Class:	Candidate Name:	Candidate Index Number:

EDGEFIELD SECONDARY SCHOOL
2022 PRELIMINARY EXAMINATION
Secondary 4

O Syllabus

CHEMISTRY

6092/02

Paper 2 Theory

August 2022

Candidates answer on the Question Paper.
No Additional Materials are required.

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, name and class register number in the above boxes.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form *either/or*.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
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 22.

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

FOR EXAMINER'S USE	
Section A	**/ 50**
Section B	**/ 30**
TOTAL	**/ 80**

My target grade/mark: _____

_____
Parent's signature

This document consists of **22** printed pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Choose from the following equations to answer the questions below.

A $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$

B $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

C $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

D $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

E $Fe(s) + 2H^+(aq) \rightarrow Fe^{2+}(aq) + H_2(g)$

F $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

G $2I^-(aq) + Br_2(aq) \rightarrow I_2(aq) + 2Br^-(aq)$

H $NH_4^+(aq) + OH^-(aq) \rightarrow H_2O(l) + NH_3(g)$

I $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$

Each equation can be used once, more than once or not at all.

Give the letter of an equation which

(a) shows the formation of gas that forms a white precipitate with limewater,

…… [1]

(b) shows a reaction that forms a blue precipitate,

…… [1]

(c) shows only oxidation,

…… [1]

(d) shows the neutralisation of hydrochloric acid by sodium hydroxide,

…… [1]

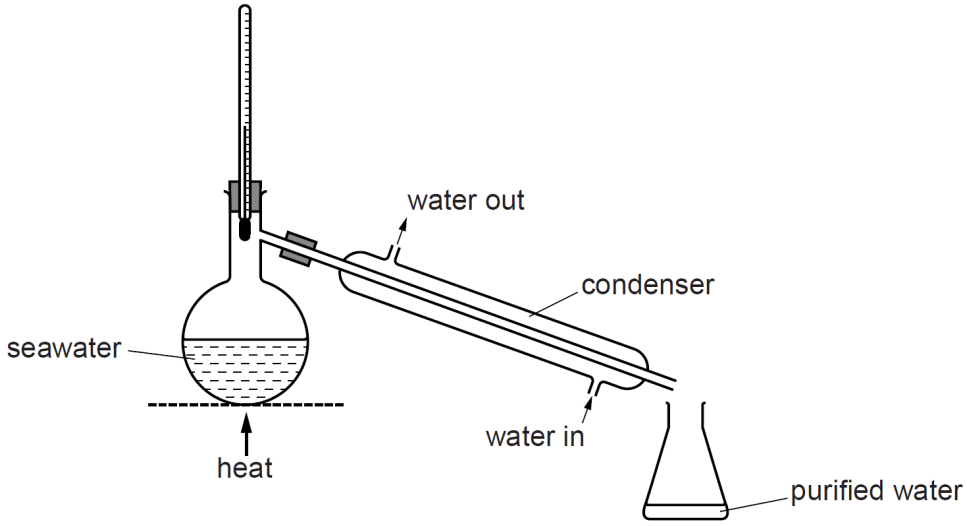
(e) shows the reaction at an inert positive electrode when copper(II) sulfate is electrolysed.

…… [1]

[Total: 5]

A2 Seawater contains a variety of dissolved salts.

(a) The diagram shows a simple distillation apparatus that can be used to produce purified water from seawater.



Explain how distillation purifies seawater.

……...

……...

……...

……...

…… [3]

(b) Magnesium chloride, $MgCl_2$, is present in seawater at a concentration of 1.26 g/dm^3.

(i) Write the formulae for the ions present in magnesium chloride.

…….... [1]

(ii) Calculate the concentration of chloride ions, in mol/dm^3, arising from the magnesium chloride in seawater.

[1]

(iii) Aqueous silver nitrate is added to a small sample of seawater. Describe what you would observe.

……..... [1]

(c) The concentration of sulfate ions in seawater is 1.24 g/dm^3.

Excess aqueous barium chloride is added to a 50.0 cm^3 sample of seawater.

(i) Write the ionic equation for the precipitation reaction

……..... [1]

(ii) Hence, calculate the mass of barium sulfate precipitated.

[3]

[Total: 10]

A3 Silicon is an element in Group IV of the Periodic Table.

(a) Give the electronic configuration for a silicon atom.

…… [1]

(b) Silicon reacts with chlorine on heating to form silicon(IV) chloride, $SiCl_4$.

Construct an equation for this reaction.

…… [1]

(c) Silicon(IV) chloride is a simple molecular compound.

(i) Suggest two physical properties of silicon(IV) chloride other than solubility.

1 ……

2 …… [2]

(ii) Draw a 'dot-and-cross' diagram to show the bonding in silicon(IV) chloride. Show the outer electrons only.

[2]

[Total: 6]

A4 Analysis of compound **Y** shows it has the following composition.

element	percentage by mass
hydrogen	3.4
nitrogen	12.0
oxygen	41.0
vanadium	43.6

(a) Determine the empirical formula of **Y**.

[3]

(b) Suggest one property of aqueous **Y** caused by the presence of vanadium.

…… [1]

(c) Aqueous sodium hydroxide is added to solid **Y** and the mixture is warmed.

A colourless gas that turns moist red litmus blue is evolved.

Deduce the formula of each of the two ions present in **Y**.

……...

…… [2]

(d) An acidified aqueous solution of **Y** reacts with aqueous potassium iodide to form iodine.

State and explain what you can deduce about the redox nature of **Y**.

……...

…… [2]

(e) When solid **Y** is heated, only V_2O_5, water and gas **Z** are formed.

(i) Name gas **Z**.

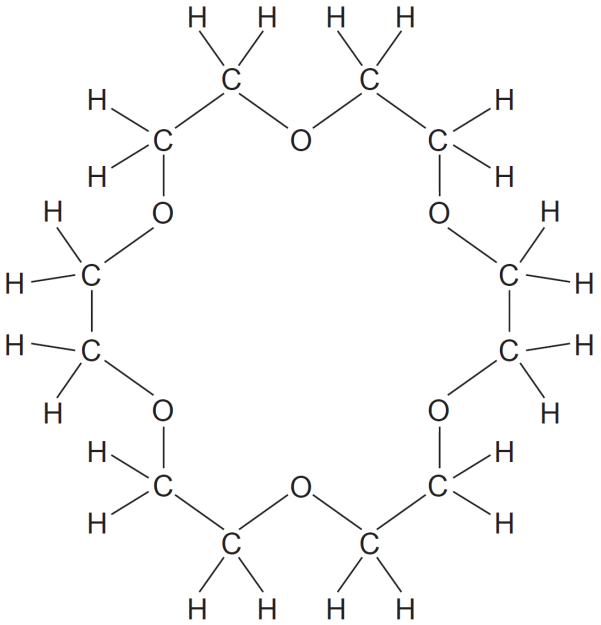
…….... [1]

(ii) Write an equation for the reaction.

…….... [1]

[Total: 10]

A5 Sodium can react with compounds called crown ethers. A typical crown ether is shown below.



(a) Write the empirical formula for this crown ether.

…… [1]

(b) When sodium reacts with crown ethers it forms Na^+ and Na^- ions. Draw the structure of an Na^- ion. Show all the electrons.

[1]

(c) Sodium reacts violently with chlorine gas to form sodium chloride.

Write an equation for the reaction of sodium with chlorine.

…… [1]

(d) The melting point of sodium chloride is 801 °C.
The melting point of chlorine is –101 °C.

Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

……...

……...

……...

……...

……...

……...

…… [4]

(e) Sodium chloride can be broken down into its elements by electrolysis.

Explain why pure sodium chloride can be electrolysed at 1000 °C but not at 600 °C.

……...

……...

…… [2]

[Total: 9]

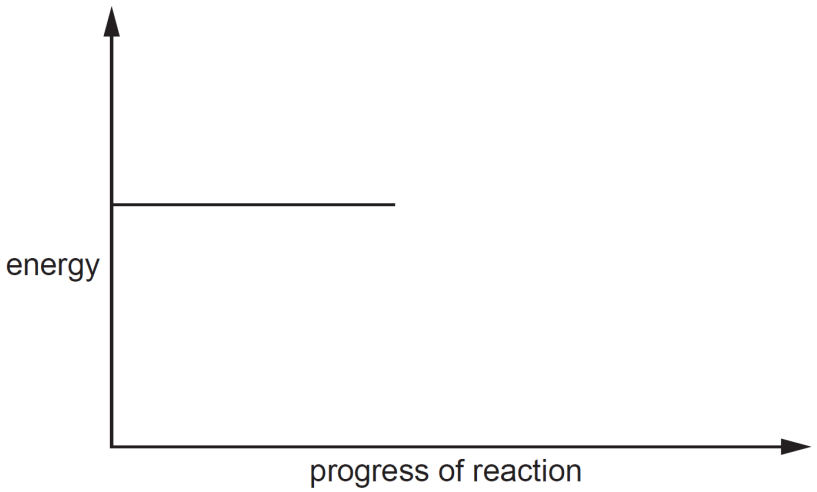
A6 Ethanoic acid is manufactured in the factories by a reaction between methanol, CH_3OH, and carbon monoxide.

$$CH_3OH + CO \rightarrow CH_3COOH \qquad \Delta H = -137 \text{ kJ/mol}$$

(a) Complete the energy profile diagram for the reaction between methanol and carbon monoxide.

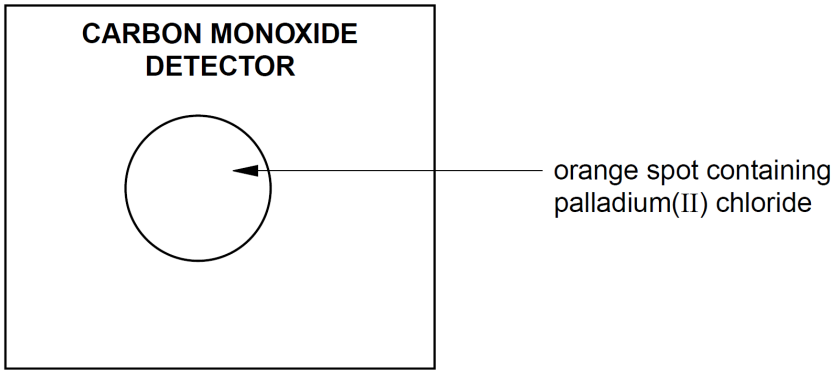
On your diagram label

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



[3]

(b) As a safety measure, carbon monoxide detectors are fitted in the factories.



The orange spot turns black if there is a high concentration of carbon monoxide in the air.

(i) Why is carbon monoxide hazardous?

……..

……..... [1]

(ii) Complete the equation by writing the formula of the missing reactant in the box.

$PdCl_2(s) +$ ☐ $+ CO(g) \rightarrow Pd(s) + 2HCl(g) + CO_2(g)$

Complete the equation by writing the formula of the missing reactant in the box.

[1]

(iii) Complete the table to show the oxidation states of palladium and carbon before and after the reaction takes place.

element	oxidation state before reaction	oxidation state after reaction
palladium		
carbon		

[2]

(iv) Use information from the table to explain why this is a redox reaction.

……..

……..... [2]

(c) Name one industrial process that used carbon monoxide as a reducing agent.

…… [1]

[Total: 10]

Section B (30 marks)

Answer all **three** questions in this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B7 Reactivity of metals

The reactivity of metals may determine by reacting them with either cold water or steam or with both. Table 7.1 shows the reactivity of five metals.

Table 7.1

metal	reactivity
barium	reacts rapidly with cold water
copper	no reaction with steam or cold water
magnesium	reacts very slowly with cold water but reacts with steam
sodium	reacts very rapidly with cold water
nickel	only reacts when powdered and heated strongly in steam

Standard Electrode Potentials

The reactivity of a metal is related to the ease at which the metal is oxidised or loses electrons. The ease at which a substance is oxidised or reduced can be quantified using standard reduction potentials.

The standard reduction potential (E°) of a substance measures how easily a substance is reduced, or how easily a substance gains electrons.

The E° value of a substance is measured relative to a standard hydrogen electrode, in which the following reaction takes place:

$$2H^+(aq) + e^- \rightleftharpoons H_2(g)$$

The reduction reaction of hydrogen ions to hydrogen is assigned an E° value of 0.00 V.

Table 7.2 shows the electrode reactions and E° values of some metals.

The more positive the E° value, the more likely the forward reaction takes place and the more easily the substance is reduced.

Conversely, the more negative the E° value, the more likely the reverse reaction takes place and the more easily the substance is oxidised.

Table 7.2

metal	electrode reaction	E°/ V
chromium	$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$	-0.74
copper	$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
iron	$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	-0.04
magnesium	$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	-2.38
nickel	$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	-0.25
sodium	$Na^{+}(aq) + e^- \rightleftharpoons Na(s)$	-2.71
tin	$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	-0.14
zinc	$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	-0.76

Determining the Products of Electrolysis

When two or more positive ions are present in the solution during electrolysis, the ion that is preferentially discharged at the cathode can be determined using the electrochemical series.

The electrochemical series is also related to the standard electrode potentials for the metal ions.

(a) Deduce the order of reactivity of these metals using the information in Table 7.1.

most reactive

least reactive

……

……

……

……

……

[1]

(b) Deduce the relationship between the E° value and reactivity of metals.

……...

……. [1]

(c) **(i)** Some E° values are shown below.

-2.55 V -0.44 V +0.16 V +0.80 V

What is the most suitable E° value for silver? Explain your reasoning.

……....

……....

……..... [2]

(ii) Write the equation for the electrode reaction for silver.

……..... [1]

(d) Which of the following displacement reactions is likely to occur? Put a tick (✓) if a reaction is likely to occur.

metal	chromium	tin
aqueous solution of nickel(II) ions		
dilute nitric acid		

[2]

(e) **(i)** Describe how the electrochemical series is related to the standard reduction potentials shown in Table 7.2.

……

…… [1]

(ii) Complete the table below for the electrolysis of a molten mixture of iron(III) chloride and tin(II) chloride using graphite electrodes.

electrode	substance that would be produced first	ionic half-equation for the reaction at each electrode
positive		
negative		

[2]

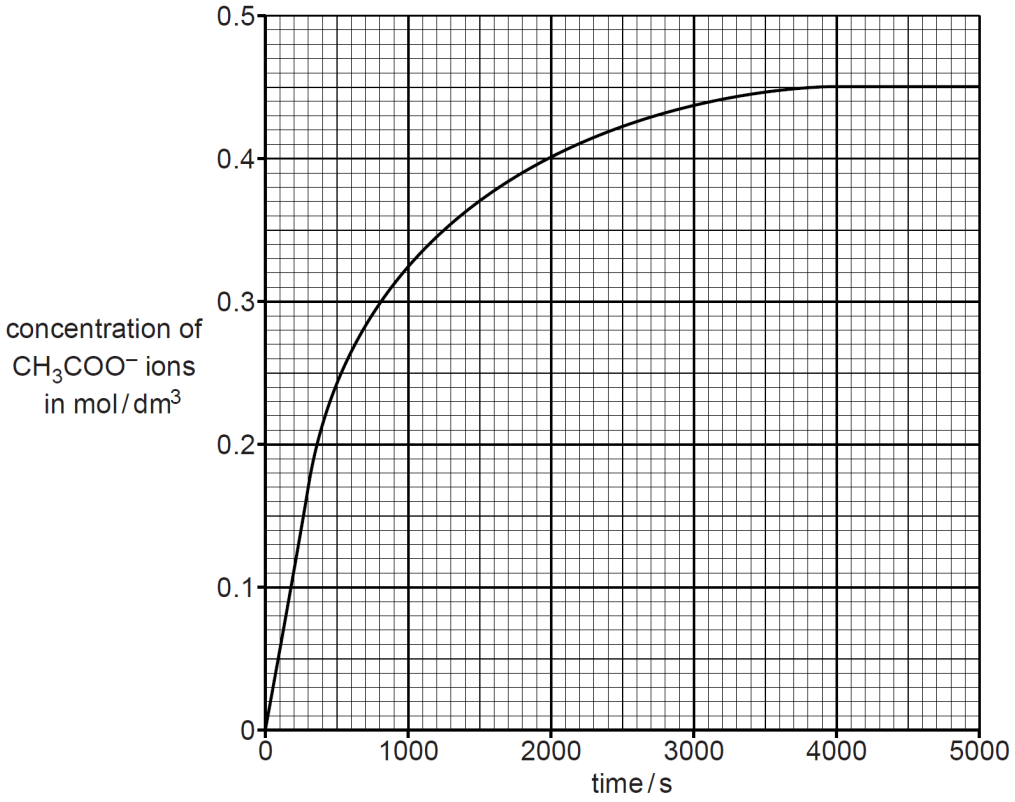
[Total: 10]

B8 The ester, ethyl ethanoate, reacts with hydroxide ions to form ethanoate ions and ethanol.

$$CH_3COOC_2H_5 + OH^- \rightarrow CH_3COO^- + C_2H_5OH$$

ethyl ethanoate — ethanoate ions

(a) The graph shows how the concentration of ethanoate ions, CH_3COO^-, changes as the reaction proceeds.



(i) Use the information in the graph to deduce the mass of ethanoate ions in 200 cm^3 of solution when the reaction is complete.

mass of ethanoate ions ..... g [2]

(ii) Use the information in the graph to calculate the average rate of reaction, in mol/dm^3/s, during the first 300 seconds.

average rate of reaction .....mol/dm^3/s [1]

(iii) Describe the change in the rate of reaction with time. Use information from the graph to support your answer.

……

……

…… [2]

(iv) Explain, using collision theory, the observed change in the rate of reaction with time.

……

……

……

…… [3]

(b) Explain why liquid ethanol does not conduct electricity.

……

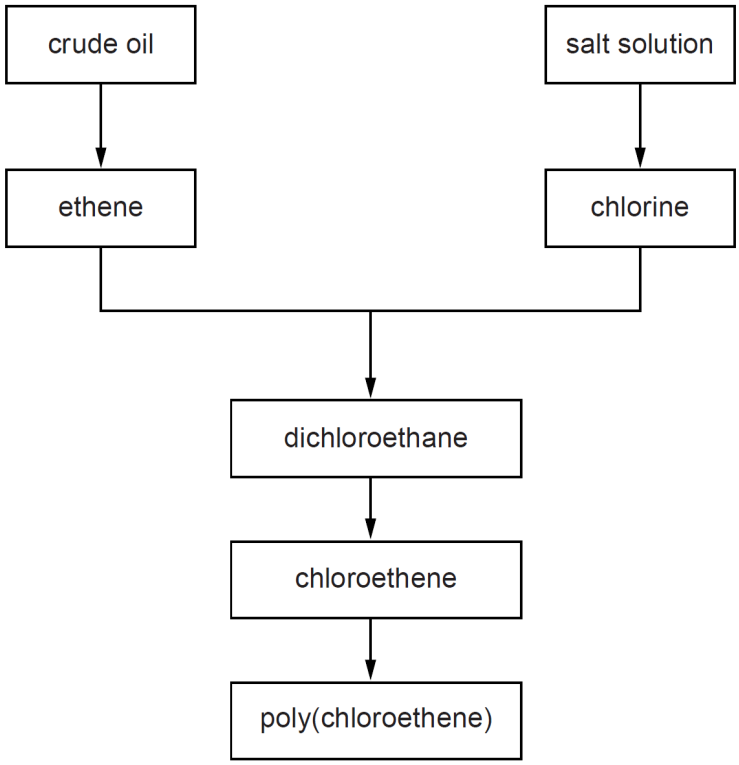
……

…… [2]

[Total: 10]

EITHER

B9 Large quantities of poly(chloroethene) are manufactured annually. The flow chart shows the steps involved in the manufacture of poly(chloroethene).



(a) Name the two processes used to obtain ethene from crude oil.

……...

…… [2]

(b) Chlorine gas is produced from the electrolysis of salt solution (aqueous sodium chloride).

Explain why the salt solution used must be concentrated.

…… [1]

(c) Draw the structure, showing all the atoms and all the bonds, of the dichloroethane.

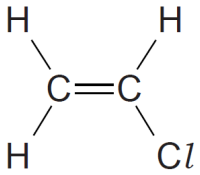
[1]

(d) When dichloroethane, $C_2H_4Cl_2$, is heated strongly, chloroethene, C_2H_3Cl, is formed.

Name the other product of this reaction.

..... [1]

(e) The structure of chloroethene is shown.



Draw the structure of a section of poly(chloroethene). Show three repeat units.

[2]

(f) A factory uses 2250 tonnes of chloroethene to make poly(chloroethene). [1 tonne = 1000 kg]

(i) Deduce the maximum mass of poly(chloroethene) the factory could make.

[1]

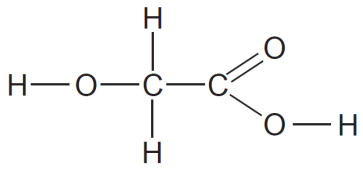
(ii) The actual yield of poly(chloroethene) is 2175 tonnes. Calculate the percentage yield.

[2]

[Total: 10]

OR

B9 The structure of glycollic acid is shown below.



(a) Name the two functional groups present in glycollic acid.

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

(b) Glycollic acid undergoes similar reactions to ethanoic acid.

Complete the equation for the reaction of glycollic acid with sodium carbonate.

..... $HOCH_2CO_2H + Na_2CO_3 \rightarrow$ ..... + ... + ...
[2]

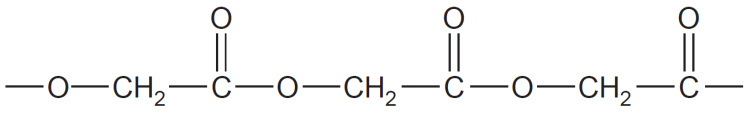
(c) Glycollic acid can be prepared from oxalic acid.

oxalic acid glycollic acid

How does this equation shows that oxalic acid has been reduced?

..... [1]

(d) Glycollic acid polymerises to form poly(glycollic acid). The diagram shows a section of this polymer.



(i) Is poly(glycollic acid) an addition polymer or a condensation polymer? Give a reason for your answer.

.....

..... [1]

(ii) Name another polymer with the same linkage as poly(glycollic acid).

..... [1]

(e) Poly(glycollic acid) is biodegradable whereas poly(ethene) is non-biodegradable.

(i) Suggest one environmental advantage of using biodegradable polymers.

……

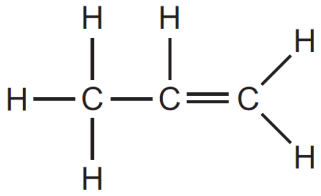
……

…… [1]

(ii) State one use of poly(ethene).

…… [1]

(iii) The structure of propene is shown.



Draw the structure of a section of poly(propene). Show three repeat units.

[2]

[Total: 10]

END OF PAPER

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							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											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 dm^3 at room temperature and pressure (r.t.p.).