O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2022
Secondary Four Express

CANDIDATE NAME: ______________________

CLASS: ____ / ____ INDEX NUMBER: ______

CHEMISTRY **6092/02**

Paper 2

18 Aug 2022

1 hour 45 minutes

0800 – 0945h

Candidates answer in the Question Paper.

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer all questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer all 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 is printed on page 22.

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

Section A	
Section B	
Total	

This document consists of **22** printed pages.

Setter: Ms Sheena Cheong

Section A

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

A1 **(a)** The diagrams can be used to represent the structures of organic compounds that produce a smell.

A	$H_3C-CH_2-CH=CH_2$
B	$H_3C-CH_2-CH_2-CH_2-CH_2(-O-H)$
C	$H_3C-CH_2-CH_2-CH_2-CH_2-CH_2(-O-H)$
D	$H_3C-CH_2-CH_2-C(-O-H)=O$
E	$H_3C-CH_2-CH_2-CH(-O-H)-CH_3$
F	$H_3C-CH=CH-CH_3$

Use the letters **A**, **B**, **C**, **D**, **E** and **F** to answer the questions.

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

(i) Which compounds are isomers?

.... [1]

(ii) Suggest one pair of compounds that undergoes a reaction to form an ester.

.... [1]

(iii) Which compounds can decolourise aqueous bromine?

.... [1]

(iv) Which compound can react with magnesium to produce a gas that extinguished a lighted splint with a 'pop' sound?

..... [1]

(b) Crude oil produces a range of substances that have many uses.

Which statements about the different fractions of crude oil are true and which are false?

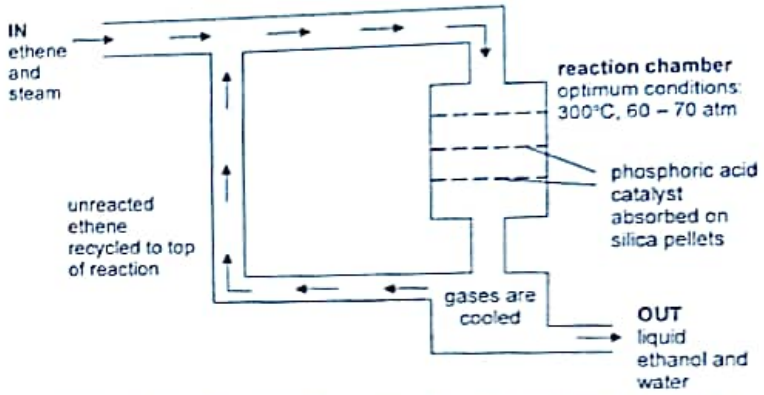
Put a tick (✓) in one box in each row.

	true	false
Petroleum is separated by different density into different fractions.		
Alkanes used in diesel fuel have lower boiling points than those used in motor cars.		
The fraction used as feedstock for making plastics is extracted from higher up the fractionating column than the fraction used for kerosene (paraffin).		
Each fraction contains a mixture of hydrocarbons.		

[2]

[Total: 6]

A2 (a) Ethanol can be manufactured by the catalysed addition of steam to ethene. Ethene is obtained from crude oil. The reaction is reversible and can be represented with the following flow scheme.



(i) Write a balanced chemical equation for the catalysed addition of steam to ethene.

..... [1]

(ii) Give a reason why the unreacted ethene is recycled.

.....

..... [1]

(iii) It is important that oxygen does **not** enter the reaction chamber.

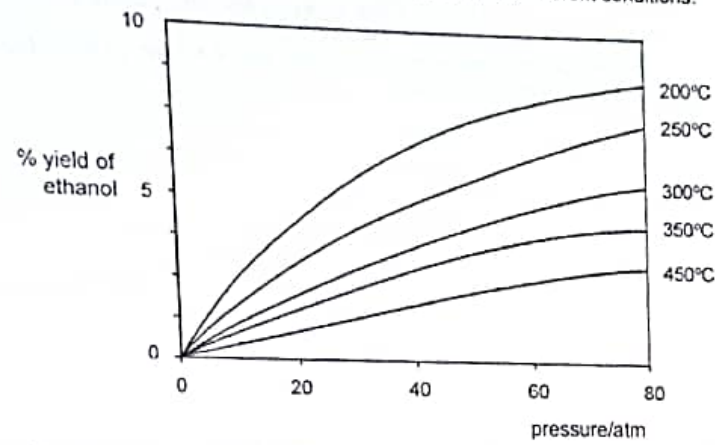
Suggest a reason why.

.....

..... [1]

(b) Temperature will affect both the rate of reaction and yield of ethanol produced.

The graph shows the yield of ethanol that is made under different conditions.



(i) Using information from the graph, state the temperature and pressure that would give the highest yield of ethanol.

..... [1]

(ii) Explain why the optimum conditions for the production of ethanol are different from your answers in **(b)(i)**.

.....

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..... [2]

[Total: 6]

A3 In 2010, the Nobel Prize Physics was awarded for production of graphene from graphite. Graphene is an allotrope of carbon consisting of a single layer of atoms arranged in a two-dimensional hexagonal lattice structure.

Fig. 3.1 shows the structure of graphene and Fig. 3.2 shows the structure of graphite.

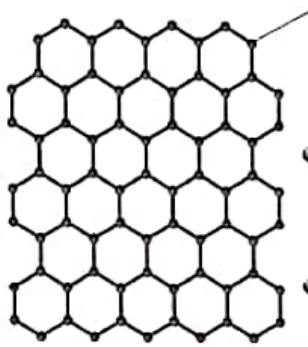

Fig. 3.1

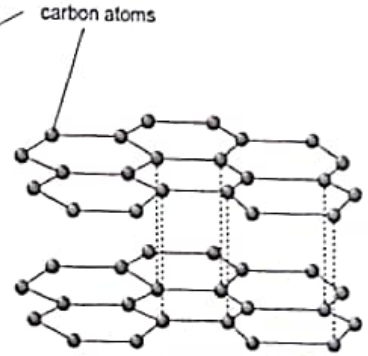

Fig.3.2

(a) Graphene can be prepared from graphite using sticky tape.

Use ideas about bonding and structure in graphite to explain why it is possible to create graphene by this method.

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..... [2]

(b) Some of the properties of graphene include having high electrical conductivity and strength.

Explain how graphene can conduct electricity and have high strength.

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..... [4]

(c) Graphene is transparent hence it is suitable to overlay a monitor screen and function as a touchscreen.

Explain why graphene is transparent.

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..... [1]

[Total: 7]

A4 Table 4.1 shows results of different tests conducted to compare the properties of two dibasic acid, sulfuric acid and tartaric acid, of the same concentration.

Table 4.1

test	sulfuric acid	tartaric acid
Universal Indicator	red	orange
volume of gas collected 10 s after reacting with magnesium	14 cm^3	6 cm^3
volume of sodium hydroxide required for complete neutralisation of 25.0 cm^3 of acid	22.00 cm^3	22.00 cm^3

(a) (i) Explain the difference between a strong acid and a weak acid.

.....

..... [1]

(ii) Use relevant tests and results in Table 4.1 to explain which acid is the weaker acid.

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..... [3]

(b) The reaction of tartaric acid with aqueous sodium hydroxide can be represented by the equation below, where the tartrate anion is given the symbol T.

$$H_2T(aq) + 2NaOH(aq) \rightarrow Na_2T(aq) + 2H_2O(l)$$

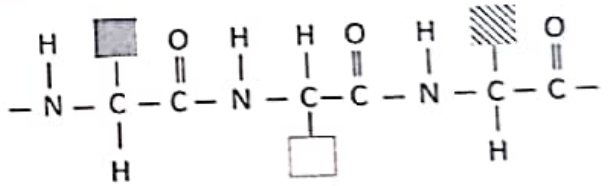
Calculate the concentration of tartaric acid in mol/dm^3, if 0.100 mol/dm^3 of sodium hydroxide is used.

[3]

[Total: 7]

A5 Proteins are natural polyamide which can be hydrolysed to determine its component amino acids. Hydrolysis is the breaking down of the protein into its constituent monomers, amino acids. Amino acids are organic compounds that dissolved in water to form colourless solutions.

Below is a representation of a protein molecule of which only the repeating units are shown.



(a) Explain what is meant by a polymer.

.....

..... [1]

(b) Draw the structural formula of the **three** amino acids obtained from the hydrolysis of this protein.

[3]

(c) Suggest how the three amino acids obtained can be identified.

.....

.....

..... [2]

(d) Chlorine is used in the manufacture of chloroethene, C_2H_3Cl. When chloroethene undergoes polymerisation, poly(chloroethene) is formed.

State **two** differences between the polymerisation processes used to manufacture proteins and poly(chloroethene).

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.....

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..... [2]

[Total:8]

A6 Chlorofluorocarbons (CFCs) have been used in large quantities as solvents and aerosol propellants.

When CFC molecules diffuse into the atmosphere, they destroy the ozone layer in the stratosphere, which is about 30 kilometres from the Earth's surface.

One of the most widely used CFCs was CCl_2F_2 and CH_3CCl_2F.

(a) CCl_2F_2 can be made from methane via photochemical substitution reaction with chlorine and fluorine gas.

(i) Draw a "dot and cross" diagram for CCl_2F_2 molecule.

Show outer electrons only.

[2]

(ii) Explain why the reaction between methane with chlorine and fluorine to form CCl_2F_2 is a substitution reaction and suggest why it is described as photochemical.

.....

.....

..... [2]

(b) CH_3CCl_2F is made by adding hydrogen fluoride to an unsaturated organic compound **A**.

Draw the structural formulae of compound **A**.

compound **A**

[1]

(c) When CFCs rise to the stratosphere, energy from sunlight breaks C–Cl bonds in CFCs to produce chlorine atoms. Chlorine atoms cause the breakdown of ozone in a two-step process.

step 1 $Cl + O_3 \rightarrow ClO + O_2$

step 2 $ClO + O \rightarrow Cl + O_2$

One Cl atom can destroy 100 000 ozone molecules.

Use the equations for step 1 and 2 to explain why.

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.....

.....

..... [2]

(d) Why is the ozone layer important to us?

.....

..... [1]

[Total: 8]

A7 Zinc can be extracted from zinc blende, ZnS, or from calamine, $ZnCO_3$ in a two stage process.

Stage 1:

equation 1 $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

equation 2 $ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$

Stage 2:

equation 3 $ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

(a) Gases from the extraction of zinc is collected and treated to prevent environmental problems.

Describe the environmental problems that could occur if the gases are released into the atmosphere.

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..... [2]

(b) Use oxidation states to explain why equation 2 is not a redox reaction.

.....

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..... [2]

(c) Zinc obtained from extraction contains impurities, like cadmium, zinc, lead and iron, and is further purified by fractional distillation.

Table 7.1 shows the boiling point of zinc and the impurities.

Table 7.1

element	boiling point/°C
cadmium	766
zinc	907
lead	1749
iron	2862

(i) Using information from Table 7.1, explain how zinc is separated from the impurities.

.....

.....

..... [2]

(ii) Purified zinc has a lot of uses and one of the uses is rust prevention.

Explain how zinc prevents rust formation.

.....

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..... [2]

[Total: 8]

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 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 – Cl	431	127
H – Br	366	141
H – I	299	161
Cl – Cl	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	Cl	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 the factors, other than atomic size of atoms, that affect bond length.

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..... [2]

(b) Explain how one of the factors stated in **(a)** affects bond energy.

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..... [2]

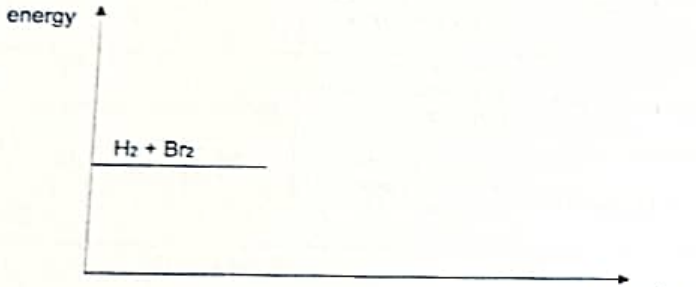
(c) (i) Using information provided, calculate the enthalpy change of the reaction between bromine and hydrogen.

[1]

(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]

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

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..... [4]

(e) Suggest a value for bond length in HF.

..... [1]

[Total: 12]

B9 In 1904, J.J. Thompson proposed a model of an atom. He called this the 'plum pudding' model with only protons and electrons filling a sphere.

Fig. 9.1 shows a 'plum pudding' model of an atom, containing 11 electrons in a sphere of protons.

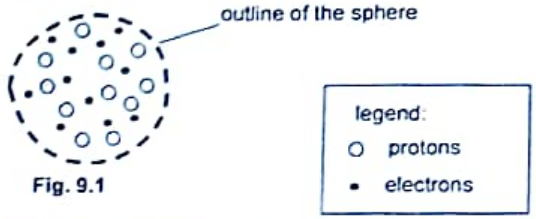

Fig. 9.1

(a) Describe **three** ways in which Thompson's 'plum pudding' model differs from our present idea of the structure of an atom.

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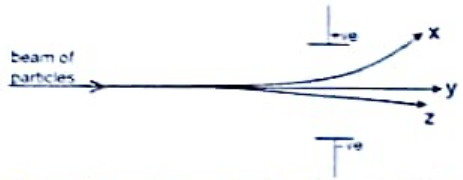
..... [3]

(b) One of the experiments that led to the development of the atomic model involves passing a beam of particles **x**, **y** and **z** between charged plates. The diagram shows how the beams are affected by the plates.



From the diagram, what can be deduced about the properties of the particles **x**, **y** and **z**?

Explain your answer.

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..... [3]

(c) Fig. 9.2 shows a model proposed by a student to show the structure of an ion formed by the atom in Fig 9.1.

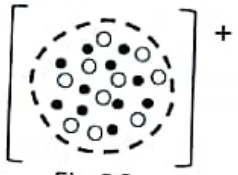

Fig. 9.2

legend:
O protons
• electrons

Explain why the model is **not** an accurate representation of the structure of the ion formed.

.....

.....

..... [2]

[Total: 8]

Either

B10 The apparatus shown in Fig. 10.1 was used to study the catalytic effect of certain substances on the reaction between zinc and dilute sulfuric acid.

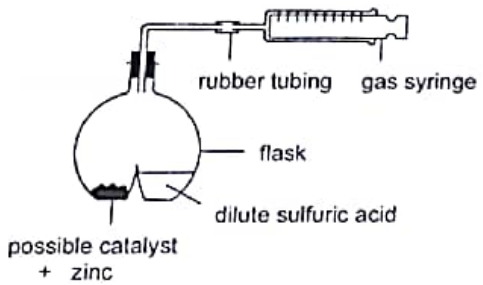

Fig. 10.1

Several experiments were carried out. In each experiment, 1.0 g of zinc powder, 50 cm^3 of 1.0 mol/dm^3 sulfuric acid and 0.1 g of a possible catalyst were used. To start the reaction, the flask was shaken.

The time taken to collect 50 cm^3 of hydrogen and other observations are shown in Table 10.2.

Table 10.2

experiment	possible catalyst added	time to collect 50 cm^3 of hydrogen / s	other observations
1	no catalyst added	65	---
2	0.1 g of copper(II) sulfate	10	colourless solution obtained and a brown solid coated the zinc
3	0.1 g of copper powder	19	brown solid remained
4	0.1 g of copper lumps	56	brown solid remained
5	0.1 g of sodium sulfate	65	colourless solution formed

(a) Explain why it was important to carry out experiment 1.

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..... [1]

(b) Temperature is a condition that should be kept constant to ensure that the experiments are fair.

Use ideas about energy and collisions to explain why.

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..... [3]

(c) Compare and explain the results obtained from experiment 3 and 4.

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..... [4]

(d) Explain the observations that occur in experiment 2.

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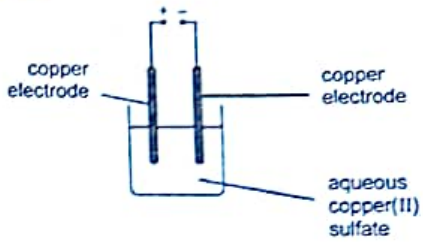
..... [2]

[Total: 10]

Or

B10 A student investigated the electrolysis of aqueous copper(II) sulfate using the apparatus shown below.



The student carried out three experiments and weighed the copper cathode before and after electrolysis.

Table 10.3 shows the results of his experiments.

Table 10.3

experiment number	current used/ A	time taken/ s	mass of cathode	
			before electrolysis/ g	after electrolysis/ g
1	2.0	180	1.24	1.36
2	4.0	180	1.20	1.44
3	2.0	360	1.34	1.58

(a) Construct an ionic equation for the reaction that occur at the anode.

anode ..... [1]

(b) Describe and explain how the factors affect the mass of copper deposited on the cathode using information from Table 10.3.

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..... [3]

(c) In experiment 2, the student measured the mass of the anode before and after electrolysis.

The mass of the anode at the start was 1.45 g.

Determine the mass of the anode after electrolysis.

[2]

(d) The student carried out a fourth experiment.

Carbon electrodes are used instead of copper electrodes, with all other conditions kept the same as experiment 1.

Describe and explain the differences in observations at the electrode(s) and in the electrolyte.

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..... [4]

[Total: 10]

The Periodic Table of Elements

Group I	II											III	IV	V	VI	VII	0
																	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 -	113 Nh nihonium -	114 Fl flerovium -	115 Mc moscovium -	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.)