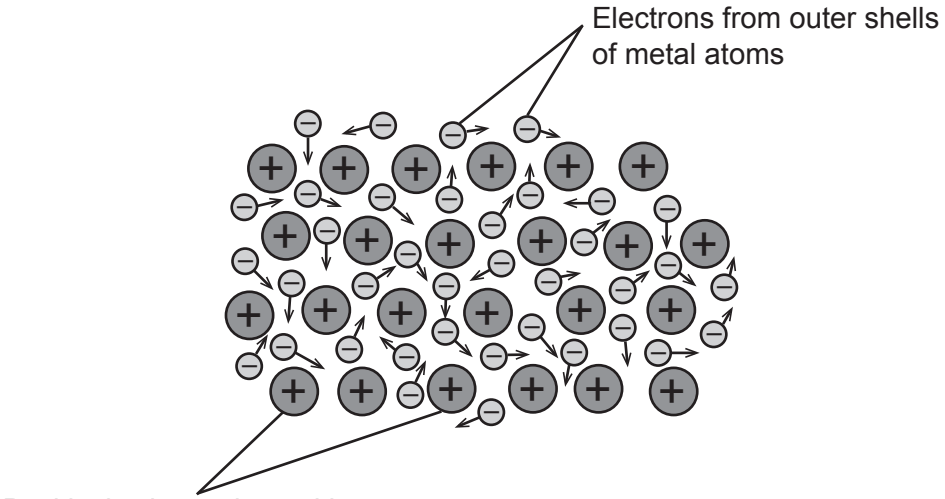
Use the equations:

$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$, V = IR and P = VI

P = ... W **[3]**

(c) Copper is a good electrical conductor and has a high melting point.

The diagram below shows the structure of a typical metallic lattice.



Use the diagram to explain why copper conducts electricity and has a high melting point.

- Copper conducts electricity because .....

.....

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.....

- Copper has a high melting point because .....

.....

.....

.....

[4]

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

The Periodic Table of the Elements

(1)	(2)												(3)	(4)	(5)	(6)	(7)	(0)
1																		18
1 H hydrogen 1.0	2												13	14	15	16	17	2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0												5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3												13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	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
Symbol
name
relative atomic mass

57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium 144.9	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.2	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 175.0
89 Ac actinium	90 Th thorium 232.0	91 Pa protactinium	92 U uranium 238.1	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

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