Name	Reg. No	Class

4EX

CHEMISTRY

6092/02

Paper 2
[80 Marks]

PRELIMINARY EXAMINATION
August 2024
1 hour 45 minutes

Additional Materials:
Approved calculator

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.
Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Paper 2: Section B
Answer **three** questions in the space provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

FOR EXAMINER'S USE	
Section	**Marks**
Paper 1 MCQ	/ 40
Paper 2: A	/ 70
Paper 2: B	
B Either	/ 10
B Or	/ 10

INFORMATION FOR CANDIDATES:
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**.

This question paper consists of **22** printed pages

Setter: Mr Chen Yanhui Timothy

Vetter: Miss Jeevana Rani

Section A (70 marks)

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

1 Fig. 1.1 shows part of the Periodic Table.

				He
C	N	O	F	Ne
		S	Cl	Ar
			Br	Kr

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 of an element which:

(a) has five electrons in its outer shell,

.....

(b) exists as monoatomic,

.....

(c) reacts with sodium to form an ionic compound with a relative mass of 62.

.....

(d) is a halogen,

.....

(e) has 4 electron shells,

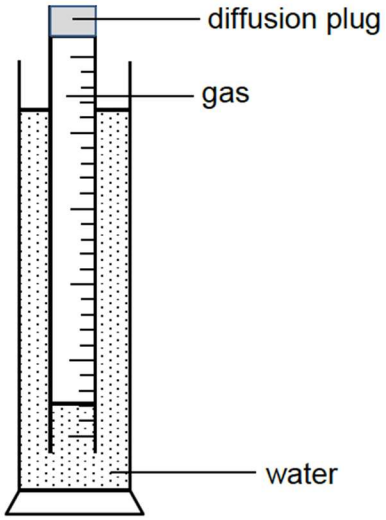
.....

(f) is the most abundant gas in the air.

.....

[Total: 6]

2 An experiment was set up to determine the rate of diffusion of gases in relation to their relative mass



The time taken for 100 cm^3 of some gases at room temperature and pressure to diffuse from this apparatus are recorded in the Table 2.1.

Table 2.1

gas	CO	Cl_2	CH_4	N_2	O_2
time / s	132	211	100	?	141

(a) State and explain, using the examples from Table 2.1, the trend in the experiment.

……...

……...

…… [2]

(b) Hence, predict the time taken for N_2 to diffuse.

…… [1]

(c) Suggest why this apparatus is unsuitable for finding the rate of diffusion of ammonia gas?

……...

…… [1]

[Total: 4]

[Turn over

3 Fig 3.1 shows an article from a textbook about elderberries.

Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.

elderberries

Fig. 3.1

The chromatogram, Fig 3.2**,** was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

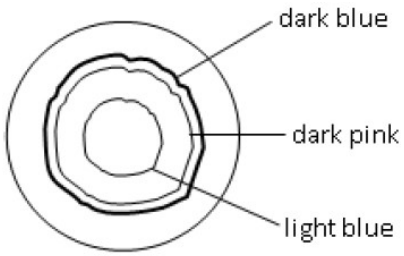


Fig. 3.2

(a) Predict the colour of the elderberries extract at pH 7.

..... [1]

(b) An alternative set-up for the above experiment is shown in Fig 3.3 below.

dye	R_f value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	

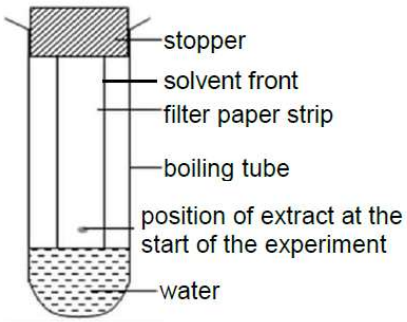
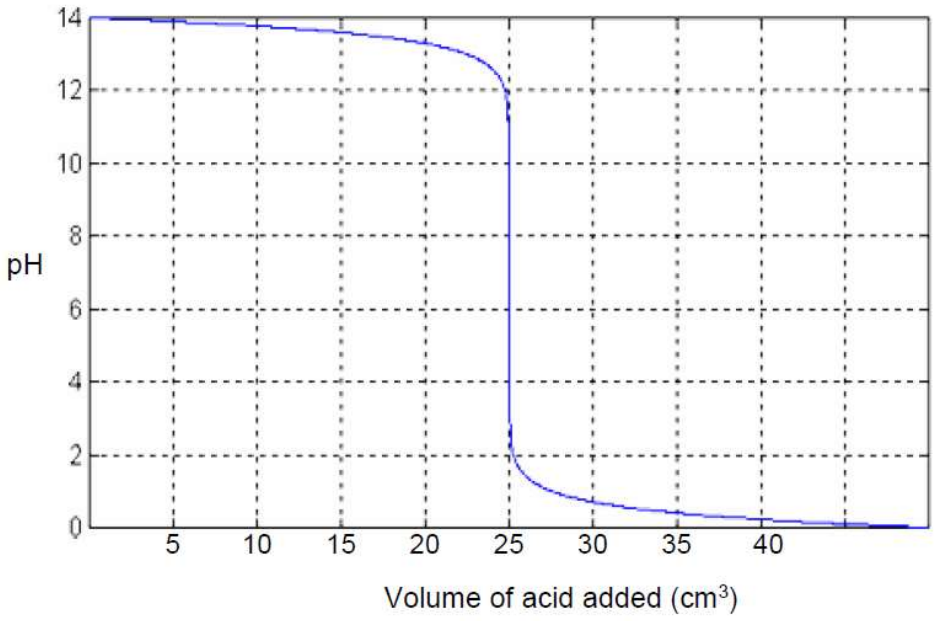


Fig. 3.3

Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes. [2]

(c) Graph 3.4 below shows how pH values changed during a titration when an acid was added from a burette into an alkali. A few drops of elderberries extract were added at the start of titration to monitor the pH of the solution.



Graph 3.4

(i) Based on the graph, state and explain whether the alkali used in the reaction is a strong alkali.

……

……

…….. [2]

(ii) State the colour of the elderberries extract when the volume of acid added was;

20 cm^3 ……

30 cm^3 ……

[2]

[Total: 7]

[Turn over

4 Copper(II) sulfate is used as a fungicide to control the growth of fungus in grapes and other kinds of berries.

Mixed with lime, it forms the Bordeaux mixture as shown below. This mixture is then added to plants to control fungus.

$$CuSO_4 + Ca(OH)_2 \rightarrow Cu(OH)_2 + CaSO_4$$

(a) There are three parts in the making of copper(II) sulfate from copper metal.

1. Copper metal is heated in hot air to form a base.
2. The base is then added in excess to an acid to form copper(II) sulfate.
3. A process is then used to separate the excess base from copper(II) sulfate solution.

(i) State the chemical formula of the base and acid used in the making of copper(II) sulfate.

…….. [2]

(ii) What is the process used in separating the excess base from the mixture?

…….. [1]

(iii) Sodium sulfate should not be made using the same method as copper (II) sulfate. Explain why, with reference to the steps listed in **(a)** above.

.....

…….....

…….....

…….. [2]

(b) Besides its ability to control fungus, the Bordeaux mixture provides an additional benefit to plants.

Determine, from its composition, what is the additional benefit.

…… [1]

[Total: 6]

5 The figure below shows the structures of diamond and graphite.
Both are giant molecular structure of carbon atoms.

diamond graphite

(a) Describe how a simple molecular structure differs from a giant molecular structure.

……...

…… [2]

(b) Diamonds are used as drill tips as they are very hard.
With reference to the bonding and structure of diamond, explain why diamonds are very hard.

……...

……...

……...

…… [2]

(c) Graphite is used as a lubricant for engines.
With reference to the structure and bonding of graphite, explain why graphite is used as a lubricant.

……...

……...

……...

…… [2]

(d) Other than its exceptional hardness of diamond, state **two** other physical properties of diamond.

……...

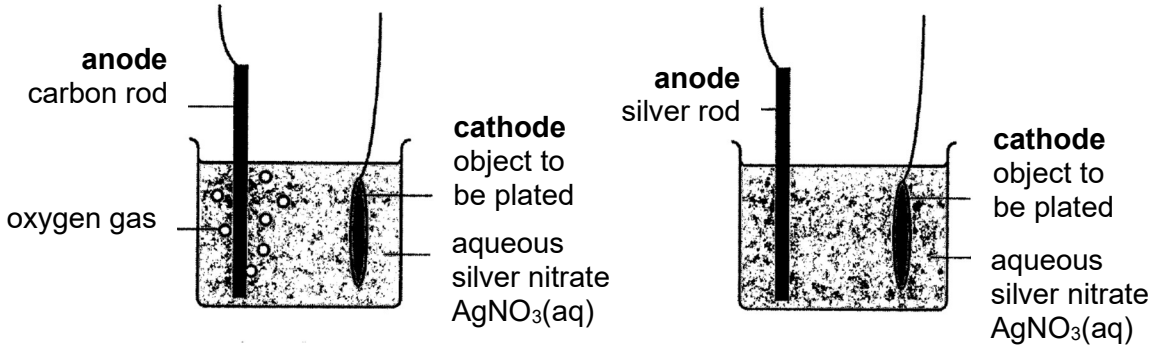
……...

……...

…… [2]

[Total: 8]

6 A student sets up two different experiments for electroplating an object with silver.



Experiment 1 Experiment 2

(a) Write equations, with state symbols, to show the reactions that take place at the anode and cathode during each experiment.

experiment 1

anode: ……

cathode: ……

experiment 2

anode: ……

cathode: ……

[3]

(b) At the beginning of each experiment the student removes a sample of the electrolyte, aqueous silver nitrate, and puts it in a test-tube.

(i) The student then adds a few drops of aqueous sodium chloride to the sample.

Describe and explain what the student sees.

Include an ionic equation in your answer.

…….

……

……... [2]

(ii) After some time, the student observes that no more silver is being deposited on the object in experiment 1 but more silver is still being deposited on the object in experiment 2.

Suggest a reason for this observation and describe how he could use aqueous sodium chloride to find out if his reasoning is correct.

…….

……

…….

…….

……... [3]

(c) If an iron object is placed in a beaker of aqueous silver nitrate, a silver coating forms on the iron.

If a gold object is placed in a beaker of aqueous silver nitrate, no reaction takes place.

Explain these two observations.

……...

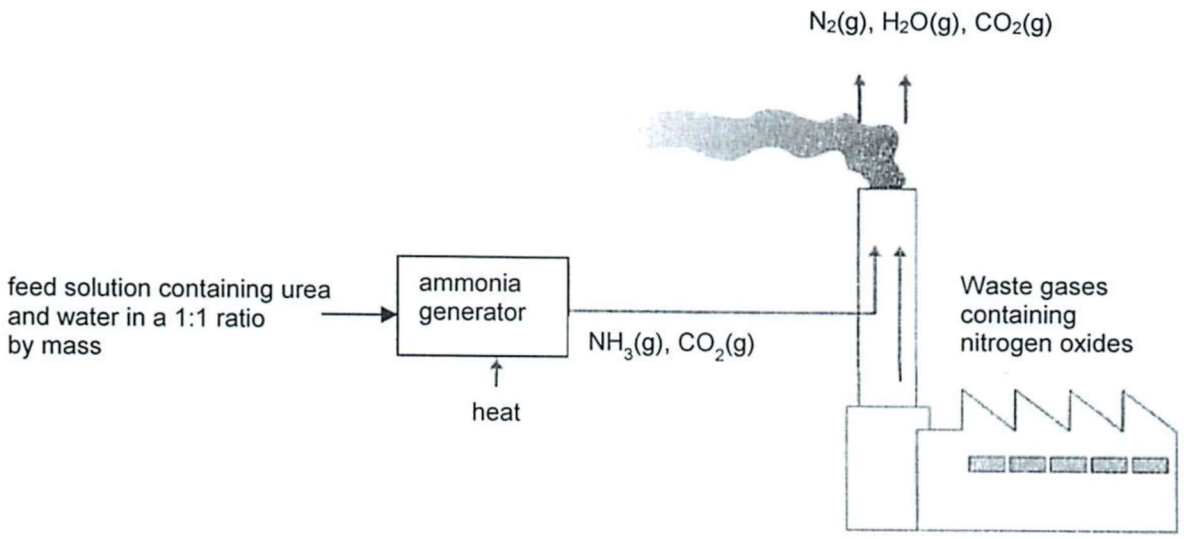
……...

…… [2]

[Total: 10]

[Turn over

7 Ammonia generated in a small-scale ammonia generator is used to treat waste gases containing nitrogen oxides. This treatment converts nitrogen monoxide to nitrogen and water.



(a) **(i)** Construct a chemical equation for the reaction between nitrogen monoxide and ammonia.

…….... [1]

(ii) Based on the reactants and products in **(a)(i)**, discuss the advantages and disadvantages of using the ammonia generator on the environment.

…….

…….

…….

…….

…….

……. [3]

(b) Decomposition of ammonia occurs at a high temperature

Explain, in terms of collisions between particles, why increasing the temperature of the ammonia generator is necessary.

……....

……....

……....

……....

……....

…….. [3]

(c) Draw the 'dot-and-cross' diagram of ammonia gas. Include only the valence electrons.

[2]

[Total: 9]

- - - - End of Section A - - - -

8 Covalent bonds are a result of the sharing of an electron pair between two atoms. The two atoms are bonded due to the electrostatic forces of attraction between the nuclei of the atoms and the shared electrons.

Table 8.1 lists the bond energy and bond length of some covalently-bonded atoms.

Table 8.1

bond	bond energy / kJ/mol	bond length / pm
H – H	435	74
H – C*l*	431	127
H – Br	366	141
H – I	299	161
C*l* – C*l*	243	198
Br – Br	193	228
I – I	149	267
C – C	331	154
C = C	590	134
C ≡ C	812	120

Bond energy is a measure of the strength of the bond and the amount of energy required to break one mole of a particular covalent bond. Bond length is the distance between the nuclei of two atoms that are covalently bonded to each other.

Bond length is also affected by the atomic size of atoms. Table 8.2 shows the atomic size of some atoms.

Table 8.2

element	H	F	C*l*	Br	I
atomic radius /pm	53	147	175	185	198

Bond energy is a factor affecting reactivity of a molecule. Reactivity of Group VII halogens changes down the group. Hydrogen halides are formed when halogens react with hydrogen.

Table 8.3 shows some information about the reactions of halogens with hydrogen to form hydrogen halides.

Table 8.3

reaction	observation	enthalpy change/ KJ/mol	percentage of hydrogen halide that decompose at 1000°C / %
$H_2 + Cl_2 \rightarrow 2HCl$	reacts explosively in sunlight but reacts slowly in the dark	–185	negligible
$H_2 + Br_2 \rightarrow 2HBr$	reacts in sunlight and on heating with platinum		0.5
$H_2 + I_2 \rightleftharpoons 2HI$	reacts very slowly on heating with platinum	26	33

(a) Using information from Table 8.1, describe two factors, other than atomic size of atoms, that affect bond length.

Explain how one of the factors stated affects bond length.

……...

……...

……...

……...

……...

……...

……...

……. [4]

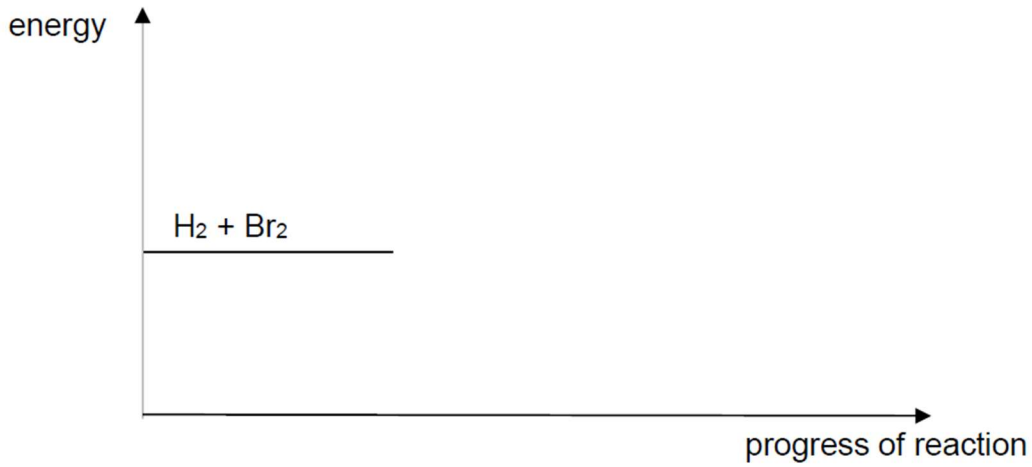
(b) **(i)** Using information provided, calculate the enthalpy change of the reaction between bromine and hydrogen.

[1]

[Turn over

(ii) Complete the energy profile diagram for the reaction between bromine and hydrogen. Your diagram should include:

- the calculated enthalpy change of reaction from (c)(i)
- the activation energy



[2]

(c) State and explain three differences in the reaction of iodine with hydrogen and reaction of chlorine with hydrogen.

……...

……...

……...

……...

……...

…… [4]

(d) Estimate the value for bond length in HF.

…… [1]

[Total: 12]

9 The extract below was found from a brochure about the extraction of gold from Waihi Gold Mine, New Zealand.

Gold ore is first loaded into a S.A.G. (semi-autonomous grinding) mill with hardened steel balls, lime and water. The tumbling action grinds the ore into fine powder.

The resulting slurry is fed into large leach tanks where a weak sodium cyanide (NaCN) solution is added to dissolve the gold into gold(I) ions. The slurry then passes through tanks containing activated carbon granules where the gold(I) ions are adsorbed onto the carbon.

The loaded carbon is screened out of the adsorption tanks and sent to an elution column where the carbon is washed with super-heated water to remove the previous metals. The washed solution, called pregnant electrolyte, is passed through a series of electrowinning where gold is deposited onto stainless steel cathodes. The cathodes are rinsed to yield a muddy sludge which is dried to a powder, mixed with fluxes and put into the furnace. The fluxes help to form a slag of impurities, leaving behind 99% pure gold.

(a) Explain why the ore is grinded to fine powder.

…… [1]

(b) The chemical equation between sodium cyanide solution and the gold present in the ore is shown below.

$$4Au + 8NaCN + O_2 + 2H_2O \rightarrow 4Na[Au(CN)_2] + 4NaOH$$

(i) State the oxidation state of gold in $Na[Au(CN)_2]$.

…… [1]

(ii) Explain, in terms of oxidation states, why the reaction is a redox reaction.

……..

……..

……..

……..

…… [2]

(c) Electrowinning, also called electroextraction, is the electrodeposition of metals from their ores that have been put in solution or liquefied using an inert anode.

Based on your understanding of electroplating, state one difference between electroplating and electrowinning.

……...

…… [1]

(d) Table 9.1 shows some examples of gold alloys and their respective alloy compositions.

Table 9.1

type of gold alloy	alloy composition
rose gold	75% gold; 20% copper; 5% silver
white gold	75% gold; 25% platinum
purple gold	80% gold; 20% aluminium

Explain, in terms of arrangement of particles, why gold alloys are used to make jewelry instead of pure gold.

Include a labelled diagram to support your answer.

……...

……...

……...

……...

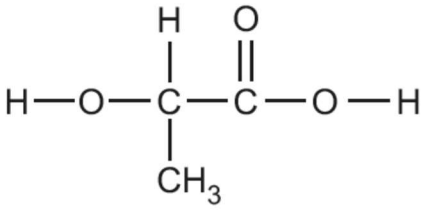
…… [3]

[Total: 8]

Section B (10 marks)

Answer **one** question from this section.

10 Lactic acid has a pH of 3.5. It can be used to make poly(lactic acid), a biodegradable polymer. The structure of lactic acid is shown below.



(a) **(i)** Suggest what is meant by the term biodegradable.

……

…….. [1]

(ii) Draw the full structural formula of poly(lactic acid).

[2]

(iii) A factory uses 500 tonnes of lactic acid to make poly(lactic acid). Explain why the mass of poly(lactic acid) made is less than 500 tonnes even when the percentage yield is 100%.

……

…….. [1]

(iv) Calculate the mass of poly(lactic acid) produced from 500 tonnes of lactic acid.

[2]

(b) Lactic acid reacts with ethanol to form an ester.

(i) State the conditions needed to form an ester.

…….. [1]

(ii) Draw the structural formula of the ester produced by the reaction of lactic acid with ethanol.

[1]

(c) When equal mass of potassium carbonate is added to same concentration and volume of lactic acid and hydrochloric acid, the rate of reaction differs.

Explain why.

……...

……...

……...

…… [2]

[Total: 10]

11 One of the components in crude oil is undecane, $C_{11}H_{24}$.

This molecule may be broken down to give 2 molecules of butene and one other product.
The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

…… [1]

(b) Construct a balanced chemical equation for this reaction.

Hence, name the other product formed in this reaction besides butene.

……...

…… [2]

(c) When the reaction is carried out, 1.00 mol of undecane produces 50.4 g of butene.

Calculate the percentage yield of butene.

[2]

(d) Butene can exist as 3 isomers. One isomer of butene is shown in Figure 11.1.

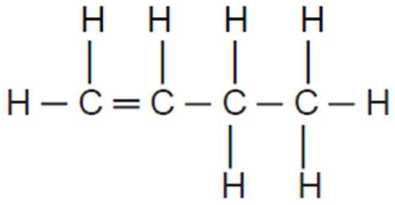


Figure 11.1

Draw the structures of the other **two** isomers of butene.

[1]

[1]

(e) The isomers of butene can undergo addition polymerisation.

Draw the structure of the polymer formed by any **one** of the isomers in **part (d)**, showing three repeating units.

[2]

(f) Butanol is manufactured by the reaction between steam and butene.

Two isomers of butanol which are miscible are formed at the same time.

State and explain the separation technique suitable for separating the components of the mixture.

……...

……...

…….. [2]

[Total: 10]

- - - - End of Section B - - - -
- - - - End of paper - - - -

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