Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

9599105666

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

[Turn over

1 A list of compounds is shown.

ammonia
carbon dioxide
carbon monoxide
cobalt(II) chloride
ethane
ethene
glucose
methane
potassium sulfate
sodium phosphate
sulfur dioxide

Answer the following questions using only the compounds from the list.
Each compound may be used once, more than once or not at all.

Give the name of the compound that:

(a) is an unsaturated hydrocarbon

→ presence of atleast one double bond or triple bond.

Ethene ..... [1]

(b) leads to the deoxygenation of water in rivers

→ nitrates and phosphates

Sodium phosphate ..... [1]

(c) is a gas which turns damp red litmus paper blue

→ alkaline gas

Ammonia ..... [1]

(d) is the main constituent of natural gas

Methane ..... [1]

(e) is a product of photosynthesis

→ oxygen, glucose

glucose ..... [1]

(f) is a compound of a transition element.

Cobalt (II) chloride ..... [1]

[Total: 6]

2 Petroleum is a mixture of hydrocarbons.

(a) Describe **two** characteristics of a mixture.

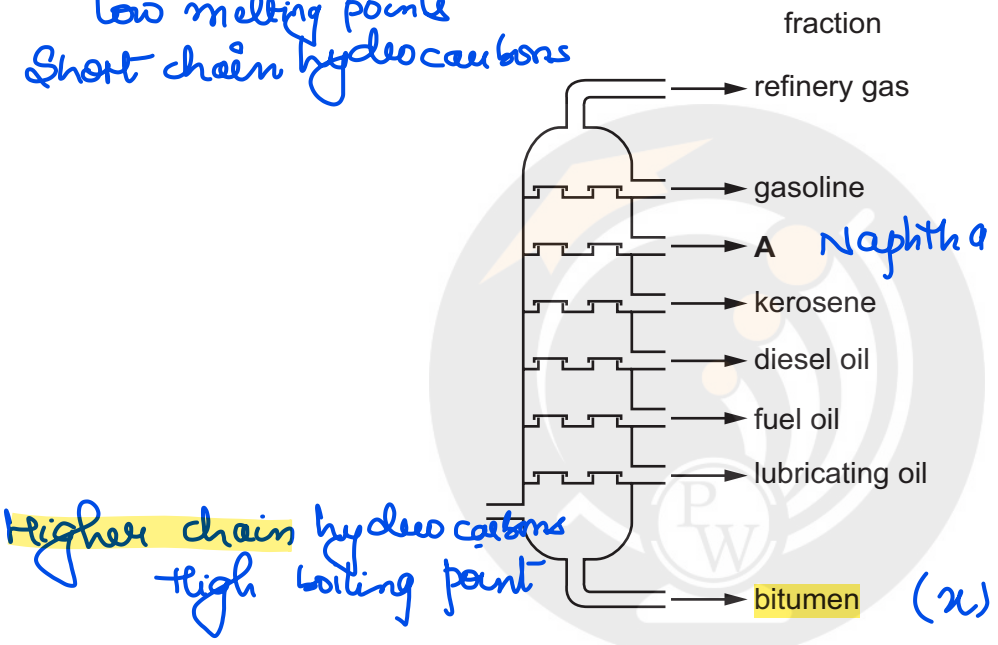
1 In mixture combining elements do not undergo any chemical reaction

2 In mixture combining elements are not in a fixed ratio

[2]

(b) Fig. 2.1 shows a fractionating column for separating petroleum into different hydrocarbon fractions.

Low melting points
Short chain hydrocarbons



Higher chain hydrocarbons
High boiling point

Fig. 2.1

(i) On Fig. 2.1, draw an **X** inside the column to show where the hydrocarbon with the lowest volatility collects. [1]

(ii) Name the fraction labelled **A** in Fig. 2.1.

Naphtha [1]

(iii) State the name of the fraction which has hydrocarbons with the longest chain length.

Bitumen [1]

(iv) State **one** use of the fuel oil fraction.

It is used for heating purpose OR Household heating [1]

[Total: 6]

3 **(a)** Table 3.1 shows the average concentrations, in ng / 1000 cm^3, of air pollutants in four different years.

Table 3.1

year	concentration of air pollutant in ng / 1000 cm^3				
	carbon monoxide	hydrocarbons	oxides of nitrogen	particulates	sulfur dioxide
2019	2.5	12.0	19.6	28.0	30.0
2020	2.0	13.5	21.8	30.1	21.7
2021	1.8	14.8	18.5	27.5	23.8
2022	1.6	16.0	22.7	26.2	25.0

(i) Name the oxide pollutant that has the highest concentration in 2021.

Sulfur dioxide ..... [1]

(ii) Name the pollutant that shows a continuous decrease in concentration from 2019 to 2022.

Carbon monoxide ..... [1]

(iii) Calculate the average mass, in ng, of particulates in a 250 cm^3 sample of polluted air in 2019.

Average mass of particulates $= \frac{250 \times 28}{1000}$

$= \frac{25 \times 28}{100}$

$= 7$

mass = 7 ng [1]

(b) (i) State **one** adverse effect of particulates on health.

Respiratory disorder. ..... [1]

(ii) Particulates are formed by the incomplete combustion of hydrocarbons.

State the meaning of the term incomplete combustion.

Incomplete combustion refers to burning of hydrocarbon in limited supply of air and product is carbon monoxide. ..... [1]

acidic → below pH 7
neutral → pH 7
Basic → above pH 7

(c) (i) Oxides of nitrogen contribute to acid rain.

Choose from the list the pH value for an acidic solution.

Draw a circle around your chosen answer.

pH 5 **pH 7** **pH 9** **pH 13** [1]

(ii) Complete the sentence about removing oxides of nitrogen from car exhausts by choosing **two** words from the list.

agent	**catalytic**	**compound**	**converter**
distillation	**filter**	**oxidising**	**pump**

The emission of oxides of nitrogen from car exhausts is reduced by using a

Catalytic Converters . [1]

(iii) Oxides of nitrogen can be formed by the action of bacteria on nitrates.

Name the aqueous solution and the metal used in the test for nitrate ions.

aqueous solution NaOH / KOH.

metal Aluminium foil.

[2]

(d) Nitrogen dioxide decomposes when heated. Nitric oxide and oxygen are produced.

(i) Complete the symbol equation for this reaction.

$2.NO_2 \rightleftharpoons 2NO + O_2$ [2]

(ii) State the meaning of the symbol $\rightleftharpoons$.

Reversible [1]

[Total: 12]

4 Tin is a solid at room temperature.

(a) State **two** general properties of a solid.

1 Solids have compact structure ie particles are arranged very closely.

2 Solids have definite shape and volume.

[2]

(b) Fig. 4.1 shows the physical states of tin.

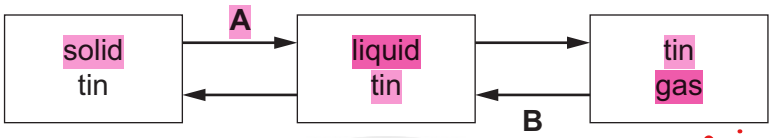


Fig. 4.1

Name the changes of physical states **A** and **B**.

A Melting.

B Condensation

[2]

(c) Describe solid and liquid tin in terms of the separation and motion of the particles.

solid tin

separation Touching

motion particles in solids only vibrate at their position

liquid tin

separation Touching

motion Particles in liquid tin can slide over each other.

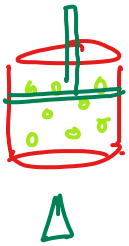
[4]

(d) A sealed gas syringe contains 80 cm^3 of carbon dioxide gas.

State how decreasing the temperature affects the volume of carbon dioxide gas in the gas syringe when the pressure remains constant.

volume decreases

..... [1]



$T_1 > T_2$.

[Total: 9]

5 This question is about metals.

(a) Table 5.1 shows some properties of some Group I metals.

Table 5.1

metal	melting point in °C	boiling point in °C	atomic volume in cm^3/mol	observations on reaction with water
lithium	181	1342	12.9	
sodium	98		23.7	bubbles form rapidly but no flame
potassium	63	760	45.4	bubbles form rapidly and flame seen
rubidium	39	686		explodes

reactivity ↑ going ↓

Use the information in Table 5.1 to predict:

(i) the boiling point of sodium ..... varies between 1342 and 760 ..... [1]

(ii) the atomic volume of rubidium ..... will be higher than 45.4 ..... [1]

(iii) the observations when lithium reacts with water .....

..... bubbles will form. ..... [1]

(iv) the physical state of lithium at 1300 °C. Give a reason for your answer.

physical state ..... liquid .....

reason ..... As it is lower than its boiling point and higher than its melting point. .....

[2]

(b) Iron is extracted in a blast furnace by reduction of iron(III) oxide, Fe_2O_3, with carbon monoxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) Explain how this equation shows that iron(III) oxide is reduced. → removal of oxygen

..... As from Fe_2O_3 there is removal of .....

..... oxygen. ..... [1]

→ oxidation no.

(ii) Choose the phrase which describes the meaning of (III) in iron(III) oxide.

Tick (✓) **one** box.

the number of oxygen atoms in iron(III) oxide	☐
the oxidation number of iron in iron(III) oxide	✓
the number of CO molecules which react with iron(III) oxide	☐
the number of electrons in one atom of iron	☐

[1]

(iii) Calcium carbonate is added to the blast furnace.

The calcium carbonate undergoes thermal decomposition.

Complete the word equation for the thermal decomposition of calcium carbonate.

calcium carbonate $\xrightarrow{\Delta}$ calcium oxide + carbon dioxide

[2]

(c) Stainless steel is an alloy. → mixture of metal – metal, metal – non-metal

(i) Choose the diagram, **A**, **B**, **C** or **D**, in Fig. 5.1 that best shows the structure of an alloy.

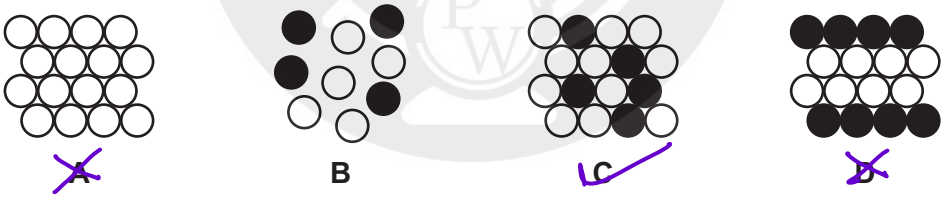


Fig. 5.1

diagram C [1]

(ii) Give **one** reason for using stainless steel instead of pure iron for cutlery.

As stainless steel is shiny in appearance [1]

(d) Table 5.2 gives the observations when four different metals react with dilute hydrochloric acid.

Table 5.2

metal	observations
iron	bubbles form slowly
mercury	no bubbles seen
strontium	bubbles form very quickly
tin	bubbles form very slowly

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive ⟶ most reactive

Mercury	Tin	Iron	Strontium

[2]

[Total: 13]

6 A student investigates the reaction of large pieces of magnesium with dilute hydrochloric acid at 20 °C. The magnesium is in excess.

(a) Fig. 6.1 shows the volume of hydrogen gas released as the reaction proceeds.

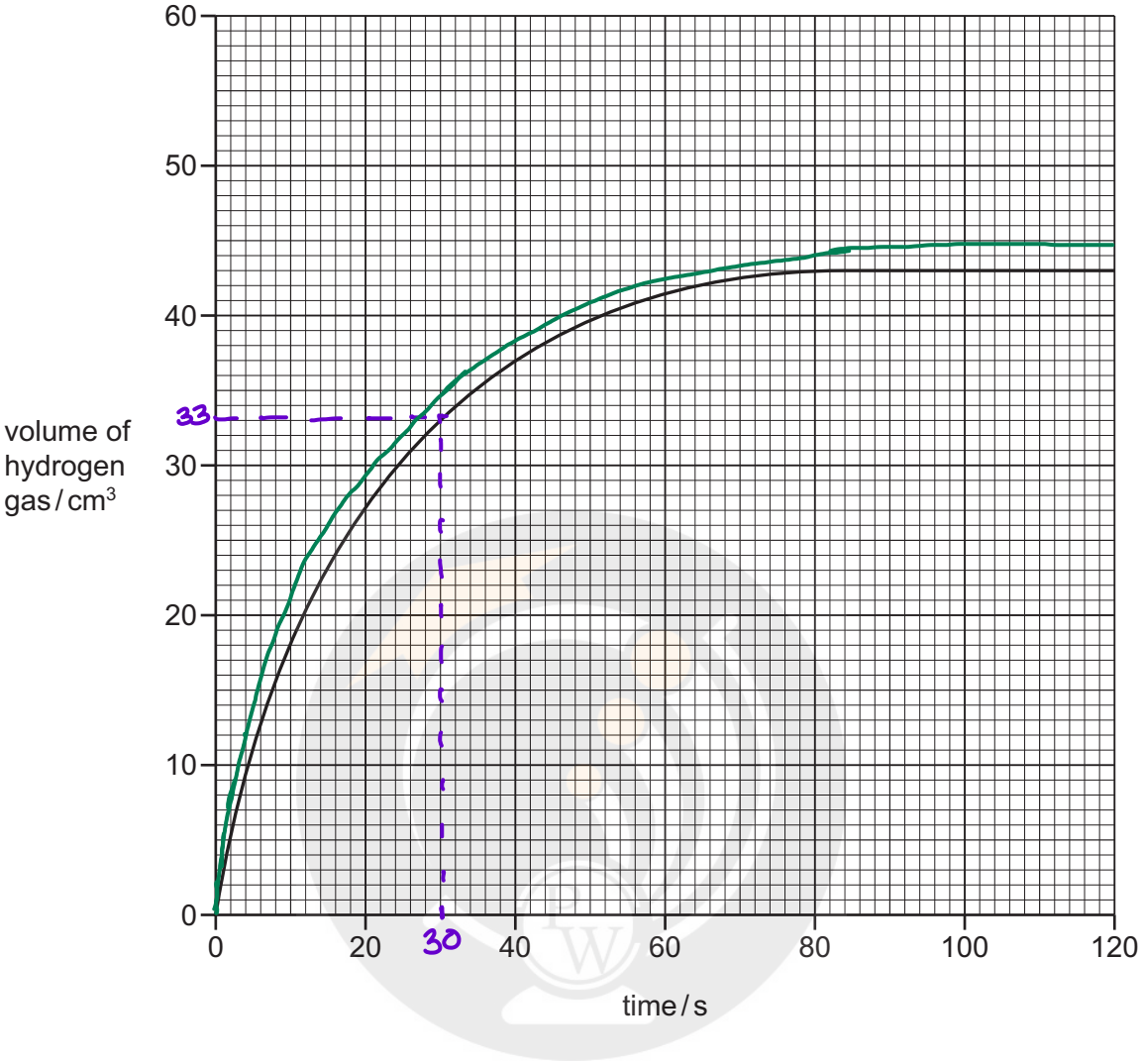


Fig. 6.1

(i) Deduce the volume of hydrogen gas released after 30 seconds.

volume of hydrogen = 33 cm^3 [1]

(ii) The student repeats the experiment using smaller pieces of magnesium. The mass of magnesium used remains the same. The magnesium is still in excess.

All other conditions stay the same.

Draw a line on the grid in Fig. 6.1 to show the volume of hydrogen gas released when smaller pieces of magnesium are used. [2]

(b) (i) The student repeats the experiment at a higher temperature of 35 °C.

All other conditions stay the same.

Describe how the rate of reaction differs when a temperature of 35 °C is used.

Rate of reaction increases ..... [1]

(ii) The student repeats the experiment using a lower concentration of acid.

All other conditions stay the same.

Describe how the rate of reaction differs when a lower concentration of acid is used.

Rate of reaction decreases ..... [1]

(c) Hydrochloric acid reacts with lithium hydroxide.

(i) Complete the word equation for this reaction.

hydrochloric acid	+	lithium hydroxide	→	lithium chloride	+	water

[2]

(ii) Choose from the list the word that best describes this reaction.

Draw a circle around your chosen answer.

addition **decomposition** **neutralisation** **oxidation** base [1]

(iii) State the colour of a solution of thymolphthalein dissolved in aqueous sodium hydroxide.

Blue ..... [1]

[Total: 9]

Thymolphthalein → acid base indicator

↓ acid → colourless

↓ base → blue

7 **(a)** Fig. 7.1 shows the displayed formula of fumaric acid.

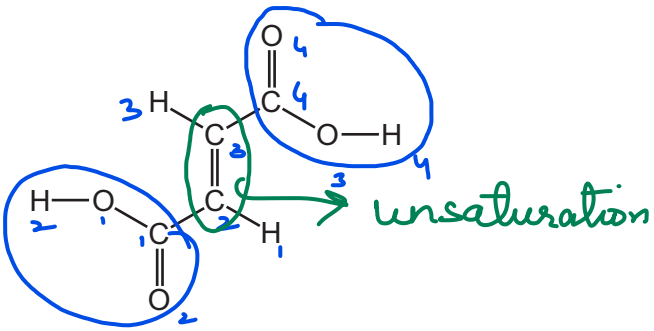


Fig. 7.1

(i) On Fig. 7.1, draw a circle around **one** carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of fumaric acid.

$C_4H_4O_4$ [1]

(iii) Fumaric acid is a colourless compound.

Describe the colour change when excess fumaric acid is added to aqueous bromine.

from orange reddish to colourless [2]

(b) Fumaric acid can be oxidised to produce a compound with the molecular formula $C_4H_6O_6$.

Complete Table 7.1 to calculate the relative molecular mass of $C_4H_6O_6$.

Table 7.1

atom	number of atoms	relative atomic mass	
carbon	4	12	4 × 12 = 48
hydrogen	6	1	6 × 1 = 6
oxygen	6	16	6 × 16 = 96

relative molecular mass = 150 [2]

(c) Ethanoic acid is a carboxylic acid.

Complete the word equation for the reaction of ethanoic acid with sodium carbonate.

ethanoic acid	+	sodium carbonate	→	Sodium ethanoate	+	carbon dioxide	+	watey

[3]

(d) Ethanoic acid can be produced by the oxidation of ethanol.

(i) State **one** use of ethanol.

as a fuel [1]

(ii) Ethanol, C_2H_5OH, is an alcohol.

Choose from the list the general formula for the alcohol homologous series.

Draw a circle around your chosen answer.

C_nH_nOH $C_nH_{2n+1}OH$ $C_nH_{2n+2}OH$ $C_{2n}H_{2n}OH$ [1]

(iii) Ethanol can be manufactured by the addition of steam to ethene.

State **two** conditions for this reaction.

1 300°C

2 600Pa.

[2]

[Total: 13]

8 Zinc chloride is an ionic compound. → presence of ions

(a) Ionic compounds are good electrical conductors when molten or in aqueous solution.

Describe one **other** physical property of ionic compounds.

High melting point ..... [1]

(b) Complete Fig. 8.1 to show:

- the electronic configuration of a chloride ion
- the charge on the ion.

Cl = 17
= 2,8,7

Cl^- = 2,8,8

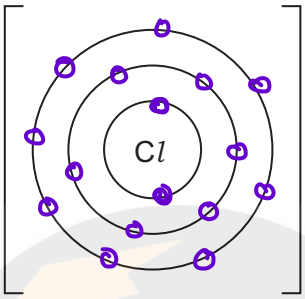


Fig. 8.1

[2]

(c) (i) Deduce the number of protons and neutrons in the zinc ion shown.

$^{67}_{30}Zn^{2+}$ → mass no, → at. no.

at no = no. of p.
no. of n = mass no. − no. of p
= 67 − 30
= 37

number of protons 30

number of neutrons 37

[2]

(ii) Complete this sentence about positive ions.

Positive ions are known as ..... Cations ..... . [1]

(d) Molten zinc chloride is electrolysed using graphite electrodes.

State the names of the products at each electrode and give the observations at the positive electrode.

product at the negative electrode ..... Zinc .....

product at the positive electrode ..... chloride .....

observations at the positive electrode

..... yellow-green vapour .....

[3]

(e) Graphite electrodes conduct electricity.

(i) State one **other** property that the electrode should have.

..... Inert ..... [1]

(ii) Choose the correct statement about the structure and bonding in graphite.

↓ allotrope of carbon

Tick (✓) **one** box.

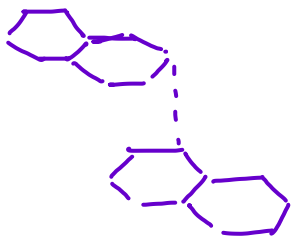
simple ionic	☐
simple covalent	☐
giant ionic	☐
giant covalent	✓

[1]

(iii) State **one** use of graphite other than as an electrode.

..... lubricant. ..... [1]

[Total: 12]



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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

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.).