OCR
Oxford Cambridge and RSA

Tuesday 14 May 2019 – Afternoon

LEVEL 3 CAMBRIDGE TECHNICAL IN APPLIED SCIENCE

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

Time allowed: 2 hours
C340/1906

C340-1906

You must have:
- a ruler
- the Data Sheet (Insert)

You may use:
- a scientific or graphical calculator

Please write clearly in black ink.

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

First name(s) _____

Last name _____

Date of Birth | D | D | M | M | Y | Y | Y | Y |

INSTRUCTIONS
- Use black ink.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The Periodic Table is printed on the back page.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/15
2	/13
3	/17
4	/18
5	/12
6	/6
7	/9
Total	**/90**

Answer **all** the questions

1 **(a)** Atoms are made up of subatomic particles.

Table 1.1 shows the type, relative charge and relative mass of subatomic particles **A**, **B** and **C** within an atom.

Complete the table.

Subatomic particle	Type	Relative charge	Relative mass
A	electron		very small
B		+1	
C			1

Table 1.1

[3]

(b) An isotope of the element **tellurium** contains 78 neutrons and 52 protons.

(i) Give the mass number and atomic number for this isotope of tellurium.

mass number.....

atomic number.....

[2]

(ii) Tellurium is in Group 6 of the Periodic Table.

Complete the sentences.

One atom of tellurium has ..... electrons.

Tellurium has ..... electrons in its outermost

..... .

[3]

(iii) Tellurium reacts with potassium to form potassium telluride.

Name the type of bond between potassium and tellurium.

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

(iv) Write the formula of potassium telluride.

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

(c) The atomic diameters of some atoms in Period 5 of the Periodic Table are shown in **Table 1.2**.

Atom	**Atomic diameter (x 10^{-12} m)**
Antimony	266
Tellurium	246
Iodine	230

Table 1.2

(i) Explain why the atomic diameter of iodine is less than the atomic diameter of antimony.

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

(ii) Some isotopes of tellurium decay to become isotopes of iodine.

What is the name of the type of force which causes this decay?

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

2 Iron is an important metal. It affects our daily lives.

For example:

- Iron metal is used in the manufacture of steel for construction.
- Iron(II) ions have a key biological role in living organisms.

(a) Small amounts of carbon are added to iron to produce steel. Steel is stronger than pure iron.

A diagram of steel is shown in **Fig. 2.1**.

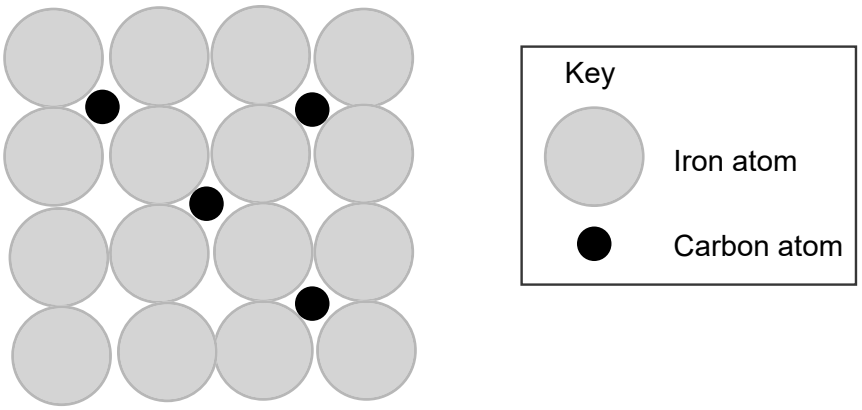

Fig. 2.1

(i) State the name for the type of mixture shown in **Fig. 2.1**.

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

(ii) Explain why the presence of carbon atoms makes steel stronger than pure iron.

Use **Fig. 2.1** in your answer.

.....

.....

.....

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

(b) A laboratory technician investigates the rate of reaction of steel nails with hydrochloric acid.

$Fe\,(s) + 2HCl\,(aq) \rightarrow FeCl_2\,(aq) + H_2(g)$

(i) Briefly describe how the technician could measure the rate of this reaction.

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.....

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

(ii) The technician repeats the experiment using powdered steel instead of steel nails, and explains why the rate of the reaction changes.

Put a (ring) around the word(s) that complete each sentence.

Powdered steel has a greater **pressure / surface area / temperature** than steel nails.

This means that there are **less frequent / more frequent / the same amount of** collisions between particles.

The rate of reaction **decreases / increases / stays the same** .

[3]

(iii) The reaction between the iron in the steel and hydrochloric acid can be shown using an ionic equation.

$Fe\,(s) + 2H^+\,(aq) \rightarrow Fe^{2+}\,(aq) + H_2\,(g)$

The reaction is a redox reaction.

Use the equation to explain, in terms of electron transfer, how this reaction involves both reduction and oxidation.

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

(c) Fe^{2+} ions have an important biological role in the transport of oxygen in human blood.

Describe how Fe^{2+} ions are involved in the transport of oxygen from the lungs to the cells.

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.....

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

3 Lactic acid is a by-product of anaerobic respiration.

The molecular formula of lactic acid is $C_3H_6O_3$, and its structural formula is shown in **Fig. 3.1**.

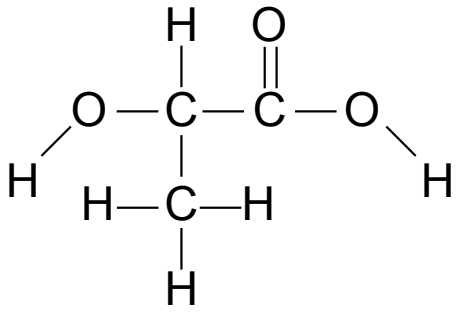

Fig. 3.1

(a) The chemical properties of lactic acid are due to the presence of its two functional groups.

One of the functional groups in lactic acid is a carboxylic acid group.

What is the name of the other functional group found in lactic acid?

Tick (✓) **one** box.

Alcohol ☐

Aldehyde ☐

Alkene ☐

Ketone ☐

[1]

(b) Lactic acid ($C_3H_6O_3$) can be a reactant or a product in an organic reaction.

For the reactions below, name the type of organic reaction and explain your answer.

(i) $CH_2{=}CHCOOH \xrightarrow{H_2O\,/\,H^+} CH_3CH(OH)COOH$

Type of organic reaction .....

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

(ii) $CH_3CHCl COOH \xrightarrow{NaOH(aq)} CH_3CH(OH)COOH$

Type of organic reaction .....

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

(iii) $CH_3CH(OH)COOH \xrightarrow{{}^{\bullet}Cl} {}^{\bullet}CH_2CH(OH)COOH$

Type of organic reaction .....

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

(c) Compounds of molecular formula $C_3H_6O_3$ show different types of isomerism.

(i) Lactic acid shows optical isomerism.

Identify the reason why lactic acid has optical isomers.

Tick (✓) **one** box.

There are four different groups attached to one carbon atom.	☐
There are two hydroxyl groups on different carbon atoms.	☐
There is a non-linear bond arrangement around the oxygen atoms.	☐
There is restricted rotation around the double bond.	☐

[1]

(ii) One isomer of lactic acid is 1,2-dihydroxymethoxyethene.

This compound shows geometric isomerism.

One geometric isomer is shown in **Fig. 3.2**.

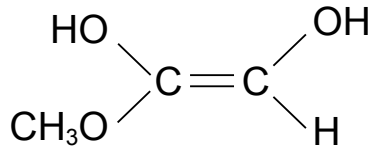

Fig. 3.2

Draw the other geometric isomer of 1,2-dihydroxymethoxyethene.

[1]

(d) One key reaction of lactic acid is the formation of the polymer polylactate.

Complete the equation in **Fig. 3.3** by drawing the structural formula of **one** unit of polylactate in the brackets.

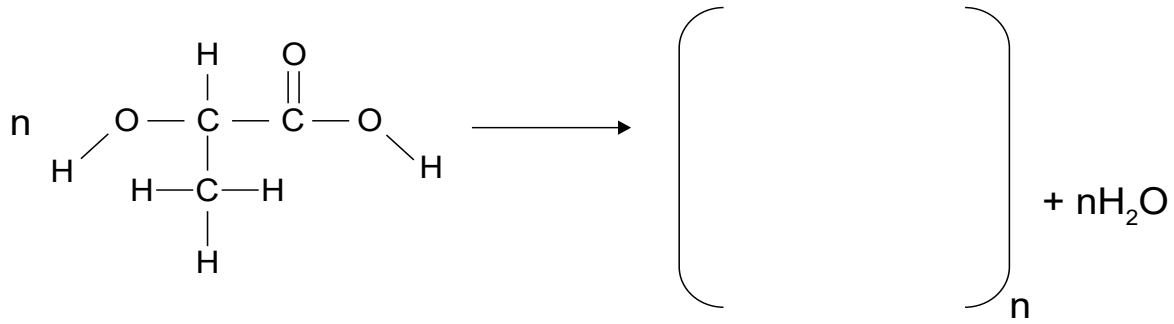

Fig. 3.3

[1]

(e) Polylactate is a biodegradable polymer that could replace other synthetic polymers for certain uses.

Polystyrene is one non-biodegradable polymer that could be replaced by polylactate.

A unit of polystyrene is shown in **Fig. 3.4**.

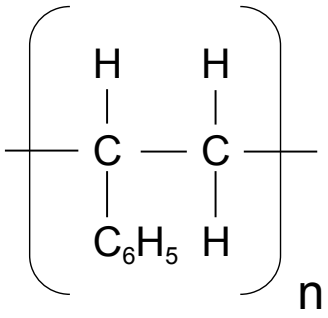

Fig. 3.4

(i) Give the empirical formula of polystyrene.

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

(ii) Polystyrene can be processed into Styrofoam™, which is used as the material in fast food packaging.

Styrofoam™ is a colloidal foam, a mixture in which microscopic particles of one substance are dispersed in another medium.

Draw a **line** to link each **colloidal foam component** to its correct **state of matter**.

Colloidal foam component	**State of matter**
Dispersed phase	Solid
Dispersion medium	Liquid
	Gas

[2]

(f) Atoms of carbon are essential in the formation of polymers such as polylactate and polystyrene.

Other non-metal atoms, such as oxygen and hydrogen, are not essential.

Explain why carbon is an essential element in the formation of polymers, but hydrogen and oxygen are not essential.

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

4 Animal and plant cells are classified as eukaryotic but bacterial cells are classified as prokaryotic.

(a) (i) Name **two** structures that are found in eukaryotic cells but not in prokaryotic cells.

1 .....

2 .....

[2]

(ii) Ribosomes are found in eukaryotic and prokaryotic cells.

Identify the molecule produced by ribosomes.

Tick (✓) **one** box.

Glycogen	☐
Lipid	☐
Protein	☐
Starch	☐

[1]

(iii) Ribosomes interact with molecules of ribonucleic acid (RNA) as part of their function.

Put a tick (✓) in the correct box to show whether each statement is **true** or **false**.

Statement	**True**	**False**
RNA usually has a single-strand polynucleotide chain.		
RNA contains a ribose sugar.		
The nitrogenous base in RNA is thymine.		

[3]

(b) **Fig. 4.1** is an image of plant cells, when seen using a microscope.

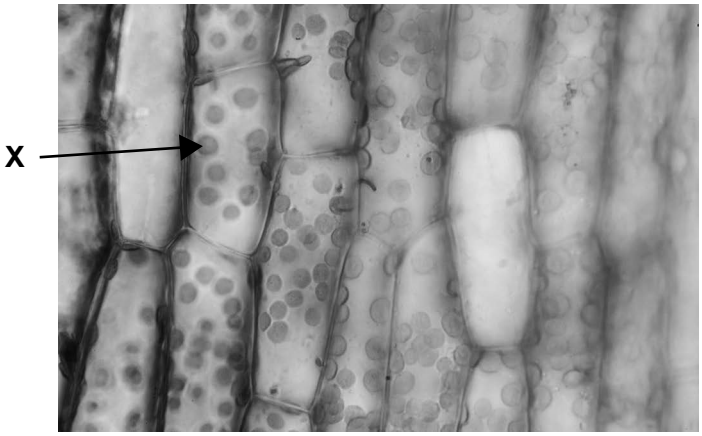

Fig. 4.1

Animal cells do **not** have plant cell walls or structure **X** seen in **Fig. 4.1**.

(i) Identify structure **X**.

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

(ii) State the function of structure **X**.

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

(iii) The reactions taking place in structure **X** involve the splitting of water.

Identify the metal ion which is a cofactor for the water-splitting enzyme involved in these reactions.

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

(c) The plasma membrane cannot be seen in **Fig. 4.1**.

(i) Outline the role of the plasma membrane.

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

(ii) The plasma membrane contains phospholipids.

The structure of a phospholipid is shown in **Fig. 4.2**.

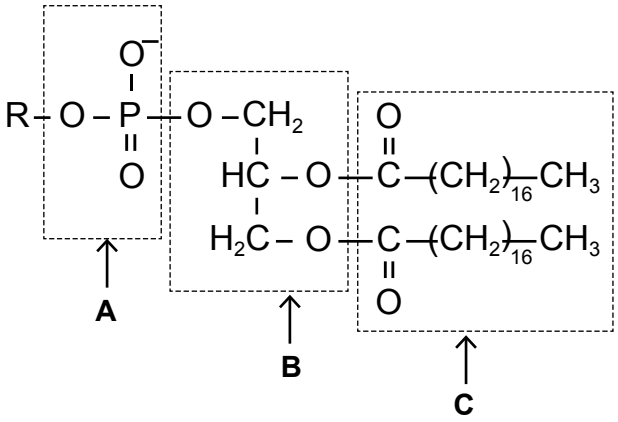

Fig. 4.2

Identify the groups labelled **A**, **B** and **C**.

A.....

B.....

C.....

[3]

(d) The cell wall is made of cellulose, a complex carbohydrate.

It is formed from a chain of glucose molecules.

A section of cellulose is shown in **Fig. 4.3**.

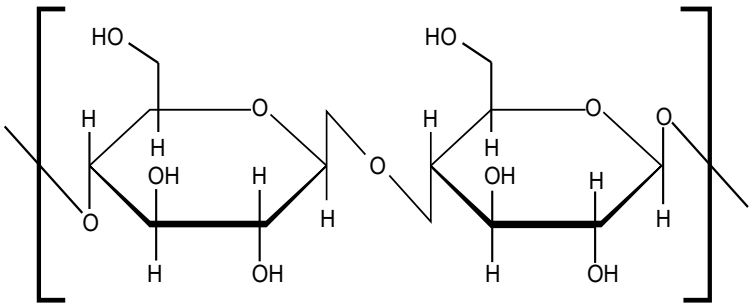

Fig. 4.3

(i) State **one** function of the cell wall.

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

(ii) Cellulose is a useful structural material for the cell wall.

Put a tick (✓) in the correct box to show whether each statement is **true** or **false**.

Statement	**True**	**False**
Cellulose is a polysaccharide.		
Cellulose contains microfibers which form cross-links.		
The tightly-packed chains found in cellulose are easily separated.		

[2]

5 Many metal ions have important uses in medical treatments.

(a) Identify the metal ion that is used to treat hypertension.

Tick (✓) **one** box.

Cu^{2+} ☐

Fe^{3+} ☐

Li^{+} ☐

Ni^{2+} ☐

[1]

(b) The platinum(II) ion, Pt^{2+}, is a component of the chemotherapy drug Cisplatin.

- Cisplatin has an isomer called Transplatin.
- Transplatin does not have the same medical properties.

The molecular structures of Cisplatin and Transplatin are shown in **Fig. 5.1**.

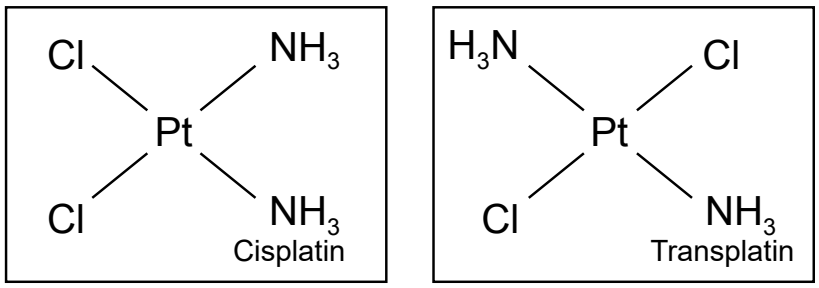

Fig. 5.1

(i) Describe how Cisplatin acts as a chemotherapy drug.

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

(ii) Use differences in the molecular structures shown in **Fig. 5.1** to suggest why Transplatin cannot be used to replace Cisplatin.

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

(c) Sodium and potassium ions are involved in the transmission of nerve impulses along nerves.

Fig. 5.2 shows a diagram of a nerve cell called a motor neuron.

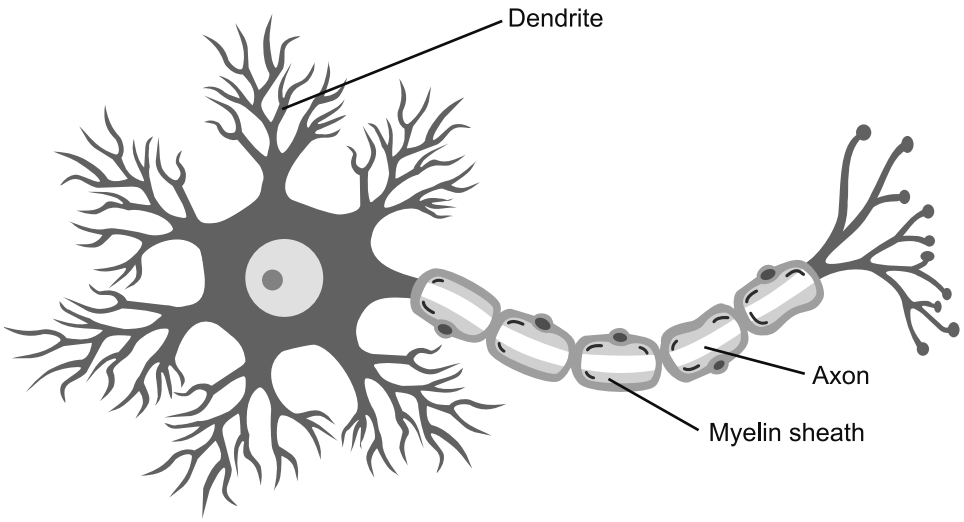

Fig. 5.2

(i) The **three** structures labelled in **Fig. 5.2** enable the nerve cell to transmit a nerve impulse.

Draw a **line** to link each **structure** to its correct **function**.

Structure	Function
Axon	To communicate with other nerve cells
Dendrite	To insulate the axon
Myelin sheath	To enable nerve impulses to run to and from different parts of the body

[3]

(ii) Sodium and potassium ions work together to transmit a nerve impulse.

This process involves six steps as shown below.

The steps are **not** in the correct order.

Step	Action
A	Potassium ions diffuse out of the cell.
B	Sodium ions diffuse into the cell.
C	Charge moves along the nerve cell.
D	Depolarisation occurs.
E	Action potential created.
F	Repolarisation occurs.

Write a letter for each step in each box to show the **correct** order.

	D			**F**	

Start ⟶ End

[4]

6 A tensile test is performed on a specimen of steel.

A stress of 1.6×10^8 N/m^2 produces a strain in the specimen of 0.01.

The stress–strain graphs for steel, glass and a type of plastic are shown in **Fig. 6.1**.

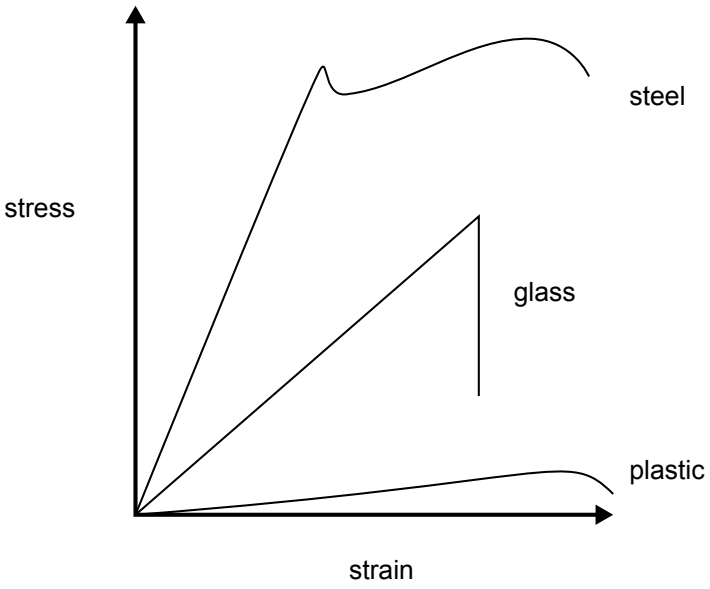

Fig. 6.1

Calculate the Young's modulus of the steel, and use **Fig. 6.1** to compare the mechanical properties of steel, glass and plastic.

Use the equation: Young's modulus = stress ÷ strain

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

7 **(a)** The **current**, I, in a conductor can be calculated using the equation $I = nAvq$.

For copper, the **charge carrier density**, $n = 8.5 \times 10^{28}\ m^{-3}$.

The **charge** on an electron, $q = 1.6 \times 10^{-19}\ C$.

(i) The current, I, in a copper rod is 5.0 A.

The copper rod has an area A of $1 \times 10^{-3}\ m^2$.

Calculate the velocity v of the electrons in the copper rod.

Give your answer to **2** significant figures and include its units.

v = ... units = ...

[4]

(ii) The current, I, in the copper rod is 5.0A.

The potential difference across the copper rod is $8.6 \times 10^{-4}\ V$.

Calculate the resistance R of the rod.

Use the equation: resistance = potential difference ÷ current

Include the units in your answer.

Show your working.

R = ... units = ...

[3]

(b) The copper rod used in **(a)(i)** and **(a)(ii)** is replaced by an insulator with the same dimensions and potential difference.

Explain why the current in the insulator is different.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s) – for example 3(f) or 5(b)(i).

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1) 1	(2) 2	3	4	5	6	7	8	9	10	11	12	(3) 13	(4) 14	(5) 15	(6) 16	(7) 17	(0) 18
1 **H** hydrogen 1.0																	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		

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