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CHEMISTRY**0620/41**

Paper 4 Theory (Extended)

October/November 2025**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

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

1 Protons, neutrons and electrons are particles found in atoms.

(a) Complete Table 1.1 to show the relative mass and relative charge of a proton, a neutron and an electron.

Table 1.1

particle	relative mass	relative charge
proton		+1
neutron		
electron	$\frac{1}{1840}$	

[2]

(b) Some elements have many isotopes.

(i) Define the term isotopes.

.....

 [2]

(ii) Explain why all isotopes of the same element have the same chemical properties.

.....
 [1]

(c) Complete Table 1.2.

Table 1.2

atom or ion	number of protons	number of neutrons	number of electrons
$^{40}_{18}\text{Ar}$	18		18
$^{32}_{16}\text{S}^{2-}$		16	
	22	28	20

[5]



- (d) The term mass number is defined as the total number of protons and neutrons in the nucleus of an atom.

State the name of **one other** term which is defined as the total number of protons and neutrons in the nucleus of an atom.

..... [1]

- (e) Calculate the number of atoms in 2.00 g of argon.

Give your answer in standard form.

number of atoms = ... [2]

[Total: 13]



2 Calcium is an element in Group II of the Periodic Table.

(a) Identify the element in Group II which has only five occupied electron shells.

..... [1]

(b) Name and describe the type of bonding found in elements in Group II.

name

description

.....

.....

..... [4]

(c) When a piece of calcium is added to some cold water containing universal indicator a reaction takes place.

(i) Give **three** observations when this reaction takes place.

1

2

3 [3]

(ii) Name the **two** products of this reaction.

..... and [2]

(d) Calcium burns in oxygen.

(i) State the colour of the flame.

..... [1]

(ii) Write the symbol equation for this reaction.

..... [2]



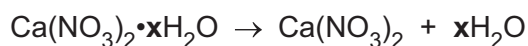
- (e) Crystals of hydrated calcium nitrate contain water molecules.

The formula of hydrated calcium nitrate is $\text{Ca}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$.
 x is a whole number.

- (i) State the term given to the water molecules present in hydrated crystals.

..... [1]

- (ii) When hydrated calcium nitrate is heated gently, the following reaction occurs.



A sample of hydrated calcium nitrate is heated gently. 3.28 g of $\text{Ca}(\text{NO}_3)_2$ forms and the mass of the crystals decreases by 1.44 g.

[M_r : $\text{Ca}(\text{NO}_3)_2$, 164; H_2O , 18]

Determine the value of x in $\text{Ca}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ using the following steps.

- Calculate the number of moles of $\text{Ca}(\text{NO}_3)_2$ that remain.

..... mol

- Calculate the number of moles of H_2O given off.

..... mol

- Determine the value of x .

$x =$ [3]

[Total: 17]

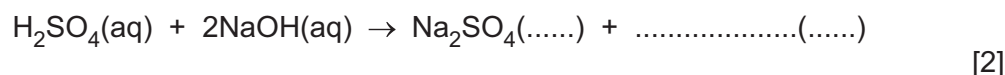


- 3 A student makes crystals of the salt sodium sulfate, Na_2SO_4 . The student reacts 0.200 mol/dm^3 dilute sulfuric acid, $\text{H}_2\text{SO}_4(\text{aq})$, with aqueous sodium hydroxide, $\text{NaOH}(\text{aq})$.

The student uses the following steps.

- step 1** The student places 40.0 cm^3 of $\text{NaOH}(\text{aq})$ into a conical flask. This volume contains 0.0100 moles of NaOH .
- step 2** The student adds a few drops of methyl orange indicator to the $\text{NaOH}(\text{aq})$ in the conical flask.
- step 3** The student adds 0.200 mol/dm^3 $\text{H}_2\text{SO}_4(\text{aq})$ to the flask until the end-point is reached.
- step 4** The student transfers the mixture from the conical flask to an evaporating basin and obtains dry crystals.

- (a) Complete the symbol equation for the reaction. Include state symbols.



- (b) State the type of exothermic reaction taking place.

..... [1]

- (c) Calculate the concentration of $\text{NaOH}(\text{aq})$ used in **step 1**.

concentration of $\text{NaOH}(\text{aq}) = \text{..... mol/dm}^3$ [1]

- (d) Name the item of apparatus the student uses to add $\text{H}_2\text{SO}_4(\text{aq})$ in **step 3**.

..... [1]

- (e) Calculate the volume of $\text{H}_2\text{SO}_4(\text{aq})$, in cm^3 , added in **step 3**.

volume of $\text{H}_2\text{SO}_4(\text{aq}) = \text{..... cm}^3$ [2]

- (f) State the colour change observed in **step 3**.

from to [2]



- (g) The dry crystals formed in **step 4** are coloured and **not** white. This is because the student should do an additional step between **step 3** and **step 4**.

Suggest what the student should do in this additional step to produce white crystals.

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

- (h) In **step 4**, the student gently heats the solution in the evaporating basin until the solution is saturated. The student then stops heating and leaves the hot solution to cool. Crystals start to appear.

- (i) Explain the term saturated solution.

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

- (ii) Explain why crystals start to appear as the hot solution cools.

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

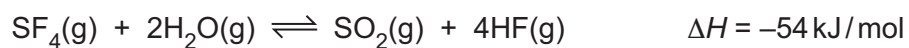
- (iii) Suggest the effect, if any, on the mass of crystals collected in **step 4** if the solution in the evaporating basin is allowed to dry without gentle heating.

..... [1]

[Total: 14]



- 4 Gaseous sulfur tetrafluoride, SF_4 , reacts with steam in a reversible reaction.



- (a) Complete the reaction pathway diagram in Fig. 4.1 for this reaction.

Include in your diagram:

- the position and the formulae of the products
- an arrow, labelled E_a , to show the activation energy
- an arrow, labelled ΔH , to show the enthalpy change of the reaction.

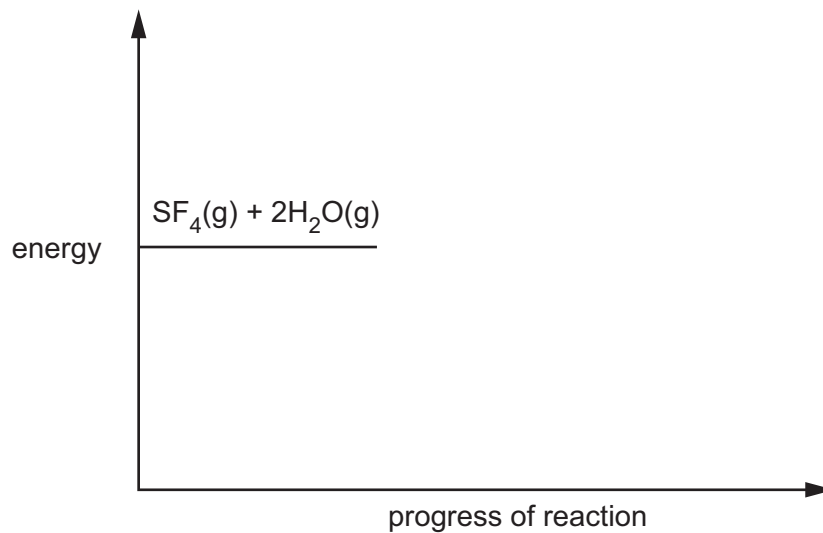


Fig. 4.1

[4]



(b) The equation for the reaction can be represented as shown in Fig. 4.2.

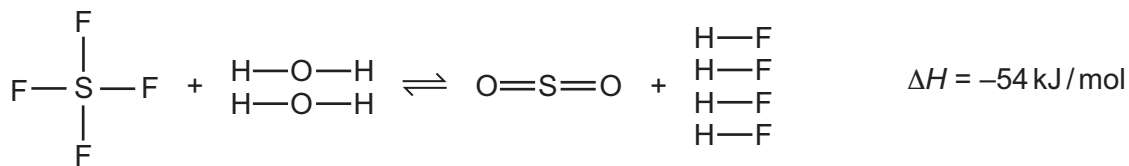


Fig. 4.2

Table 4.1 shows some bond energies.

Table 4.1

bond	S–F	O–H	H–F
bond energy in kJ/mol	330	460	570

Use the bond energies in Table 4.1 and the value of ΔH of the reaction to calculate the S=O bond energy in kJ/mol.

Use the following steps.

- Calculate the energy needed to break the bonds in the reactants.

..... kJ

- Calculate the energy released when the bonds in the products form.

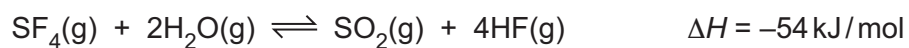
..... kJ

- Calculate the S=O bond energy.

..... kJ/mol
[4]



(c) The equation for the reaction is shown.



State the effect, if any, on the position of equilibrium when the following changes are made.

Give a reason for each of your answers.

- The temperature is increased.

.....

.....

- The pressure is increased.

.....

.....

- A catalyst is added.

.....

.....

[5]

(d) Explain, in terms of collision theory, why reducing the temperature decreases the rate of the reverse reaction.

.....

.....

.....

.....

..... [3]

[Total: 16]





Question 5 starts on the next page.



5 This question is about the homologous series of alcohols.

(a) A homologous series is a family of organic compounds whose members have the same general formula.

(i) State the general formula for alcohols.

..... [1]

(ii) Give **one other** characteristic that is the same for all members of a homologous series.

..... [1]

(b) Ethanol can be manufactured by two methods:

- **method 1** uses glucose as the starting material
- **method 2** uses ethene as the starting material.

(i) Complete Table 5.1.

Table 5.1

	method 1 glucose as starting material	method 2 ethene as starting material
typical temperature used / °C		
two other essential conditions	1	1
	2	2

[6]

(ii) Write the symbol equation for the reaction in **method 1**.

..... [2]

(iii) Write the symbol equation for the reaction in **method 2**.

..... [2]

(c) Butane-1,4-diol has the structural formula $\text{HO}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{OH}$.

(i) Deduce the molecular formula of butane-1,4-diol.

..... [1]

(ii) Butane-1,4-diol reacts with ethanoic acid.

Determine the number of moles of ethanoic acid which react fully with **one** mole of butane-1,4-diol.

..... [1]



(d) Butanedioic acid has the structural formula $\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{COOH}$.

(i) Deduce the empirical formula of butanedioic acid.

..... [1]

(ii) Name the gas formed when butanedioic acid reacts with sodium.

..... [1]

(e) Butane-1,4-diol can be represented as shown.



Butanedioic acid can be represented as shown.



Butane-1,4-diol reacts with butanedioic acid to form a polymer.

(i) Draw **two** repeat units of the polymer formed from the reaction of butane-1,4-diol with butanedioic acid.

Show all the atoms and all the bonds in the ester linkages.

[3]

(ii) State the type of polymerisation when butane-1,4-diol reacts with butanedioic acid.

..... [1]

[Total: 20]





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The Periodic Table of Elements

Group

Group																		
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII	
		Key atomic number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —

lanthanoids

actinoids

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 —

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

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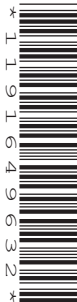
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1 The three states of matter are solid, liquid and gas.

(a) Complete Table 1.1 to describe the structures of solids, liquids and gases in terms of particle separation, particle arrangement and particle motion.

Table 1.1

state of matter	particle separation	particle arrangement	particle motion
solid	touching		
liquid			
gas		random	random

[3]

(b) Substances can physically change.

Name each physical change:

- solid to liquid
- gas to liquid
- solid to aqueous.

[3]

(c) Gases diffuse.

(i) Describe, in terms of particles, why gases diffuse.

..... [1]

(ii) State what determines the relative rate of diffusion of gases at constant temperature.

..... [1]

(d) Gaseous oxides of nitrogen are atmospheric pollutants. One adverse effect of oxides of nitrogen is the formation of acid rain.

State **two other** adverse effects of oxides of nitrogen.

1.....

2.....

[2]



(e) In a catalytic converter, oxides of nitrogen are removed by reaction with the toxic gaseous product of the incomplete combustion of hydrocarbon fuels. Two non-toxic gases are formed in this reaction.

(i) Name the toxic gaseous product of the incomplete combustion of hydrocarbon fuels.

..... [1]

(ii) Name the **two** non-toxic gases formed in the catalytic converter.

1

2 [2]

[Total: 13]



2 Iron is extracted from iron ore in a blast furnace.

(a) The iron compound in the main iron ore used in the blast furnace is iron(III) oxide.

(i) State the name of the main iron ore used in the blast furnace.

..... [1]

(ii) State how the main source of heat is provided in the blast furnace.

..... [1]

(iii) Name the gaseous reducing agent in the blast furnace.

..... [1]

(iv) Write a symbol equation for the reduction of iron(III) oxide by the gaseous reducing agent in (a)(iii).

..... [2]

(v) The main impurity in iron ore is silicon(IV) oxide.

Write **two** symbol equations to show the role of limestone in removing silicon(IV) oxide from iron ore.

1

2 [2]

(b) Table 2.1 shows four different isotopes of iron, **A**, **B**, **C** and **D**.

Table 2.1

A	B	C	D
^{54}Fe	^{56}Fe	^{57}Fe	^{58}Fe

Explain why **A**, **B**, **C** and **D** are isotopes of iron.

..... [2]



(c) Iron can form two different ions, Fe^{2+} and Fe^{3+} .

- (i) Complete Table 2.2 to show the number of protons, neutrons and electrons in the two iron ions shown.

Table 2.2

	$^{54}\text{Fe}^{2+}$	$^{58}\text{Fe}^{3+}$
protons		
neutrons		
electrons		

[3]

- (ii) Describe a test for aqueous Fe^{2+} ions.

test

observations

[2]

(d) An oxidising agent converts Fe^{2+} ions to Fe^{3+} ions.

- (i) Define the term oxidising agent.

.....

..... [2]

- (ii) Explain why the conversion of Fe^{2+} ions to Fe^{3+} ions is described as oxidation.

..... [1]

- (iii) The oxidising agent for the conversion of Fe^{2+} ions to Fe^{3+} ions is aqueous potassium manganate(VII).

State **one** condition needed for the oxidation to take place.

..... [1]

(e) Iodide ions, I^- , reduce Fe^{3+} ions to Fe^{2+} ions in aqueous solution.

Suggest the identity of the other product formed in this reaction.

..... [1]

[Total: 19]



- 3 A student prepares a sample of the insoluble salt barium sulfate, BaSO_4 .
The student adds aqueous sodium sulfate, $\text{Na}_2\text{SO}_4(\text{aq})$, to aqueous barium chloride, $\text{BaCl}_2(\text{aq})$.

The student carries out the following steps.

- step 1** Dissolve 0.100 moles of solid BaCl_2 in 100 cm^3 of distilled water in a beaker to form $\text{BaCl}_2(\text{aq})$.
- step 2** Add an aqueous solution which contains 0.100 moles of $\text{Na}_2\text{SO}_4(\text{aq})$ to the beaker containing the $\text{BaCl}_2(\text{aq})$ from **step 1**.
- step 3** Stir the mixture and then filter it.
- step 4** Dry the solid left in the filter paper.

- (a) Complete the symbol equation for the reaction. Include state symbols.



[2]

- (b) Calculate the mass of solid BaCl_2 dissolved in **step 1**.

mass = ... g [2]

- (c) The concentration of $\text{Na}_2\text{SO}_4(\text{aq})$ in **step 2** is 1.25 mol/dm^3 .

Calculate the volume, in cm^3 , of 1.25 mol/dm^3 $\text{Na}_2\text{SO}_4(\text{aq})$ added in **step 2** which contains 0.100 moles of Na_2SO_4 .

volume = ... cm^3 [1]

- (d) State the colour of the solid formed in **step 2**.

..... [1]

- (e) The mixture is filtered in **step 3**.

State the general term given to a solid left in the filter paper after filtration.

..... [1]



- (f) The actual mass of dry BaSO_4 collected in **step 4** is greater than the expected mass. This is because the student should do an additional step between **step 3** and **step 4**.

Suggest what the student should do in this additional step, and explain why the actual mass collected is greater than the expected mass.

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

- (g) State the name of this method of salt preparation.

..... [1]

- (h) State the name of a different:

- barium salt that can be used in place of BaCl_2
- sulfate salt that can be used in place of Na_2SO_4
- barium salt that can be made by this method. [3]

[Total: 13]



4 Nitric acid, HNO_3 , and sulfuric acid, H_2SO_4 , are strong acids. Ethanoic acid, CH_3COOH , is a weak acid.

(a) One mole of each acid is added separately to 1000cm^3 of distilled water to form a dilute solution. All three acids dissociate in distilled water.

(i) State the formula of the common cation produced when each of the three acids dissociates in water.

..... [1]

(ii) Explain, in terms of dissociation, why:

- nitric acid is described as a strong acid

.....

- ethanoic acid is described as a weak acid.

.....

[2]

(iii) State which of the three dilute acids will have the highest pH value.

..... [1]

(iv) State the colour of thymolphthalein in all three dilute acids.

..... [1]

(v) Give the formula of the anion formed when:

- sulfuric acid dissociates in water

.....

- ethanoic acid dissociates in water.

.....

[2]

(vi) Name the **two** gaseous products formed during the electrolysis of dilute sulfuric acid using inert electrodes.

..... and [2]

(vii) Name the salt formed when calcium reacts with ethanoic acid.

..... [1]



(b) Aluminium nitrate, $Al(NO_3)_3$, is made when dilute nitric acid reacts with aluminium hydroxide, $Al(OH)_3$.

(i) $Al(OH)_3$ acts as a base in this reaction.

Define the term base.

..... [1]

(ii) $Al(OH)_3$ is **not** an alkali.

State what this tells you about the solubility of $Al(OH)_3$.

..... [1]

(iii) Name **one other** compound which forms aluminium nitrate when added to dilute nitric acid.

..... [1]

(iv) The oxidation number of the O atoms in $Al(NO_3)_3$ is -2 .

The formula of the aluminium ion in $Al(NO_3)_3$ is Al^{3+} .

Determine the oxidation number of the N atoms in $Al(NO_3)_3$.
Show your working.

oxidation number of N = ... [2]

[Total: 15]



5 This question is about the homologous series of alkanes.

Three general characteristics of alkanes are:

- they are generally unreactive because they do **not** have a functional group
- they show trends in their physical properties, such as melting points and boiling points
- they have similar chemical properties.

(a) Describe **two other** general characteristics of the homologous series of alkanes.

1.....

2.....

[2]

(b) (i) State the trend in the boiling points of the alkanes as the carbon chain length increases.

..... [1]

(ii) Name **one other** physical property of alkanes that shows a trend, other than melting points and boiling points.

Describe this trend as the carbon chain length of alkanes increases.

name

description

[2]

(c) State why alkanes are described as saturated.

..... [1]



(d) Propane has the structural formula $\text{CH}_3\text{CH}_2\text{CH}_3$.

When propane undergoes a monosubstitution reaction with chlorine at room temperature, **two** organic products can be formed.

(i) State **one** condition needed for this substitution reaction to take place.

..... [1]

(ii) Give the structural formula and state the name of each organic product formed.

- structural formula of product 1

name of product 1

- structural formula of product 2

name of product 2

[4]

(iii) The two products formed are structural isomers of each other.

Define the term structural isomers.

.....

..... [1]

[Total: 12]



6 Compound **E** shown in Fig. 6.1 is an ester.

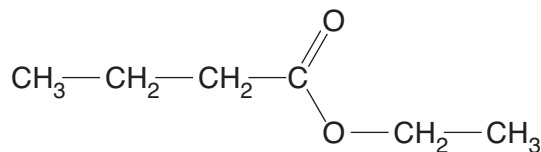


Fig. 6.1

- (a) On Fig. 6.1, draw a circle around all the atoms which make up the ester linkage. [1]
- (b) Name compound **E**.
..... [1]
- (c) Deduce the empirical formula of compound **E**.
..... [1]
- (d) Compound **E** is produced when two different compounds react together in the presence of a catalyst.
- (i) Name the **two** compounds that react together to produce compound **E**.
- 1
2 [2]
- (ii) Suggest a suitable catalyst for this reaction.
..... [1]
- (e) Determine the number of unbranched esters which have the molecular formula $\text{C}_5\text{H}_{10}\text{O}_2$.
..... [1]
- (f) All unbranched esters with the molecular formula $\text{C}_5\text{H}_{10}\text{O}_2$ combust completely to form carbon dioxide and water only.
- Write the symbol equation for the complete combustion of $\text{C}_5\text{H}_{10}\text{O}_2$.
..... [1]

[Total: 8]







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The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
		1 H hydrogen 1																
		Key atomic number atomic symbol name relative atomic mass																
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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —	

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
	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.).