Name	Class		Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2024

CHEMISTRY **6092/02**

Paper 2

August 2024

Candidates answer on Question Paper
No Additional Materials are required.

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams or graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A [70 marks]
Answer **all** questions in the spaces provided.

Section B [10 marks]
Answer **one** question from this section.

Write your answers in the spaces provided on the question paper.

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 **23**.

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

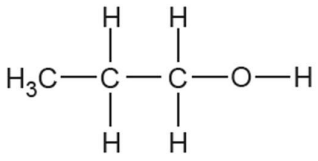
FOR EXAMINER'S USE	
Section A	/ 70
Section B	/ 10
Total	**/ 80**

Section A

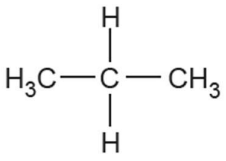
Answer **all** questions.

1 Choose from the following compounds to answer the questions.

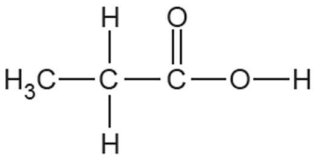
For Examiner's Use



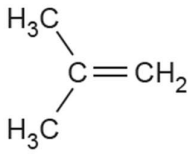
A



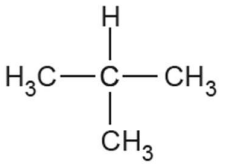
B



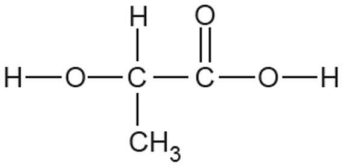
C



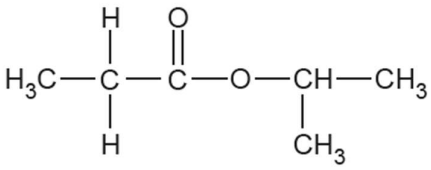
D



E



F



G

Each compound may be used once, more than once or **not** at all.

(a) State which compound:

(i) reacts with hydrogen gas at 150 °C, in the presence of nickel catalyst

…… [1]

(ii) can be oxidised to form propanoic acid

…… [1]

(iii) is an isomer of butane

…… [1]

(iv) is an unsaturated hydrocarbon.

…… [1]

(b) Identify the two compounds that will turn moist blue litmus red.

…… and …… [1]

[Total: 5]

For Examiner's Use

2 **(a)** The table shows information on five different particles.

particle	number of protons	number of electrons	number of neutrons
P	19	19	20
Q	19	19	19
R	9	10	10
S	9	9	9
T	8	10	10

(i) Explain why particle T is an ion.

……..……... [1]

(ii) Identify the two particles that are isotopes.

…… and …… [1]

(b) A sample of Krypton was found during a space mission.

Experiments were conducted on the sample and the following information was obtained.

relative isotopic mass	percentage abundance
80	2
82	12
83	12
84	57
85	17

Calculate the relative atomic mass of the sample of Krypton and give your answer to three significant figures.

relative atomic mass = …… [1]

[Total: 3]

[Turn Over

3 The table below shows the physical properties of four substances.

substance	melting point / °C	boililng point / °C	electrical conductivity
phosphorus trichloride	-94	76	poor
diamond	3550	4830	poor
calcium oxide	2570	2850	poor in solid state, good in aqueous state
sodium oxide	1130	1950	

(a) Which substance(s) exist(s) as a solid at 2000 °C?

……[1]

(b) Describe the arrangement and motion of phosphorus trichloride molecules at 0 °C.

……

……

……[2]

(c) Explain why calcium oxide has a higher melting point as compared to sodium oxide.

……

……

……

……[2]

(d) With reference to structure and bonding, explain why diamond is a poor conductor of electricity.

……

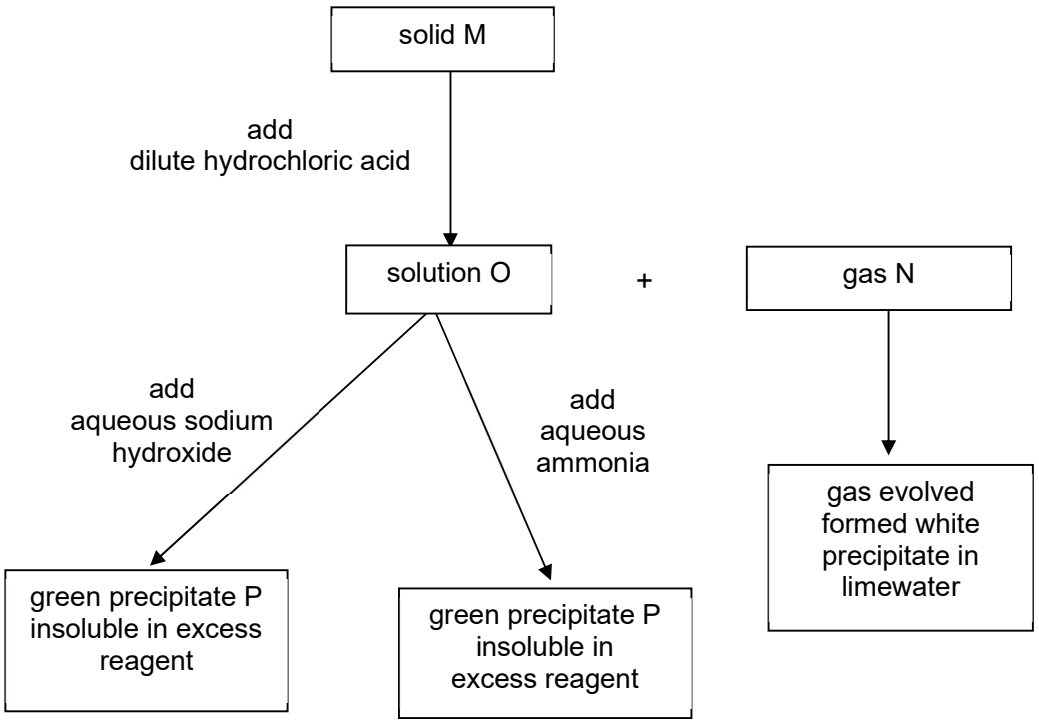
……

……[2]

[Total: 7]

For Examiner's Use

4 The diagram describes some of the substances that result from the chemical reactions with solid M.



(a) Name the following compounds.

M: .....

N: .....

O: .....

P: ..... [4]

(b) Write the balanced ionic equation for the reaction between solid M and dilute hydrochloric acid.

[2]

……..……...……..…

[Total: 6]

[Turn Over

5 A scientist added 24.00 cm^3 of 0.75 mol/dm^3 dilute nitric acid to 23.5 g of potassium oxide.

For Examiner's Use

$$K_2O + 2HNO_3 \rightarrow 2KNO_3 + H_2O$$

(a) Calculate the number of moles of dilute nitric acid added by the scientist.

number of moles = …… mol [1]

(b) Determine the limiting reactant.

Workings should be clearly shown.

limiting reactant: …….. [3]

(c) Assuming that all of the water produced is evaporated to form water vapour.

Calculate the volume of water vapour produced at room temperature and pressure.

volume = …… cm^3 [2]

[Total: 6]

6 The table below shows the boiling point and melting point of three halogens.

They are chlorine, bromine and iodine.

halogen	melting point / °C	boiling point / °C
	-7	59
	-103	-34
	113	185

(a) Complete the table above by filling in the names of the halogens. [1]

(b) In an experiment involving a solution of colourless potassium bromide, some fluorine gas was bubbled into the solution. After a while, the solution turns reddish-brown.

Explain why did the solution turn reddish-brown.

……

……

…… [2]

(c) A student commented that among the three halogens, chlorine, bromine and iodine, iodine has the most metallic character.

Do you agree with the comment? Explain your answer.

……

……

…… [2]

[Total: 5]

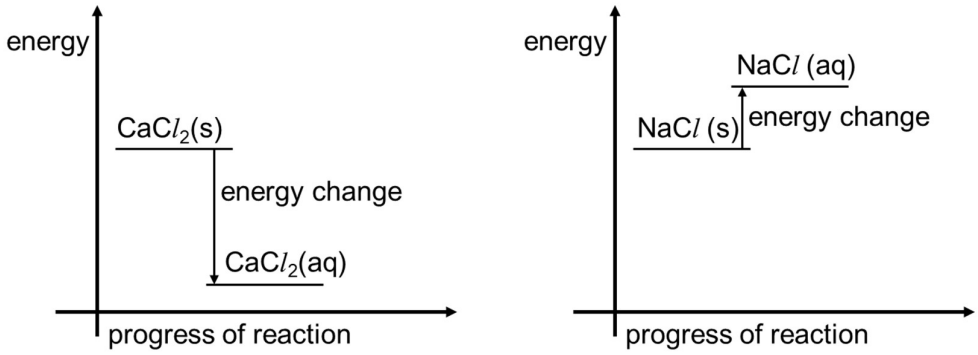
[Turn Over

For Examiner's Use

7 A student conducted some experiements to study the compounds sodium chloride and calcium chloride.

(a) In the first experiment, both compounds were dissolved in water to study the enthalpy change for dissolving.

The diagrams below show the energy changes when sodium chloride and calcium chloride are dissolved in water.



Describe the differences in **energy changes** and **temperature changes** that happen as each compound dissolves.

……

……

……

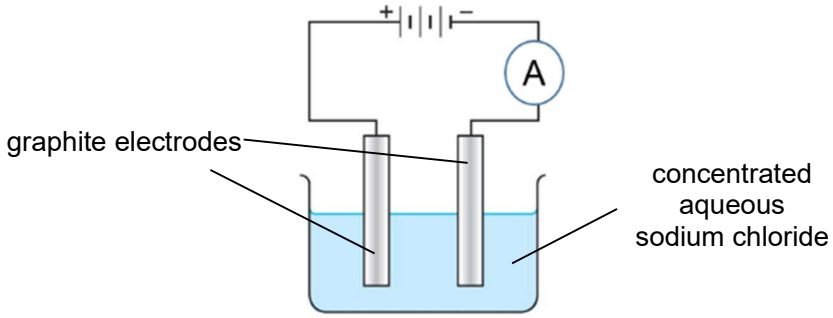
……

……

……

…… [4]

(b) In another experiment, electrolysis was conducted using concentrated aqueous sodium chloride as the electrolyte and graphite electrodes.



(i) Write the ionic equation for the reaction at the cathode and the anode.

At the cathode:

……

At the anode:

…… [2]

(ii) After a long period of time, a few drops of Universal Indicator solution were added into the electrolyte.

State the colour of the solution observed and explain your answer.

……

……

…… [2]

(iii) Give one difference between the products of electrolysis of dilute and concentrated aqueous sodium chloride.

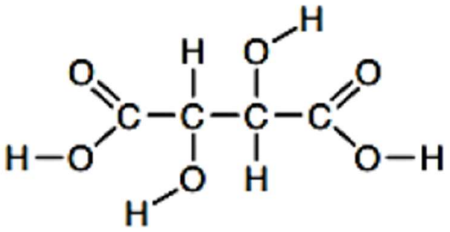
……

…… [1]

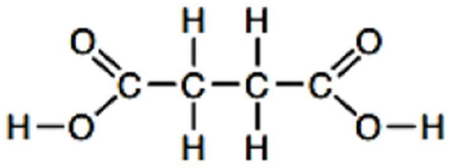
[Total: 9]

[Turn Over

8 A scientist was given two different acids, P and Q.



acid P



acid Q

(a) Describe a chemical test that allows the scientist to differentiate between the two acids. Include the expected observations.

.....

.....

.....

..... [2]

(b) Draw the full structural formulae of the products formed when acid Q reacts with methanol in the presence of concentrated sulfuric acid.

[2]

[Total:4]

For Examiner's Use

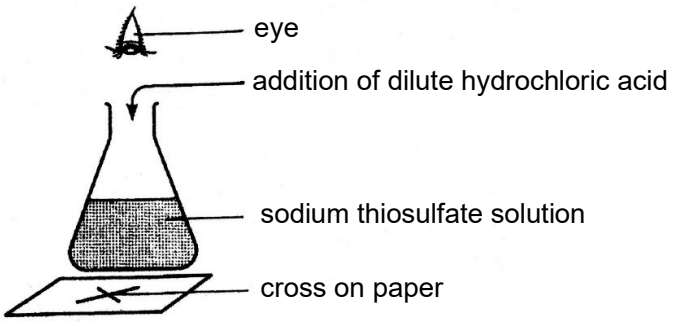
9 Sodium thiosulfate solution is mixed with dilute hydrochloric acid in a conical flask.

For Examiner's Use

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

The conical flask is placed on a piece of paper with a cross.

Experiments were carried out to investigate the rate of reaction by measuring the time taken for the cross on the paper to be covered by the sulfur solid formed.



The table shows the results of the experiments, each repeated using 10 cm^3 of 0.8 mol/dm^3 solution of dilute hydrochloric acid.

experiment	1	2	3	4	5
volume of $Na_2S_2O_3$ / cm^3	50	40	30	20	10
volume of water / cm^3	0	10	20	30	40
time for cross to disappear / s	44	55	74	125	270

(a) Using the information in the table, comment about the relationship between the volume of sodium thiosulfate solution used and the rate of reaction.

……. [1]

(b) With reference to your answer in **(a)**, explain in terms of collision theory, how the volume of sodium thiosulfate used affects the rate of reaction.

……

……

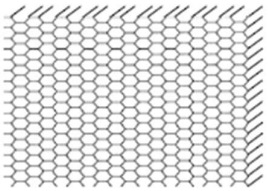
……. [2]

[Turn Over

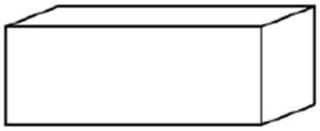
For Examiner's Use

(c) A scientist wants to study the effect of two catalysts on the chemical reaction.

Catalyst 1 has a porous, honey-combed shaped design and catalyst 2 has a non-porous, blocked shaped design. Both catalysts are made of identical material and have the same mass.



catalyst 1



catalyst 2

Which catalyst is most likely to have a larger impact on the rate of reaction. Explain why.

……

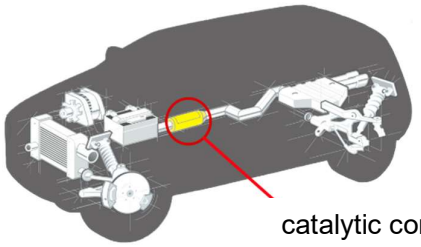
……

…… [2]

[Total: 5]

10 Climate change has become increasingly severe, leading to more frequent weather events.

To reduce the amount of pollutants in the air, countries around the world has made it compulsory for catalytic converters to be installed in vehicles and encouraged the planting of more trees.



catalytic converter

(a) Within a catalytic converter, the following reactions take place.

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(i) Draw a 'dot-and-cross' diagram to show the bonding in carbon dioxide.

Show outer electrons only.

[2]

(ii) Explain why the catalytic converter does not reduce the impact of exhaust gases on extreme weather events?

……

…… [1]

(iii) Explain why the catalytic converter reduces the amount of pollutants released in the air.

……

…… [1]

For Examiner's Use

[Turn Over

(b) Much of the internal parts of vehicles are made using plastics. However, plastics have to be recycled to reduce the impact of land pollution.

Describe two methods to recycle plastics.

……

……

……

……

…… [2]

(c) Suggest why planting more trees does **not** solve the problem of global warming caused by the use of vehicles.

……

…… [1]

(d) Bioethanol is an alternative fuel to fossil fuels.

Describe briefly how bioethanol is produced.

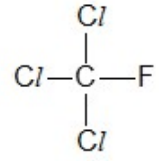
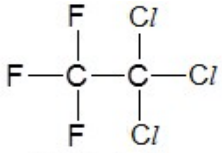
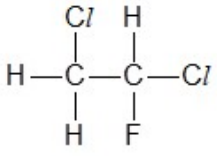
…… [1]

[Total: 8]

For Examiner's Use

11 Chlorofluorocarbons (CFCs) are a group of compounds which can be classfied as ozone depleting compounds.

Other than CFCs, there are also hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and perfluorocarbons (PFCs). Some common examples of CFC and HCFC molecules are shown below with their names.

 CFC-11	 CFC-113a	 HCFC-141

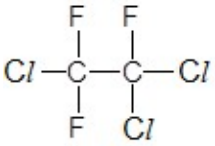
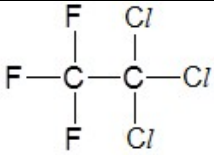
A naming system for these substances was devised several decades ago. The prefixes to the name tell us the elements present in the compound as shown in the table below.

prefix	elements present
PFC	Carbon, Fluorine
CFC	Carbon, Fluorine, Chlorine
HFC	Hydrogen, Carbon, Fluorine
HCFC	Hydrogen, Carbon, Fluorine, Chlorine

The numbers suffixed to the names of the compounds give us the number of each type of atom present in one molecule of the compound. The key to decoding the number is simply to add 90 to the number suffixed to the name.

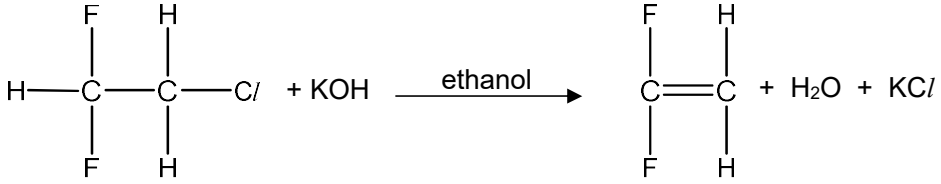
For example, to decode the number of atoms in CFC-113a, we add 113 to 90 to obtain 203. The first number, 2, tells us the number of carbon atoms, the second number, 0, tells us the number of hydrogen atoms, and the third number, 3, tells us the number of fluorine atoms. Chlorine atoms make up the remaining bonds since all these compounds are saturated.

The letter 'a' in CFC-113a tells us about the structural formula of the compound. The arrangement of the type of atoms on the compound that most evenly distributes atomic masses has no letter. The second most even distribution is given the letter 'a', the third most even distribution is given the letter 'b', so on and so forth.

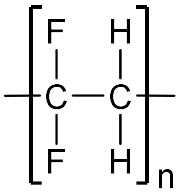
molecule	atomic mass on left carbon	atomic mass on right carbon
 CFC-113	73.5	90
 CFC-113a	57	106.5

[Turn Over

Although most of these substances are harmful to the ozone layer, they can also be used to make polymers by first converting them to alkenes. For example, HCFCs react with potassium hydroxide dissolved in ethanol (solvent) to give an alkene, potassium chloride and water. An example of the reaction is shown below:



The alkene produced from the above reaction can be used to make useful polymers such as the one shown below.



(a) Draw the structure of a PFC molecule with three carbon atoms.

[1]

(b) Draw the full structural formule of two other isomers of HCFC-141 in the correct respective boxes.

HCFC-141a	HCFC-141b

[2]

(c) Explain why compounds such as HCFCs, similarly to CFCs, harm the environment.

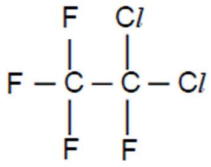
For Examiner's Use

……

…… [1]

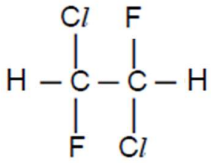
(d) Using the naming system from the passage, deduce the names of the following molecules.

(i)



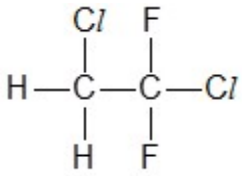
…… [2]

(ii)



…… [1]

(e) Draw two isomers of the following compound within the box below.



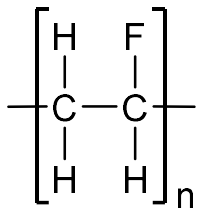
[2]

isomer 1 isomer 2

[Turn Over

(f) A scientist wants to produce the polymer, polyvinyl fluoride using HCFCs.

For Examiner's Use



polyvinyl fluoride

Using a suitable HCFC, write down the equation showing the reaction needed to produce polyvinyl fluoride. Show the full structural formulae of the organic compounds in your equation.

[3]

[Total: 12]

Section B

Answer **one** question from this section.

12 Small pieces of different metals were added to the sulfate solutions containing different metal ions. The results are summarised in the table below.

For Examiner's Use

'√' represents that reaction is observed while 'x' represents that **no** reaction took place.

metal / solution	copper	nickel	iron	scandium	zinc
copper(II)		√	√	√	√
nickel(II)	x		√	√	√
iron(II)	x	x		√	√
scandium(II)	x	x	x		x
zinc	x	x	x	√	

(a) Arrange the given metals in increasing order of reactivity.

……. [1]

(b) **(i)** State the conditions required for rusting to occur.

…….. [1]

(ii) State and explain whether attaching a block of zinc to iron will prevent the iron from rusting.

……..

……..

…….. [2]

(c) Describe the observations when zinc was placed into a test-tube containing copper(II) sulfate solution.

……

……

…… [2]

[Turn Over

(d) In another experiment, zinc was added to a sample of iron(III) nitrate to produce iron.

(i) Write a balanced chemical equation for the chemical reaction. State symbols are **not** required.

[2]

……..

(ii) Describe the observation when a few drops of aqueous iron(III) nitrate was added into potassium iodide solution.

……..

…….. [1]

(e) Scandium is found above carbon in the reactivity series.

Name the method used to extract scandium from its ore.

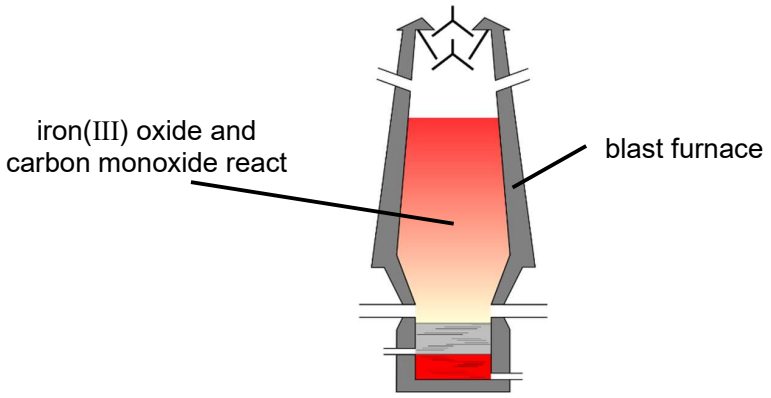
…… [1]

[Total:10]

For Examiner's Use

13 An experiment was conducted to study the properties of iron and its compounds.

To extract iron from its ore, iron(III) oxide and carbon monoxide are made to react within a blast furnace.



The temperatures within a blast furnace can be as high as 2000 °C.

(a) The following chemical equation represents the formation of iron in the blast furnace.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) Complete the table below.

element	oxidation state before decomposition	oxidation state after decomposition
Fe	+3	
C		+4

[2]

(ii) Name the substance that acts as a reducing agent in the reaction. Explain your answer.

……..

……..

……..

[2]

[Turn Over

For Examiner's Use

(b) On a recent space mission on Mars, two large ores of impure barium were found.

Each ores contains different amounts of barium carbonate.

When excess dilute acid is mixed with the powdered ore, a gas is produced. The volume of gas formed is a measure of the amount of barium carbonate in the ore.

(i) Design and describe an experiment that compares the amount of barium carbonate in the two different ores.

You may include a diagram if it helps you answer the question.

……..

……..

……..

……..

……..

……..

…….. [4]

(ii) Other than using powered carbonates, describe one other measure that you had taken in **(i)** to ensure your experiment is fair.

……..

…….. [1]

(iii) In the experiment, an assumption was made about the substances within the barium ores. The assumption made it possible to compare the amount of barium carbonate present in each of the ores.

Deduce the assumption made.

……..

…….. [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		Key proton (atomic) number atomic symbol name relative atomic mass									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 –

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, $L = 6.02 \times 10^{23}\ mol^{-1}$.