Cambridge Assessment International Education

# Cambridge IGCSE™

**CHEMISTRY** **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2020**

**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. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Blank pages are indicated.




**[Turn over**

**1** A mixture of ice and water is left to stand and the ice melts.

Which row describes what happens as the ice is melting?

| | temperature of mixture | energy changes |
|---|---|---|
| **A** | increases | average kinetic energy of particles increases |
| **B** | increases | energy is used to overcome attractive forces |
| **C** | stays the same | average kinetic energy of particles increases |
| **D** | stays the same | energy is used to overcome attractive forces |

**2** Which piece of apparatus should be used to measure exactly 21.4 $cm^3$ of water?

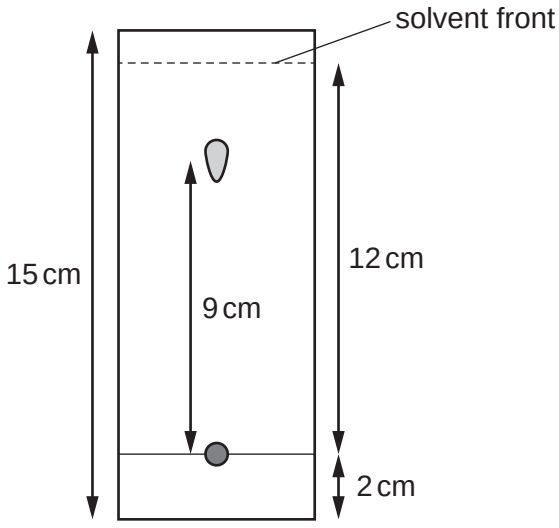
**A** 25 $cm^3$ beaker

**B** 25 $cm^3$ pipette

**C** 50 $cm^3$ burette

**D** 50 $cm^3$ measuring cylinder

**3** The chromatogram for an unknown dye is shown.




What is the $R_f$ value of the dye?

**A** 0.60 **B** 0.64 **C** 0.75 **D** 0.82

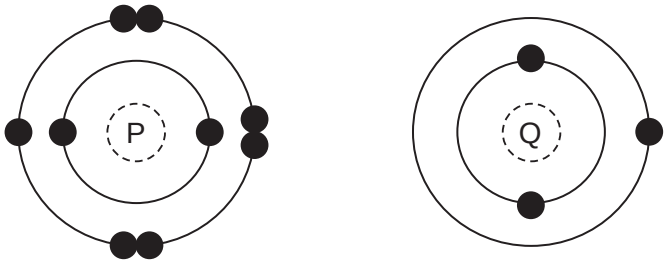
**4** The atomic number and nucleon number of a potassium atom are shown.

| | potassium atom |
|---|---|
| atomic number | 19 |
| nucleon number | 39 |

How many protons, neutrons and electrons are in a potassium ion, $K^+$?

| | protons | neutrons | electrons |
|---|---|---|---|
| **A** | 19 | 20 | 18 |
| **B** | 19 | 20 | 20 |
| **C** | 20 | 19 | 18 |
| **D** | 20 | 19 | 19 |

**5** The electronic structures of two atoms, P and Q, are shown.




P and Q combine together to form a compound.

What is the type of bonding in the compound and what is the formula of the compound?

| | type of bonding | formula |
|---|---|---|
| **A** | ionic | PQ |
| **B** | ionic | $PQ_2$ |
| **C** | covalent | $PQ_2$ |
| **D** | covalent | PQ |

**6** Which row contains a description of metallic bonding and a property that is explained by reference to metallic bonding?

| | description of metallic bonding | property explained by metallic bonding |
|---|---|---|
| **A** | a lattice of negative ions in a sea of electrons | a metal will react with an acid, producing hydrogen |
| **B** | a lattice of negative ions in a sea of electrons | a piece of a metal can be moulded into different shapes |
| **C** | a lattice of positive ions in a sea of electrons | a metal will react with an acid, producing hydrogen |
| **D** | a lattice of positive ions in a sea of electrons | a piece of a metal can be moulded into different shapes |

**7** Which statement explains why methane has a lower boiling point than water?

**A** Methane has weaker covalent bonds than water.

**B** Methane has weaker attractive forces than water.

**C** Methane molecules are heavier than water molecules.

**D** Methane molecules have more bonds than water molecules.

**8** A solution of iron(III) sulfate reacts with aqueous sodium hydroxide to form a red–brown precipitate.

What is the balanced equation, including state symbols, for the reaction?

**A** $FeSO_4(aq) + 2NaOH(aq) \rightarrow Fe(OH)_2(s) + Na_2SO_4(aq)$

**B** $FeSO_4(l) + 2NaOH(l) \rightarrow Fe(OH)_2(s) + Na_2SO_4(l)$

**C** $Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(aq)$

**D** $Fe_2(SO_4)_3(l) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(l)$

**9** The Haber process is a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction has a 30% yield of ammonia.

Which volume of ammonia gas, $NH_3$, measured at room temperature and pressure, is obtained by reacting 0.75 moles of hydrogen with excess nitrogen?

**A** $3600\,cm^3$ **B** $5400\,cm^3$ **C** $12\,000\,cm^3$ **D** $18\,000\,cm^3$

**10** Dilute aqueous sodium chloride is electrolysed using platinum electrodes.

What is the half-equation for the reaction at the cathode?

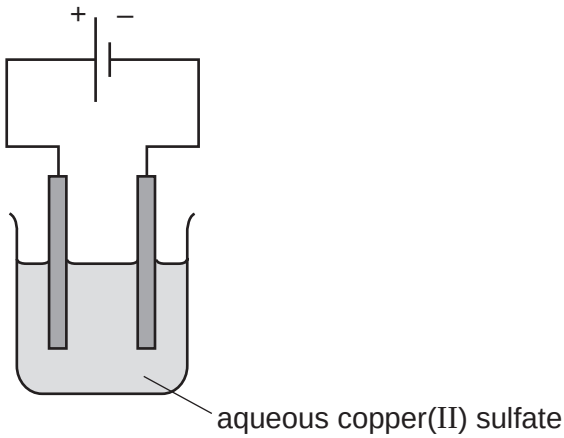
**A** $2H^+ + 2e^- \rightarrow H_2$

**B** $Na^+ + e^- \rightarrow Na$

**C** $2Cl^- \rightarrow Cl_2 + 2e^-$

**D** $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

**11** The electrolysis of aqueous copper(II) sulfate, using inert electrodes, is shown.




Which statement about a reaction at an electrode is correct?

**A** Copper ions gain electrons at the negative electrode.

**B** Copper ions gain electrons at the positive electrode.

**C** Hydrogen ions gain electrons at the negative electrode.

**D** Hydrogen ions gain electrons at the positive electrode.

**12** The equation for the complete combustion of methane gas is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

Bond energies are shown.

| bond | bond energy in kJ / mol |
|---|---|
| C–H | 412 |
| H–O | 463 |
| C=O | 743 |
| O=O | 498 |

What is the overall energy change, in kJ / mol, for the above reaction?

**A** –1192 **B** –694 **C** +694 **D** +1192

**13** Which statements about hydrogen fuel cells are correct?

1 Water is formed as the only waste product.

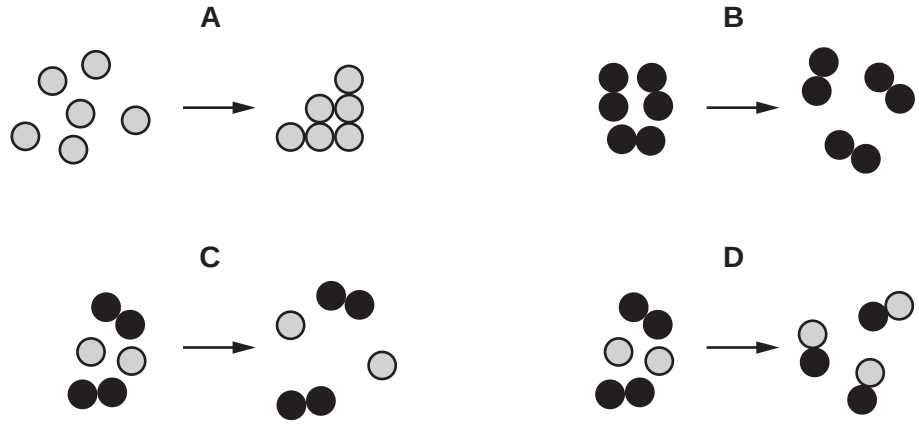
2 Both water and carbon dioxide are formed as waste products.

3 The overall reaction is $2H_2 + O_2 \rightarrow 2H_2O$.

4 The overall reaction is endothermic.

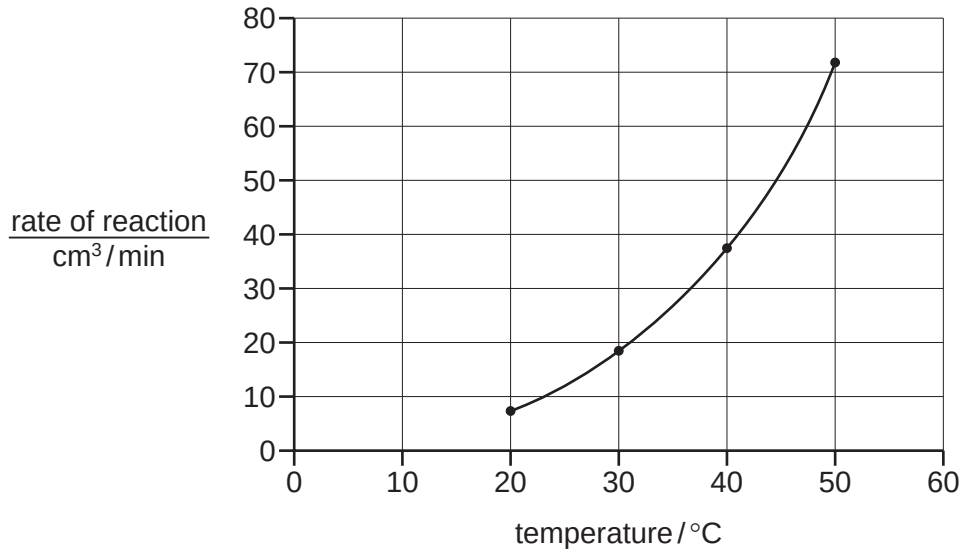
**A** 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

**14** Which diagram represents a chemical change?



**15** The rate of reaction between calcium carbonate chips and hydrochloric acid is studied by collecting the volume of gas released in one minute at different temperatures.

A graph of rate of reaction against temperature is shown.




Which statement fully explains why increasing the temperature has this effect on the rate?

**A** The kinetic energy of the particles increases so the collisions are harder.

**B** The number of collisions between particles increases.

**C** The activation energy needed for the particles to react is reduced.

**D** There are more frequent collisions between particles with enough energy to react.

**16** The equation shows the equilibrium between dinitrogen tetroxide, $N_2O_4$, and nitrogen dioxide, $NO_2$.

The colours of the reactant and product are also shown.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$
colourless brown

The forward reaction is endothermic.

Which statement is **not** correct?

**A** At equilibrium the concentrations of the reactant and the product are constant.

**B** At equilibrium the rate of the forward reaction is equal to the rate of the reverse reaction.

**C** When the pressure is increased a darker brown colour is seen.

**D** When the temperature is increased a darker brown colour is seen.

**17** The equations for two reactions of iodide ions are shown.

reaction 1 $2I^-(aq) + H_2O_2(aq) \rightarrow I_2(aq) + 2OH^-(aq)$

reaction 2 $I^-(aq) + Ag^+(aq) \rightarrow AgI(s)$

Which statement is correct?

**A** Both reactions are redox reactions.

**B** Neither reaction is a redox reaction.

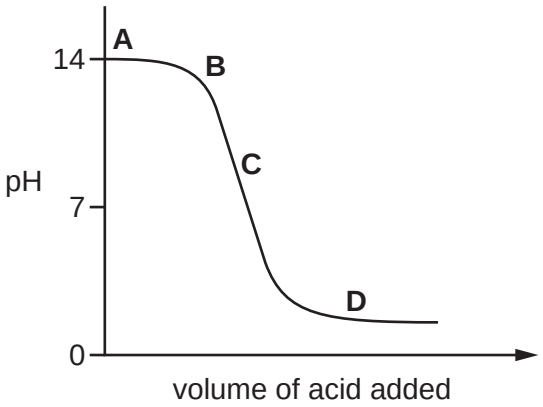
**C** Only reaction 1 is a redox reaction.

**D** Only reaction 2 is a redox reaction.

**18** The graph shows how the pH of a solution changes as an acid is added to an alkali.

acid + alkali → salt + water

Which letter represents the area of the graph where both acid and salt are present?




**19** Which statement describes a weak acid?

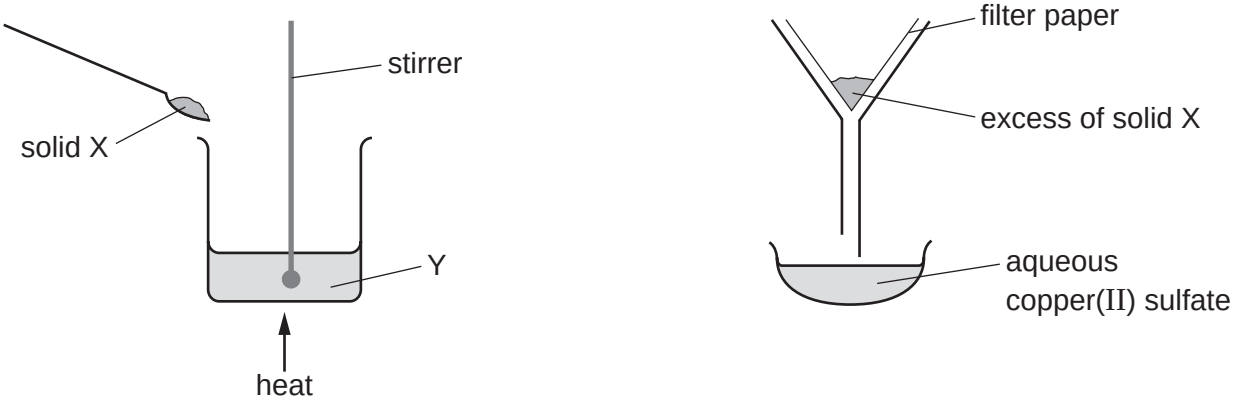
**A** It is a proton acceptor and is fully ionised in aqueous solution.

**B** It is a proton acceptor and is partially ionised in aqueous solution.

**C** It is a proton donor and is fully ionised in aqueous solution.

**D** It is a proton donor and is partially ionised in aqueous solution.

**20** The apparatus shown is used to prepare aqueous copper(II) sulfate.




What are X and Y?

| | X | Y |
|---|---|---|
| **A** | copper | aqueous iron(II) sulfate |
| **B** | copper(II) chloride | dilute sulfuric acid |
| **C** | copper(II) oxide | dilute sulfuric acid |
| **D** | sulfur | aqueous copper(II) chloride |

**21** Lead(II) sulfate is an insoluble salt.

Which method is suitable for obtaining solid lead(II) sulfate?

**A** Mix aqueous lead(II) nitrate and aqueous potassium sulfate, heat to evaporate all of the water, collect the solid and then wash and dry it.

**B** Mix aqueous lead(II) nitrate and aqueous potassium sulfate, filter, collect the filtrate, crystallise, then wash and dry the crystals.

**C** Mix aqueous lead(II) nitrate and dilute sulfuric acid, filter, then wash and dry the residue.

**D** Titrate aqueous lead(II) hydroxide with dilute sulfuric acid, crystallise, then wash and dry the crystals.

**22** A Group I metal (lithium, sodium or potassium) is reacted with a Group VII element (chlorine, bromine or iodine).

Which compound is formed when the Group I metal of highest density reacts with the Group VII element of lowest density?

**A** lithium chloride

**B** potassium chloride

**C** potassium iodide

**D** lithium iodide

**23** The properties of the element titanium, Ti, can be predicted from its position in the Periodic Table.

Which row identifies the properties of titanium?

| | can be used as a catalyst | conducts electricity when solid | has low density | forms coloured compounds |
|---|---|---|---|---|
| **A** | ✓ | ✓ | ✓ | ✗ |
| **B** | ✓ | ✓ | ✗ | ✓ |
| **C** | ✓ | ✗ | ✓ | ✓ |
| **D** | ✗ | ✓ | ✓ | ✓ |

**24** A balloon is filled with helium. Helium is a noble gas and makes the balloon rise up in the air.

The density of air is $1.23\,g/dm^3$.

Which gas is helium?

| | density in $g/dm^3$ | reaction with oxygen |
|---|---|---|
| **A** | 0.0899 | burns rapidly |
| **B** | 0.179 | does not react with oxygen |
| **C** | 1.78 | does not react with oxygen |
| **D** | 3.75 | does not react with oxygen |

**25** Which property is shown by **all** metals?

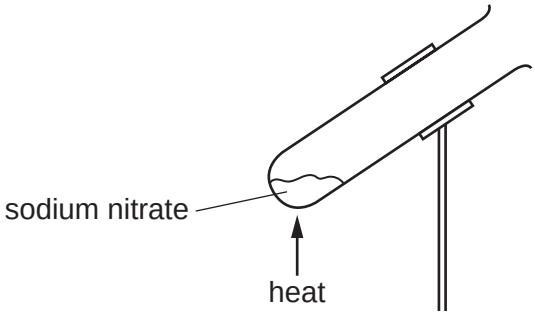
**A** They are extracted from their ores by heating with carbon.

**B** They conduct electricity.

**C** They form acidic oxides.

**D** They react with hydrochloric acid to form hydrogen.

**26** Sodium nitrate is a white crystalline solid that decomposes on heating.




Which row describes the decomposition products formed when sodium nitrate is heated strongly?

| | solid products | gaseous products |
|---|---|---|
| **A** | sodium nitrite | $NO_2$ and $O_2$ |
| **B** | sodium nitrite | $O_2$ only |
| **C** | sodium oxide | $NO_2$ and $O_2$ |
| **D** | sodium oxide | $O_2$ only |

**27** Molten iron from the blast furnace contains impurities.

The process of turning the impure iron into steel involves blowing oxygen into the molten iron and adding calcium oxide.

What are the reasons for blowing in oxygen and adding calcium oxide?

| | blowing in oxygen | adding calcium oxide |
|---|---|---|
| **A** | carbon is removed by reacting with oxygen | reacts with acidic impurities making slag |
| **B** | carbon is removed by reacting with oxygen | reacts with slag and so removes it |
| **C** | iron reacts with the oxygen | reacts with acidic impurities making slag |
| **D** | iron reacts with the oxygen | reacts with slag and so removes it |

**28** Element Y reacts with copper(II) oxide to form copper.

Element Y will not react with zinc oxide. Copper has no reaction with zinc oxide.

What is the order of reactivity of these three elements, most reactive first?

**A** Cu → Y → Zn

**B** Cu → Zn → Y

**C** Zn → Cu → Y

**D** Zn → Y → Cu

**29** Which statement shows that a liquid is pure water?

**A** It boils at 100 °C.

**B** It has a pH value of 7.

**C** It turns blue cobalt(II) chloride pink.

**D** It turns white copper(II) sulfate blue.

**30** Which process removes carbon dioxide from the atmosphere?

**A** combustion

**B** decomposition

**C** photosynthesis

**D** respiration

**31** Ammonia is manufactured by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

What are the conditions used in the Haber process?

| | temperature / °C | pressure / atm |
|---|---|---|
| **A** | 400 | 100 |
| **B** | 400 | 300 |
| **C** | 20 | 300 |
| **D** | 20 | 100 |

**32** Coating iron helps to prevent rusting.

Which coating will continue to protect the iron even when the coating is damaged?

**A** copper

**B** paint

**C** plastic

**D** zinc

**33** A student suggests three uses of calcium carbonate (limestone).

1 manufacture of cement

2 manufacture of iron

3 treating alkaline soils

Which suggestions are correct?

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

**34** The Contact process is used to manufacture concentrated sulfuric acid and consists of four steps.

Which step involves a catalyst?

**A** production of sulfur dioxide gas

**B** production of sulfur trioxide gas

**C** production of oleum

**D** production of concentrated sulfuric acid

**35** Which row about the production of ethanol by fermentation is correct?

| | raw materials | energy requirement | rate of reaction |
|---|---|---|---|
| **A** | non-renewable | high | slow |
| **B** | renewable | low | slow |
| **C** | non-renewable | low | fast |
| **D** | renewable | high | fast |

**36** Which statement about homologous series is correct?

**A** Members of a homologous series have the same structural formula.

**B** Members of a homologous series all have similar chemical properties.

**C** Members of a homologous series all have similar physical properties.

**D** Members of all homologous series are hydrocarbons.

**37** Increasing the number of atoms in one molecule of a hydrocarbon increases the amount of energy released when it burns.

What is the correct order?

| | less energy released → | | more energy released |
|---|---|---|---|
| **A** | ethene | ethane | methane |
| **B** | ethene | methane | ethane |
| **C** | methane | ethane | ethene |
| **D** | methane | ethene | ethane |

**38** Some properties of an organic compound J are listed.

- It is a liquid at room temperature.
- It is soluble in water.
- A solution of J reacts with calcium carbonate to form carbon dioxide.
- A solution of J has a pH of 3.

In which homologous series does J belong?

**A** alkane

**B** alkene

**C** alcohol

**D** carboxylic acid

**39** Ethane, $C_2H_6$, reacts with chlorine in a substitution reaction.

What are the products of this reaction?

**A** chloroethane and hydrogen

**B** chloroethane and hydrogen chloride

**C** chloroethene and hydrogen

**D** chloroethene and hydrogen chloride

**40** Which polymers or types of polymer are synthetic?

1 carbohydrates

2 nylon

3 proteins

4 *Terylene*

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

## The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | VIII |
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89–103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

atomic number
atomic symbol
name
relative atomic mass

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

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).