CHUNG CHENG HIGH SCHOOL (YISHUN)

O

2025 Preliminary Examination
Secondary Four Express

CANDIDATE NAME

CLASS | INDEX NUMBER

CHEMISTRY

6092/02

Paper 2

19 August 2025

Candidates answer on the Question Paper.
Additional Materials: NIL

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue, correction fluid or correction tape.

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 **22**.

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

For Examiner's Use	
Section A	
Section B	
Total	

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Section A

Answer **all** questions.

1 Fig. 1.1 shows part of the Periodic Table.

Li													C	N	O
												Al			
	Ca						Fe			Cu	Zn				

Fig. 1.1

Select elements from Fig. 1.1 to answer the following questions. You may use each element once, more than once or not at all.

Write down the symbol for an element which

(a) forms a stable ion by losing three electrons,

……[1]

(b) exists as diatomic molecules,

……[1]

(c) forms an ion which gives a red-brown precipitate on additon of aqueous ammonia,

……[1]

(d) has chemical properties similar to those of magnesium,

……[1]

(e) has a giant covalent structure,

……[1]

(f) reacts with sodium to form an ionic compound with Mr less than 70.

……[1]

[Total: 6]

2 Fig. 2.1 shows the label on a bottled mineral water.

ions present	mol/dm^3
Ca^{2+}	20
K^+	30
Na^+	145
H^+	185
OH^-	225
HCO_3^-	289
SO_4^{2-}	410

dry residue at 180^{o}C	210 mol/dm^3

Fig. 2.1

(a) Suggest whether the bottled mineral water is acidic, alkaline or neutral.

Explain your reasoning.

……..

……..[2]

(b) State the name and formulae of two salts that could be present in the bottled mineral water.

	name of salt	formula of salt
salt 1		
salt 2		

[2]

(c) Describe how the dry residue is obtained from the bottled mineral water.

……..……..….[1]

[Total: 5]

3 Fig. 3.1 shows a strip of moist Universal Indicator paper pasted in a hollow cylindrical tube.

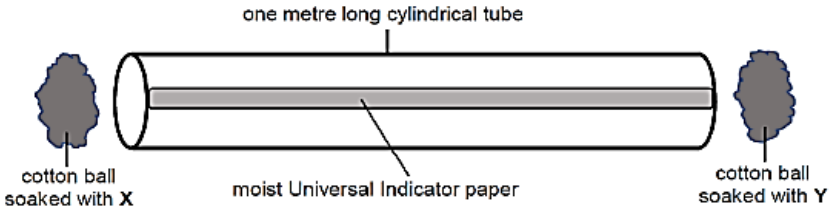


Fig. 3.1

One cotton ball is soaked with concentrated hydrochloric acid which will produce hydrogen chloride gas. The other cotton ball is soaked with concentrated aqueous ammonia which will produce ammonia gas.

Both cotton balls are inserted at both ends of the cylindrical tube simultaneously.

When no more changes are observed on the Universal Indicator paper, the cotton balls are removed, and the Universal Indicator paper is taken out.

The results are shown in Fig. 3.2.

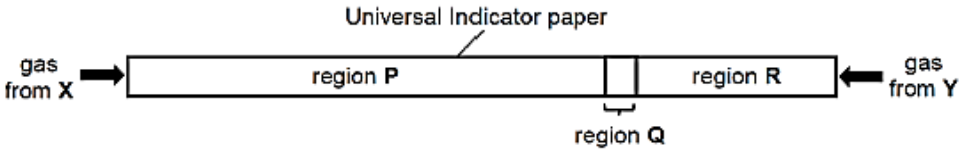


Fig. 3.2

Region **P** is uniformly of one colour and region **R** of another colour.

(a) Suggest identity of **X** and **Y**.

Explain your answer.

……..

……..

……..…

……..…[3]

(b) State the colours of region **P** and region **R**.

Region **P**: ……. Region **R**: …….. [2]

(c) Region **Q** remains green throughout the experiment. Explain why.

……..…

……..…[1]

[Total: 6]

4 Table 4.1 shows information about the atomic radii and ionic radii of some Group 1 and Group 17 elements.

Table 4.1

element	atomic radius/pm	ionic radius/pm
lithium	152	68
sodium	185	98
chlorine	99	181
bromine	115	196

(a) Describe, in terms of electron loss and gain, how and why a lithium atom reacts with a chlorine atom.

……

……

……

……[2]

(b) Describe and explain, in terms of electron shells, the change in radius when a lithium atom forms a lithium ion.

……

……

……

……[2]

(c) What would you observe when aqueous bromine is added to lithium chloride solution?

Explain your answer.

……

……

……

……[2]

[Total: 6]

5 Climate change is 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.

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

……...

……..[1]

(ii) Explain why the catalytic converter does **not** solve all the environmental problems caused by the pollutant gases in the exhaust emissions from cars.

……...

……..[1]

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

……

……

……[2]

(c) Ethanol can also be used as a car fuel. In some countries, it is produced from the sugars in the sugar cane.

An environmentalist claims that ethanol as a fuel is 'carbon neutral' because using it does **not** add to the amount of carbon dioxide in the atmosphere.

Explain why this is true.

……

……

……

……

……

……[3]

[Total: 7]

6 Three experiments are conducted using iron, manganese and chromium and the observations from each experiment are recorded.

Experiment 1: The metals are added separately into flasks of dilute sulfuric acid.
Experiment 2: The metals are heated strongly in air.
Experiment 3: Strips of the metals are added into flasks of metal salt solutions.

The results for Experiments 1 and 2 are shown in Table 6.1.

Table 6.1

metal	experiment 1	experiment 2
iron	metal dissolves slowly with effervescence, a pale green iron(II) sulfate solution is formed	burns in air to form a dark brown iron(III) oxide solid
manganese	metal dissolves very quickly with effervescence, a pale pink manganese(II) sulfate solution is formed	burns in air with an intense white light forming a red solid mixture of manganese(II) oxide and manganese(III) oxide
chromium	metal dissolves readily with effervescence, a violet chromium(II) sulfate solution is formed	burns in air to form green chromium(III) oxide

(a) Using information from Table 6.1, give reasons why iron, manganese and chromium can be identified as transition metals.

……..

……..

……[2]

(b) **(i)** Write an ionic equation, with state symbols, for the reaction of chromium metal with dilute sulfuric acid.

……[2]

(ii) In terms of electron transfer, explain why the reaction in **(b)(i)** is a redox reaction.

……

……

……[2]

(c) Fig. 6.1 illustrates the different set-ups in experiment 3.

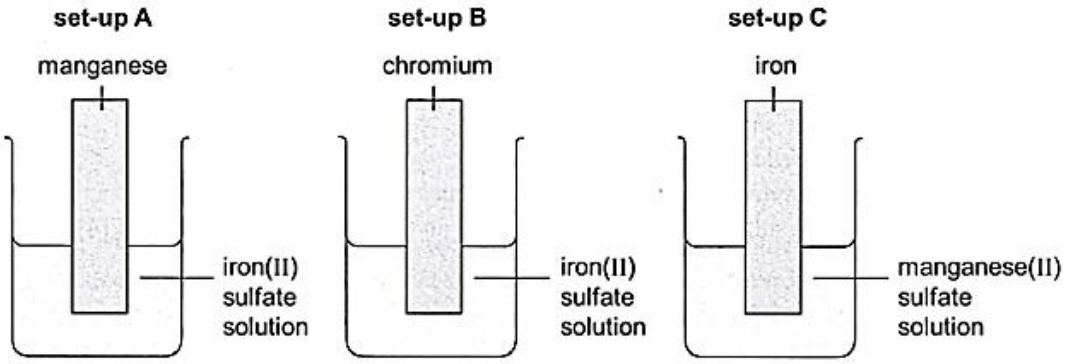


Fig. 6.1

List the three metals in order of increasing reactivity. Hence, describe the observations you would see for set-ups **A**, **B** and **C**.

……..

……..

……..

……..

……..

……..

……..

……..[4]

[Total: 10]

7 Table 7.1 compares the time taken for excess alloy to react with ethanoic acid, hydrochloric acid and phosphoric acid, each at three different concentrations.

The time taken for the alloy to decrease in mass by 1.0 g was measured. Hydrogen gas was collected as the alloy reacts with the acid. All other conditions are kept the same.

Table 7.1

concentration of acid, mol/dm^3	time taken for alloy to decrease in mass by 1.0 g/min		
	ethanoic acid	hydrochloric acid	phosphoric acid
0.04	92	2	19
0.02	190	6	39
0.01	410	18	80

(a) Using ideas of colliding particles, explain how the concentration of acid affects the rate of reaction.

……

……

……

……[3]

(b) Estimate the time taken for the mass of alloy to decrease by 1.0 g if 0.01 mol/dm^3 sulfuric acid reacts with the excess alloy.

……[1]

(c) A student makes the following statement:

"The final volume of hydrogen gas collected for the concentration of 0.02 mol/dm^3 of hydrochloric acid and 0.02 mol/dm^3 ethanoic acid would be different."

Is this statement correct?

Explain your reasoning.

……

……

……[2]

(d) 20.0 cm^3 of sodium hydroxide is transferred to a conical flask. A few drops of an indicator are added into the flask and titrated against 0.5 mol/dm^3 hydrochloric acid. 20.0 cm^3 of the sodium hydroxide requires 18.50 cm^3 of acid for the colour of indicator to change.

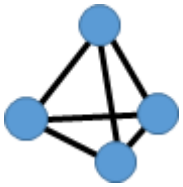
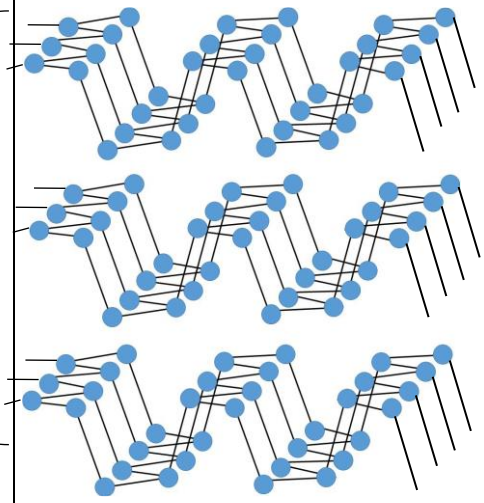
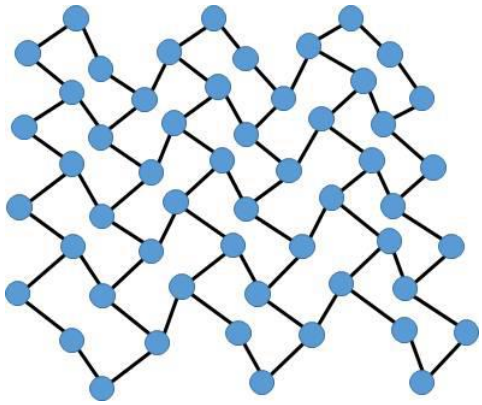
Calculate the concentration of sodium hydroxide in g/dm^3.

[4]

[Total: 10]

8 Phosphorus can exist as different allotropes where the same element can be arranged differently. The structures and melting points of two such allotropes, white phosphorus and black phosphorus, are shown in Table 8.1

Table 8.1

allotrope	structure	melting point/ °C
white phosphorus		44
black phosphorus	part of the structure (side view): layers of atoms  part of the structure of one single layer (top view): 	610

(a) State the chemical formula of white phosphorus.

……..[1]

(b) Identify the structure of each allotrope of phosphorus.

white phosphorus ……..

black phosphorus ……..[2]

(c) Explain, in terms of bonding, the difference in the melting points of the two allotropes of phosphorus.

……...

……...

……...

……..……

……..……..…[3]

(d) State another physical property of white phosphorus.

……..[1]

(e) A single layer of black phosphorus can be obtained by using the adhesive tape delamination method. This method involves the use of an adhesive tape to peel off a single layer.

Suggest why a single layer of black phosphorus can be easily peeled off using a adhesive tape.

……..……

……..……..….[1]

[Total: 8]

9 Properties of Alkynes

The alkynes are a homologous series of hydrocarbons. All alkynes contain a carbon to carbon triple bond (C ≡ C). Table 9.1 gives the structural formula of some alkynes.

Table 9.1

name of alkyne	structural formula	molecular formula	Mr
ethyne	H — C ≡ C — H	C_2H_2	26
propyne	H — C ≡ C — CH_3	C_3H_4	40
butyne	H — C ≡ C — CH_2 — CH_3	C_4H_6	54
pent-1-yne	H — C ≡ C — CH_2 — CH_2 — CH_3	C_5H_8	68

Fig. 9.1 shows the graph of boiling points of some alkynes plotted against the number of carbon atoms in each alkyne molecule.

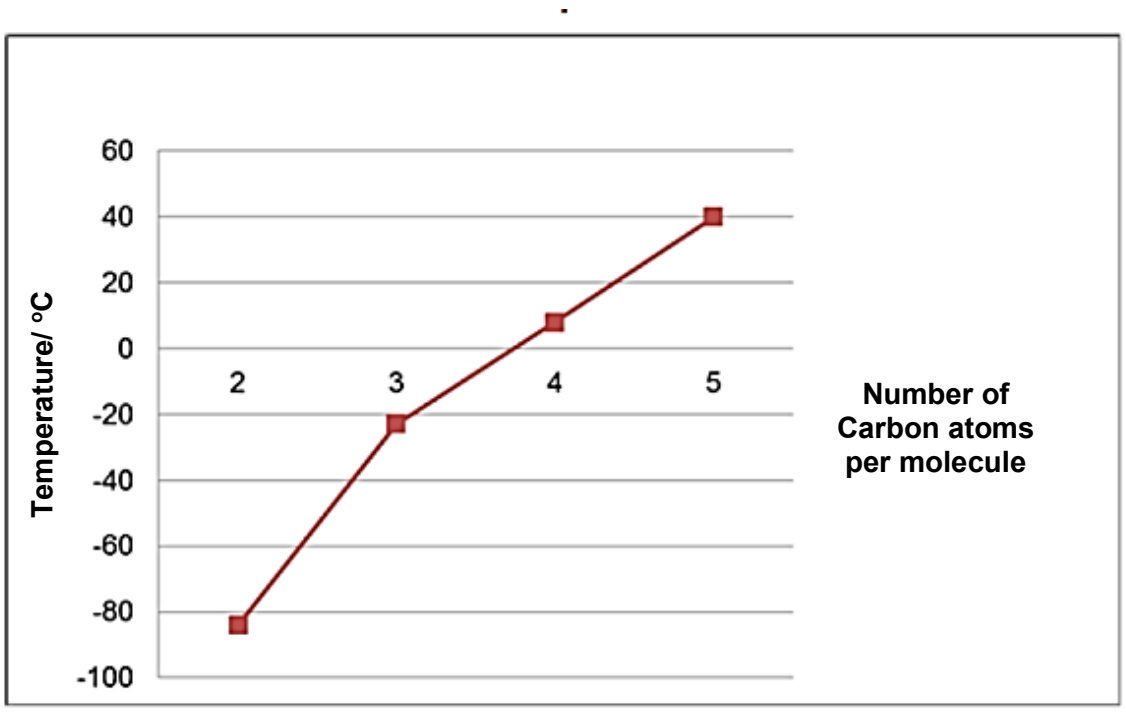


Fig. 9.1

Manufacture of Ethyne

For the past 50 years, ethyne was produced by the reaction of calcium carbide with water according to the equation below.

$$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$$

A modern method for producing a good yield of ethyne is by heating ethene above 1150 ^oC. The reaction is represented by the equation shown below.

$$CH_2{=}CH_2\ (g) \rightarrow H-C{\equiv}C-H + H_2\ (g)$$

Reaction of Alkynes

Alkynes are unsaturated compounds that react similarly to alkenes in many chemical reactions such as addition reactions.

For example, like alkenes, alkynes undergo addition reaction with bromine water. However, unlike alkenes, alkynes react more slowly with bromine water.

(a) Describe and explain the trends show shown in the data in **Table 9.1** and **Fig. 9.1**.

……..……

……..……

……..…[2]

(b) Draw a 'dot and cross' diagram to show the bonding in ethyne.
Show outer electrons only.

[2]

(c) **(i)** Deduce the general formula of the homologous series of alkynes.

……[1]

(ii) Write the chemical formula of hex-1-yne, a six carbon alkyne.

……[1]

(iii) Predict the boiling point of hex-1-yne.

……[1]

(d) Calculate the volume of ethyne that will be obtained at room temperature and pressure from 500 g of calcium carbide.

volume of ethyne: ……[2]

(e) Describe a test to distinguish an alkyne from an alkene. Include appropriate apparatus and chemicals used in the test.

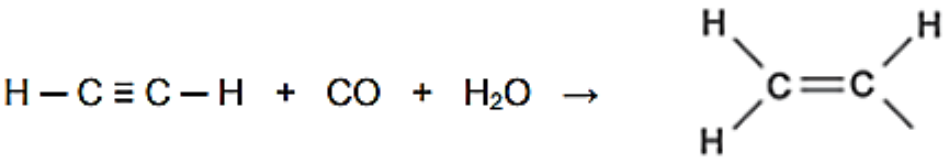
……

……

……[2]

(f) When ethyne reacts with carbon monoxide and water, in the presence of a catalyst, propenoic acid is formed.

Complete the structure of the propenoic acid in the equation shown below.



[1]

[Total: 12]

Section B

Answer **one** question from this section.

10 Fig. 10.1 shows the electrolysis of concentrated aqueous caesium chloride.

A few drops of Universal Indicator are added to the caesium chloride solution before the start of the experiment.

As the experiment proceeds, a coloured gas is observed at electrode **2**.

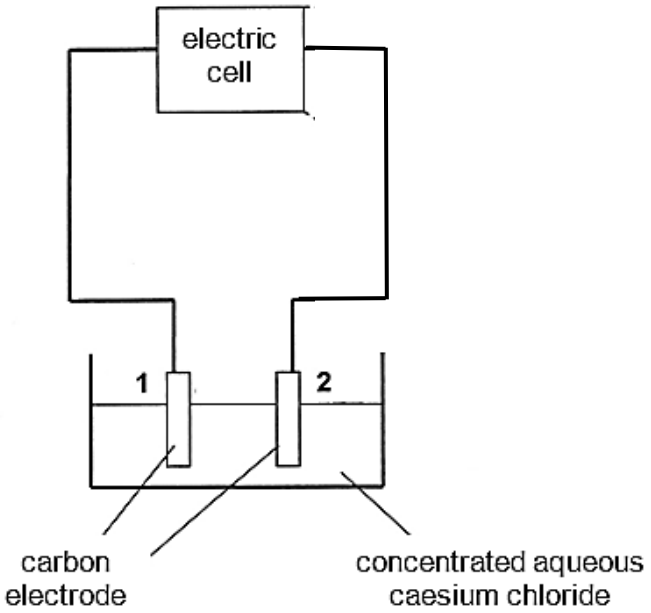


Fig. 10.1

(a) Determine whether electrode **2** is the positive electrode or negative electrode.

Write the half-equation for the reaction that occurs at this electrode.

.....

.....

..... [2]

(b) Describe and explain the observations at electrode **1**.

.....

.....

..... [2]

(c) State and explain the observations made on the electrolyte as the experiment proceeds.

……

……

……

……[2]

(d) Fig. 10.2 shows the actual electric cell used. The electrolyte used is aqueous copper(II) sulfate.

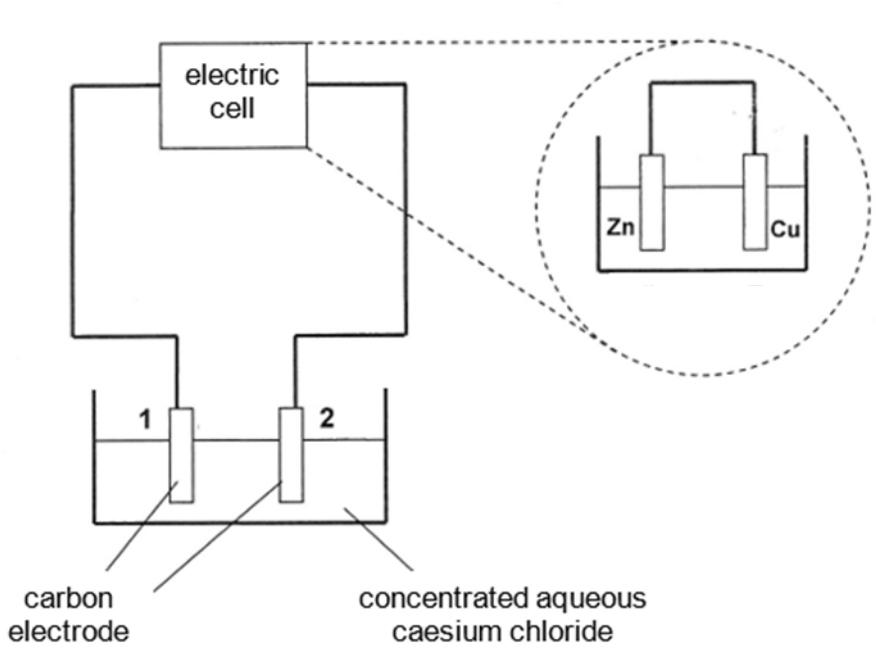


Fig. 10.2

(i) State the direction of flow of electrons.

……[1]

(ii) Write the half-equation for the reaction at the copper metal.

……[1]

(iii) State the element that is reduced during the experiment. Explain your reasoning using oxidation state.

……

……

……[2]

[Total: 10]

11 **(a)** Proteins are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid monomers. **Fig. 11.1** shows the repeat unit of the protein.

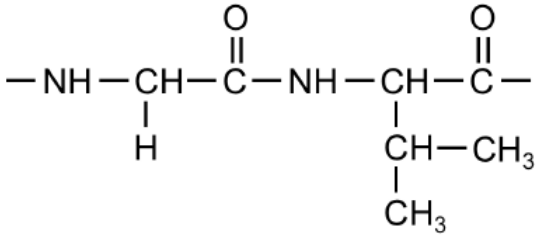


Fig. 11.1

Draw the full structural formula of the monomers that make up this section of the protein.

[2]

(b) When a surgeon repairs a wound, a mesh can be inserted to minimise the wound from opening. Poly(propene) is the recommended material for the mesh.

(i) Draw a section of poly(propene) showing 2 repeat units.

[1]

(ii) Describe **two** differences between the type of polymerisation for poly(propene) and the protein in **(a)**.

……..

……..

……..

……..[2]

(iii) A polymer of propene was manufactured and have an average relative molecular mass in the range of 5000 to 10 200.

Calculate the minimum number of repeating units in the polymer.

[2]

(iv) Suggest one reason why poly(propene) is used rather than a natural fibre such as cotton.

……..

……..[1]

(v) Propene is obtained from the cracking of long chain hydrocarbons such as hexadecane, $C_{16}H_{34}$, which is less useful.

When 1 mole of hexadecane is cracked, it produces 4 moles of propene and one other product.

Write the chemical equation and state the condition for this cracking process.

equation: ……

conditions: …….

……..[2]

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