



# Cambridge IGCSE™

## CHEMISTRY

Paper 1 Multiple Choice (Core)

0620/13

May/June 2024

45 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet  
Soft clean eraser  
Soft pencil (type B or HB is recommended)

## INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

## INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.



1 Which two processes are required to change ice into steam?

- A boiling and melting
- B boiling and freezing
- C condensing and melting
- D condensing and freezing

2 Which row describes how the volume of a gas changes when the temperature increases, or when the pressure increases?

|   | temperature increases | pressure increases |
|---|-----------------------|--------------------|
| A | volume decreases      | volume decreases   |
| B | volume decreases      | volume increases   |
| C | volume increases      | volume decreases   |
| D | volume increases      | volume increases   |

3 Four substances in a mixture are listed.

- calcium nitrate
- iron(II) sulfate
- oxygen
- water

Which statement describes the mixture?

- A It contains 6 elements.
- B It contains 3 compounds and 1 element.
- C It contains 2 compounds and 2 elements.
- D It contains 4 compounds.

- 4 An ion is represented by the symbol  $^{18}_8\text{O}^{2-}$ .

Which statements about this ion are correct?

- 1 The ion contains 8 electrons.
- 2 The ion contains 10 neutrons.
- 3 The ion contains 8 protons.

**A** 1 and 2      **B** 1 and 3      **C** 2 only      **D** 2 and 3

- 5 What is the meaning of the term nucleon number?

- A** the number of neutrons in the nucleus of an atom  
**B** the number of protons in the nucleus of an atom  
**C** the total number of protons and electrons in the nucleus of an atom  
**D** the total number of protons and neutrons in the nucleus of an atom

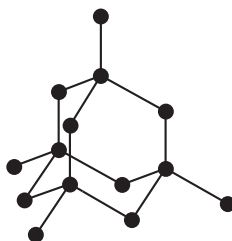
- 6 Which row describes the electrical conductivity of covalent and ionic compounds when solid and when molten?

|          | covalent compounds      |                          | ionic compounds         |                          |                                                       |
|----------|-------------------------|--------------------------|-------------------------|--------------------------|-------------------------------------------------------|
|          | conductivity when solid | conductivity when molten | conductivity when solid | conductivity when molten |                                                       |
| <b>A</b> | x                       | x                        | x                       | ✓                        | key<br>✓ = good conductivity<br>x = poor conductivity |
| <b>B</b> | x                       | ✓                        | x                       | ✓                        |                                                       |
| <b>C</b> | ✓                       | ✓                        | x                       | x                        |                                                       |
| <b>D</b> | x                       | ✓                        | ✓                       | ✓                        |                                                       |

- 7 Which statement about the bonding in sodium chloride is correct?

- A** The sodium and chlorine atoms share pairs of electrons.  
**B** The chlorine atoms give electrons to the sodium atoms to form positive and negative ions.  
**C** There is covalent bonding between sodium and chlorine.  
**D** The positive and negative ions have noble gas electronic configurations.

- 8 The diagram shows the arrangement of carbon atoms in a giant covalent structure.



Which row identifies the substance and describes a use of this substance?

|          | substance | use of substance                                                         |
|----------|-----------|--------------------------------------------------------------------------|
| <b>A</b> | diamond   | It is an electrode because electrons can move.                           |
| <b>B</b> | diamond   | It is used as a cutting tool because atoms are strongly bonded together. |
| <b>C</b> | graphite  | It is used as an insulator because electrons cannot move.                |
| <b>D</b> | graphite  | It is a lubricant because atoms can slide over each other.               |

- 9 Which statement is the correct definition for molecular formula?
- A** an atom or group of atoms that determine the chemical properties of a compound
- B** a structure which shows all the atoms and all the bonds in a compound
- C** the number and arrangement of different atoms in one gram of a compound
- D** the number and type of different atoms in one molecule of a compound
- 10 A compound, T, has the formula  $\text{CH}_3\text{Cl}$ .

Three statements about this compound are listed.

- 1 A molecule of the compound contains five atoms.
- 2 A molecule of the compound contains five different elements.
- 3 The relative molecular mass of the compound is 50.5.

Which statements are correct?

- A** 1, 2 and 3      **B** 1 and 2 only      **C** 1 and 3 only      **D** 2 and 3 only

**11** Iron water taps are often electroplated with a layer of chromium.

Which statements explain why iron water taps are electroplated?

- 1 It improves the appearance of the taps.
- 2 It increases the strength of the taps.
- 3 It prevents the corrosion of the taps.
- 4 It improves the electrical conductivity of the taps.

**A** 1 and 3      **B** 1 and 4      **C** 2 and 3      **D** 2 and 4

**12** Molten caesium bromide is electrolysed using inert electrodes.

Which row identifies the product at each electrode?

|          | anode    | cathode  |
|----------|----------|----------|
| <b>A</b> | bromine  | caesium  |
| <b>B</b> | caesium  | bromine  |
| <b>C</b> | hydrogen | oxygen   |
| <b>D</b> | oxygen   | hydrogen |

**13** Which equation represents the overall reaction in a hydrogen–oxygen fuel cell?

- A**  $4\text{H} + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- B**  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- C**  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
- D**  $2\text{H} + \text{O} \rightarrow \text{H}_2\text{O}$

**14** Which statements about endothermic reactions are correct?

- 1 The energy of the products is greater than the energy of the reactants.
- 2 The energy of the reactants is greater than the energy of the products.
- 3 The temperature of the surroundings increases during the reaction.
- 4 The temperature of the surroundings decreases during the reaction.

**A** 1 and 3      **B** 1 and 4      **C** 2 and 3      **D** 2 and 4

15 Which process is a physical change?

- A firework exploding
- B burning wood
- C chocolate melting
- D iron rusting

16 Magnesium reacts with dilute hydrochloric acid,  $\text{HCl}$ , to produce hydrogen gas.

Which row identifies the reaction conditions that give the fastest rate of reaction?

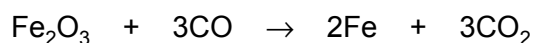
|   | temperature<br>in $^{\circ}\text{C}$ | $\text{HCl}$ concentration<br>in $\text{mol/dm}^3$ | magnesium solid |
|---|--------------------------------------|----------------------------------------------------|-----------------|
| A | 30                                   | 1.0                                                | powder          |
| B | 40                                   | 2.0                                                | powder          |
| C | 30                                   | 1.0                                                | ribbon          |
| D | 40                                   | 2.0                                                | ribbon          |

17 Which reaction produces a white-coloured substance?

- A adding water to anhydrous cobalt(II) chloride
- B adding water to anhydrous copper(II) sulfate
- C heating hydrated cobalt(II) chloride
- D heating hydrated copper(II) sulfate

18 In a blast furnace, iron is extracted when iron(III) oxide reacts with carbon monoxide.

The equation is shown.



Which substance is oxidised and which is reduced in this reaction?

|   | oxidised                | reduced                 |
|---|-------------------------|-------------------------|
| A | CO                      | $\text{Fe}_2\text{O}_3$ |
| B | $\text{CO}_2$           | Fe                      |
| C | Fe                      | $\text{CO}_2$           |
| D | $\text{Fe}_2\text{O}_3$ | CO                      |

- 19 Which row shows the colours of litmus and methyl orange with solutions of acids or bases?

|          | solution | litmus | methyl orange |
|----------|----------|--------|---------------|
| <b>A</b> | acid     | red    | red           |
| <b>B</b> | acid     | blue   | yellow        |
| <b>C</b> | base     | blue   | red           |
| <b>D</b> | base     | red    | yellow        |

- 20 Aqueous sodium hydroxide is reacted with excess dilute hydrochloric acid.

Which ion causes the resulting mixture to be acidic?

- A**  $\text{Na}^+$                       **B**  $\text{H}^+$                       **C**  $\text{OH}^-$                       **D**  $\text{Cl}^-$

- 21 Universal indicator is added to an aqueous solution of oxide X.

The indicator changes colour from green to red.

What is X?

- A**  $\text{MgO}$                       **B**  $\text{CaO}$                       **C**  $\text{K}_2\text{O}$                       **D**  $\text{NO}_2$

- 22 Which rows identify two aqueous salts which react together to produce a precipitate?

|   | salt 1            | salt 2           |
|---|-------------------|------------------|
| 1 | sodium sulfate    | barium nitrate   |
| 2 | sodium chloride   | barium sulfate   |
| 3 | barium chloride   | lead(II) nitrate |
| 4 | lead(II) chloride | barium nitrate   |

- A** 1 and 4                      **B** 1 and 3                      **C** 2 and 3                      **D** 2 and 4

**23** Which statements about elements in the Periodic Table are correct?

- 1 Elements in the same group have the same number of electrons in their outer shell.
- 2 Elements in the same period have the same number of occupied electron shells.
- 3 The elements are arranged in order of their atomic mass.
- 4 Every period contains eight elements.

**A** 1 and 2      **B** 1 and 3      **C** 2 and 4      **D** 3 and 4

**24** Four mixtures each contain a halogen and an aqueous sodium halide.

Which row describes what happens in the mixtures shown?

|          | mixture                   | description                                                                    |
|----------|---------------------------|--------------------------------------------------------------------------------|
| <b>A</b> | iodine + sodium bromide   | A displacement reaction occurs because iodine is more reactive than bromine.   |
| <b>B</b> | bromine + sodium chloride | A displacement reaction occurs because chlorine is more reactive than bromine. |
| <b>C</b> | chlorine + sodium bromide | A displacement reaction occurs because chlorine is more reactive than bromine. |
| <b>D</b> | bromine + sodium iodide   | A displacement reaction occurs because iodine is more reactive than bromine.   |

**25** Which row describes a transition element?

|          | density<br>in g / cm <sup>3</sup> | colour of<br>chloride |
|----------|-----------------------------------|-----------------------|
| <b>A</b> | 0.98                              | green                 |
| <b>B</b> | 0.98                              | white                 |
| <b>C</b> | 8.90                              | green                 |
| <b>D</b> | 8.90                              | white                 |

**26** Which statement about the use of metals is correct?

- A** Aluminium has a high strength and high density so is used to make aircraft.
- B** Copper has a low melting point so is used in electrical wiring.
- C** Aluminium is resistant to corrosion so is used in food containers.
- D** Zinc is used to make the alloy stainless steel which is used in cutlery.

27 Which statements explain why stainless steel is used in cutlery?

- 1 It is resistant to rusting.
- 2 It is a hard material.
- 3 It is a pure metal.

**A** 1, 2 and 3      **B** 1 and 2 only      **C** 1 and 3 only      **D** 2 and 3 only

28 Four different metals are separately mixed with an equal volume of dilute hydrochloric acid.

The table shows the rate of effervescence for each metal.

| metal     | rate of effervescence |
|-----------|-----------------------|
| calcium   | very high             |
| copper    | none                  |
| iron      | low                   |
| magnesium | high                  |

What is the order of reactivity of the four metals starting with the **most** reactive?

- A** iron → magnesium → calcium → copper
- B** magnesium → calcium → copper → iron
- C** copper → iron → magnesium → calcium
- D** calcium → magnesium → iron → copper

29 Which statement about the rusting of iron is correct?

- A** The rusting of iron forms hydrated iron(II) oxide.
- B** Barrier methods prevent rusting by excluding nitrogen and water.
- C** A piece of iron submerged in water will **not** rust.
- D** Coating with plastic is a barrier method that prevents iron rusting.

**30** Water is extracted from a river for use in a domestic water supply.

Some treatments for domestic water are listed.

- chlorination
- sedimentation and filtration
- treatment with carbon

Which statement about these treatments is correct?

- A** Filtration is used to remove soluble substances.
- B** Treatment with carbon is used to remove unpleasant odours.
- C** Chlorination is used to remove unpleasant tastes.
- D** Sedimentation is used to kill microbes.

**31** A farmer knows his soil needs phosphorus and potassium.

He has a choice of four fertilisers.

- 1  $\text{NH}_4\text{NO}_3$
- 2  $(\text{NH}_4)_3\text{PO}_4$
- 3  $\text{KNO}_3$
- 4  $(\text{NH}_2)_2\text{CO}$

Which fertilisers should he use?

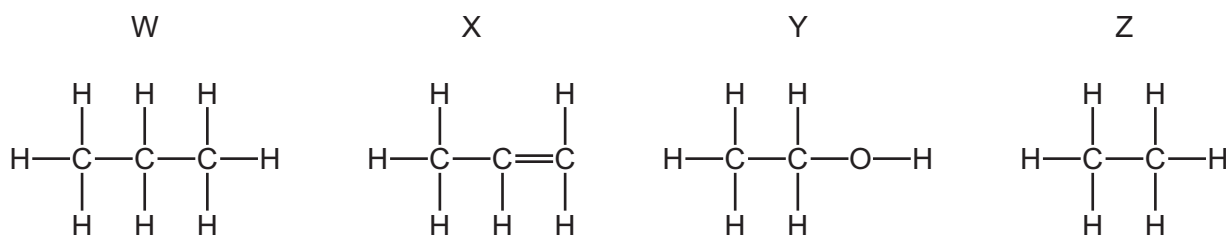
- A** 1 and 2      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

**32** Which strategies are useful in reducing the production of acid rain?

- 1 planting trees
- 2 using catalytic converters in motor vehicles
- 3 reducing livestock farming
- 4 using low-sulfur fuels

- A** 1 and 3      **B** 1 and 4      **C** 2 and 3      **D** 2 and 4

33 The structures of four organic compounds, W, X, Y and Z, are shown.



Which compounds are members of the same homologous series?

- A** W and X      **B** W and Z      **C** X and Y      **D** Y and Z

34 Which molecular formula represents an alkene?

- A**  $\text{C}_2\text{H}_6\text{O}$       **B**  $\text{C}_2\text{H}_6$       **C**  $\text{CH}_4$       **D**  $\text{C}_3\text{H}_6$

35 Which row identifies the petroleum fractions used to reduce the friction between metal parts in engines and as a fuel in cars?

|          | fraction used to reduce friction in engines | fraction used as a fuel in cars |
|----------|---------------------------------------------|---------------------------------|
| <b>A</b> | gas oil                                     | gasoline                        |
| <b>B</b> | gas oil                                     | fuel oil                        |
| <b>C</b> | lubricating oil                             | fuel oil                        |
| <b>D</b> | lubricating oil                             | gasoline                        |

36 Four fuels are listed.

- 1 ethanol
- 2 coal
- 3 hydrogen
- 4 natural gas

Which fuels are fossil fuels?

- A** 1, 2 and 3      **B** 1 and 3 only      **C** 2 and 4      **D** 4 only

**37** Aqueous bromine is added to two test-tubes.

Excess hexene is added to one test-tube.

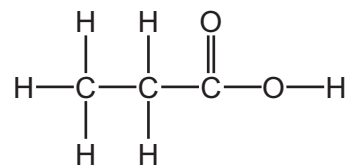
Excess hexane is added to the second test-tube.

Which row describes the observation in each test-tube?

|          | hexene               | hexane               |
|----------|----------------------|----------------------|
| <b>A</b> | orange to colourless | orange to colourless |
| <b>B</b> | orange to colourless | remains orange       |
| <b>C</b> | colourless to orange | remains colourless   |
| <b>D</b> | remains orange       | orange to colourless |

**38** The structure of a compound, G, is shown.

G is in the same homologous series as ethanoic acid.



Which row describes an aqueous solution of G?

|          | produces a gas with magnesium | turns methyl orange yellow |
|----------|-------------------------------|----------------------------|
| <b>A</b> | no                            | yes                        |
| <b>B</b> | no                            | no                         |
| <b>C</b> | yes                           | no                         |
| <b>D</b> | yes                           | yes                        |

**39** When zinc reacts with dilute sulfuric acid, hydrogen gas is produced.

Which apparatus is needed to investigate the effect of temperature on the rate of this reaction?

- 1 thermometer
- 2 stop-watch
- 3 volumetric pipette
- 4 gas syringe

**A** 1 and 2      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

**40** Two tests are carried out on substance Z.

test 1 A flame test produces a red flame.

test 2 Z is dissolved in water and dilute nitric acid is added, followed by aqueous silver nitrate. A yellow precipitate is produced.

What is substance Z?

- A** lithium bromide
- B** lithium iodide
- C** sodium bromide
- D** sodium iodide

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The Periodic Table of Elements

| Group                    |                             |                                                                                             |  |  |  |  |  |  |  |  |  |                         |                       |                        |                          |                        |                          |                        |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| I                        | II                          |                                                                                             |  |  |  |  |  |  |  |  |  | III                     | IV                    | V                      | VI                       | VII                    | VIII                     |                        |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3<br>Li<br>lithium<br>7  | 4<br>Be<br>beryllium<br>9   | <div>Key</div> <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |  |  |  |  |  |  |  |  |  | 1<br>H<br>hydrogen<br>1 | 5<br>B<br>boron<br>11 | 6<br>C<br>carbon<br>12 | 7<br>N<br>nitrogen<br>14 | 8<br>O<br>oxygen<br>16 | 9<br>F<br>fluorine<br>19 | 10<br>Ne<br>neon<br>20 | VIII |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 11<br>Na<br>sodium<br>23 | 12<br>Mg<br>magnesium<br>24 |                                                                                             |  |  |  |  |  |  |  |  |  |                         |                       |                        |                          |                        |                          |                        |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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|-------------|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| lanthanoids | 57<br>La<br>lanthanum<br>139 | 58<br>Ce<br>cerium<br>140  | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144 | 61<br>Pm<br>promethium<br>— | 62<br>Sm<br>samarium<br>150 | 63<br>Eu<br>europium<br>152 | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159 | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165   | 68<br>Er<br>erbium<br>167 | 69<br>Tm<br>thulium<br>169    | 70<br>Yb<br>ytterbium<br>173 | 71<br>Lu<br>lutetium<br>175  |
|             | 89<br>Ac<br>actinium<br>—    | 90<br>Th<br>thorium<br>232 | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238    | 93<br>Np<br>neptunium<br>—  | 94<br>Pu<br>plutonium<br>—  | 95<br>Am<br>americium<br>—  | 96<br>Cm<br>curium<br>—       | 97<br>Bk<br>berkelium<br>— | 98<br>Cf<br>californium<br>—  | 99<br>Es<br>einsteinium<br>— | 100<br>Fm<br>fermium<br>— | 101<br>Md<br>mendelevium<br>— | 102<br>No<br>nobelium<br>—   | 103<br>Lr<br>lawrencium<br>— |

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).