



Cambridge IGCSE™ (9–1)

CHEMISTRY**0971/22**

Paper 2 Multiple Choice (Extended)

October/November 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.



2

1 Which gas has the slowest rate of diffusion?

- A** H₂ **B** NH₃ **C** CH₄ **D** CO₂

2 A chromatography experiment is carried out to analyse the pigments present in four different types of leaf. The student carrying out the experiment forgot to complete his table of results, which is shown.

| plant leaf | number of pigments identified | colour of identified pigments | distance travelled by the solvent front (cm) | distance travelled from the origin by each pigment (cm) | R _f value |
|------------|-------------------------------|-------------------------------|--|---|---|
| maple | F | green /yellow | 3.7 | green: 3.0 yellow: 3.1 | green: 0.81 yellow: 0.83 |
| laurel | 2 | green /yellow | G | green: 2.5 yellow: 2.5 | green: 0.78 yellow: 0.78 |
| lime | 3 | green /yellow /orange | 3.5 | green: 2.9 yellow: 3.0 orange: 2.7 | green: 0.83 yellow: 0.86 yellow: 0.77 |
| ash | 3 | green /yellow /orange | 3.5 | green: 2.8 yellow: 3.0 orange: 2.7 | green: 0.80 yellow: H orange: 0.77 |

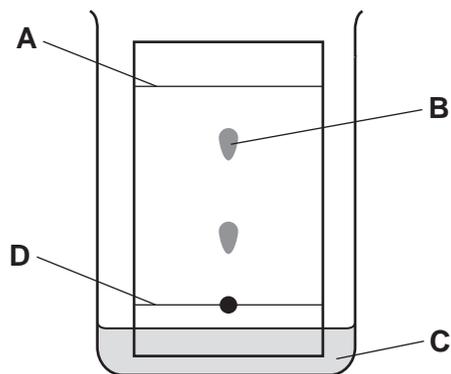
Which row identifies the values of **F**, **G** and **H**?

| | F | G | H |
|----------|----------|----------|----------|
| A | 2 | 3.2 | 0.80 |
| B | 3 | 3.5 | 0.83 |
| C | 2 | 3.2 | 0.86 |
| D | 3 | 3.5 | 0.78 |

3 Which statement about isotopes is correct?

- A** They have different proton numbers.
B They have different chemical properties.
C They have the same nucleon number.
D They have the same number of electrons in their outer shell.

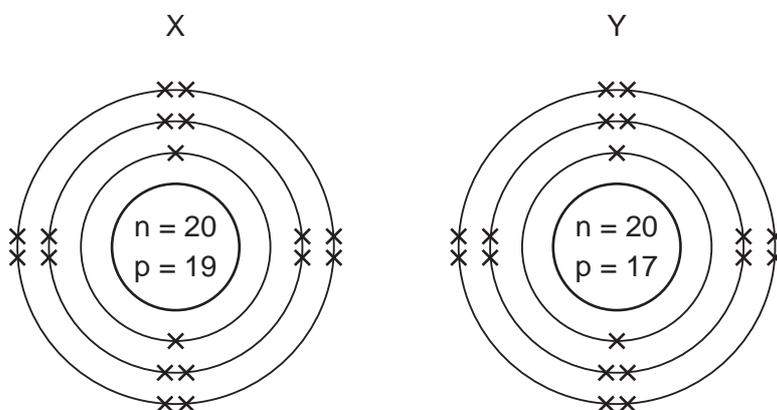
- 4 In the chromatography experiment shown, which label represents the solvent front?



- 5 Different methods of separation rely on substances having different properties.

Which property does distillation make use of?

- A boiling point
 - B colour
 - C particle size
 - D solubility in different solvents
- 6 The arrangements of the electrons in two ions formed from elements X and Y are shown.



Which equation represents the reaction between elements X and Y?

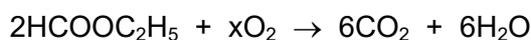
- A $X_2 + 2Y \rightarrow 2X^+ + 2Y^-$
- B $X_2 + 2Y \rightarrow 2X^- + 2Y^+$
- C $2X + Y_2 \rightarrow 2X^+ + 2Y^-$
- D $2X + Y_2 \rightarrow 2X^- + 2Y^+$

- 7 Which row identifies compounds that contain single covalent bonds only, double covalent bonds only or both single and double covalent bonds?

| | single covalent bonds only | double covalent bonds only | both single and double covalent bonds |
|----------|-------------------------------|-------------------------------|---------------------------------------|
| A | C ₂ H ₄ | CH ₃ OH | CO ₂ |
| B | CH ₃ OH | C ₂ H ₄ | CO ₂ |
| C | CH ₃ OH | CO ₂ | C ₂ H ₄ |
| D | CO ₂ | C ₂ H ₄ | CH ₃ OH |

- 8 Ethyl methanoate, HCOOC₂H₅, burns in excess oxygen to produce carbon dioxide and water.

The equation is shown.



What is the value of x?

- A** 2 **B** 7 **C** 9 **D** 18
- 9 Rubidium is in Group I of the Periodic Table and bromine is in Group VII.

Rubidium reacts with bromine to form an ionic compound.

Which row shows the electron change taking place for rubidium and the correct formula of the rubidium ion?

| | electron change | formula of ion formed |
|----------|-----------------|-----------------------|
| A | electron gained | Rb ⁺ |
| B | electron gained | Rb ⁻ |
| C | electron lost | Rb ⁺ |
| D | electron lost | Rb ⁻ |

- 10 Which statement explains why graphite is used as a lubricant?

- A** All bonds between the atoms are weak.
B It conducts electricity.
C It has a low melting point.
D Layers in the structure can slide over each other.

- 11 The relative atomic mass of chlorine is 35.5.

When calculating relative atomic mass, which particle is the mass of a chlorine atom compared to?

- A a neutron
- B a proton
- C an atom of carbon-12
- D an atom of hydrogen-1

- 12 Universal indicator solution is added to a neutral solution of concentrated aqueous sodium chloride.

The solution, which contains H^+ (hydrogen), Na^+ (sodium), Cl^- (chloride) and OH^- (hydroxide) ions, is electrolysed.

The product at the cathode is hydrogen gas and the product at the anode is chlorine gas.

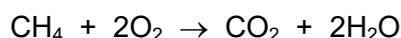
What happens to the colour of the indicator **in the solution** during electrolysis?

- A The colour changes from blue to green.
- B The colour changes from blue to red.
- C The colour changes from green to blue.
- D The colour changes from green to red.

- 13 What is the empirical formula of an oxide of iron, formed by reacting 2.24 g of iron with 0.96 g of oxygen?

- A FeO B Fe₂O C Fe₂O₃ D Fe₃O₄

- 14 The combustion of methane is exothermic.



Which statement about this reaction is correct?

- A The energy needed to break the bonds in methane and oxygen is greater than the energy released in making new bonds in carbon dioxide and water.
- B The energy needed to break the bonds in methane and oxygen is less than the energy released in making new bonds in carbon dioxide and water.
- C The energy released in breaking bonds in methane and oxygen is greater than the energy needed to make new bonds in carbon dioxide and water.
- D The energy released in breaking bonds in methane and oxygen is less than the energy needed to make new bonds in carbon dioxide and water.

- 15 Hydrogen reacts with oxygen in a fuel cell.



The reaction is exothermic.

286 kJ of energy is released for every mole of water formed.

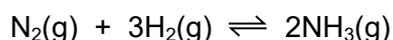
Which volume of hydrogen gas, measured at room temperature and pressure, would react with oxygen with the release of 7000 J of energy?

- A 587 cm³ B 1175 cm³ C 587 dm³ D 1175 dm³
- 16 Which substance does **not** require oxygen in order to produce energy?
- A coal
B hydrogen
C natural gas
D ²³⁵U
- 17 Nitrogen, N₂, and hydrogen, H₂, can be converted into ammonia, NH₃, using a catalyst.

What is the purpose of the catalyst?

- A to increase the amount of ammonia produced
B to increase the rate of reaction
C to reduce the amount of reactants needed
D to reduce the rate of reaction

- 18 Ammonia is produced by the Haber process. The equation is shown.

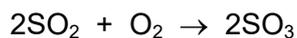


The forward reaction is exothermic.

Which statement is correct?

- A Increasing pressure decreases the yield of ammonia, but speeds up the reaction.
B Increasing temperature decreases the yield of ammonia, but speeds up the reaction.
C Increasing the concentration of hydrogen and nitrogen results in a lower yield of ammonia.
D Increasing the temperature increases the yield of ammonia and speeds up the reaction.

19 During the manufacture of sulfuric acid, sulfur dioxide is converted to sulfur trioxide.



Which type of reaction is this?

- A displacement
- B neutralisation
- C oxidation
- D thermal decomposition

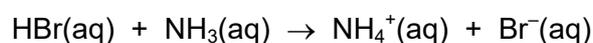
20 The equation for a redox reaction is shown.



Which element is reduced?

- A chlorine
- B iron
- C oxygen
- D sulfur

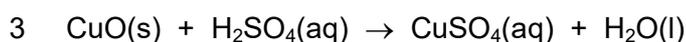
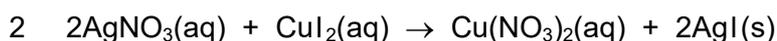
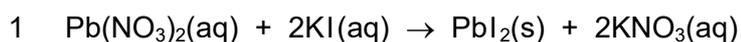
21 The equation shows a reaction between aqueous hydrogen bromide and aqueous ammonia.



Which statement describes the role of aqueous hydrogen bromide?

- A It is a catalyst.
- B It is a reducing agent.
- C It is a proton acceptor.
- D It is a proton donor.

22 The equations for three reactions are shown.



Which reactions are suitable for making a salt by precipitation?

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

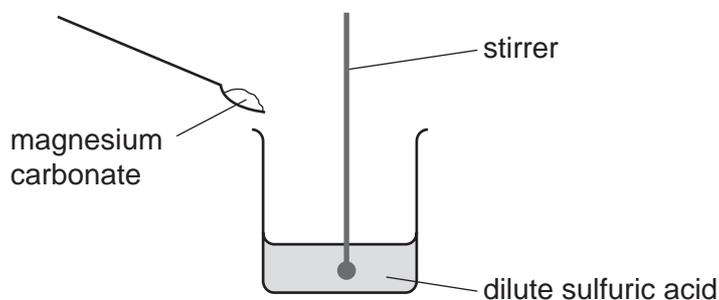
23 Zinc oxide is an amphoteric oxide.

Which row describes the reactions of zinc oxide?

| | reaction with alkalis | reaction with acids |
|----------|-----------------------|---------------------|
| A | ✓ | ✓ |
| B | ✓ | x |
| C | x | ✓ |
| D | x | x |

24 A student carries out an experiment to prepare pure magnesium sulfate crystals.

The diagram shows the first stage of the preparation.



He adds magnesium carbonate until no more reacts.

Which process should he use for the next stage?

- A** crystallisation
- B** evaporation
- C** filtration
- D** neutralisation

25 Which row about elements in the Periodic Table is correct?

| | statement 1 | statement 2 |
|----------|--|--------------------------------------|
| A | two elements in the same group have similar chemical properties | metals are on the left of the table |
| B | two elements in the same group have similar chemical properties | metals are on the right of the table |
| C | two elements in the same period have similar chemical properties | metals are on the left of the table |
| D | two elements in the same period have similar chemical properties | metals are on the right of the table |

26 A new element oxfordium, Ox, was discovered with the following properties.

| solubility | electrical conduction | formula of element | bonding in a molecule of Ox ₂ |
|--------------------|-----------------------|--------------------|--|
| insoluble in water | doesn't conduct | Ox ₂ | Ox≡Ox |

In which group of the Periodic Table should the new element be placed?

- A Group III
- B Group V
- C Group VII
- D Group VIII

27 A flammable gas needs to be removed from a tank at an industrial plant.

For safety reasons, an inert gas is used.

Which gas is suitable?

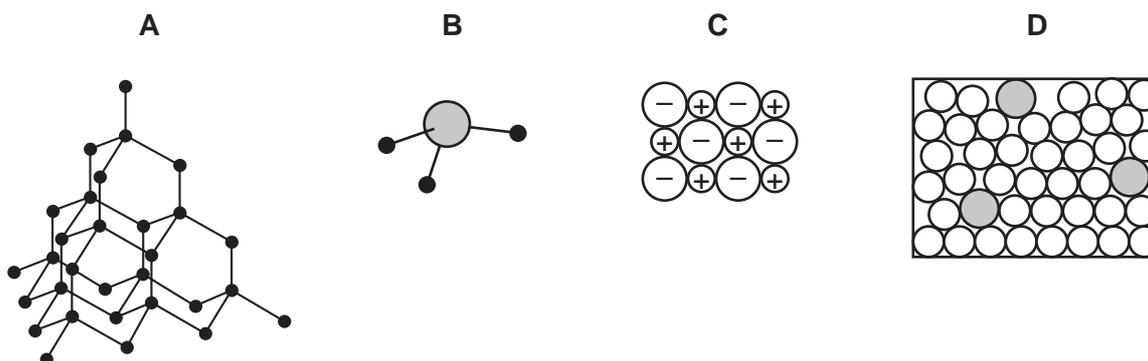
- A argon
- B hydrogen
- C methane
- D oxygen

28 Transition elements can have variable oxidation states.

Which pair of compounds shows a transition element in two different oxidation states?

- A Cr₂O₃ and Cr₂(SO₄)₃
- B Cu₂O and CuCO₃
- C ZnS and ZnSO₄
- D NiO and Ni(NO₃)₂

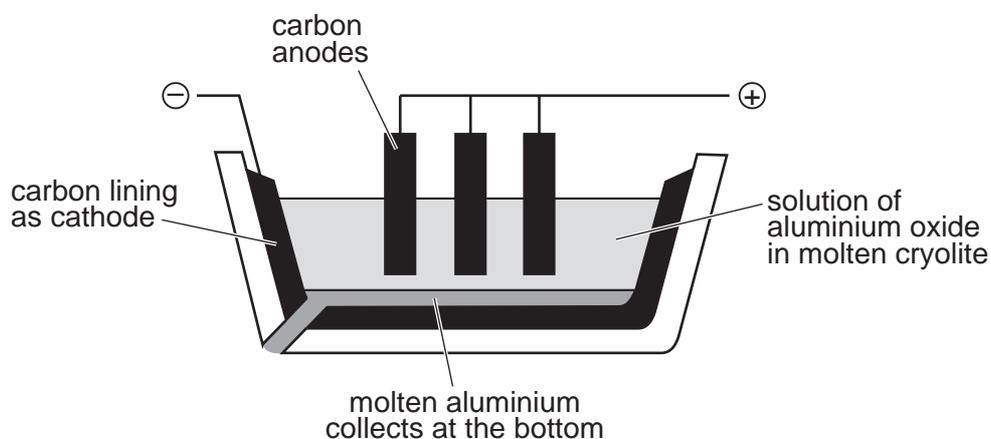
29 Which diagram best represents the structure of a substance that is a good conductor of electricity at 25 °C?



30 Why is aluminium metal unreactive with air?

- A** It is covered with a layer of oxide.
- B** It is low in the reactivity series.
- C** It is produced by electrolysis of its oxide.
- D** It melts at a high temperature.

31 The apparatus used for the extraction of aluminium oxide by electrolysis is shown.



Which equation represents a reaction taking place at the anode?

- A** $\text{O} + 2\text{e}^- \rightarrow \text{O}^{2-}$
- B** $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$
- C** $\text{Al}^{3-} \rightarrow \text{Al} + 3\text{e}^-$
- D** $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$

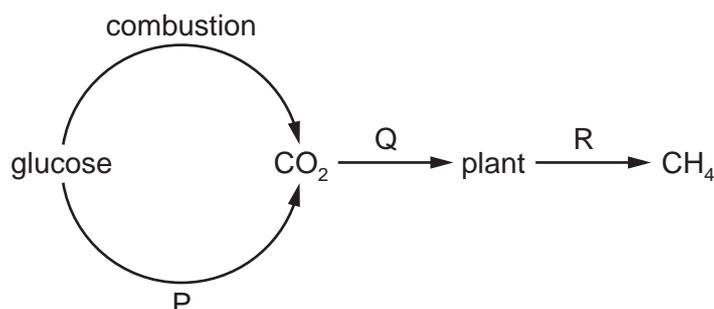
32 The results of tests on solid S and its aqueous solution are shown.

| tests on solid S | tests on aqueous solution of S | |
|--|---|---|
| effect of heat | effect of aqueous sodium hydroxide | effect of aqueous ammonia |
| brown gas given off, together with a gas which relights a glowing splint | white ppt., soluble in excess, giving a colourless solution | white ppt., soluble in excess, giving a colourless solution |

What is S?

- A aluminium nitrate
- B aluminium sulfate
- C zinc sulfate
- D zinc nitrate

33 Part of the carbon cycle is shown.



What are processes P, Q and R?

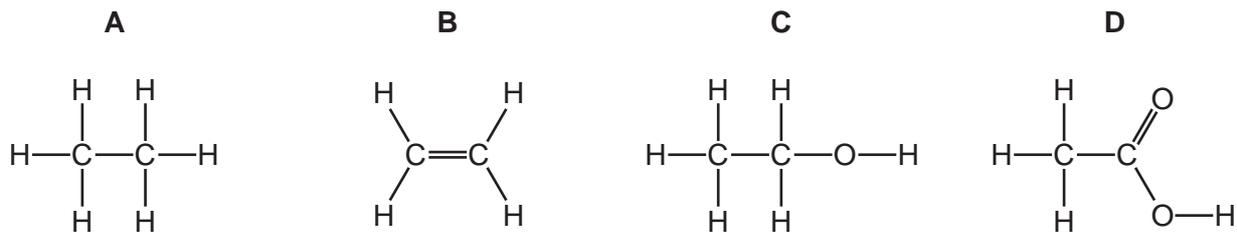
| | P | Q | R |
|---|----------------|----------------|----------------|
| A | decomposition | respiration | photosynthesis |
| B | respiration | photosynthesis | decomposition |
| C | respiration | decomposition | photosynthesis |
| D | photosynthesis | respiration | decomposition |

34 The element sulfur is found in a number of different minerals.

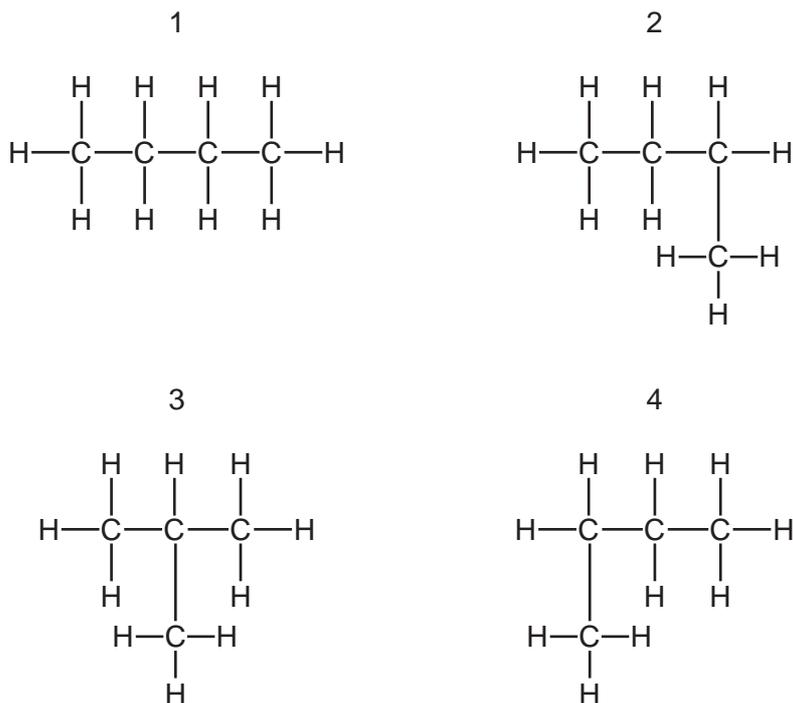
Which mineral contains the greatest percentage by mass of sulfur?

- A barite, BaSO_4
- B galena, PbS
- C gypsum, CaSO_4
- D pyrite, FeS_2

35 Which structure represents a molecule of ethanol?



36 Which structures are structural isomers of each other?

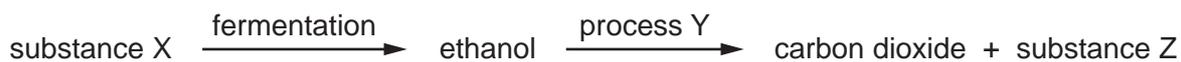


- A** 1, 2, 3 and 4
B 1, 2 and 4 only
C 1 and 3 only
D 2 and 4 only

37 Which molecule is **not** produced by an addition reaction of ethene?

- A** CH_3CH_3 **B** $\text{CH}_2\text{BrCH}_2\text{Br}$ **C** $\text{CH}_3\text{CH}_2\text{OH}$ **D** $\text{CH}_3\text{CH}_2\text{CH}_3$

38 The flow chart shows the preparation of ethanol and some important chemistry of ethanol.



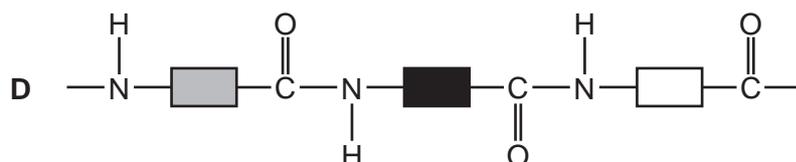
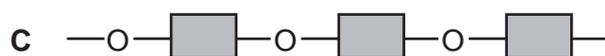
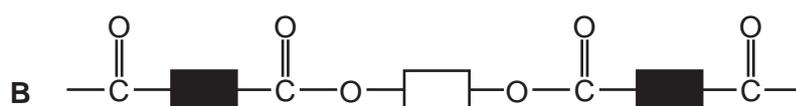
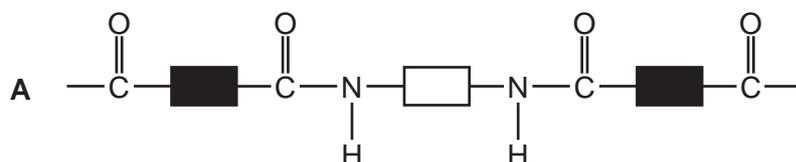
What are X, Y and Z?

| | X | Y | Z |
|----------|---------|----------------|---------|
| A | yeast | combustion | oxygen |
| B | glucose | combustion | steam |
| C | glucose | polymerisation | water |
| D | yeast | fermentation | glucose |

39 Which statement about nylon and *Terylene* is correct?

- A** Nylon and *Terylene* are made from monomers with C=C bonds.
- B** Nylon and *Terylene* contain the same linkage.
- C** Nylon is a polyester.
- D** *Terylene* is made from two different monomers.

40 Which diagram represents the structure of a protein?



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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 | <div style="border: 1px solid black; padding: 5px; text-align: center;"> Key atomic number atomic symbol name relative atomic mass </div> | | | | | | | | | | 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 — | — | — | — | — |

| | | | | | | | | | | | | | | | |
|-------------|-------------------------------------|-----------------------------------|--|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| 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 dm³ at room temperature and pressure (r.t.p.).