COMPASSVALE SECONDARY SCHOOL
Secondary Four Express
Preliminary Examination 2024

NAME											
CENTRE NUMBER	S					CLASS				INDEX NUMBER	

CHEMISTRY **6092/02**

Paper 2 **23 August 2024**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **21** printed pages and **1** blank page.

Set by: Ms Tay SW

[Turn over

Section A

Answer **all** questions.

1 **(a)** A list of symbols and formulae is shown.

Al^{3+}
Ar
CH_4
CO_2
CI_2
Fe^{3+}
H_2
O_2
O^{2-}
NO
NO_2
Zn^{2+}

Answer the following questions about these symbols and formulae.

Each symbol or formula may be used once, more than once or not at all.

Which symbol or formula represents:

(i) a compound which contributes to global warming,

……..... [1]

(ii) a compound which is taken in by plants during photosynthesis,

……..... [1]

(iii) a gas which comprises 0.93% of clean dry air,

……..... [1]

(iv) a gas which bleaches damp litmus paper,

……..... [1]

(v) an ion which forms a white precipitate that is insoluble in excess aqueous ammonia,

……..... [1]

(vi) an ion formed when an atom gains electrons?

……..... [1]

(b) Oxides of non-metals can be classified as acidic or neutral.

Give an example of each and explain its classification.

acidic oxide …….....

…….....

neutral oxide …….....

……..... [2]

[Total: 8]

2 The experiment in Fig. 2.1 was set up to investigate the movement of gaseous ammonia and gaseous hydrogen chloride.

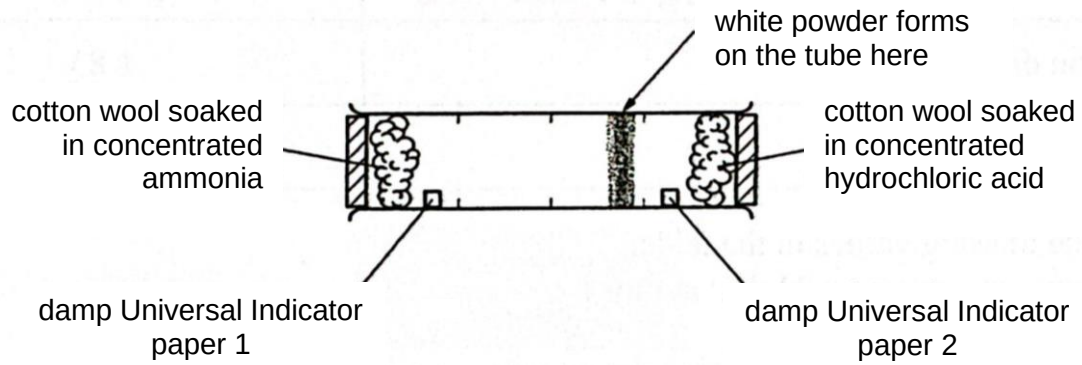


Fig. 2.1

(a) The white powder forms on the tube due to the reaction between gaseous ammonia and gaseous hydrogen chloride. The white powder can be decomposed to form ammonia and hydrogen chloride.

Write an equation for this reaction.

……..... [1]

(b) The tube contains two pieces of Universal Indicator paper.

Complete Table 2.1 to show the colours of each piece of Universal Indicator paper and the pH values at the end of the experiment.

Table 2.1

Universal Indicator paper	colour	pH
1		
2		

[2]

(c) Explain why the white powder does **not** form in the centre of the tube.

……

……

……

……..... [3]

[Total: 6]

3 Niobium is a transition element while sodium is an element in Group 1 of the Periodic Table.

(a) Give **one** similarity and **one** difference between the physical properties of niobium and sodium.

similarity ……

……

difference ……

……

[2]

(b) Fig. 3.1 shows the structure of a molecule of niobium(V) chloride.

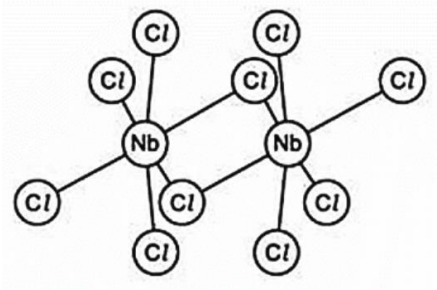


Fig. 3.1

(i) What is unusual about the structure of niobium(V) chloride?

……

…… [1]

(ii) State the formula of niobium(V) chloride.

…… [1]

(c) Sodium chloride has a much higher boiling point than niobium(V) chloride.

Use ideas about structure and bonding to explain this difference in boiling points.

……

……

……

……

…… [3]

[Total: 7]

[Turn over

4 This question is about halogens.

(a) Table 4.1 shows some information about three halogens, chlorine, bromine and iodine.

Table 4.1

halogen	melting point / °C	boiling point / °C	density / gcm^{-3}
chlorine	–101	–35	0.03
bromine	–7	59	3.12
iodine	114	184	4.93

(i) Describe the arrangement and movement of chlorine molecules at –10 °C.

……

……

…… [2]

(ii) A student makes a comment about the densities of chlorine and bromine.

'The difference in molecular mass of chlorine and bromine is not enough to account for the difference in densities.'

Explain why the student is correct.

……

……

…… [2]

(b) Seawater contains potassium bromide. Bromine can be produced from seawater by displacement.

(i) Which element can displace bromine? Explain your answer.

Include any observations and an ionic equation in your explanation.

……

……

……

……

……

…… [4]

(ii) Seawater also contains iodide ions.

Describe a test, other than displacement, that can be used to show that seawater contains iodide ions.

test ……..……...…….....

…….....

result ……..…….…….....

……..……..…….....
[2]

[Total: 10]

5 A sample of black ink contains a mixture of blue, red and yellow dyes. The solvent used to separate the dyes in black ink is usually a mixture of ethanol and water. The coloured dyes have different R_f values in solvents with different compositions of ethanol as shown in Fig. 5.1.

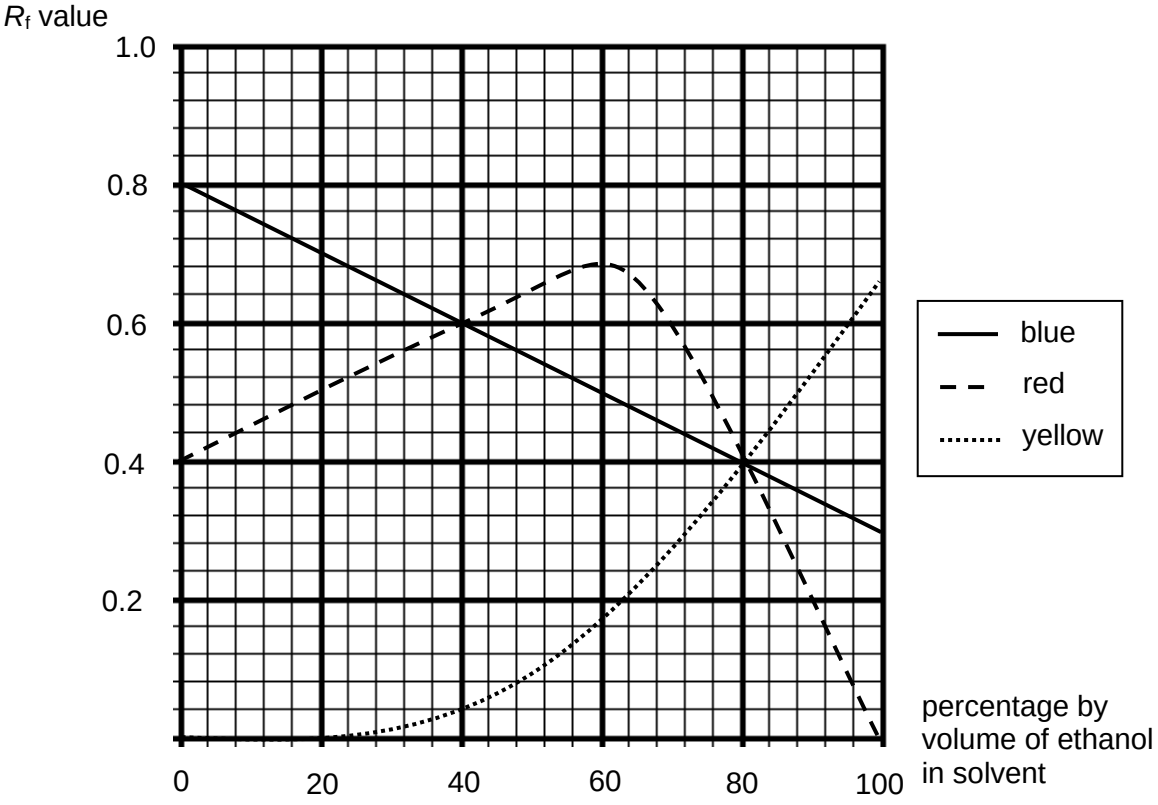


Fig. 5.1

(a) What property must **all** the dyes in the black ink have in order for separation to occur?

……[1]

(b) Use Fig. 5.1 to explain why the solvent used to separate the dyes in black ink is usually a mixture of ethanol and water.

……

……

……

……

……[3]

(c) What is the R_f value of the blue dye dissolved in a mixture of 32 cm^3 of ethanol in 200 cm^3 of solvent?

Show your working.

R_f = ……..... [2]

(d) A student carried out paper chromatography on the black dye using a mixture of ethanol and water as solvent.

(i) The student observed only one spot on the resulting chromatogram.

Can the student conclude that the black dye is a pure substance?

Explain your reasoning using information from the graph above.

……..

……..

……..

……..[2]

(ii) State **two** precautions that the student needs to take during the paper chromatography.

……..

……..

……..

……[2]

[Total: 10]

6 A series of experiments were carried out to investigate the effect of concentration on the rate of reaction.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

Table 6.1 shows the rates of reaction when the concentration of the reactants was varied.

Table 6.1

experiment	concentration of BrO_3^- in mol/dm^3	concentration of Br^- in mol/dm^3	concentration of H^+ in mol/dm^3	initial rate in moldm^{-3}/s
1	1.00	1.00	1.00	0.008
2	2.00	1.00	1.00	0.016
3	1.00	2.00	1.00	0.032
4	2.00	1.00	2.00	0.032

(a) Use the information in Table 6.1 to describe how the concentration of Br^- and H^+ affect the initial rate of reaction.

……

……

……

……

…… [2]

(b) Use ideas about collisions between particles to explain how concentration affects the initial rate of reaction.

……

……

……

……

…… [2]

(c) The reaction that occurred is a disproportionation reaction.

A disproportionation reaction is when one element is simultaneously reduced and oxidised in a single reaction.

(i) Complete Table 6.2 by giving the oxidation state of bromine in each of the following species.

Table 6.2

species	BrO_3^-	Br^-	Br_2
oxidation state			

[2]

(ii) With reference to your answer in **(c)(i)**, explain why this reaction is a disproportionation reaction.

……

……

…… [2]

[Total: 8]

7 **(a)** A student investigated the electrolysis of aqueous copper(II) sulfate using the apparatus shown in Fig. 7.1.

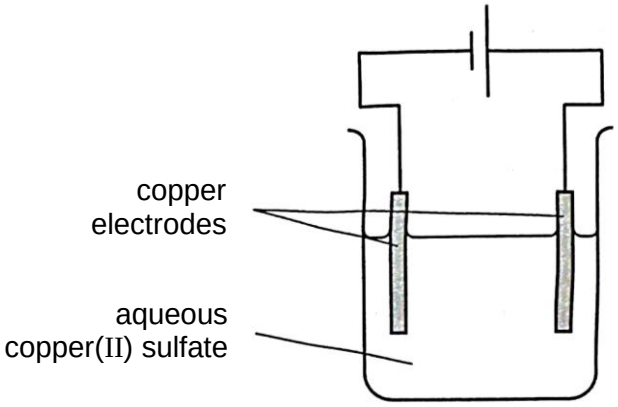


Fig. 7.1

The student carried out three experiments and the results obtained is shown in Table 7.1.

Table 7.1

experiment	current used / A	time taken / s	mass of cathode	
			before electrolysis / g	after electrolysis / g
1	2.0	180	1.24	1.36
2	4.0	180	1.20	1.44
3	2.0	360	1.34	1.58

(i) In experiment 2, the student measured the mass of the anode before and after electrolysis. The mass of the anode at the start was 1.45 g.

Determine the mass of the anode after electrolysis.

mass of anode = ……..... g [2]

(ii) The student carries out a fourth experiment, using a current of 8.0 A for 90 seconds. The mass of the cathode at the start was 1.51 g.

Deduce the mass of the cathode after electrolysis.

mass of cathode = ……..... g [1]

(iii) The student carried out a fifth experiment.

Carbon electrodes are now used instead of copper electrodes, with all other conditions kept the same as experiment 1.

Predict and explain the expected observations at the end of the fifth experiment.

……..…….....

……..…….....

……..…….....

……..…….....

……..... [3]

(b) Fig. 7.2 shows a simple cell which is used to determine the reactivity of five metals.

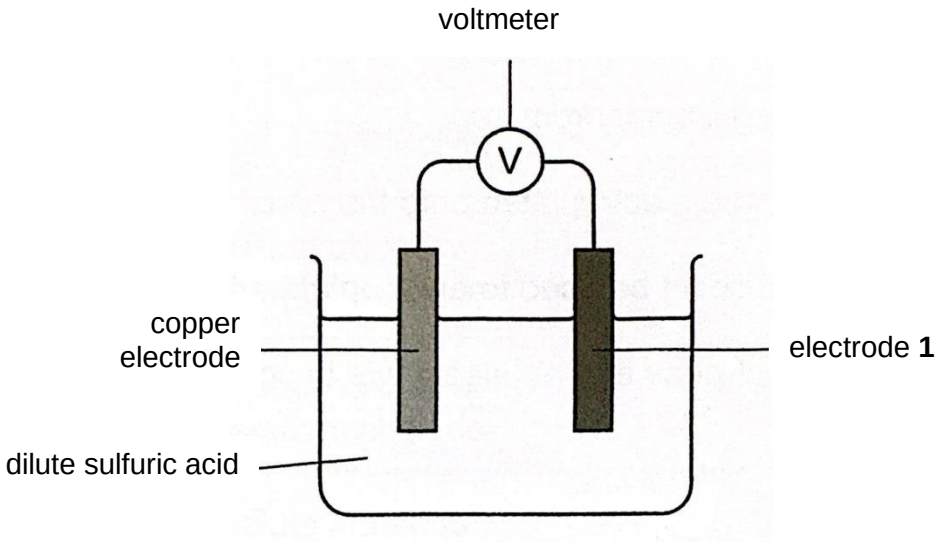


Fig. 7.2

Table 7.2 shows the voltages of the cell when the following metals were used as electrode **1**.

Table 7.2

electrode **1**	voltage / V
A	0.25
B	1.70
C	2.50
D	–0.40

(i) Use the information in Table 7.2 to deduce the order of reactivity of copper, **A**, **B**, **C** and **D**.

most reactive …….....

…….....

…….....

…….....

least reactive ……..... [1]

(ii) Explain your answer in **(b)(i)**.

……..…….....

……..... [2]

[Total: 9]

8 The precipitation of salts

A precipitation reaction occurs when two aqueous solutions are mixed together to form an insoluble salt.

Experiments were carried out to study the precipitation of an insoluble salt using dilute sulfuric acid and aqueous barium hydroxide.

Table 8.1 shows the results of the study conducted.

Table 8.1

experiment	1	2	3	4	5	6
volume of aqueous barium hydroxide used / cm^3	5.0	5.0	5.0	5.0	5.0	5.0
volume of 1.0 mol/dm^3 diluted sulfuric acid used / cm^3	1.0	1.5	2.0	2.5	3.0	3.5
height of precipitate / cm	2.5	3.0	3.5	4.0	4.0	4.0

The electrical conductivity of each experiment was also measured to monitor the progress of the reaction.

Fig. 8.1 shows how the electrical conductivity of aqueous barium hydroxide changes as dilute sulfuric acid is added in experiment 6.

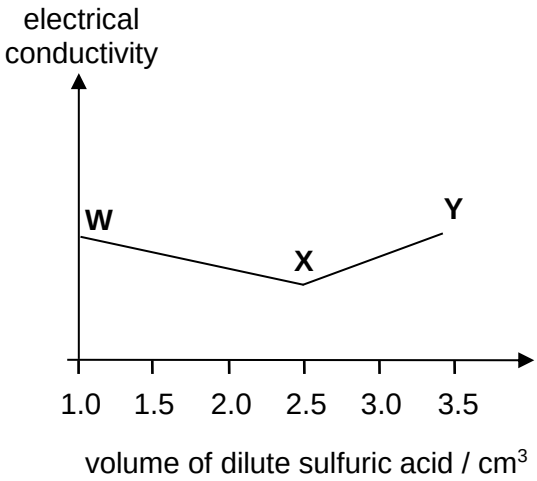


Fig. 8.1

(a) Construct an equation, with state symbols, for this reaction.

…….…….. [2]

(b) Explain why the height of the precipitate does **not** increase after a certain volume of dilute sulfuric acid was added.

……

…… [1]

(c) Use information from Table 8.1 to calculate the concentration of aqueous barium hydroxide used in the experiments.

concentration = …… mol/dm^3 [3]

(d) Describe and explain the changes in electrical conductivity in Fig. 8.1.

……

……

……

……

…… [3]

(e) Suggest another way to monitor the progress of the reaction.

……[1]

(f) Two students discuss about alternative methods of preparation for this insoluble salt.

Student 1: 'I think the same insoluble salt can be formed if barium carbonate was used instead.'

Student 2: 'I think the same insoluble salt can be formed if barium nitrate was used instead.'

Which student is correct?

Explain your reasoning.

……

……

…… [2]

[Total: 12]

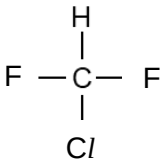
Section B

Answer **one** question from this section.

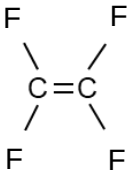
9 Chlorodifluoromethane, CHF_2Cl, is used to make tetrafluoroethene, C_2F_4.

$$2CHF_2Cl \rightarrow C_2F_4 + 2HCl \qquad \Delta H = +32.0 \text{ kJ/mol}$$

Fig. 9.1 shows the structural formulae of chlorodifluoromethane and tetrafluoroethene.



chlorodifluoromethane



tetrafluoroethene

Fig. 9.1

(a) Draw a 'dot-and-cross' diagram to showing the bonding in tetrafluoroethene.

Show the outer shell electrons only.

[2]

(b) Table 9.1 shows some bond energy values.

Table 9.1

bond	C – C*l*	C – H	C – F	C – C	C = C	H – C*l*
bond energy in kJ/mol	339	413	495	348	x	431

Determine the value of x.

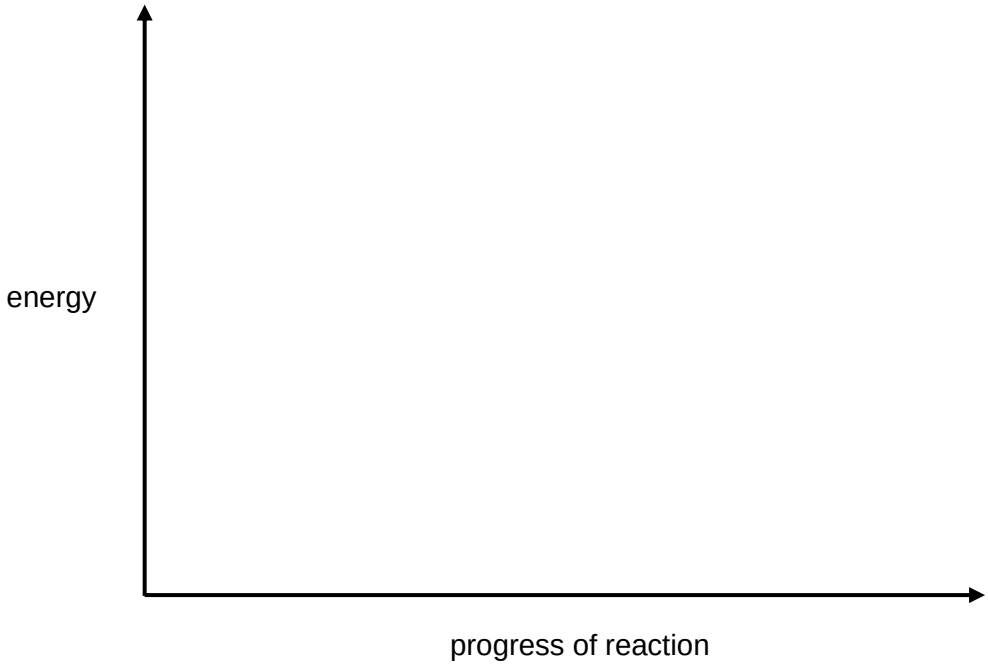
x = ……..... kJ/mol [3]

[Turn over

(c) Draw an energy profile diagram for this reaction.

Your diagram should show:

- the reactants and products of the reaction,
- the energy profile and activation energy,
- the enthalpy change of reaction.



[3]

(d) Both chlorodifluoromethane and tetrafluoroethene are colourless gases at room temperature and pressure.

Describe a test that can be used to differentiate chlorodifluoromethane and tetrafluoroethene.

test ……..…….....

…….....

observation ……..…….....

……..…….....

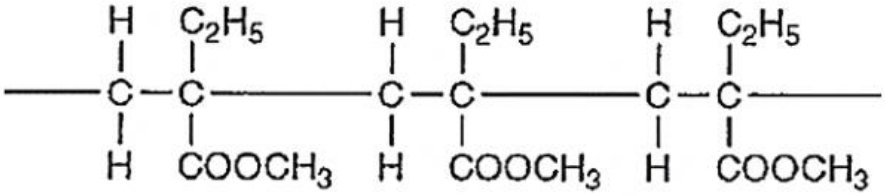
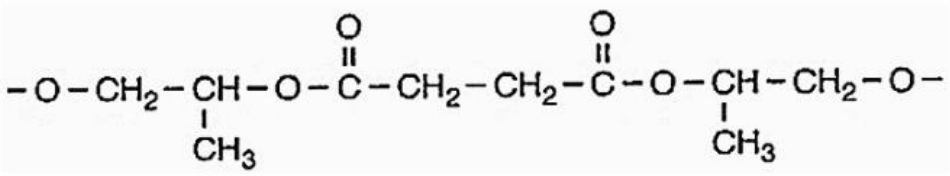
……..…….....

[2]

[Total: 10]

10 Table 10.1 shows the structure of two polymers, **X** and **Y**. Polymer **X** is an addition polymer and polymer **Y** is a condensation polymer.

Table 10.1

polymer	structure
X	
Y	

(a) Describe **two** differences between addition polymers and condensation polymers.

1 ……..……..…….....

……..…….....

……..…….....

2 ……..……..……..…….....

……..…….....

……..…….....

[2]

(b) **(i)** Draw the structure of the monomer of polymer **X**.

[1]

[Turn over

(ii) During the manufacturing process, the chain length of polymer **X** needs to be controlled so that the polymer molecules have an average relative molecular mass in the range of 20 000 to 50 000.

What is the range of the average number of repeat units in the polymer molecules?

Show your working.

[2]

(c) **(i)** Draw a circle on the structure of polymer **Y** to show the ester linkage. [1]

(ii) Draw the structures of the **two** monomers that react to form polymer **Y**.

[2]

(d) **(i)** Explain why the careless disposal of polymers can result in long-term pollution.

……

…… [1]

(ii) Describe a chemical method used to recycle polymers.

……

…… [1]

[Total: 10]

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							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	3	4	5	6	7	8	9	10	11	12	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 –

Key

proton (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.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.

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