Name: **Register Number:** **Class:**

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南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 2020
SECONDARY FOUR EXPRESS

Parent's Signature

CHEMISTRY **6092/02**

Paper 2 **21 August 2020, Friday**

Students answer on the Question Paper **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

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

Section A [50 marks]
Answer **all** the questions in the spaces provided.

Section B [30 marks]
Answer all **three** questions, the last question is in the form either/or.
Answer **all** the questions 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 in printed on page 18.

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

A1 Use the given elements to answer the questions.

zinc	**carbon**	**iron**	**helium**
nickel	**phosphorus**	**chlorine**	**sulfur**

In your answers, you may use an element once, more than once or not at all.
Choose **one** element which

(a) forms a neutral oxide.

……[1]

(b) is a major constituent of stainless steel.

……[1]

(c) forms a compound with hydrogen with the formula, XH_3.

……[1]

(d) is a good oxidising agent.

……[1]

(e) is unreactive.

……[1]

A2 Bath bombs are a mixture of dry ingredients that are packed tightly into various shapes and sizes. They can be used in bathtubs and are commonly mixed with essential oils. The label shows some common ingredients found in many different bath bombs.

Ingredients: Sodium hydrogen carbonate, citric acid, titanium dioxide, tin oxide, benzyl alcohol

One common trait among most bath bombs is that they effervesce when dropped into water.

(a) (i) Suggest why bath bombs will effervesce when dropped into water.

……

……

……[2]

(ii) Describe how the identity of the gas liberated can be tested.

……

……[1]

(iii) Tin oxide is also commonly used in ceramic glazing and pottery. It can undergo the following reactions to form salt and water.

Reaction 1: $SnO_2 + 2\ H_2SO_4 \rightarrow Sn(SO_4)_2 + 2\ H_2O$
Reaction 2: $SnO_2 + 2\ NaOH \rightarrow Na_2SnO_3 + H_2O$

Suggest a compound that can undergo similar reactions like tin oxide. Explain your answer.

……

……

……[2]

(b) Describe how silver chloride can be formed from silver oxide.

……

……

……

……[3]

A3 Under different conditions, hydrogen peroxide can undergo different types of reactions.

Reaction 1: $Na_2B_4O_7 + 4\ H_2O_2 + 2\ NaOH \rightarrow 2\ Na_2B_2O_4(OH)_4 + H_2O$
Reaction 2: $NaOCl + H_2O_2 \rightarrow O_2 + NaCl + H_2O$

(a) (i) State the oxidation states of boron in $Na_2B_4O_7$ and $Na_2B_2O_4(OH)_4$ respectively.

$Na_2B_4O_7$: ……...

$Na_2B_2O_4(OH)_4$: …….. [1]

(ii) State if hydrogen peroxide is an oxidising or reducing agent in **Reaction 2**. Explain your answer.

…….

…….

…….[2]

(iii) Explain a unique property of hydrogen peroxide when reacted under different conditions.

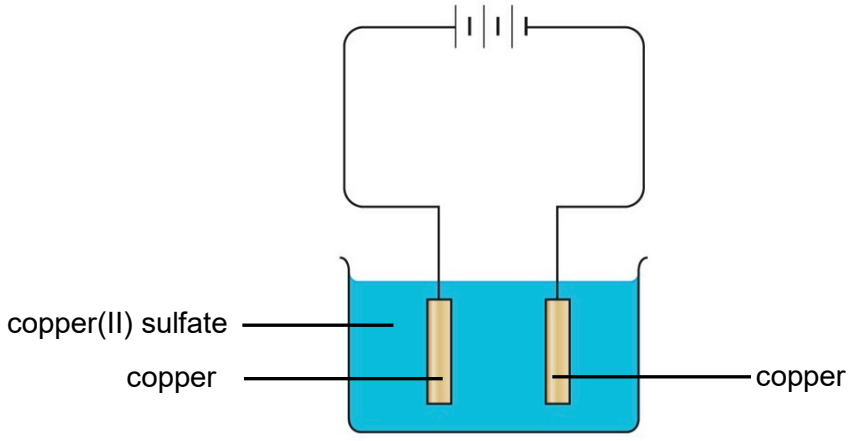
…….

…….[1]

(b) Hydrogen peroxide can be used as a food preservative in very low concentrations. Name another substance that is suitable as a food preservative.

…….[1]

A4 Leesa was working on a Science project on electrolysis and the following diagram shows her setup of an electrolytic cell using 1g of copper as electrodes.



(a) (i) State the ions present in the electrolyte.

…….[1]

(ii) Write the ionic half equations, with state symbols, for the cathode and the anode.

Cathode: ……

Anode: …….. [2]

(b) The initial concentration of copper(II) sulfate in 50 cm^3 of electrolyte was 1 mol/dm^3. Given that all the ions in the electrolyte was used up and the efficiency of the reaction at the anode containing 1 g of copper is only 50%, calculate the gain in mass at the cathode.

[3]

(c) (i) Leesa decided to modify the setup by swapping the cathode with a zinc mug to electroplate the mug. Describe the observations after the electrode was swapped.

…….

…….

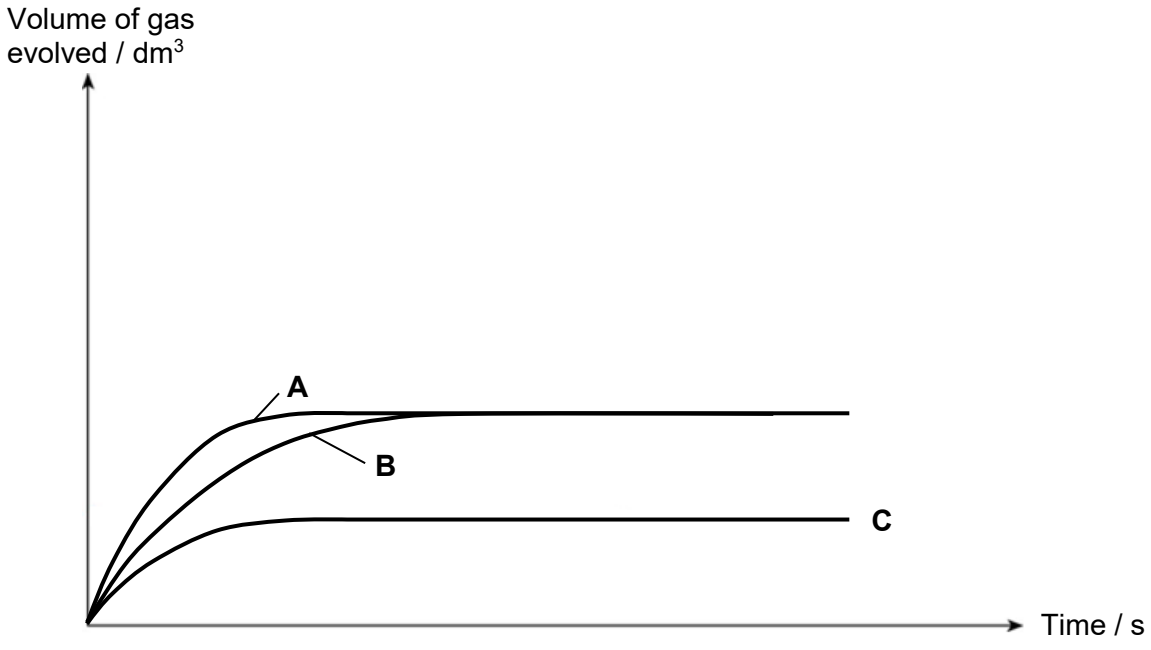
…….

…….[2]

(ii) Explain why the setup may not be ideal for electroplating the mug.

…….[1]

A5 Kaygen was testing the effects of varying the volume and concentration of sulfuric acid on zinc metal. He started experiment **A** using 50 cm^3 of 1 mol/dm^3 of sulfuric acid reacting with excess zinc metal and plotted the graphs of the experiments as shown below.



(a) (i) Write a balanced chemical equation for the reaction.

……[1]

(ii) Kaygen mixed up the labels on the different experimental setups. Suggest the volumes **and** concentrations of sulfuric acid used in experiments **B** and **C**.

Experiment **B**	Experiment **C**
Concentration: ……	Concentration: ……
Volume: ……	Volume: …… [2]

(iii) Using the answer from (a)(ii), explain, in terms of collisions, why the speed of reaction in experiment **B** is slower.

……

……

……

……

……[2]

(b) Draw a labelled diagram, showing how the gas evolved in the experiment can be collected.

.

[2]

(c) State one use of sulfuric acid.

……[1]

A6 Barium metal is known to be able to react readily with cold water, similar to Group I metals.

(a) (i) Suggest why barium has a reaction similar to the Group I metals, unlike magnesium, which is also found in Group II.

……

……[1]

(ii) Explain why barium cannot be classified as a Group I metal in the Periodic Table though it reacts readily with water.

……

……[1]

(iii) Suggest a difference in the observation between the reaction of sodium and calcium with cold water. Explain your answer.

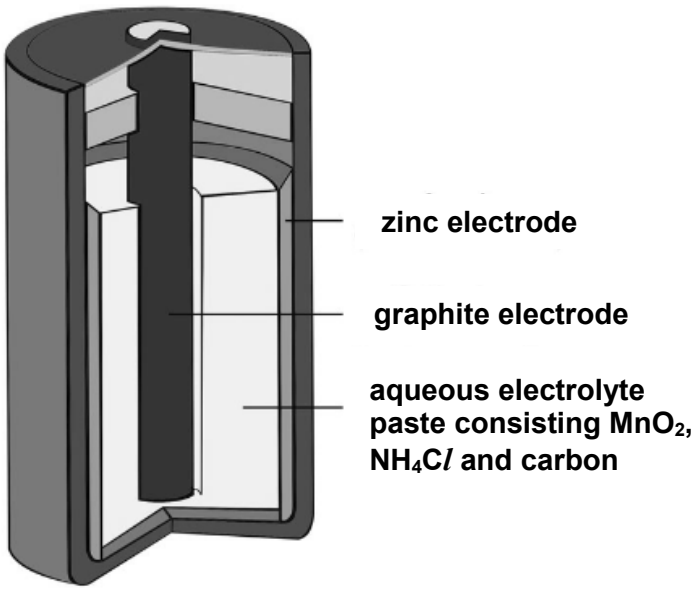
……

……

……

……[2]

(b) The diagram below shows a dry cell.



(i) State the conversion of energy involved in the dry cell.

……[1]

(ii) State one advantage and one disadvantage of changing the zinc electrode to barium metal.

……

……

……

……[2]

A7 Hydrosulfurisation is a chemical process used to remove sulfur from fossil fuels to reduce sulfur dioxide emissions.

(a) (i) State the difference between flue gas desulfurisation and hydrosulfurisation.

……

……[1]

(ii) Using appropriate chemical equation(s), explain why sulfur dioxide is a pollutant and how it can impact the environment.

……

……

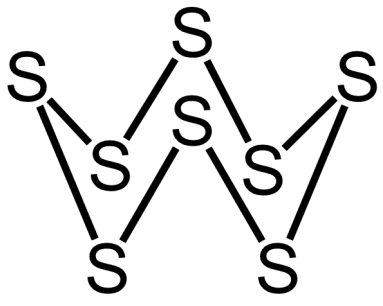
……

……

……

……[3]

(b) Crown sulfur is the most common allotrope of sulfur. It is a solid at room temperature with a molecular formula of S_8. The structural formula of crown sulfur is shaped like a crown and is shown below.



(i) Describe the structure and bonding of crown sulfur.

……

……

……

……

……[2]

(ii) State two properties of crown sulfur.

……

……[2]

Section B

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.

B8 Co-ordinate bonds

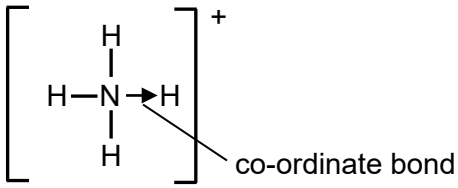
In 1913, the Bohr model was introduced to explain the breakdown of the structure of an atom. Based on the Bohr model, an atom consists of a small, dense nucleus surrounded by electrons in fixed orbits.

The Bohr model also shows the formation of a simple covalent bond as the sharing of a pair of valence electrons from two atoms. A co-ordinate bond is a covalent bond in which both electrons come from the same atom.

An example of a co-ordinate bond can be found in the ammonium cation. The reaction between ammonia gas and hydrogen chloride will result in the formation of ammonium ion formed by the transfer of the H^+ ion while the electron from hydrogen remains on the chlorine atom to form a chloride ion.

$NH_3 + HCl \rightarrow NH_4Cl$

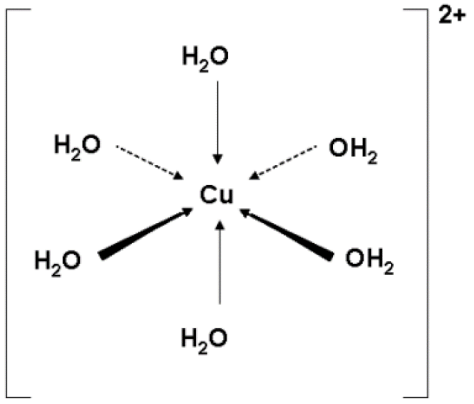
The co-ordinate bond is represented by an arrow in the structural formula, pointing from the atom that contributes the pair of electrons to the other atom. The structural formula of ammonium cation is as shown.



Ligand Exchange Reactions

Ligands are ions or molecules that bind to a central metal atom to form a complex metal ion. Ligands share one of its electron pairs with the central metal atom, forming a co-ordinate bond.

In general, the cations involved in qualitative analysis are considered as complex metal ions. For example, in a beaker containing $CuSO_4$ solution, water acts as a ligand, sharing one electron pair with Cu^{2+} ion, forming a complex ion of copper(II) with molecular formula $[Cu(H_2O)_6]^{2+}$. The structural formula of $[Cu(H_2O)_6]^{2+}$ is as shown.



When a small volume of aqueous sodium hydroxide is added to a solution of copper(II) ions, a complex, light blue precipitate of $Cu(H_2O)_4(OH)_2$ is formed. The molecular formula of the precipitate remains the same when excess aqueous sodium hydroxide is added.

When a small volume of aqueous ammonia is added to a solution of copper(II) ions, $Cu(H_2O)_4(OH)_2$ is formed, containing four H_2O ligands and two OH^- ligands. When aqueous ammonia is added in excess, four ammonia ligands replaces two OH^- ligands and two H_2O ligands.

(a) (i) Draw the dot-and-cross diagram of ammonium chloride, showing only the outer shell electrons.

[2]

(ii) Given that there is only one co-ordinate bond formed from the reaction between ammonia and boron trifluoride, draw the structural formula of the product, NH_3BF_3.

[1]

(b) (i) Describe the observations when aqueous ammonia is added to a solution of copper(II) ions until there are no further changes.

……

……

……

……[2]

(ii) Suggest the molecular formula of the complex ion of copper(II) after adding excess aqueous ammonia.

……[1]

(iii) Draw the structural formula of the complex ion of copper(II) after adding excess aqueous ammonia.

[2]

(c) (i) Suggest the molecular formula of the complex ion of iron(II) after adding excess aqueous ammonia.

……[1]

(ii) With reference to the complex ions of both metals, explain the difference in observations when excess aqueous ammonia is added to copper(II) and iron(II) solutions in separate test tubes.

……

……[1]

(iii) It was observed that the surface of the green precipitate turns orange in the test tube containing iron(II) solution. Explain the observation.

……

……

……

……[2]

B9 Weng Xian was testing several fuels in a laboratory. He summarised his results in the following table.

Fuel	Melting point / °C	boiling point / °C	Energy release per mole of fuel / kJ
Octane, C_8H_{18}	-57.1	125.1	5460
Hydrogen	-259.2	-252.9	286
Coal	Cannot be melted	Cannot be determined	393

(a) (i) Calculate the energy output for 1 g of each fuel.

[3]

(ii) Using only the calculated values from (a)(i) and information from the table, determine the advantages and disadvantages of using hydrogen as a fuel in a motor vehicle. Explain your answer.

……

……

……

……

……[2]

(b) Explain why the combustion is exothermic in terms of energy changes that take place during bond breaking and bond forming.

……

……[2]

(c) Explain why hydrogen is considered a renewable fuel.

……[1]

EITHER

B10 Nicko conducted two experiments to investigate the reactivity of elements **Q** and **R** with respect to copper, zinc and calcium.

She heated Elements **Q** and **R** with anhydrous copper(II) oxide, zinc oxide and calcium oxide respectively in experiments 1 and 2.
The observations are recorded in the table below.

	Observations	
	Experiment 1	**Experiment 2**
	Reaction with element Q	**Reaction with element R**
Copper(II) oxide	Gas **A** evolved. Gas **A** forms white precipitate when bubbled through aqueous calcium hydroxide. Pink solid deposited.	Liquid **B** formed. **B** turned white anhydrous copper (II) sulfate blue. Pink solid deposited.
Zinc oxide		No observable changes
Calcium oxide	No observable changes	No observable changes

(a) Identify **Q**, **R**, **A** and **B**.

Q: ……

R: ……

A: ……

B: …… [2]

(b) Predict the observations that Nicko would expect to make when zinc oxide reacts with **Q**.

……

……

……[2]

(c) Arrange all five elements, **Q**, **R**, copper, zinc and calcium in the order of decreasing reactivity.

……[1]

Explain the following observations.

(d) (i) An iron can that has been electroplated with copper rusts much faster than an iron can that has been electroplated with zinc when scratched.

……

……

……

……[2]

(ii) Drink cans are usually alloyed with aluminium.

……

……

……

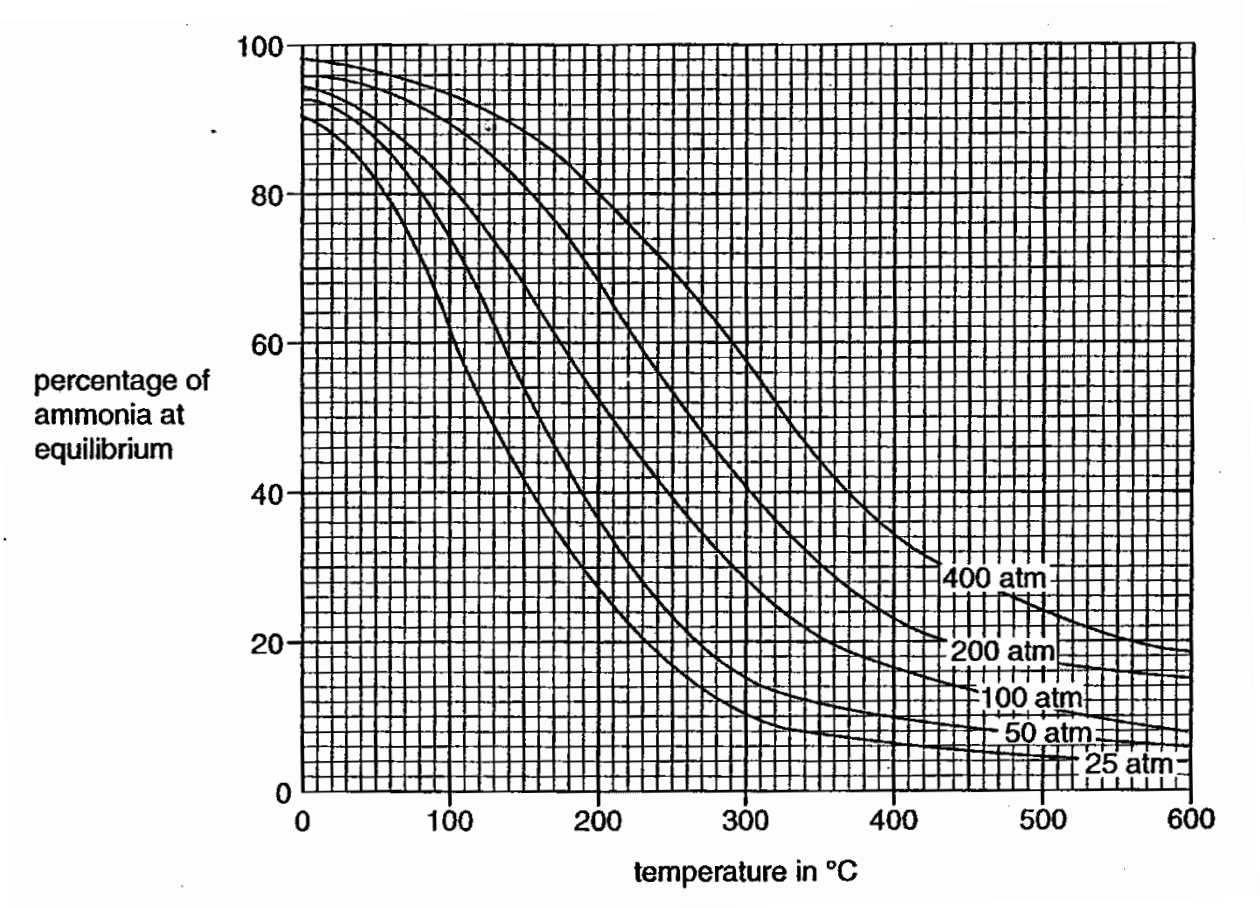
……[2]

(e) State one use of stainless steel.

……[1]

OR

B10 Ammonia that is produced is used to manufacture nitrogenous fertilisers such as ammonium nitrate. The graphs below give information about the percentage of ammonia present in the equilibrium mixture at different temperatures and pressures.



(a) Use the graphs to deduce the effect of increasing pressure on the percentage of ammonia in the equilibrium mixture.

……

……[1]

(b) Suggest one advantage and one disadvantage of using 400 °C rather than 300 °C as the working temperature.

……

……

……

……[2]

(c) An industrial process uses conditions of 400 °C and 200 atm. 6000 dm^3 of each nitrogen and hydrogen were reacted under these conditions. Calculate the mass of ammonia produced.

[3]

(d) Suggest the best substance used to dry ammonia gas after being produced.

……[1]

(e) (i) Explain why ammonium nitrate is a good fertiliser.

……

……[1]

(ii) Suggest why adding ammonium nitrate fertiliser after adding slaked lime to the soil is usually not advisable.

……

……

……

……[2]

-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.).