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CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2024

CANDIDATE NAME	
CLASS	REGISTER NUMBER

SCIENCE (CHEMISTRY) 5086/03 or 5088/03

Paper 3 Chemistry **22 August 2024**

1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

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

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

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

A copy of the Data Sheet is printed on page 17.
A copy of the Periodic Table is printed on page 18.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A

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

1 Choose from the list of compounds to answer these questions.

calcium oxide

carbon dioxide

carbon monoxide

calcium hydroxide

lead(II) chloride

potassium oxide

sodium nitrate

sodium sulfate

sulfur dioxide

water

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

Identify the substance which

(a) is a gas that forms a white precipitate in limewater,

carbon dioxide QA: test for carbon dioxide gas ..... [1]

(b) is a gas that turns acidified potassium manganate(VII) from purple to colourless

sulfur dioxide QA: test for sulfur dioxide gas ..... [1]

(c) contains an anion with a charge of -1, (anion = negatively charged ion)

calcium **hydroxide** / lead(II) **chloride** / sodium **nitrate** ..... [1]

(d) is a basic oxide, (oxide of a **metal**, and reacts with acids to produce salt and water)

calcium oxide / potassium oxide ..... [1]

(e) is used in farms to neutralise the pH of the soil.

calcium hydroxide ACCEPT calcium oxide ..... [1]

[Total: 5]

2 Use the Periodic Table of Elements to help in answering this question.

(a) Lead is a metal with proton number of 82.

(i) State the number of occupied electron shells in an atom of lead.

6 [lead is in Period 6] [1]

(ii) State the number of electrons in the outer shell of an atom of lead.

4 [lead is under Group 14] [1]

(b) Explain briefly why

(i) the elements from Group 1 all have similar chemical properties,

Number of valence electrons determine chemical properties.

Their atoms have the **same number of valence electrons** (and thus forms ions with the same charge, hence have similar chemical properties)

[1]

(ii) the elements in Group 17 act as non-metals.

Loss / gain of electrons during chemical reactions determines nature of elements (i.e. act as metals or non-metals)

The atoms have **7 valence electrons** / 7 electrons in most outer shell, hence tend to **gain 1 electron** to obtain stable electronic configuration / during chemical reactions.

[1]

[Total: 4]

[Turn over

3 Table 3.1 describes four substances.

Table 3.1

substance	description
A	A colourless liquid that can be separated into two substances by evaporation. can be separated by physical method, thus **A - mixture**
B	A substance with fixed melting and boiling point
C	A substance that can be separated into simpler substances by electricity only separated by electrolysis, C - **compound**
D	Only carbon dioxide is formed when the substance is burnt in air Can be C or CO

Classify the four substances as element, compound, mixture or either an element or a compound.

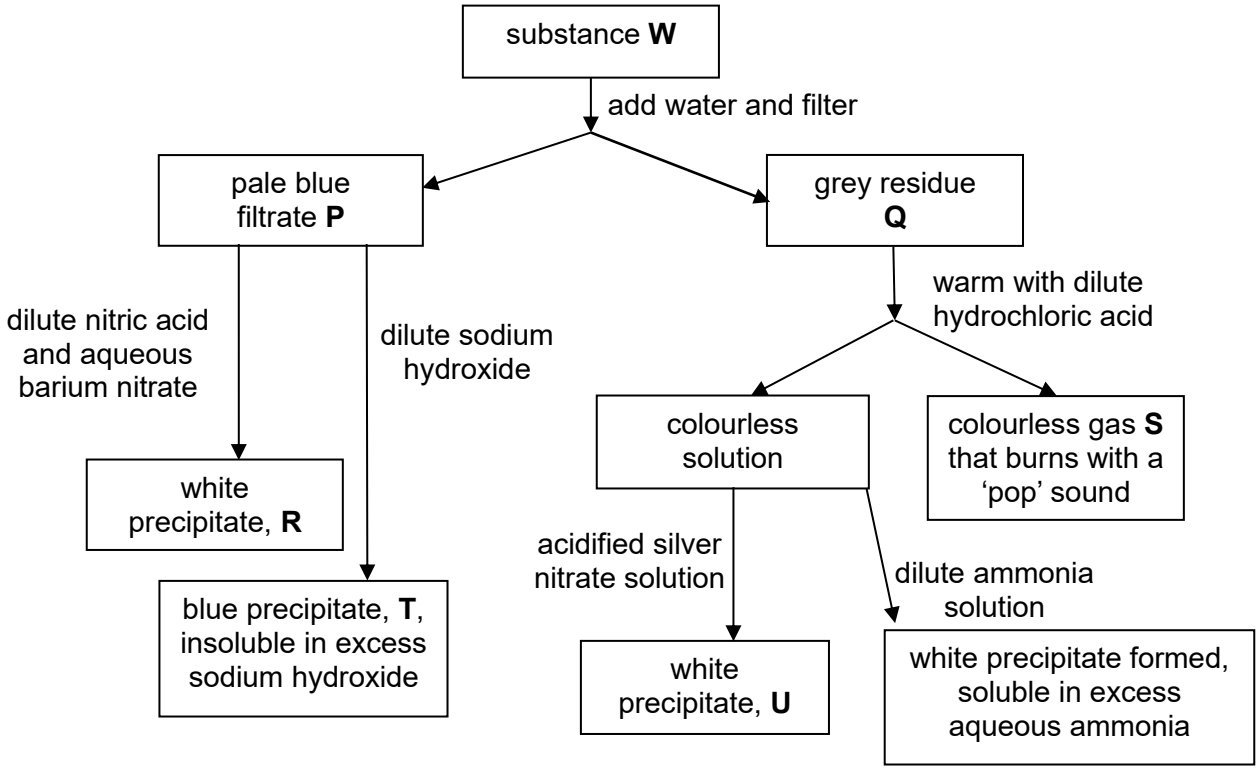
Complete Table 3.2 by placing a tick (√) in one box in each row.

Table 3.2

substance	element	compound	mixture	either an element or a compound
A			√	
B				√
C		√		
D				√

[Total: 4]

4 Substance **W** is a mixture of compound **P** and element **Q**. The reaction scheme shows the results of some experiments on substance **W**.



(a) Identify substances **P**, **Q**, **R**, **S** and **T**.

P copper(II) sulfate / $CuSO_4$

Q zinc / Zn

R barium sulfate / $BaSO_4$

S hydrogen (gas) / H_2

T copper(II) hydroxide / $Cu(OH)_2$ [5]

(b) Write the ionic equation, with state symbols, for the formation of white precipitate **U**.

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ [1]

(c) Describe how you would separate compound **P** from the pale blue filtrate **P**.

[1] Heat filtrate **P** until saturated
Leave filtrate to cool and crystallise
[1] Collect crystals of **solid P** by filtration (as residue)
[1] Wash residue / compound **P** with little amount of (cold) distilled water (to remove soluble impurities), dry between pieces of filter paper

[3]

[Total: 9]

[Turn over

5 Sulfur dioxide is bubbled through yellow iron(III) chloride solution.

The equation for the reaction is given below.

$$2FeCl_3(aq) + 2H_2O(l) + \overset{(+4)}{SO_2}(g) \rightarrow 2FeCl_2(aq) + 2HCl(aq) + \overset{(+6)}{H_2SO_4}(aq)$$

(a) Describe the colour in appearance of the iron(III) chloride solution when ~~sulfuric~~ sulfur dioxide is bubbled through it.

Solution changes from yellow to (light/pale) green ..... [1]

(b) Which substance is oxidised? Explain your answer in terms of oxidation state.

[1] Sulfur dioxide has been oxidised as .....

[1] its oxidation state **increases** from **+4** (in SO_2) to **+6** (in H_2SO_4).

.....

.....

..... [2]

[Total: 3]

6 **Fig 6.1** shows some reaction of butene.

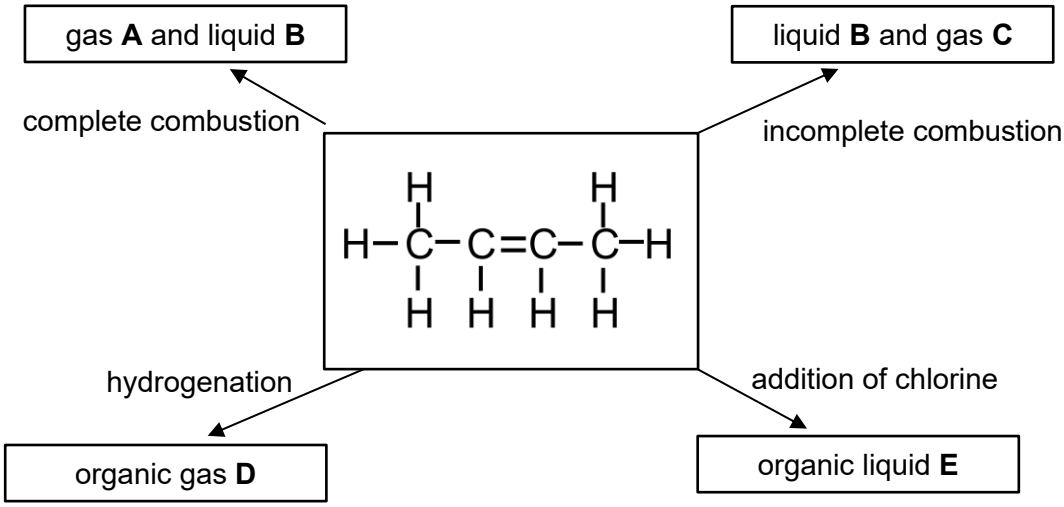


Fig. 6.1

(a) Identify **A**, **B** and **D**.

A carbon **dioxide** .....

B water .....

D butane ..... [3]

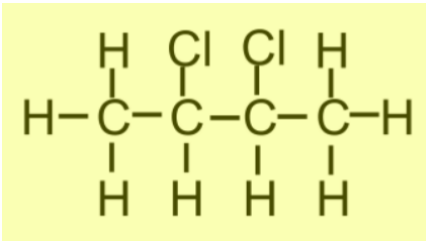
(b) Gas **C** is an atmospheric pollutant.

Describe the toxic nature of gas **C** on human beings.

C - carbon monoxide
Gas **C** binds irreversibly with haemoglobin, prevents absorption and transport of oxygen into the body

..... [1]

(c) Draw the structure of organic liquid **E**.



[1]

[Total: 6]

[Turn over

7 Bromate(V) ions, $BrO3^-$, react with bromide ions, Br^-, in an acidic solution to form bromine water.

$$BrO3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

(a) **(i)** Universal Indicator is added into the solution at the start of the experiment. What is the colour shown by the indicator?

red / orange / yellow ..... [1]

(ii) Explain why the acidity of the reaction mixture decreases as the reaction proceeds.

Hydrogen ions (H^+) is used up in the reaction. .....

..... [1]

(b) This reaction is exothermic.

Define the term *exothermic*.

[1] Reaction / process in which **heat is released** to the **surroundings**, ...
[1] resulting in an **increase in the temperature of the surroundings**.
..... [2]

(c) **Fig 7.1** shows the displayed formula of fumaric acid.

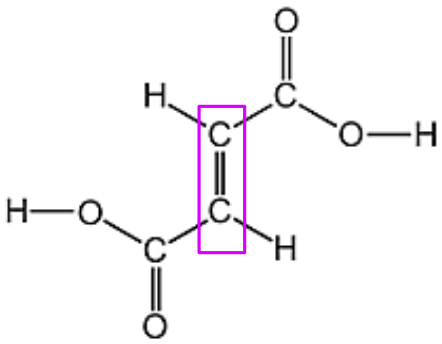


Fig. 7.1

Describe what will be observed when bromine water is added to fumaric acid.
Give a reason for your answer.

observation **reddish-brown** bromine water **turns colourless / decolourises** .....

reason **Addition of bromine** to C=C double bond in molecule had occurred ..... [2]

[Total: 6]

8 A student investigates the reaction of small pieces of zinc with 0.5 mol/dm^3 of hydrochloric acid at 25 °C. The dilute hydrochloric acid is in excess. (does not affect final amount of products)

(a) Construct the balanced chemical equation for the reaction between zinc and hydrochloric acid.

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ [1]

(b) **Fig. 8.1** shows the volume of hydrogen released as the reaction proceeds.

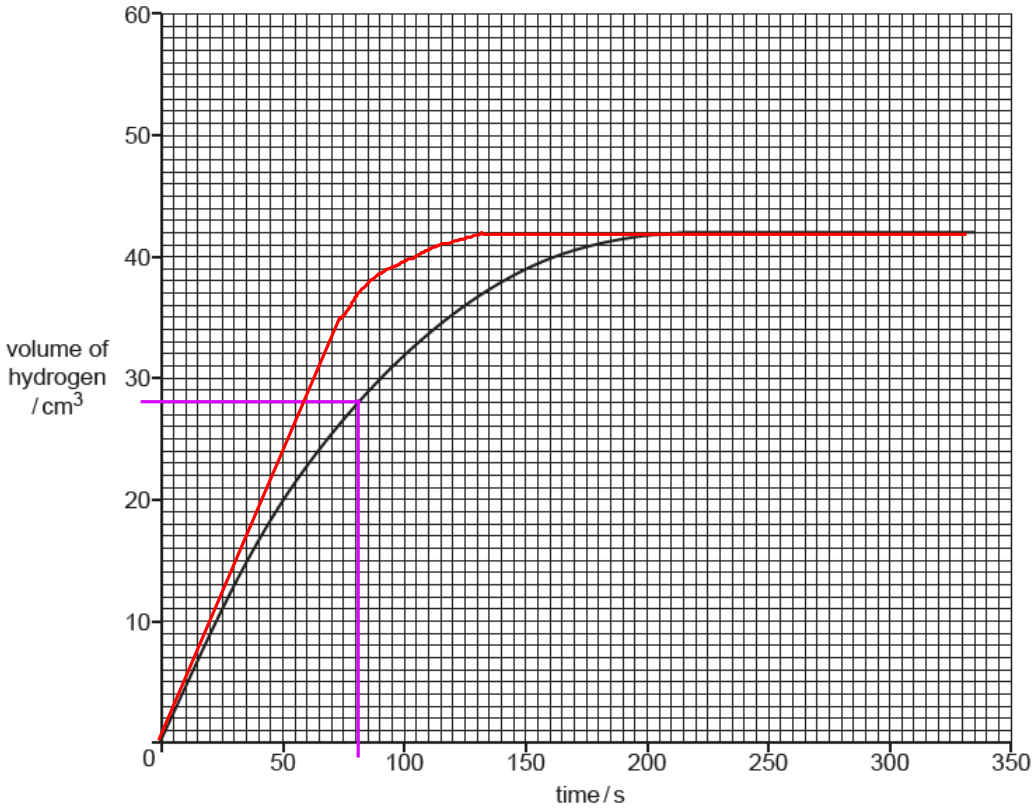


Fig. 8.1

(i) Deduce the time taken to collect 28 cm^3 of hydrogen.

time: 80 s [1]

(ii) The student repeats the experiment using 1.0 mol/dm^3 of hydrochloric acid. All other conditions remain the same. higher concentration, faster rate, steeper gradient

Draw a graph on Fig. 8.1 to show how the volume of hydrogen changes when 1.0 mol/dm^3 of hydrochloric acid is used. [2]

[1] steeper gradient

[1] volume of H_2 no change

[Turn over

(c) The student repeats the experiment with 0.5 mol/dm^3 of hydrochloric acid at 30 °C. All other conditions remain the same.

Describe and explain how the rate of reaction differs when the reaction takes place at 30 °C.

……...

……...

……...

…… [2]

(d) A sample of hydrogen is placed into a gas syringe. The end of the gas syringe is blocked so that no gas can escape.

Suggest an explanation why decreasing the pressure in the gas syringe increases the volume of gas when the temperature remains the same.

……...

…… [1]

[Total: 6]

9 Polymers are large molecules built up from small units called monomers.

(a) **Fig. 9.1** shows the structure of an organic compound that can be polymerised.

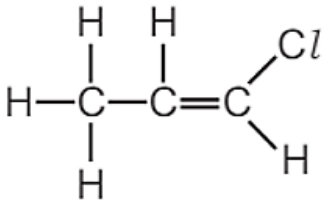


Fig. 9.1

Draw two repeat units of the polymer formed when the above compound is polymerised.

[1]

(b) Poly(propene) is a polymer used to make plastic food containers.

(i) State one environmental problem caused by the disposal of waste poly(propene) plastics.

Explain how this problem is related to the properties of poly(propene)

environmental problem ……...……...

……

explanation ……..…… [2]

(ii) Describe one chemical method used to recycle poly(propene) plastics.

……..… [1]

[Total: 4]

[Turn over

10 Sodium is a Group 1 element.

(a) State one physical property of sodium.

……. [1]

(b) Sodium is added to cold water containing a few drops of Universal Indicator.

The ionic equation for the reaction is shown.

$$2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$$

(i) Describe what is observed during this reaction.

……

……. [1]

(ii) State, in terms of electrons, why sodium is a reducing agent in this reaction.

……. [1]

(c) If 80g of sodium hydroxide is dissolved in water and then made up to 250 cm^3, what will be the concentration in mol/dm^3?

concentration of sodium hydroxide = …….. mol/dm^3 [3]

(d) Sodium hydroxide reacts with dilute sulfuric acid as shown.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

What volume of 1.0 mol/dm^3 sulfuric acid will react with 100 cm^3 of 2.0 mol/dm^3 sodium hydroxide.

volume of sulfuric acid = …… cm^3 [2]

[Total: 8]

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

Section B

Answer **one** question from this section.

11 Air pollutants are also known as atmospheric pollutants. They cause harm to the environment and to living things.

Oxides of nitrogen such as nitrogen monoxide, NO, are atmospheric pollutants.

The exhaust gas from a car engine contains 0.00200% by volume of nitrogen monoxide.

(a) Calculate the **number of molecules** of nitrogen monoxide in 960 dm^3 of exhaust gas at room temperature and pressure.

number of molecules …….. [3]

(b) Another oxide of nitrogen formed in car engines is nitrogen dioxide.

Nitrogen dioxide emissions can be reduced by adding an aqueous solution of urea, $(NH_2)_2CO$, to car exhaust gases.

The heat of the exhaust gases breaks down the urea into simple substances. One molecular of urea breaks down to form one molecule of ammonia and another molecule.

Complete the chemical equation to show the formula of the other molecule formed in this reaction.

$(NH_2)_2CO \rightarrow NH_3 +$ …….. [1]

[Turn over

(c) A student wants to investigate the rate of rusting between clean air and air containing nitrogen dioxide. She set up two experiments as shown in Fig. 11.1. The test-tubes are left for 10 days.

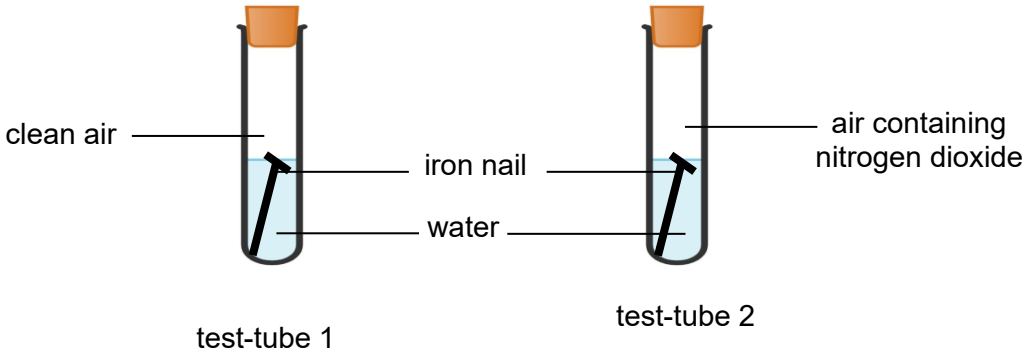


Fig. 11.1

(i) Predict which test-tube will rust the **most**.

Explain how you made this prediction.

prediction .....

explanation .....

..... [1]

(ii) Describe one method of preventing iron from rusting.

Explain how this method works.

method of rust prevention .....

explanation .....

..... [2]

(c) Beside air pollution, global warming also has major implication for human civilization.

(i) Carbon dioxide is a greenhouse gas.

Name one process that releases carbon dioxide into the atmosphere.

..... [1]

(ii) Explain how an increase in greenhouse gas emissions can lead to global warming.

.....

..... [1]

(iii) Describe one potential effect of increased level of greenhouse gases.

.....

..... [1]

[Total: 10]

12 The symbol of an isotope of nitrogen is shown.

$$^{14}_{7}\mathbf{N}$$

(a) **(i)** Explain what the number 14 and the number 7 tell you about the particles in this isotope of nitrogen.

……..……..

……..…….

……..……..……..

…….. [2]

(ii) Another isotope of nitrogen has the symbol $^{15}_{7}$N. Compare the atomic structures of these two isotopes of nitrogen.

……..……..

……..……..

…….. [1]

(b) Nitrogen can combine with other atoms to form different compounds.

(i) One of these compounds is ammonia, NH_3.

Draw a 'dot and cross' diagram to show the arrangement for the outer shell electrons in ammonia.

[2]

(ii) Another of these compounds is formed when nitrogen reacts with magnesium. The compound is magnesium nitride.

Draw a 'dot and cross' diagram to show the arrangement for the outer shell electrons in magnesium nitride.

[2]

[Turn over

(c) Explain, in terms of structure and bonding, why ammonia exists as a gas while magnesium nitride exists as a solid at room temperature and pressure.

……..……..

……..……..

……..……..

……..……..

……..……..

……..…… [3]

[Total: 10]

DATA SHEET

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
zinc hydroxide	white

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