Raffles Girls' School
(SECONDARY)

Established in 1879

Name: _____

Class: 4 / ____ Register No: _____

CHEMISTRY
YEAR FOUR

End-of-Year Assessment

Monday **5 October 2020** **2 hours**

INSTRUCTIONS TO CANDIDATES

This question paper contains two sections.

Section A – Answer **ALL** questions and record your answers as instructed on the OMR answer sheet.

Section B – Answer **ALL** questions and write your answers in the spaces provided.

Use only a black or dark blue pen, except for diagrams.

Do not use correction tape or fluid.

Omission of essential working or units, or expressing answers with an incorrect number of significant figures will result in a loss of marks.

School approved calculators are allowed.

INFORMATION FOR CANDIDATES

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

The weighting for this paper is **50%**.

A copy of the Periodic Table is provided on page 20 for your reference.

For examiners' use	
Question	**Marks Obtained**
Section A (20 marks)	
1-20	
Section B (60 marks)	
B1	**/8**
B2	**/9**
B3	**/6**
B4	**/6**
B5	**/16**
B6	**/15**
Units	
Statements	
Significant Figures	
Total	**80**

Parents's / Guardian's Name: _____

Signature: _____ Date: _____

Section A – Multiple Choice Questions [20 marks]

*Four possible answers (**A**, **B**, **C**, and **D**) are given for each question. Choose the most appropriate answer and record your answer in the OMR form provided.*

1 Which substance is unlikely to react with aqueous sodium hydroxide?

A zinc oxide
B nitrogen dioxide
C carbon monoxide
D phosphorus(V) oxide

2 What is the source of hydrogen in Haber process?

A air
B water
C nitric acid
D petroleum

3 Which substances can be found in the reaction vessel during the Haber process?

A ammonia
B hydrogen and nitrogen
C ammonia, hydrogen and nitrogen
D ammonia, hydrogen, nitrogen and iron

4 Across the period, the element changes from metallic to non-metallic.

Which statement explains the change in trend?

A a decrease in atomic radii
B an increase in number of protons
C an increase in number of neutrons
D an increase in number of valence electrons

5 The table below shows the properties of sodium chloride and sulfur.

Which set of properties is correct?

	sodium chloride	sulfur
A	contains covalent bonds	contains metallic bonds
B	contains ionic bonds	contains covalent bonds
C	conducts electricity in aqueous state	conducts electricity in solid state
D	conducts electricity in solid state	conducts electricity in aqueous state

6 Which statement is incorrect for diamond and silicon dioxide?

A Both substances have low melting point.
B Both substances are poor electrical conductors.
C Both substances have a tetrahedral structure.
D Both substances form giant molecular structures.

7 Which substance has the same number of atoms as 6 dm^3 of chlorine gas at room temperature and pressure?

A 20 g of argon gas
B 23 g of sodium metal
C 8.5 g of ammonia gas
D 0.25 g of hydrogen gas

8 A sample of 100 cm^3 of carbon monoxide was burnt in 100 cm^3 of oxygen. What is the composition of the gas mixture after the reaction?

A 100 cm^3 of carbon dioxide only
B 200 cm^3 of carbon dioxide only
C 100 cm^3 of carbon dioxide and 50 cm^3 of oxygen
D 100 cm^3 of carbon dioxide and 50 cm^3 of carbon monoxide

9 Which statement mainly accounts for the risk of explosion in a flour mill?

A Flour is a volatile substance.
B Flour can react with oxygen in the air.
C The temperature of the surroundings is high.
D Flour dust is made up of fine, combustible particles.

10 Which change will decrease the speed of reaction between two gases?

A an increase in temperature
B an increase in surface area of the catalyst
C an increase in volume of the reaction flask
D an increase in pressure of the reaction flask

11 The equation shows a redox reaction between iron(II) chloride and chlorine gas.

$$2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$$

Which equation describes the oxidation process in this reaction?

A $2Cl^- \rightarrow Cl_2 + 2e^-$
B $Cl_2 + 2e^- \rightarrow 2Cl^-$
C $Fe^{2+} \rightarrow Fe^{3+} + e^-$
D $Fe^{2+} + e^- \rightarrow Fe^{3+}$

12 What are the products formed when aqueous copper(II) sulfate is electrolysed using copper electrodes?

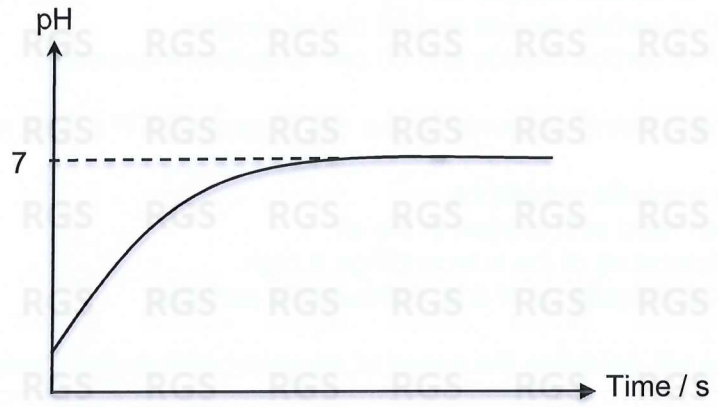
	anode product	cathode product
A	aqueous copper (II) ions	copper metal
B	aqueous copper (II) ions	hydrogen gas
C	oxygen gas	copper metal
D	oxygen gas	hydrogen gas

13 Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which statement about this electrolysis is correct?

A Gases are given off at both electrodes.
B Sodium metal is formed at the cathode.
C Electrons travel through the solution to the sodium ions.
D Hydrogen ions travel through the solution to the anode.

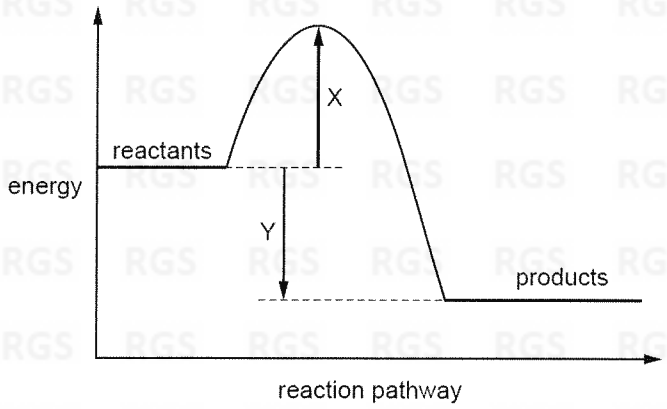
14 The graph below shows the pH change when excess solid X is added to dilute hydrochloric acid.



Which substance could be solid X?

A lead(II) nitrate
B zinc carbonate
C sodium carbonate
D potassium hydroxide

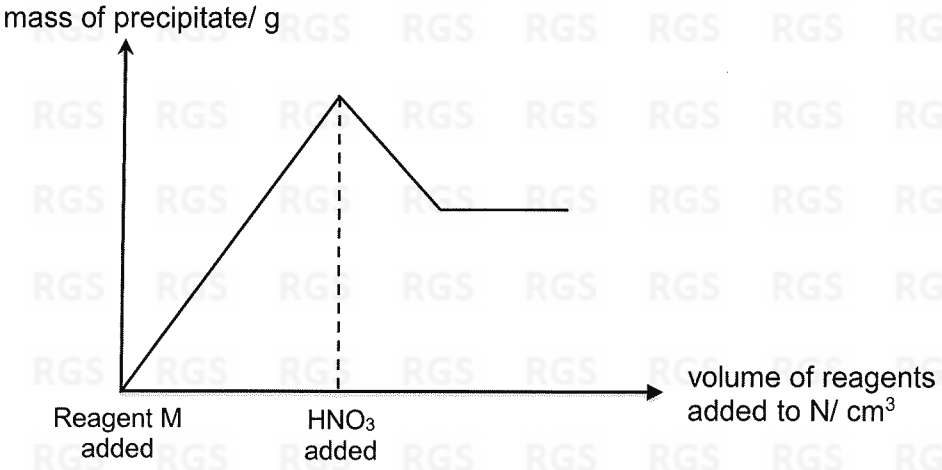
15 The diagram shows the energy profile of a reversible chemical reaction.



Which statement about the **reverse** reaction is correct?

A The reaction is exothermic.
B The enthalpy change of the reaction is Y.
C The activation energy of the reaction is X - Y.
D The enthalpy change of the reaction is X + Y.

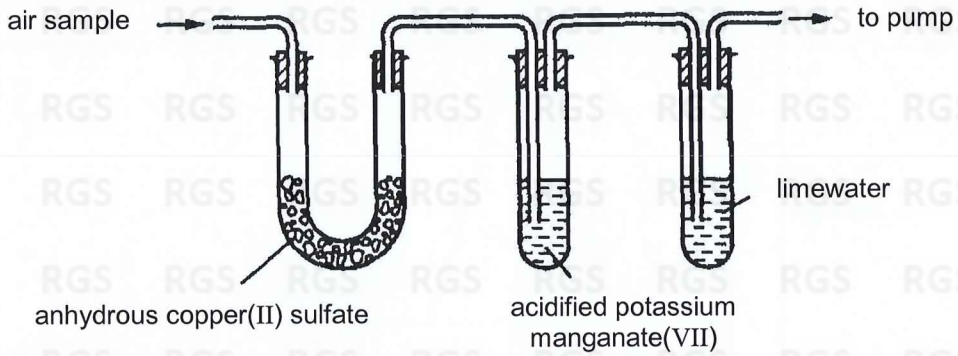
16 Reagent M is gradually added to a salt solution N, followed by the addition of dilute nitric acid. The graph below shows the change in mass of precipitate formed.



Which set of reagent would produce the given results?

	reagent M	anion(s) present in N
A	aqueous lead(II) nitrate	SO_4^{2-}
B	aqueous lead(II) nitrate	I^- and SO_4^{2-}
C	aqueous silver nitrate	CO_3^{2-}
D	aqueous silver nitrate	I^- and CO_3^{2-}

17 A student used the apparatus shown to examine air.



The student found that the copper(II) sulfate turned blue, acidified potassium manganate(VII) turned colourless and white precipitate was formed in limewater.

Which gases were present in the sample of air?

A CO, H_2, CO_2
B CO, O_2, SO_2
C CO_2, Cl_2, H_2O
D CO_2, H_2O, SO_2

18 Petroleum is separated into fractions by fractional distillation.

Which fraction distils off at the highest temperature?

A petrol
B bitumen
C kerosene
D lubricating oil

19 Which statement about vegetable oil and the margarine made from it is correct?

A Both are found in nature.
B Both are liquids at room temperature.
C Margarine is produced by hydrogenation of vegetable oil.
D Vegetable oil has fewer carbon-carbon double bonds than margarine.

20 Which two organic molecules contain the same number of hydrogen atoms?

A butane and but-2-ene
B hexane and cyclohexane
C butane and 2-methylbutane
D pentane and 2-methylbutane

End of Section A

Section B (60 Marks)

*Answer **ALL** questions and write your answers in the spaces provided.*

B1 Group I and Group VII elements show different trends in their physical and chemical properties.

(a) State the trends in melting points down Group I and Group VII.

.....

..... [2]

(b) Explain why reactivity of Group I elements increases down the group.

.....

.....

.....

..... [2]

(c) Group I elements react readily with Group VII elements to form stable compounds such as potassium fluoride.

(i) Explain, in terms of its bonding and structure, why the electrical conductivity of solid potassium fluoride is negligible.

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.....

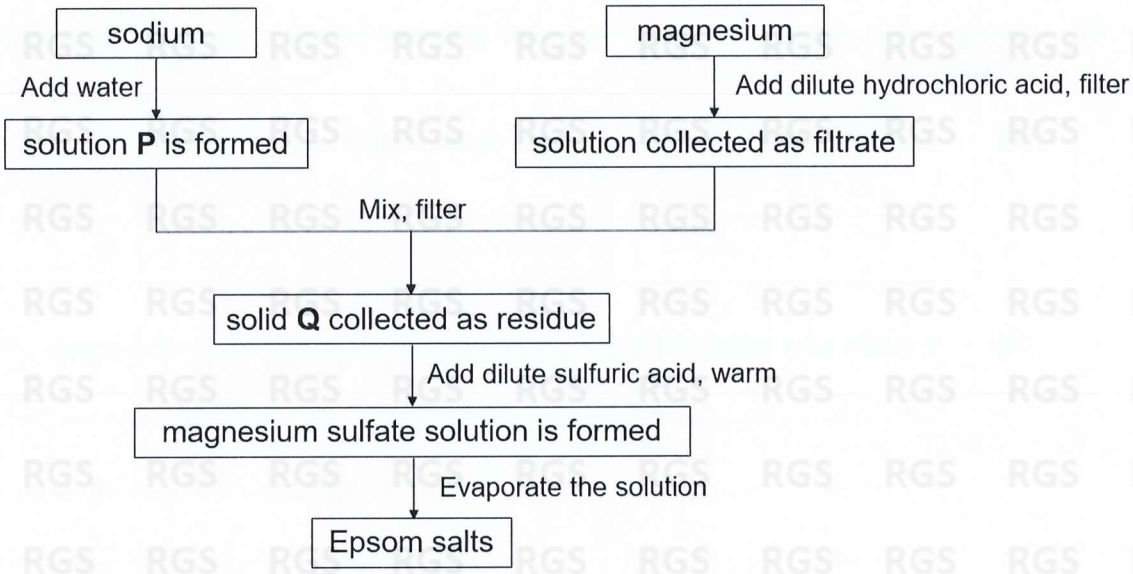
.....

..... [2]

(ii) Draw the dot-and-cross diagram of potassium fluoride. Show only the outer shell electrons.

[2]

B2 The reaction scheme shows how Epsom salts, containing hydrated $MgSO_4$, can be produced.



(a) Identify **P** and **Q**.

P: .....

Q: ..... [2]

(b) Write the chemical equation, including state symbols, for the reaction between insoluble solid **Q** and dilute sulfuric acid.

..... [2]

(c) 5.25 g of solid **Q** is collected as residue.

Calculate the concentration of magnesium sulfate solution formed, when 50 cm^3 of 1.25 mol/dm^3 dilute sulfuric acid is added to solid **Q**.

[3]

(d) State why it is not advisable to evaporate magnesium sulfate solution to complete dryness.

.....

..... [1]

(e) Suggest a more direct method to prepare Epsom salts in the laboratory.

.....

..... [1]

B3 This question is on different types of oxides and their reactions.

(a)

	test	observation
1	Add dilute acid **B** to metal oxide **A** until no further change.	Yellow solid dissolve to form a colourless solution.
2	To the mixture from Test 1, add aqueous sodium hydroxide until no further change.	White precipitate formed which dissolved in excess aqueous sodium hydroxide to form a colourless solution.
3	To the mixture from Test 2, add aluminium foil and warm.	Gas **C** evolved turn damp red litmus paper blue.
4	Add zinc powder to a fresh portion of metal oxide **A**, and heat strongly until no further change.	White solid **D** and grey deposit observed upon cooling.

(i) Identify **A** to **D**

A: .....

B: .....

C: .....

D: ..... [4]

(b) Copper(II) oxide is a black solid used as a pigment in ceramics.

(i) Write the chemical equation for the reaction between copper(II) oxide and zinc when they are heated.

..... [1]

(ii) State one observation when copper(II) oxide is added to sulfuric acid.

.....

..... [1]

B4 Experiments are carried out to investigate the effect of concentration of reactants on the rate of reaction.

A precipitation reaction occurs when cadmium(II) sulfate, $CdSO_4$, is added to potassium sulfide, K_2S.

experiment	concentration of $CdSO_4$ / mol/dm^3	concentration of K_2S / mol/dm^3	rate of formation of CdS / g/s
1	0.100	0.100	0.0200
2	0.200	0.100	0.0400
3	0.100	0.300	0.180

(a) Write the ionic equation, including state symbols, for this reaction.

..... [1]

(b) State the relationship between the concentration of K_2S and the rate of reaction.

.....

..... [1]

(c) Explain the effect of concentration of $CdSO_4$, in terms of collisions between particles, on the rate of reaction.

.....

.....

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..... [2]

(d) State and explain how the rate of this reaction can be measured in the laboratory.

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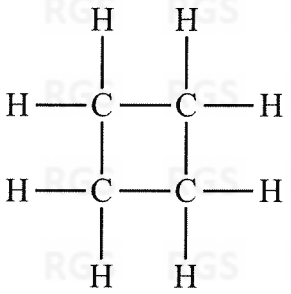
..... [2]

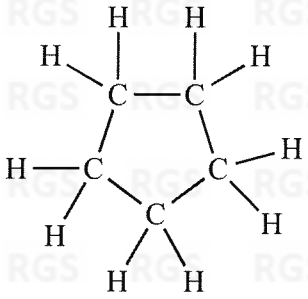
B5 Cycloalkanes are a type of alkane that have one or more rings of carbon atoms in their structure. Many cycloalkanes are used in motor fuel, kerosene, and other heavy oils.

Cyclobutane and cyclopentane are two members of this homologous series. Their structures are shown below.

cyclobutane



cyclopentane



(a) State why cycloalkanes are saturated compounds.

.....

..... [1]

(b) Cyclobutane has a boiling point of 12.5 °C but cyclopentane has a boiling point of 49 °C. Explain the difference in boiling points, in terms of their bonding and structure.

.....

.....

.....

.....

.....

..... [3]

(c) Cyclopentane has several structural isomers which are alkenes.

Name and draw the displayed formula of one of these isomers.

Name: ..... [2]

(d) The alkene from part **(c)** was converted to an alcohol.

State the reagents and conditions for this reaction.

Reagents:.....

Conditions:..... [2]

(e) A student conducted a calorimetric experiment and found that the complete combustion of one mole of cyclobutane released 2702 kJ of heat energy.

(i) Construct an equation for the complete combustion of cyclobutane.

..... [1]

(ii) Calculate the heat energy released when 500 dm^3 of cyclobutane, at room temperature and pressure, is completely combusted.

[2]

(iii) The table below shows some average bond energies, measured in kJ/mol.

bond type	average bond energies
C-H	413
C-C	348
C=C	614
C-O	358
C=O	799
O-O	146
O=O	495
O-H	463
H-H	436

Using average bond energies, calculate the theoretical amount of heat energy released when one mole of cyclobutane is combusted.

[2]

(iv) Suggest a reason for the difference between the theoretical value calculated in part **(iii)** and experimental value of heat energy obtained.

.....

..... [1]

(v) Explain, in terms of the energy associated with bond breaking and bond making, why combustion of cyclobutane is exothermic.

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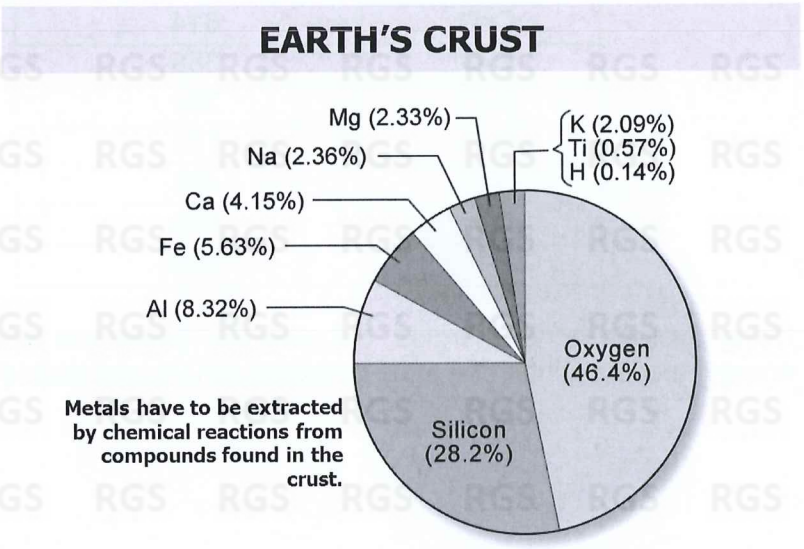
..... [2]

B6 About 98% of the minerals making up the Earth's crust are made up of just eight elements. Most of these elements are found combined with other elements to form compounds.

The diagram below shows the minerals that occur naturally in the Earth's crust.



(a) Aluminium ores are called bauxite. Bauxite is purified to produce aluminium oxide. Aluminium oxide is then mixed with molten cryolite and converted to pure aluminium by electrolysis.

(i) State the function of adding cryolite to aluminium oxide during electrolysis.

.....

..... [1]

(ii) Write the half equations, with state symbols, for the reactions at the electrodes.

Anode: .....

Cathode: ..... [2]

(iii) The manufacturing of aluminium is very expensive as the carbon anode needs to be replaced often.

Suggest a reason for this.

.....

..... [1]

(iv) Pure aluminium reacts with atmospheric oxygen readily to form a layer of aluminium oxide.

Suggest how this oxide layer can be removed.

.....

..... [1]

(b) A student decides to produce aluminium metal in the school laboratory by electrolysis of aluminium nitrate solution.

State and explain if this method is feasible.

.....

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..... [3]

(c) Aluminium is widely used in food packaging, electrical cables and aircraft construction. It is 100% recyclable and it experience no loss in quality during the recycling process.

Suggest another reason why we should recycle aluminium instead of relying on mining of aluminium ores.

.....

..... [1]

(d) Molybdenum is a transition element and can be manufactured by heating together molybdenum(VI) oxide, MoO_3, and aluminium. There is only one other product in this reaction.

(i) Construct the equation for this reaction.

..... [1]

(ii) Explain if this is a redox reaction.

.....

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.....

..... [2]

(iii) A student commented that the reaction occurs **spontaneously** because molybdenum is **more reactive** than aluminium.

State and explain if you agree with this statement, elaborating on the words in bold.

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.....

.....

..... [3]

End of Paper

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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	Key proton (atomic) number atomic symbol name relative atomic mass										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 –		

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.).