



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education (9–1)

CHEMISTRY

0971/22

Paper 2 Multiple Choice (Extended)

October/November 2018

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

* 3 0 8 7 8 8 1 5 1 4 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO NOT WRITE IN ANY BARCODES.

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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

This document consists of **16** printed pages.

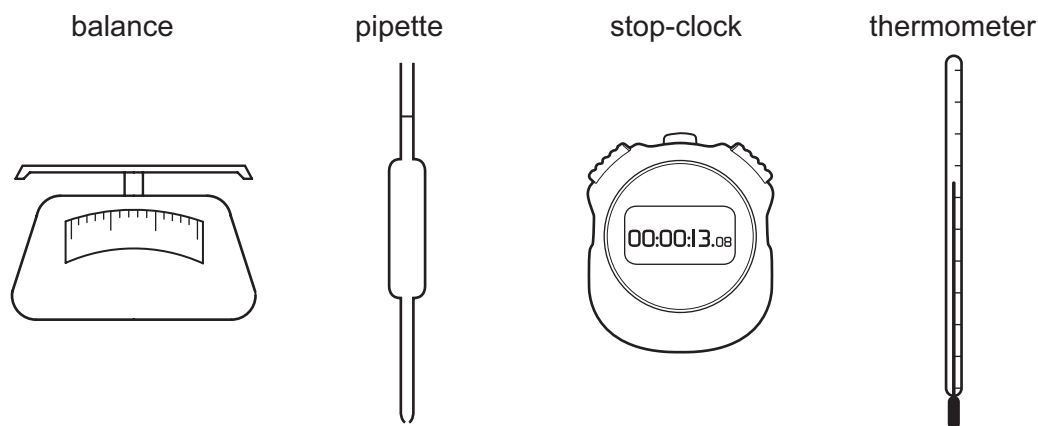
- 1 Oxygen and fluorine are gaseous elements next to each other in the Periodic Table.

Under the same conditions of temperature and pressure, oxygen diffuses1..... than fluorine because its2..... is less than that of fluorine.

Which words correctly complete gaps 1 and 2?

| | 1 | 2 |
|----------|--------|----------------|
| A | faster | molecular mass |
| B | faster | reactivity |
| C | slower | molecular mass |
| D | slower | reactivity |

- 2 The diagrams show four pieces of laboratory equipment.



Which equipment is essential to find out if dissolving a salt in water is an exothermic process?

| | balance | pipette | stop-clock | thermometer |
|----------|---------|---------|------------|-------------|
| A | x | x | x | ✓ |
| B | ✓ | x | x | ✓ |
| C | x | ✓ | x | ✓ |
| D | ✓ | x | ✓ | x |

- 3 How many neutrons are present in the atom ${}_{21}^{45}\text{X}$?

A 21 **B** 24 **C** 45 **D** 66

- 4 Two naturally occurring isotopes of oxygen are ^{16}O and ^{17}O .

Which statement is correct?

- A** Both isotopes react with iron to form rust.
B Neither isotope reacts with iron to form rust.
C Only ^{16}O reacts with iron to form rust.
D Only ^{17}O reacts with iron to form rust.
- 5 How many electrons are used to form covalent bonds in a molecule of methanol, CH_3OH ?
- A** 5 **B** 6 **C** 8 **D** 10
- 6 Potassium bromide and methanol are both compounds.

Their melting points are different.

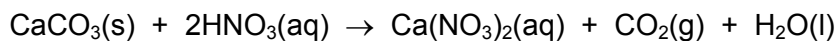
Which row is correct?

| | substance with the higher melting point | reason why the melting points are different |
|----------|---|---|
| A | methanol | the attractive forces between oppositely charged ions is greater than the attractive forces between molecules |
| B | methanol | the attractive forces between molecules is greater than the attractive forces between oppositely charged ions |
| C | potassium bromide | the attractive forces between oppositely charged ions is greater than the attractive forces between molecules |
| D | potassium bromide | the attractive forces between molecules is greater than the attractive forces between oppositely charged ions |

- 7 Which gas sample contains the smallest number of molecules?

- A** 4 g of helium
B 16 g of oxygen
C 28 g of carbon monoxide
D 28 g of nitrogen

- 8 The equation for the reaction between calcium carbonate and dilute nitric acid is shown.



25 g of calcium carbonate is reacted with an excess of dilute nitric acid.

Which mass of calcium nitrate and which volume of carbon dioxide is produced at room temperature and pressure?

| | mass of calcium nitrate / g | volume of carbon dioxide / dm ³ |
|----------|-----------------------------|--|
| A | 29 | 6 |
| B | 29 | 12 |
| C | 41 | 6 |
| D | 41 | 12 |

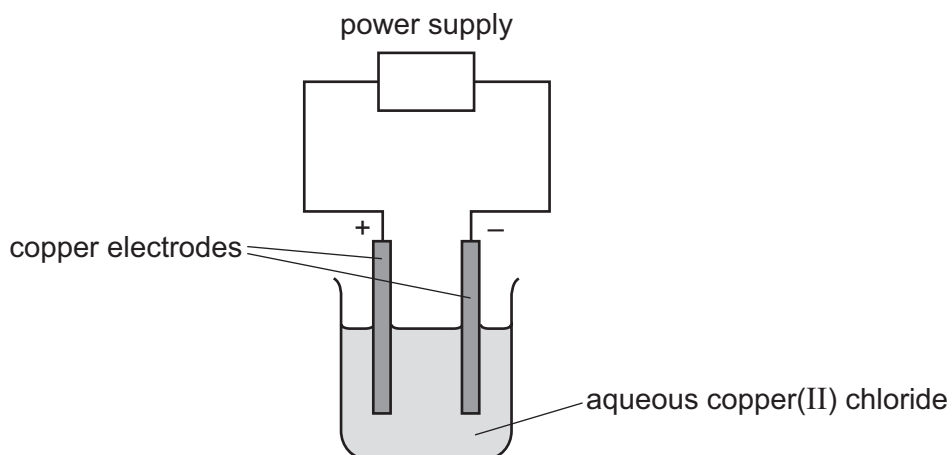
- 9 The formulae of some ions are shown.

| positive ion | negative ion |
|------------------|-------------------------------|
| Ti ⁴⁺ | PO ₄ ³⁻ |
| Al ³⁺ | SO ₄ ²⁻ |
| Mg ²⁺ | NO ₃ ⁻ |
| K ⁺ | Cl ⁻ |

Which formula is **not** correct?

- A** Al₃(SO₄)₂ **B** K₃PO₄ **C** Mg(NO₃)₂ **D** TiCl₄

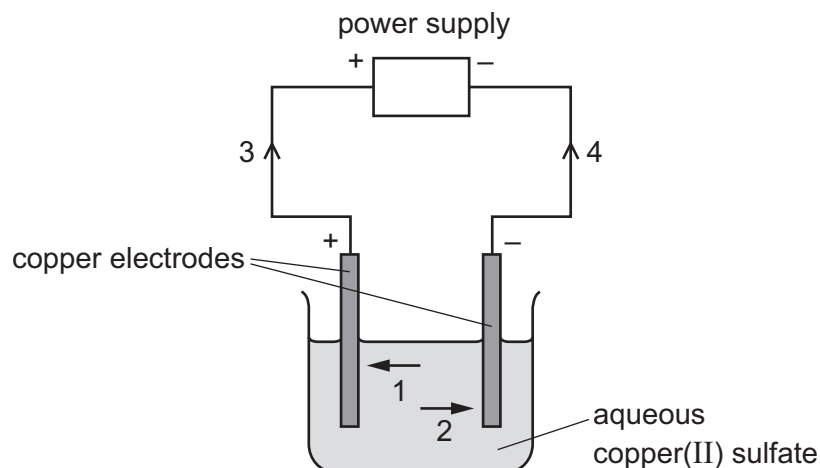
10 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes as shown.



What happens to the mass of each electrode during this process?

| | positive electrode | negative electrode |
|----------|--------------------|--------------------|
| A | decreases | decreases |
| B | decreases | increases |
| C | increases | decreases |
| D | increases | increases |

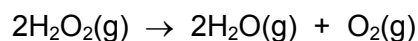
11 The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

| | copper ions | electrons |
|----------|-------------|-----------|
| A | 1 | 3 |
| B | 1 | 4 |
| C | 2 | 3 |
| D | 2 | 4 |

12 Hydrogen peroxide, H–O–O–H, decomposes to form water and oxygen.



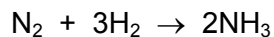
The bond energies are shown in the table. The reaction is exothermic.

| bond | bond energy in kJ/mol |
|------|-----------------------|
| O–H | +460 |
| O–O | +150 |
| O=O | +496 |

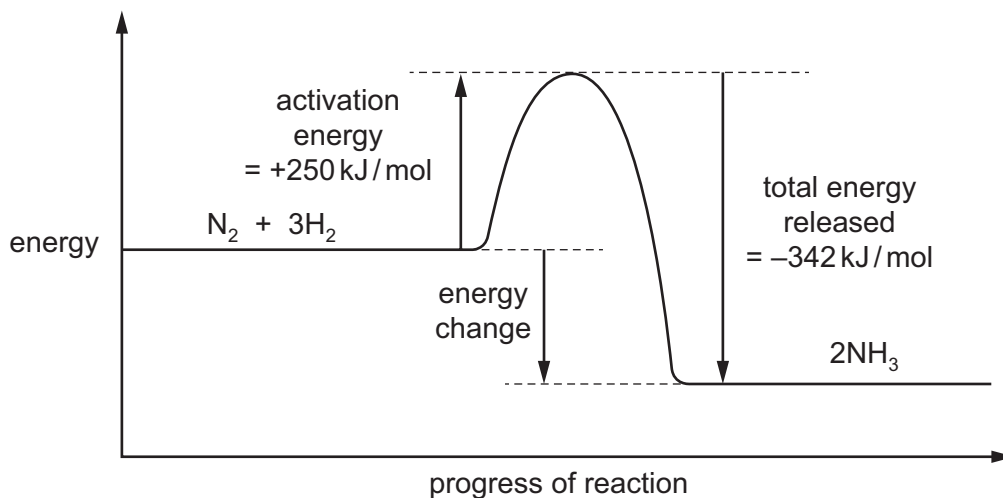
What is the energy change for the reaction?

- A** –346 kJ/mol **B** –196 kJ/mol **C** +196 kJ/mol **D** +346 kJ/mol

- 13 The equation for the formation of ammonia is shown.



The energy level diagram for the reaction is shown.



What is the energy change for the reaction?

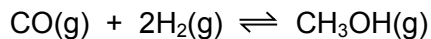
- A -592 kJ/mol
 B -92 kJ/mol
 C $+92 \text{ kJ/mol}$
 D $+592 \text{ kJ/mol}$
- 14 The rate of reaction between magnesium ribbon and 2 mol/dm^3 hydrochloric acid at 25°C to produce hydrogen gas is measured.

In another experiment, either the concentration of the hydrochloric acid or the temperature is changed. All other conditions are kept the same.

Which conditions increase the rate of reaction?

- A 1 mol/dm^3 hydrochloric acid at 25°C
 B 2 mol/dm^3 hydrochloric acid at 10°C
 C 2 mol/dm^3 hydrochloric acid at 20°C
 D 3 mol/dm^3 hydrochloric acid at 25°C

15 Methanol is prepared by the reversible reaction shown.



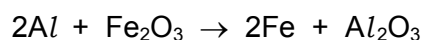
The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol?

| | temperature | pressure |
|----------|-------------|----------|
| A | high | high |
| B | high | low |
| C | low | high |
| D | low | low |

16 The thermite reaction can be used to produce iron from iron(III) oxide.

The equation for the reaction is shown.



Which statements about this reaction are correct?

- 1 Aluminium is the oxidising agent.
- 2 Aluminium is less reactive than iron.
- 3 Electrons are transferred from aluminium to iron.
- 4 The iron in the iron(III) oxide is reduced.

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

17 In which row are the oxides correctly identified?

| | acidic | basic |
|----------|---------------------------------|--------------------------------|
| A | magnesium oxide, calcium oxide | sulfur dioxide, carbon dioxide |
| B | magnesium oxide, sulfur dioxide | carbon dioxide, calcium oxide |
| C | sulfur dioxide, carbon dioxide | calcium oxide, magnesium oxide |
| D | sulfur dioxide, magnesium oxide | calcium oxide, carbon dioxide |

- 18 When dilute sulfuric acid is added to solid X, a colourless solution is formed and a gas is produced.

What is X?

- A copper(II) oxide
- B sodium oxide
- C copper(II) carbonate
- D sodium carbonate

- 19 A few drops of methyl orange are added to a reaction mixture.

During the reaction, a gas is produced and the methyl orange turns from red to orange.

What are the reactants?

- A aqueous sodium hydroxide and ammonium chloride
- B aqueous sodium hydroxide and calcium carbonate
- C dilute hydrochloric acid and magnesium
- D dilute hydrochloric acid and aqueous sodium hydroxide

- 20 Some general rules for the solubility of salts in water are listed.

- Carbonates are insoluble (except ammonium carbonate, potassium carbonate and sodium carbonate).
- Chlorides are soluble (except lead(II) chloride and silver chloride).
- Nitrates are soluble.
- Sulfates are soluble (except barium sulfate, calcium sulfate and lead(II) sulfate).

Which substances produce an insoluble salt when aqueous solutions of them are mixed?

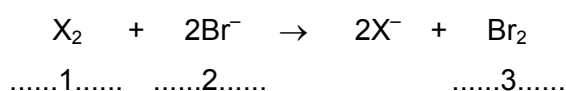
- A barium chloride and magnesium nitrate
- B calcium chloride and ammonium nitrate
- C silver nitrate and zinc chloride
- D sodium carbonate and potassium sulfate

21 Elements in Group I of the Periodic Table react with water.

Which row describes the products made in the reaction and the trend in reactivity of the elements?

| | products | trend in reactivity |
|----------|------------------------------|------------------------------|
| A | metal hydroxide and hydrogen | less reactive down the group |
| B | metal hydroxide and hydrogen | more reactive down the group |
| C | metal oxide and hydrogen | less reactive down the group |
| D | metal oxide and hydrogen | more reactive down the group |

22 The equation shows the reaction between a halogen and aqueous bromide ions.



Which words complete gaps 1, 2 and 3?

| | 1 | 2 | 3 |
|----------|----------|------------|------------|
| A | chlorine | brown | colourless |
| B | chlorine | colourless | brown |
| C | iodine | brown | colourless |
| D | iodine | colourless | brown |

23 An inert gas R is used to fill weather balloons.

Which descriptions of R are correct?

| | number of outer shell electrons in atoms of R | structure of gas R |
|----------|---|--------------------|
| A | 2 | diatomic molecules |
| B | 2 | single atoms |
| C | 8 | diatomic molecules |
| D | 8 | single atoms |

24 Heating copper(II) carbonate produces copper(II) oxide and carbon dioxide.

Heating the copper(II) oxide formed with carbon produces copper.

Which processes are involved in this conversion of copper(II) carbonate to copper?

- A sublimation followed by oxidation
- B sublimation followed by reduction
- C thermal decomposition followed by oxidation
- D thermal decomposition followed by reduction

25 Four metals, W, X, Y and Z, are separately reacted with water and dilute hydrochloric acid.

The results are shown.

| | metal | | | |
|--|--------|-------------|-------------------|-------------|
| | W | X | Y | Z |
| reaction with water | fizzes | no reaction | fizzes vigorously | no reaction |
| reaction with dilute hydrochloric acid | fizzes | no reaction | fizzes violently | fizzes |

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

| | least reactive | → | most reactive |
|---|----------------|---|---------------|
| A | X | W | Z Y |
| B | X | Z | W Y |
| C | Y | W | Z X |
| D | Y | Z | W X |

26 Which statement about the uses of metals is **not** correct?

- A Aluminium is used in aircraft because of its strength and good electrical conductivity.
- B Copper is used in electrical wiring because of its good electrical conductivity.
- C Stainless steel resists corrosion and is used to make cutlery.
- D Transition elements are often used as catalysts.

27 Bauxite contains aluminium oxide.

Aluminium is extracted from aluminium oxide by electrolysis.

Why is cryolite added to the electrolytic cell used to extract aluminium?

- A Cryolite prevents the carbon anodes being burned away.
- B Cryolite removes impurities from the bauxite.
- C Cryolite increases the rate at which aluminium ions are discharged.
- D Molten cryolite dissolves the aluminium oxide.

28 Which statement about the Haber process is correct?

- A The hydrogen used is obtained from the air.
- B The nitrogen used is obtained from nitrates in the soil.
- C Nitrogen reacts with hydrogen to make ammonia.
- D The reaction takes place at room temperature and pressure.

29 Which statements about sulfur dioxide pollution are correct?

- 1 It increases the pH of rivers.
- 2 It damages limestone buildings.
- 3 It causes respiratory problems.

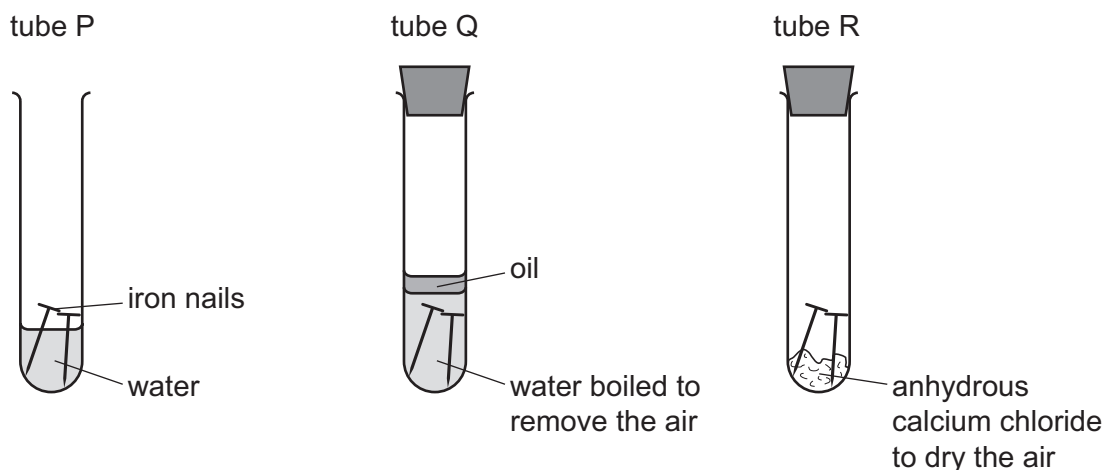
- A 1 only B 2 only C 1 and 3 D 2 and 3

30 Argon is a noble gas used to fill light bulbs.

What is the approximate percentage of argon in air?

- A 1% B 20% C 79% D 99%

31 The diagrams show experiments involving the rusting of iron.



A student predicted the following results.

- 1 In tube P, the iron nails rust.
- 2 In tube Q, the iron nails do not rust.
- 3 In tube R, the iron nails do not rust.

Which predictions are correct?

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

32 In the carbon cycle, which two processes add carbon dioxide to the atmosphere?

- A** combustion and carbonate formation
B combustion and photosynthesis
C combustion and respiration
D respiration and photosynthesis

33 Which statement about sulfur or one of its compounds is correct?

- A** Sulfur occurs naturally as the element sulfur.
B Sulfur dioxide is used to kill bacteria in drinking water.
C Sulfuric acid is a weak acid.
D Dilute sulfuric acid is a dehydrating agent.

34 What is **not** a use of lime?

- A It is used as a bleach in the manufacture of wood pulp.
- B It is used to desulfurise flue gases.
- C It is used to neutralise acidic industrial waste.
- D It is used to treat acidic soil.

35 Which equation representing a reaction of methane is correct?

- A $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- B $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_4\text{Cl}_2$
- C $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + \text{H}_2$
- D $2\text{CH}_4 + 2\text{Cl}_2 \rightarrow 2\text{CH}_3\text{Cl} + \text{Cl}_2 + \text{H}_2$

36 Which two compounds are molecules which both contain a double bond?

- A ethane and ethanoic acid
- B ethane and ethanol
- C ethene and ethanoic acid
- D ethene and ethanol

37 Ethanol can be formed by:

- 1 fermentation
- 2 reaction between steam and ethene.

Which of these processes use a catalyst?

| | 1 | 2 |
|----------|---|---|
| A | ✓ | ✓ |
| B | ✓ | x |
| C | x | ✓ |
| D | x | x |

38 Ethanol is manufactured from ethene.

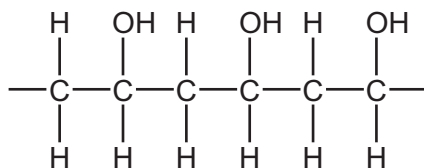
What is an advantage of this process?

- A It is a continuous process.
- B It has high labour costs.
- C It needs high temperature and pressure.
- D It uses non-renewable materials.

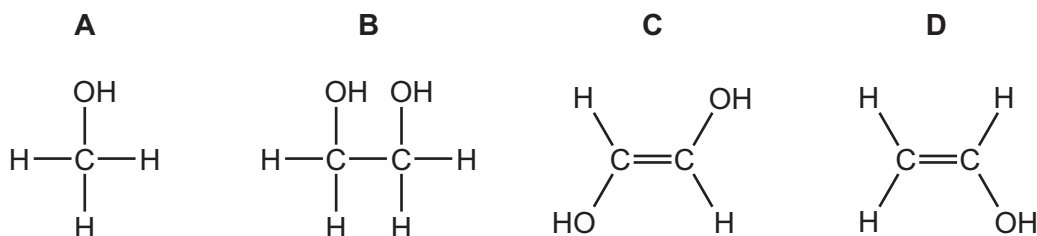
39 Which reaction can be used to make ethanoic acid?

- A oxidation of ethanol
- B oxidation of ethene
- C reduction of ethanol
- D reduction of ethene

40 The structure of an addition polymer is shown.



Which monomer is used to make this polymer?



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The Periodic Table of Elements

| | | Group | | | | | | | | | | | | | | | |
|----------------------------|-----------------------------|---|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-------------------------------|-----------------------------|-------------------------------|-------------------------------|------------------------------|
| I | II | III | IV | V | VI | VII | VIII | | | | | | | | | | |
| 3 Li lithium 7 | 4 Be beryllium 9 | 1 H hydrogen 1 | 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 | <p>Key</p> <p>atomic number</p> <p>atomic symbol</p> <p>name</p> <p>relative atomic mass</p> | | | | | | | | | | | | | | | |
| 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 — | 118 Og oganesson — | 119 Uue unbinilium — | 120 Uub unbinilium — | 121 Uut ununilium — |

| | | | | | | | | | | | | | | |
|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| 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 |
| 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 — |

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).