YUYING SECONDARY SCHOOL
PRELIMINARY EXAMINATION
Secondary 4 Express

NAME			
CLASS		**REG. NO**	

CHEMISTRY 6092/2

Paper 2

25 August 2022

1 hour 45 minutes

Candidates answer on the Question Paper.
Additional Materials: Nil

Setter: Mr Danny Louis

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer **all** the questions in this section in the spaces provided.
The last question is in the form either/or and only **one** of the alternatives should be attempted.
Write your answers in the spaces provided on the Question Paper.

The use of an approved calculator is expected, where appropriate.
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 19.

For Examiner's Use	
Total	**80**

Section A

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

A1 A list of gases is given below.

A	CO
B	NO
C	CH_4
D	SO_2
E	NH_3
F	CO_2

Use the letters **A**, **B**, **C**, **D**, **E** and **F** to answer the following questions. Each letter may be used once, more than once or not at all. [5]

(a) Which gas can be formed by lightning activity in the atmosphere? _____

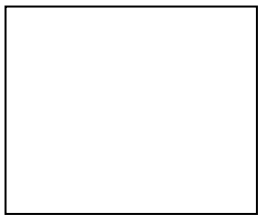
(b) Which is the lightest gas? _____

(c) Which gas is formed by the decay of organic matter? _____

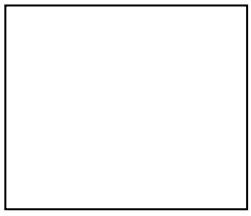
(d) Which gas is used to reduce iron(III) oxide in the blast furnace? _____

(e) Which gas turns damp red litmus paper blue? _____

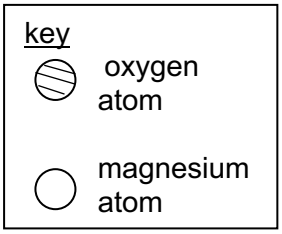
A2 A block of magnesium is burnt in oxygen to form magnesium oxide. Complete the diagrams below to show the arrangement of particles before and after the reaction. [2]



magnesium

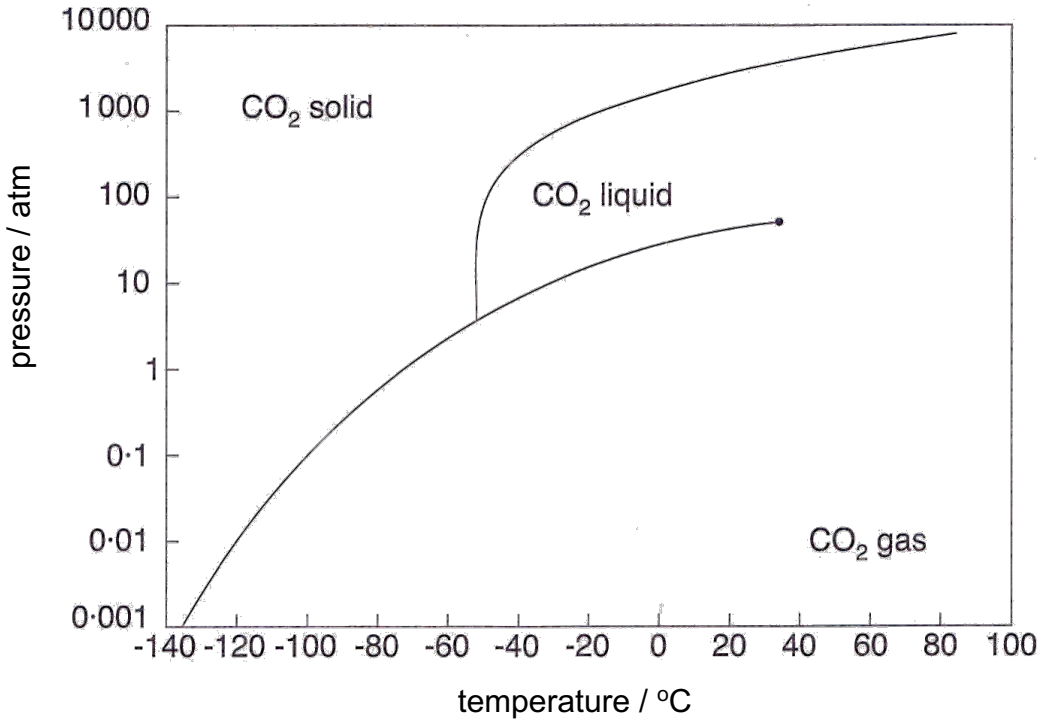


magnesium oxide



A3 The triple point of a pure substance is the temperature at which the substance can exist as a solid, liquid and gas at the same time.

The figure below shows the triple point of carbon dioxide.



(a) Mark the triple point of carbon dioxide on the figure with an 'X'. [1]

(b) A student is given carbon dioxide gas at room conditions (25 °C and 1 atm). Suggest how liquid carbon dioxide can be obtained by changing **one** of the conditions. [1]

_____

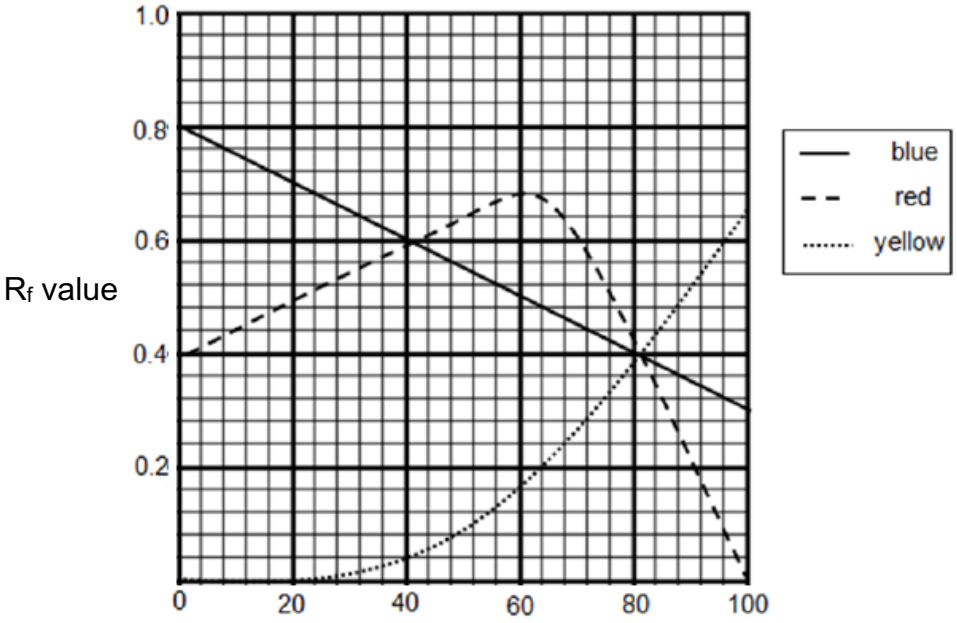
(c) Draw a 'dot-and-cross' diagram to show the electrons in a molecule of carbon dioxide. Show only the valence electrons in your diagram. [2]

(d) What type of oxide is carbon dioxide? State one property you would expect this oxide to have. [2]

_____

_____

A4 A sample of ink contains a mixture of red, blue and yellow dyes. To separate the dyes in the ink, the solvent used is a mixture of water and ethanol. The R_f values of the coloured dyes in solvents with different percentage of ethanol by volume in water are shown in the graph below.



Use the information above to answer the following questions.

(a) Explain why a pure solvent of either water or ethanol **cannot** be used to identify the dyes in the ink. [2]

_____

_____

_____

_____

(b) A mixture of water and ethanol was used to separate a sample of this ink. Only one spot was formed on the chromatogram.
Explain why it **cannot** be concluded that the ink sample is a pure substance. [1]

_____

_____

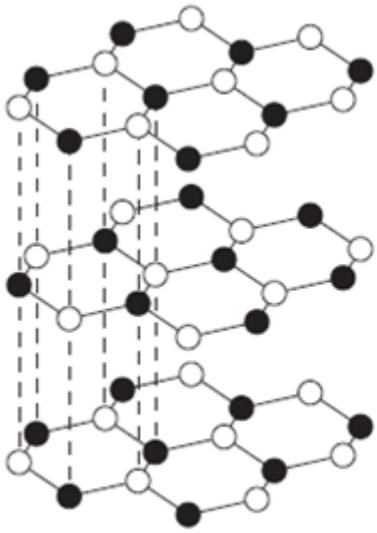
(c) What is the R_f value of the blue, red and yellow dye when a solvent mixture containing 90 cm^3 ethanol and 60 cm^3 water is used in the chromatography? [2]

blue: _____ red: _____ yellow: _____

A5 Boron is in Group III of the Periodic Table and exhibits the properties of a non-metal. It reacts with nitrogen to form boron nitride. One form of boron nitride is

the hexagonal form which has a structure similar to graphite as shown in the figure below.

Unlike graphite, hexagonal boron nitride does not conduct electricity.



(a) Explain w nal ectricity. [2]

_____ _____

_____ _____

_____ _____

_____ _____

(b) Hexagona aking of lipsticks. Explain, in terms of the stru l boron nitride, why it is suitable as the material for making lipsticks. [2]

_____

_____

_____

_____

(c) How would you expect the melting point of hexagonal boron nitride to be like? [1]

_____

A6 Copper can react with either chlorine or bromine to form copper(II) halide.

$$Cu + Cl_2 \rightarrow CuCl_2$$

$$Cu + Br_2 \rightarrow CuBr_2$$

(a) Which statement(s) about the formation of copper(II) halide is/are true and which is/are false? [3]

Put a tick (✓) in one box in each row.

	true	**false**
The formation of copper(II) chloride is faster than that of copper(II) bromide.		
The number of electron shells of the halide increase by one after copper(II) halide is formed.		
The reactions are redox in nature.		

(b) Describe how a **pure and dry** sample of copper can be separated from a solid mixture containing copper(II) halide and copper. [2]

_____

_____

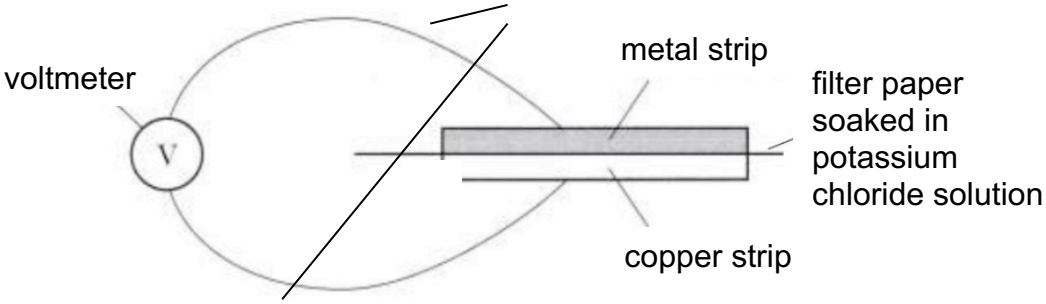
_____

_____

(c) 96 g of copper metal reacted with an excess of chlorine gas. What is the mass of copper(II) chloride formed? [2]

A7 The set-up below is used to determine the order of reactivity of five metals; copper, **P**, **Q**, **R** and **S**.

wire



The results are summarised in the table below.

metal strip	direction of electron flow	voltage / V
P	from **P** to copper	0.52
Q	from copper to **Q**	0.33
R	from **R** to copper	1.51
S	from **S** to copper	1.25

(a) Arrange the five metals in order of increasing reactivity. [1]

_____

(b) Given that metal **S** is from Group II, give two observations that will be seen when a piece of metal **S** is dipped in a solution of copper(II) sulfate. [2]

1. _____

2. _____

(c) When a zinc strip is used with the copper strip, the voltage is 1.10 V. Using this information, suggest with reasons, how metal **P** is extracted from its oxide. [2]

_____

_____

_____

(d) The metal wires in the circuit are able to conduct electricity. With reference to the structure and bonding in metal, explain why metals are good conductors of electricity. [1]

_____

_____

A8 You are provided with bench reagents, Bunsen burner, test tubes and teat pipettes.

Using these chemicals and apparatus only, describe how you would distinguish between each of the following pairs of substances in the table below.

Include in your answers the expected observations for each substance in the given pair.

	substances	chemical test	expected observations	
(a)	aqueous sodium chloride and aqueous sodium sulfate			[2]
(b)	solid sodium carbonate and solid zinc carbonate			[3]

A9 Hydrocarbons such as alkanes and alkenes can undergo many different types of reactions.

(a) (i) What is the meaning of hydrocarbons? [1]

_____

_____

(ii) Write down the general formula of alkanes. _____ [1]

(b) Alkanes can undergo cracking. During cracking, a mixture of compounds are produced. Under different temperature and pressure, various types of products can be produced.

An alkane, $C_{20}H_{42}$ undergoes cracking in the laboratory producing a gas and two alkenes, $C_{12}H_{24}$ and **X**.

(i) Write the chemical formula of **X**. _____ [1]

(ii) Write the balanced chemical equation to show the cracking of $C_{20}H_{42}$. [1]

_____

(iii) What are the reaction conditions needed for cracking? [1]

_____

(iv) Explain why cracking is an important industrial process. [1]

_____

(c) Propene, C_3H_6 is part of the alkene homologous series.
it can react with aqueous bromine to form a colourless product.

(i) Give any one property of a homologous series. [1]

_____

_____

(ii) Name and draw the structural formula of the colourless product below. [2]

Section B

Answer **all** the questions in this section in the spaces provided.

The last question is in the form either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

B10 Read the information about the elements in Group II of the Periodic Table.

element	number of electron shells in atom	atomic radius/ pm	ionic radius/ pm	effect of adding metal to water
magnesium	3	150	66	reacts very slowly
calcium	4	180	99	reacts quickly with water
strontium	5	200	134	reacts vigorously with water

(1 000 000 000 000 pm = 1 meter)

Thermal stability of Group II elements and its polarising power

Polarisation is the distortion of the electron cloud of an anion by a positively charged particle. The ability of a cation to polarise an anion is called its polarising power. An approximate measure of the polarising power of a cation is its charge density.

Charge density is proportional to $\frac{charge\ of\ cation}{ionic\ radius}$.

Group II hydroxides decompose on heating to form metal oxides and steam. The temperature at which the metal hydroxides decompose are shown in the table below.

metal hydroxide	decomposition temperature/ ^{o}C
$Mg(OH)_2$	332
$Ca(OH)_2$	520 – 580
$Sr(OH)_2$	500 – 850

(a) (i) What is the relationship between atomic radius and the reactivity of the metals in Group II? [1]

_____

_____

(ii) Explain the relationship in **(a)(i)**. [2]

_____

_____

_____

_____

(b) Suggest why the radius of magnesium atom changes when it forms a magnesium ion. [1]

_____

_____

(c) (i) Determine which ion, Mg^{2+}, Ca^{2+} or Sr^{2+}, has the highest polarising power. [1]

_____

(ii) A student proposes that the temperature at which Group II metal hydroxides decompose is directly proportional to the polarising power. Use the information given in the question and your answer in (c)(i) to determine if the statement proposed is true or false. [3]

_____

_____

_____

_____

_____

_____

(d) Strontium chloride is useful in reducing tooth sensitivity by forming a barrier over the teeth. A way to produce strontium chloride in the lab is to react strontium hydroxide with an acid.

(i) Name the acid that is added to react with strontium hydroxide. [1]

_____

(ii) Write the balanced chemical equation for the reaction. [1]

_____

B11 (a) The table below provides some information about four types of fuel; petrol, diesel, coal and hydrogen, that are currently used in the world today. A fuel

is a substance that is used to provide heat or power, usually by combustion. Combustion is a high-temperature exothermic chemical reaction between a fuel and atmospheric oxygen.

Unlike petrol, diesel and coal, hydrogen is used in fuel cells to generate power using a chemical reaction rather than combustion. The hydrogen-fuel cell is a device that converts the chemical energy from the chemical reaction of oxygen and hydrogen into electricity.

name of fuel	**cost in cents / 100 g**	**energy in kJ / 100 g**	**energy in kJ per cent**	**product(s) formed during energy production**		
				carbon dioxide	**sulfur dioxide**	**water vapour**
petrol	6.0	4800	800	√		√
diesel	4.0	2000	500	√		√
coal	3.5	1050	300	√	√	√
hydrogen	18.0	14400	800			√

A student was tasked to use the information above to compare these four types of fuel and rank them from the best to worst. He ranked them as follows:

best fuel → worst fuel

hydrogen → petrol → diesel → coal

With reference to the information in the table above,

(i) Suggest a reason why the student placed coal as the worst fuel. [1]

_____

_____

(ii) Suggest a reason why the student placed hydrogen-fuel cell as the best fuel. [1]

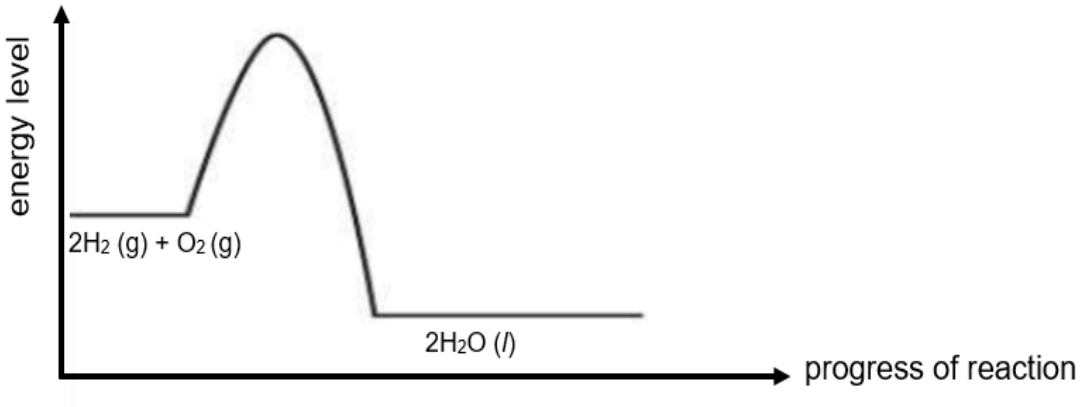
_____

_____

(b) In the future, hydrogen-fuel cell may be used to power cars. In a hydrogen-fuel cell, the overall reaction is represented by the chemical equation as shown.

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(l)$$

The figure below shows the energy profile diagram for the overall reaction in a hydrogen-fuel cell.



(i) With reference to the figure above, is the reaction exothermic or endothermic? Explain your answer in terms of the energies involved in bond breaking and bond making. [2]

_____

_____

_____

_____

_____

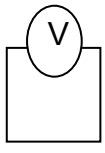
_____

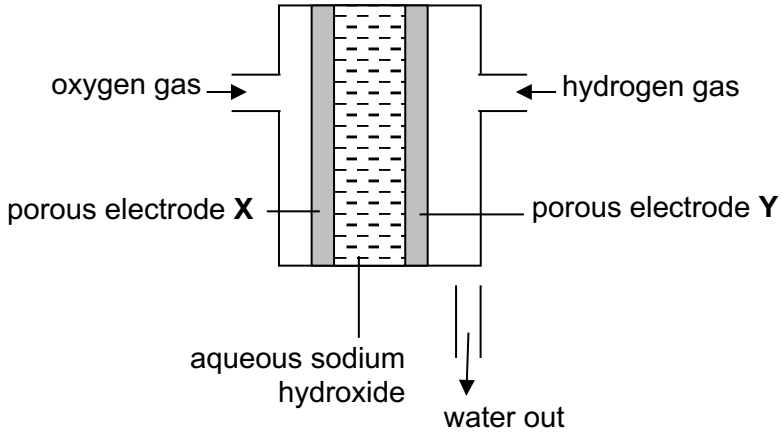
_____

_____

(ii) A catalyst is added to the hydrogen-fuel cell. Draw and label clearly a second curve, on the figure above, to show the energy profile for the catalysed reaction. [1]

(c) An example of a fuel cell is shown below. It is used to produce electricity from the controlled reaction between hydrogen and oxygen, in the presence of aqueous sodium hydroxide.





The reaction taking place at electrode **X** can be represented by the equation below.

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

(i) Draw arrows on the diagram to indicate the direction of electron flow in the external circuit. [1]

(ii) Write the equation for the reaction occurring at electrode **Y**. [1]

_____

(iii) Describe the function of aqueous sodium hydroxide in the fuel cell. [1]

_____

_____

(iv) State with a reason, whether oxidation or reduction has occurred at electrode **X**. [2]

_____

_____

_____

_____

EITHER

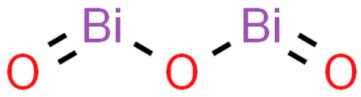
B12 Bismuth is a silvery-white metal added into other metals to lower their melting points.

Bismuth oxide is prepared by first reacting bismuth with hot dilute nitric acid to form bismuth nitrate, followed by the addition of excess aqueous sodium hydroxide to form bismuth hydroxide.

Roasting bismuth hydroxide in air will produce bismuth oxide. Bismuth oxide is a yellow solid which has been used in fireworks. Some properties of bismuth oxide at room conditions are given below.

properties	
electrical conductivity	poor
solubility in water	insoluble
solubility in dilute citric acid	soluble
solubility in aqueous potassium hydroxide	soluble

A book gave the structural formula of bismuth oxide shown below.



(a) (i) What is the empirical formula of bismuth oxide? [1]

_____

(ii) Describe how you would prepare pure and dry crystals of bismuth nitrate from bismuth. [3]

_____

_____

_____

_____

_____

_____

_____

_____

(iii) Write down the balanced chemical equation for the reaction of bismuth nitrate and aqueous sodium hydroxide. [2]

_____

(iv) Explain why excess aqueous sodium hydroxide is used in the preparation of bismuth hydroxide. [1]

_____

_____

(v) Why does roasting bismuth hydroxide in air produce bismuth oxide? [1]

_____

_____

(b) (i) How does the structure of bismuth oxide explain that it has poor electrical conductivity? [1]

_____

_____

(ii) What type of oxide is bismuth oxide? [1]
Explain your answer using information from the table.

_____

_____

OR

B13 Poly(propene) and nylon are both used to make waterproof ropes.
Poly(propene) is an addition polymer and nylon is a condensation polymer.

(a) (i) Give another example of addition polymer and condensation polymer. [2]

_____

_____

(ii) State two differences between addition polymers and condensation polymers. [2]

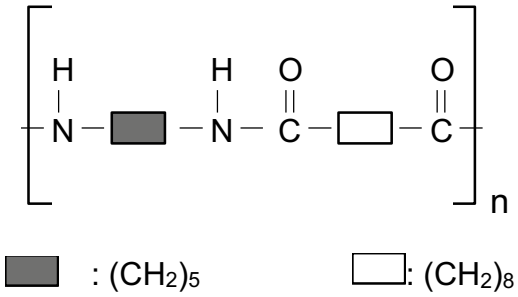
1. _____

_____

2. _____

_____

(b) There are many commercial types of nylon. The figure below shows a repeating unit of nylon-5,8.



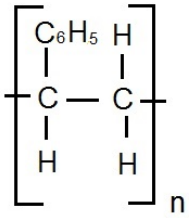
: $(CH_2)_5$: $(CH_2)_8$

(i) Draw the structural formulae of the two monomers that react to form nylon-5,8. [2]

(ii) During the production process, the length of the chain of nylon polymer can be controlled with the processing temperature and time. Depending on the type of nylon produced, a nylon polymer can have 12 000 to 20 000 repeating units. [2]

What is the relative molecular mass of nylon-5,8 with 20 000 repeating units?

(c) Similarly, there are also many types of addition polymers such as polystyrene, shown below.



(i) Draw the structural formula of the monomer that is used to produce polystyrene. [1]

(ii) Suggest a use of polystyrene in our daily life. [1]

_____

_____

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											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 –		

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.).