Name: _____ ( ) Class: _____

CHIJ KATONG CONVENT

PRELIMINARY EXAMINATIONS 2022

Secondary Four Express

CHEMISTRY 6092/02

Duration: 1 hour 45 minutes

Class: 405, 406

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer all **three** questions, the last question is in the form either/ or.
Answer **all** questions in the spaces provided.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

At the end of the examination fasten all your work securely together.
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 20.

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

FOR EXAMINER'S USE	
Paper 1	**/ 40**
Section A	**/ 50**
Section B	**/ 30**
TOTAL	**/ 120**

Section A

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

A1 Choose from the following oxides to answer the questions.

calcium oxide
iron(III) oxide
lithium oxide
magnesium oxide
nitrogen dioxide
silicon dioxide

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

State which oxide

(a) has a simple molecular structure,

…..…….. [1]

(b) is a coloured solid,

…..…….. [1]

(c) contains ions with a +1 charge,

…..…….. [1]

(d) is a product of the thermal decomposition of limestone,

…..…….. [1]

(e) is used in the cracking of long-chain hydrocarbons.

…..…….. [1]

[Total: 5]

A2 Table 2.1 shows a list of elements and their atomic and mass numbers.

Table 2.1

element	A	B	C	D	E	F	G	H
atomic number	8	11	15	17	18	28	30	35
mass number	16	23	31	37	40	59	65	80

A to H are not the atomic symbols of the elements.
Using the letters, A to H, choose an element which

(a) forms coloured compounds,

…..…….. [1]

(b) forms an anion with a charge of -2 most readily,

…..…….. [1]

(c) has lower density than potassium and reacts vigorously with water,

…..…….. [1]

(d) forms a diatomic molecule which displaces bromine from sodium bromide solution.

…..…….. [1]

[Total: 4]

A3 Fig. 3.1 shows a part of the metal reactivity series.

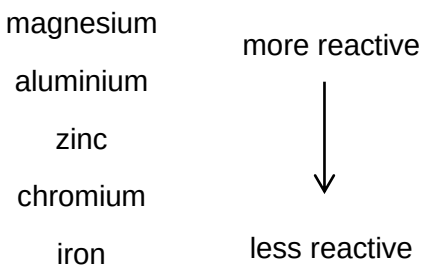


Fig. 3.1

(a) When chromium reacts with dilute hydrochloric acid, its oxidation state increases from 0 to +2.

Give the chemical formulae of the products formed when chromium reacts with dilute hydrochloric acid.

…..…….. [1]

A3 **(b)** Aluminium is a reactive metal. However, when an aluminium wire is immersed in dilute hydrochloric acid, no visible reaction was observed.

Explain why this is so.

…..……..……..…

…..……..……..…

…..……..……..… [2]

(c) Pure zinc metal is soft and has limited uses as it corrodes easily.

A brass alloy consists of 11% copper and 89% zinc.

However it is widely used to make musical instruments and statues because of its corrosion resistance and aesthetic appearance.

Draw a labelled diagram to show the arrangement of the atoms in this brass alloy in the box provided.

[2]

[Total: 5]

A4 This question is about the reactions of aqueous potassium hydroxide.

(a) Aqueous potassium hydroxide reacts with dilute sulfuric acid as shown.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

In an experiment, 0.78 g of aqueous potassium hydroxide was added to 45 cm^3 of 0.20 mol / dm^3 sulfuric acid.

Show by calculation that sulfuric acid is in excess.

[3]

(b) Aqueous potassium hydroxide is warmed with aqueous ammonium carbonate.

State the name of the gaseous product formed in this reaction.

…..…..…..… [1]

[Total: 4]

A5 Hydrogen reacts with chlorine to produce hydrogen chloride. The reaction is represented by the equation.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \triangle H = -184 \text{ kJ / mol}$$

(a) Apart from temperature, state and explain, in terms of collisions between reacting particles, another factor that increases the rate of this chemical reaction.

…..…..…….

…..…..…….

…..…..…….

…..…..… [2]

A5 (b) (i) Calculate the energy released when excess hydrogen reacts with 2 moles of chlorine. You may assume that no other side reaction occurs.

energy released = ……. kJ [1]

(ii) Explain why the reaction is exothermic, in terms of the energy changes that take place during bond breaking and bond making.

…..……..…….

…..……..……

…..……..…… [2]

[Total: 5]

A6 (a) Ammonia is manufactured by the Haber Process as shown in the equation.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \triangle H = -92.4 \text{ kJ / mol}$$

Table 6.1 shows how the percentage yield of ammonia at equilibrium varies with both temperature and pressure.

Table 6.1

pressure / atm	percentage yield of ammonia at equilibrium			
	200 °C	300 °C	400 °C	500 °C
40	72	34	13	5
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(i) Describe how the percentage yield of ammonia at equilibrium changes with temperature.

……..……...

……..……..…… [1]

A6 **(a)** **(ii)** Describe how the percentage yield of ammonia at equilibrium changes with pressure.

……..……...

……..……..…… [1]

(iii) Finely divided iron acts as a catalyst in the Haber Process.

Explain how using a catalyst has an economic advantage.

……..……...

……..……...

……..……..…… [2]

(b) The ammonia produced in the Haber Process is used to manufacture nitric acid by a two-stage process.

Stage 1 Ammonia is converted to nitrogen monoxide.

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

Stage 2 Nitrogen monoxide is converted to nitric acid.

$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$

Use the equations in the two stages to construct an overall chemical equation for the conversion of ammonia to nitric acid.

……..……..…… [1]

[Total: 5]

A7 This question is about alkanes and alkenes.

(a) The boiling point, melting point and density of alkanes increase as the number of carbon atoms increases.

State another physical property of alkanes which increases as the number of carbon atoms increases.

…..……..……..…… [1]

(b) Two typical reactions of alkanes are combustion and cracking.

(i) State the name of another typical chemical reaction of alkanes.

……..……..…… [1]

(ii) State the chemical name of the reactant for the reaction in **(b)(i).**

……..……..…… [1]

A7 **(c)** Alkenes are produced by cracking alkanes. Tridecane, $C_{13}H_{28}$, can be cracked to produce an alkene with four carbon atoms and one other hydrocarbon only.

Construct a chemical equation for this reaction.

…..……..…… [1]

(d) A hydrocarbon contains 88.9% carbon by mass.

Calculate the empirical formula of this compound.

[2]

[Total: 6]

A8 The structure of an organic compound, T, is shown in Fig. 8.1.

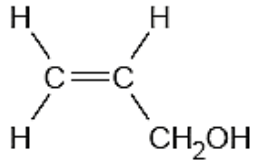


Fig. 8.1

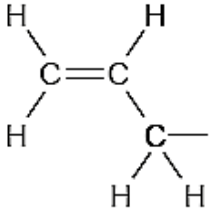
(a) Compound T can be oxidised to a carboxylic acid.

Suggest a suitable oxidising agent for this reaction.

…..……..…… [1]

(b) Compound T reacts with methanoic acid, HCOOH, to form an ester.

Complete the structure of this ester to show all the atoms and all the covalent bonds.



[1]

A8 **(c)** Dilute methanoic acid is a weak acid. Dilute nitric acid is a strong acid.

Give the formula of the ion that is present in both acids.

…..…….....… [1]

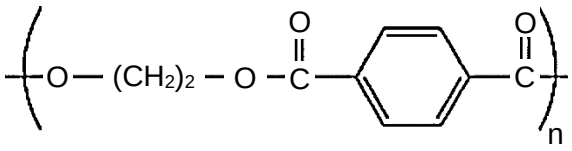
(d) Write a chemical equation for the reaction of methanoic acid with zinc.

…..…….....… [2]

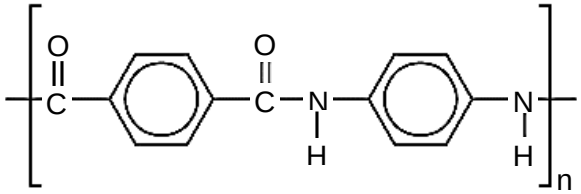
[Total: 5]

A9 Fig 9.1 shows the structure of some polymers A, B, C and D.

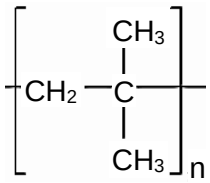
A



B



C



D

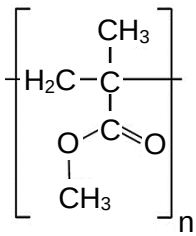


Fig. 9.1

(a) A sample of polymer C contains molecules with a relative molecular mass of 14 000.

Determine the number of carbon atoms present in a molecule of the polymer.

[2]

A9 **(b)** Predict if each statement is true or false.

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

	true	false
Polymer D is a polyester.		
Water is formed as a by-product when monomers react to form polymers A and B.		
The empirical formula of polymer C is the same as its monomer.		
One of the monomers that reacts to form polymer B is an alcohol.		

[2]

(c) Draw the structural formulae of the two monomers that react to form polymer A.

[2]

(d) **(i)** Draw the structural formula of the monomer that reacts to form polymer D.

[1]

A9 (d) (ii) The monomer in **(d)(i)** can be formed by reacting an acid and an alcohol under suitable conditions.

Draw the structural formulae of the acid and alcohol.

[2]

(e) Polymers A, B, C and D are non-biodegradable.

State why being non-biodegradable is both an advantage and a disadvantage.

……..……...…….……..…....…....

……..……...…….……..…....…....

……..……...…….……..…....…....

…..……...……..… [2]

[Total: 11]

Name: _____ ( ) Class: _____

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.

B10 This question is about copper and its compounds.

(a) Anhydrous copper(II) sulfate is used to test for the presence of water. When this test is positive, hydrated copper(II) sulfate is formed.

(i) State the colour change observed during this test.

…… [1]

(ii) State how hydrated copper(II) sulfate can be changed back into anhydrous copper(II) sulfate.

…… [1]

(iii) Describe a test to determine if a sample of water is pure.

……

……

…… [2]

(b) When 4.7 g of copper(II) nitrate is heated strongly, it decomposes to produce copper(II) oxide, nitrogen dioxide and oxygen as shown by the chemical equation.

$$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$$

Calculate

(i) the volume of nitrogen dioxide formed at room temperature and pressure,

[2]

B10 **(b)** **(ii)** the mass of oxygen formed.

[2]

(c) Copper(II) oxide powder can be reduced to copper by reacting with hydrogen gas.

Write the chemical equation for this reaction with state symbols included.

……..….[2]

[Total: 10]

B11 Figure 11.1 shows an experimental set-up of two cells, Cell 1 and Cell 2 connected together. Both electrodes X and Y are made of graphite.

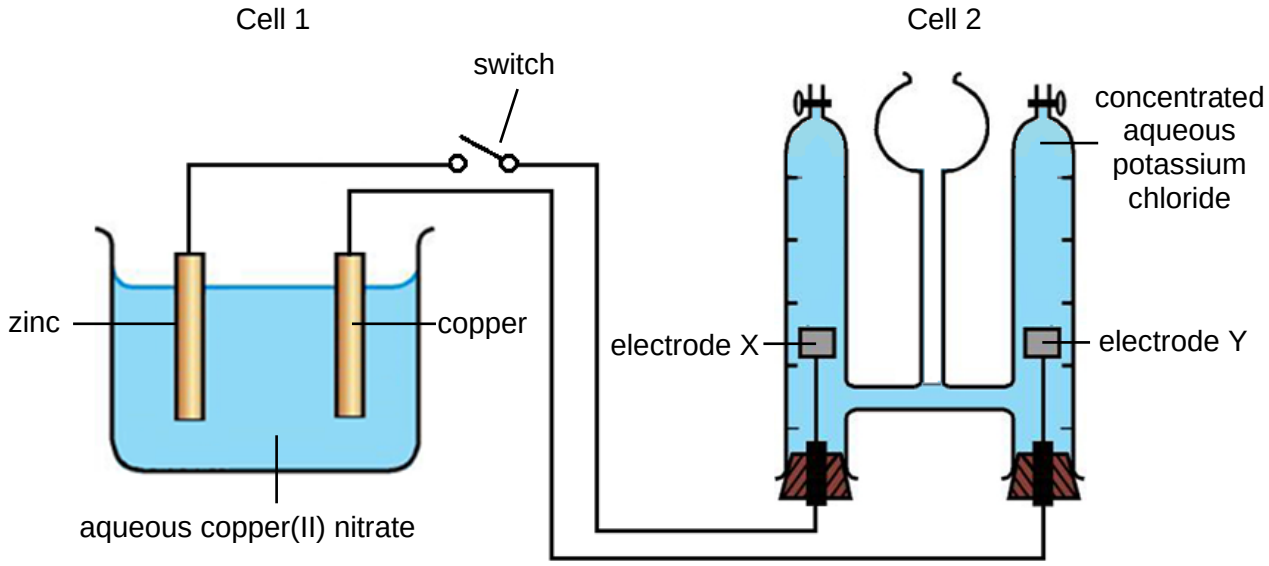


Fig. 11.1

When the switch is closed, reactions occur in both cells.

(a) Deduce which cell is a simple cell.

State a reason for your answer.

……..……...

……..……..[2]

B11 **(b)** Name all the ions present in aqueous copper(II) nitrate in Cell 1.

…… [1]

(c) Write ionic equations for the reactions at the electrodes in Cell 1.

zinc electrode: ……

copper electrode: ……
[2]

(d) A gas is produced at each of the electrodes in Cell 2.

(i) Identify the gas produced at electrode Y.

Explain your answer using ideas of selective discharge.

……

……

…… [2]

(ii) A student draws Fig. 11.2 for Cell 2 after the switch is closed for a period of time to show the volume of the gas collected at each electrode.

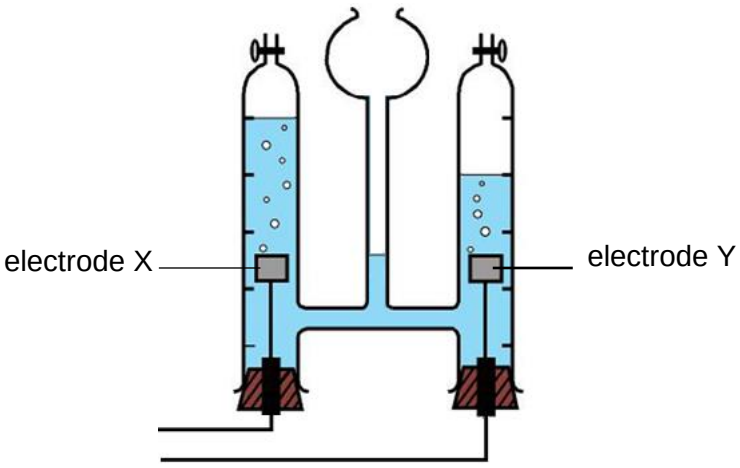


Fig. 11.2

Do you agree with the student's drawing?

Give a reason for your answer.

……

…… [1]

B11 (d) (iii) After the electrolysis has been running for some time in Cell 2, a new product is formed at electrode Y.

Explain the reason for this observation.

……..……...

……..……..……..……..……..……..……. [2]

[Total: 10]

EITHER

B12 Table 12.1 shows some data about the composition of the mixtures of exhaust gases from a car.

Table 12.1

substances in exhaust gases	percentage by volume	
	without catalytic converter	with catalytic converter
nitrogen	67.60	67.75
carbon dioxide	12.00	12.60
water vapour	11.00	11.45
oxygen	9.00	8.20
carbon monoxide	0.20	0
nitrogen oxides	0.15	0
unburnt hydrocarbons (C_8H_{18})	0.05	0

(a) Explain why the exhaust gases from the car contain a large amount of nitrogen.

……..……..……..…

…..……..…… [1]

(b) One of the exhaust gases may contribute to global warming.

State the name of this gas and describe a possible consequence of global warming.

……..……...

……..……...

……..……..……..... [2]

B12 (c) (i) Fig. 12.1 shows the structure of a catalytic converter.

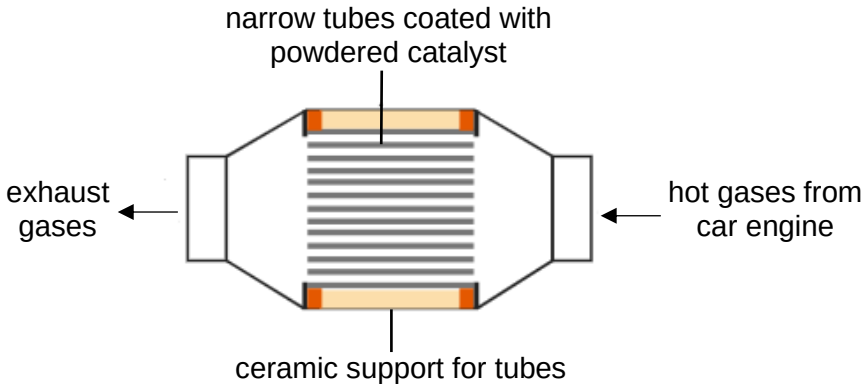


Fig. 12.1

Using the information from Fig. 12.1, state and explain two factors other than a catalyst, why the reactions in the catalytic converters are fast.

……

……

……

…… [2]

(ii) Using the information in the Table 12.1, suggest with explanations, two substances in the exhaust gases that are removed by the catalytic converter.

Write a balanced chemical equation to support your answer.

……

……

……

…… [3]

(iii) Using the information in the Table 12.1, explain why the percentage of nitrogen increases while the percentage of oxygen decreases when using a catalytic converter.

……

……

…… [2]

[Total: 10]

OR

B12 Alcohols can be partially oxidised to form aldehydes.

Aldehydes are a homologous series of organic compounds.

Partial oxidation is achieved by reacting an alcohol with the oxidising agent in a distillation apparatus as shown in Fig. 12.1.

In an experiment carried out in the laboratory, ethanol was partially oxidised to form ethanal which is an aldehyde.

The boiling points of ethanol and ethanal are given in the Table 12.1.

Table 12.1

	ethanol	ethanal
boiling point / °C	78.0	20.0

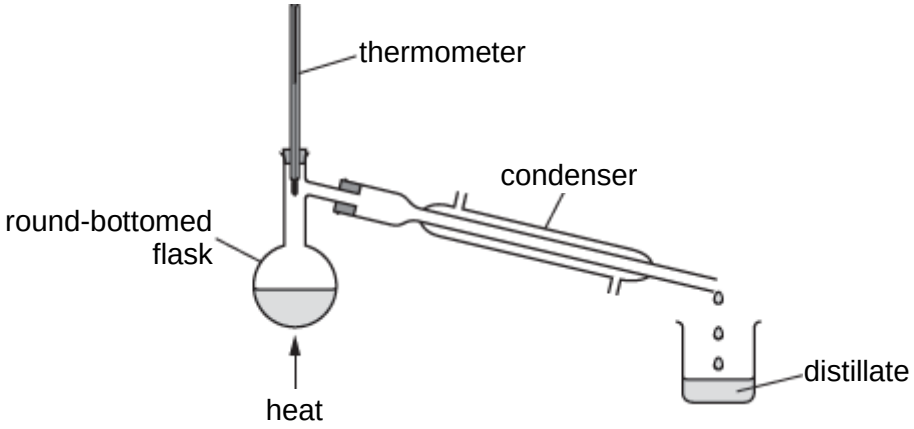


Fig. 12.1

(a) Suggest why only a small amount of distillate was collected using this set-up.

…..…….……..…… [1]

(b) Table 12.2 shows some information about aldehydes.

Table 12.2

name	……	ethanal	propanal	butanal
molecular formula	CH_2O	C_2H_4O	C_3H_6O	……

(i) Complete the missing information in Table 12.2. [1]

B12 **(b)** **(ii)** Deduce the general formula of aldehydes.

…… [1]

(c) The full structural formula of ethanal is shown in Fig. 12.2.

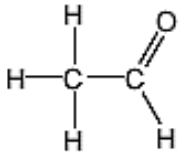


Fig. 12.2

The C=O group in aldehydes is located at the end of the carbon chain.

The C=O group is responsible for the characteristic reactions of aldehydes.

(i) State the name given to the C=O group in aldehydes.

…… [1]

(ii) With reference to Fig. 12.2, draw the dot-and-cross diagram to show the electron arrangement in a molecule of ethanal. Only the valence shells need to be drawn.

[3]

(d) Propanone belongs to another homologous series called ketones.

Ketones have the same C=O group as aldehydes but the C=O group is not at the end of the carbon chain.

Propanone has the same molecular formula as propanal, C_3H_6O.

(i) State the term used to describe molecules with different structural formula but with the same molecular formula.

…… [1]

B12 (d) (ii) Draw the full structural formula of propanone, C_3H_6O.

[2]

[Total: 10]

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.).