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CHEMISTRY **0620/32**

Paper 3 Theory (Core) **October/November 2025**

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 Fig. 1.1 shows part of the Periodic Table.

I	II											III	IV	V	VI	VII	VIII
							H										He
												B	C	N	O		Ne
Na																Cl	
K	Ca						Fe				Zn					Br	
										Ag						I	

Fig. 1.1

Answer the following questions using only the symbols of the elements in Fig. 1.1.
Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(a) is used as a lubricant

..... [1]

(b) forms an ion which is present in every dilute acid

..... [1]

(c) is a metal which does **not** react with steam

..... [1]

(d) is in Period 3 and forms an ion with a charge of 1– when it reacts.

..... [1]

[Total: 4]

2 The symbol for an atom of krypton is shown.

$$^{84}_{36}Kr$$

(a) Complete Table 2.1 to show the number of electrons and neutrons in one atom of $^{84}_{36}Kr$.

Table 2.1

number of electrons	
number of neutrons	

[2]

(b) Krypton is a gas at room temperature and pressure.

A sample of krypton is placed in a sealed syringe with a freely moving plunger.

Complete Table 2.2 to show the effect, if any, on the volume of krypton when:

- the temperature of the krypton is decreased
- the pressure of the krypton is increased.

Use the words **increases**, **decreases** or **no change** in your answer.

Table 2.2

change	effect on the volume of krypton
temperature is decreased	
pressure is increased	

[2]

(c) When krypton is cooled, it becomes a liquid.

Describe the arrangement of the particles in liquid krypton.
Give your answer in terms of particle separation and motion.

particle separation .....

.....

particle motion .....

.....

[2]

[Total: 6]

3 **(a)** Table 3.1 shows the masses of ions, in mg, present in a 500 cm^3 sample of contaminated water.

Table 3.1

name of ion	formula of ion	mass of ion in 500 cm^3 of contaminated water / mg
ammonium		2.5
chloride	Cl^-	4.2
hydrogencarbonate	HCO_3^-	6.0
iodide	I^-	0.4
lithium	Li^+	4.3
magnesium	Mg^{2+}	0.8
nitrate	NO_3^-	8.5
phosphate	PO_4^{3-}	0.7
potassium	K^+	9.3
sulfate	SO_4^{2-}	0.3

Answer these questions using the information from Table 3.1.

(i) Name the negative ion that has the highest concentration.

..... [1]

(ii) State the formula of the ammonium ion.

..... [1]

(iii) Describe a test to identify the presence of chloride ions, Cl^-, in a sample of water.

test .....

observations .....

.....
[2]

(iv) Calculate the mass of hydrogencarbonate ions, HCO_3^-, in 200 cm^3 of the contaminated water.

mass = ... mg [1]

(b) The water sample is **not** suitable for use in practical chemistry.

Name a process that makes the water suitable for use in practical chemistry.

..... [1]

(c) Water extracted from a river is made suitable for drinking by filtration and then treatment with carbon followed by chlorination.

(i) State why carbon is used in the treatment of water.

..... [1]

(ii) State why water is chlorinated.

..... [1]

(d) Fig. 3.1 shows the apparatus used to analyse a sample of water containing coloured substances and the results obtained.

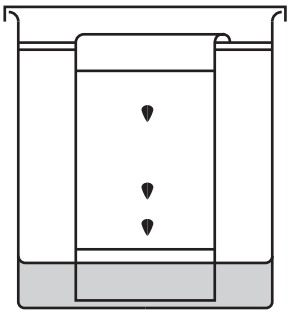

Fig. 3.1

(i) Name the separation method shown in Fig. 3.1.

..... [1]

(ii) Label the solvent front in Fig. 3.1. [1]

[Total: 10]

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4 **(a)** Molecules of compound **A** are found in some plants.

Fig. 4.1 shows the displayed formula of a molecule of compound **A**.

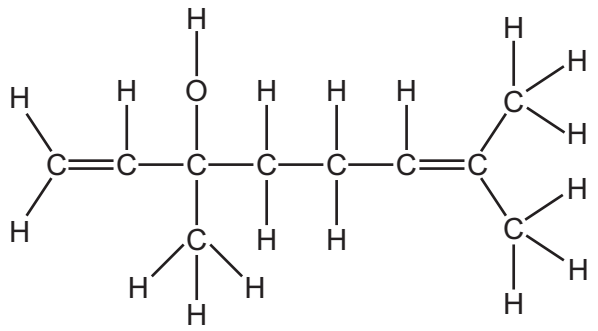

Fig. 4.1

Deduce the molecular formula of compound **A** to show the number of atoms of carbon, hydrogen and oxygen.

..... [1]

(b) On Fig. 4.1, draw a circle around **one** part of the molecule responsible for the decolourisation of aqueous bromine. [1]

(c) A different molecule found in plants has the molecular formula $C_{10}H_{16}O_2$.

Complete Table 4.1 to calculate the relative molecular mass of $C_{10}H_{16}O_2$.

Table 4.1

type of atom	number of atoms	relative atomic mass	
carbon	10	12	10 × 12 = 120
hydrogen		1	
oxygen		16	

relative molecular mass = ... [2]

(d) Petroleum is a fossil fuel.

Name **one other** fossil fuel.

..... [1]

(e) Fig. 4.2 shows the names of some of the fractions obtained from petroleum using a fractionating column.

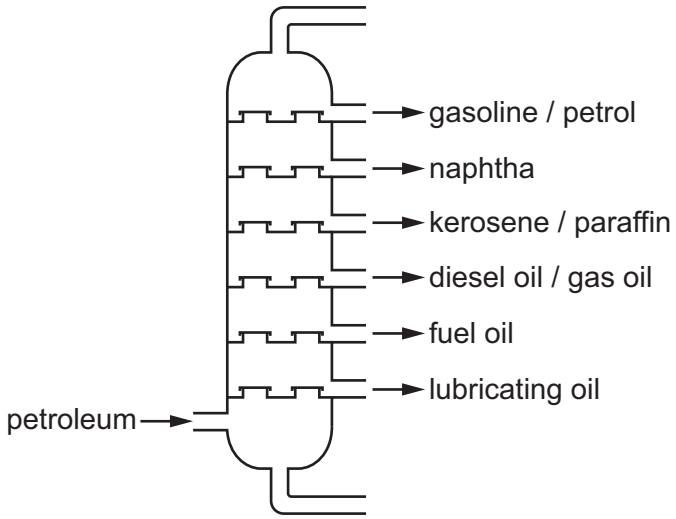

Fig. 4.2

Using only the fractions shown in Fig. 4.2, name the fraction which contains compounds that:

(i) have the longest chain length

..... [1]

(ii) have the highest volatility

..... [1]

(iii) are used for home heating systems.

..... [1]

(f) Table 4.2 shows some properties of hydrocarbons found in fuel for jet engines.

Table 4.2

name	molecular formula	melting point / °C	boiling point / °C
nonene	C_9H_{18}	–81	147
decane	$C_{10}H_{22}$	–30	174
undecane	$C_{11}H_{24}$	–26	195
dodecane	$C_{12}H_{26}$	–10	216
tridecane	$C_{13}H_{28}$	–5	234

(i) Identify the unsaturated hydrocarbon in Table 4.2.

..... [1]

(ii) Explain your answer in **(f)(i)**.

.....

..... [1]

(g) (i) In excess oxygen, decane undergoes complete combustion to produce carbon dioxide and one other product.

Identify this other product.

..... [1]

(ii) State **one** adverse effect to the environment of the production of carbon dioxide.

.....

..... [1]

(h) (i) Ethanol can be used to make jet fuel.

Draw the displayed formula of ethanol. Show all the atoms and all the bonds.

[2]

(ii) Ethanol can be manufactured from ethene and one other reactant.

Name the other reactant, and state the temperature and pressure used.

reactant .....

temperature ..... °C

pressure ..... atm

[3]

[Total: 17]

5 This question is about elements in different groups of the Periodic Table and their compounds.

(a) Nitrogen is in Group V of the Periodic Table.

Explain why nitrogen is placed in Group V.
Give your answer in terms of electronic configuration.

..... [1]

(b) Tellurium is in Group VI of the Periodic Table.

Table 5.1 shows the melting point and the boiling point of tellurium.

Table 5.1

melting point / °C	450
boiling point / °C	988

Use Table 5.1 to deduce the physical state of tellurium at 650 °C.

Give a reason for your answer.

physical state .....

reason .....

.....
[2]

(c) Bromine is in Group VII of the Periodic Table.

Give the colour and state of bromine at room temperature and pressure.

colour .....

state .....
[2]

(d) When a sample of sodium is added to a large container of cold water, a chemical reaction occurs.

(i) Describe what is observed when sodium is added to water.

.....

.....

.....

.....

.....

..... [3]

(ii) Complete the word equation for the reaction of sodium with water.

sodium	+	water	→	....	+	hydrogen

[1]

(e) Sodium carbonate reacts with sulfuric acid to form sodium sulfate, carbon dioxide and one other product.

Complete the symbol equation for this reaction.

Na_2CO_3 + ... → Na_2SO_4 + CO_2 + ...

[2]

(f) Solid sodium hydroxide is slowly added to distilled water containing a few drops of thymolphthalein and the mixture is stirred.

(i) State the colour change observed when sodium hydroxide is added to water containing thymolphthalein.

from ..... to ..... [2]

(ii) Aqueous sodium hydroxide is an alkali.

Complete the sentence about an alkali using **one** of the words from the list.

acid **base** **indicator** **salt**

An alkali is a soluble ..... . [1]

(g) Fluorine is in Group VII of the Periodic Table. Fluorine reacts with sodium to form the ionic compound sodium fluoride.

Complete the dot-and-cross diagram in Fig. 5.1 for sodium fluoride to show:

- the electronic configuration for each ion
- the charge on each ion.

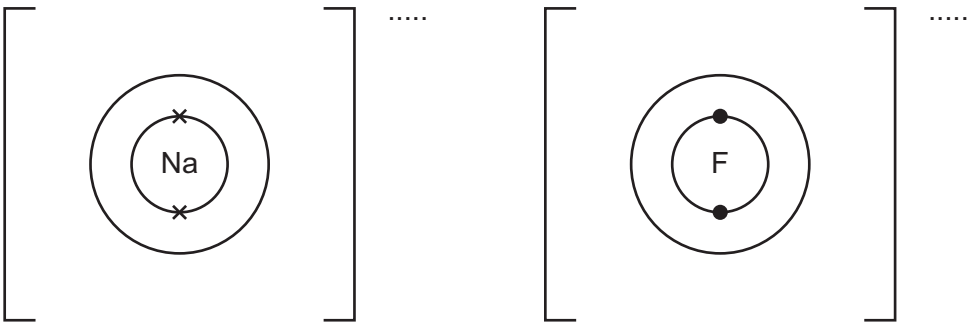

Fig. 5.1

[3]

[Total: 17]

6 This question is about metals.

(a) Iron is extracted from its ore using carbon in a blast furnace.
Aluminium is extracted from its ore using electrolysis.

(i) Name the main ore of aluminium.

..... [1]

(ii) Explain why aluminium is **not** extracted from its ore by reduction with carbon.
Give your answer in terms of the reactivity series.

.....

..... [1]

(iii) An equation for the reduction of iron(III) oxide using carbon is shown.

$$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$

Explain how this equation shows that iron(III) oxide is reduced.

.....

..... [1]

(b) Iron is made into stainless steel. Stainless steel is an alloy that resists rusting.

(i) State what is meant by the term alloy.

.....

..... [2]

(ii) Name the **two** substances required for iron to rust.

..... and ..... [2]

(iii) State the chemical name for rust.

..... [2]

(c) Table 6.1 shows the observations when four different metals are added separately to dilute hydrochloric acid.

Table 6.1

metal	observations
Mn	bubbles of gas given off quickly and the temperature of the mixture increases slowly
Fe	a few bubbles of gas given off very slowly and the temperature of the mixture increases very slowly
Sr	many bubbles of gas given off very quickly and the temperature of the mixture increases rapidly
Nb	no bubbles of gas given off and no temperature increase of the mixture

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

least reactive ⟶ most reactive

[2]

(ii) Complete the word equation for the reaction of strontium with hydrochloric acid.

strontium	+	hydrochloric acid	→	....	+	.....

[2]

[Total: 13]

7 Fig. 7.1 shows the apparatus used to pass electricity through molten magnesium chloride using platinum electrodes.

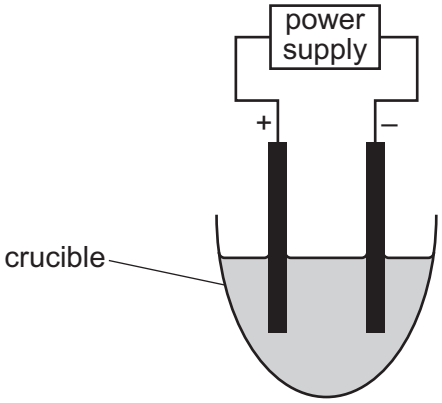

Fig. 7.1

(a) Name the process shown in Fig. 7.1.

..... [1]

(b) Label the electrolyte in Fig. 7.1. [1]

(c) Name the product formed at the anode.

..... [1]

(d) The electrodes are made of platinum.

(i) State **one** property of platinum that makes it suitable for use as an electrode.

..... [1]

(ii) Suggest a non-metal that could be used as the electrodes.

..... [1]

(e) State whether the process shown in Fig. 7.1 produces a physical or chemical change.

Explain your answer.

type of change .....

explanation .....

.....

[1]

(f) Magnesium chloride, $MgCl_2$, exists in different forms.

Draw **one** line from each form of magnesium chloride to its description.

form of magnesium chloride	**description**
aqueous $MgCl_2$	solid $MgCl_2$ chemically combined with water
anhydrous $MgCl_2$	$MgCl_2$ dissolved in water
hydrated $MgCl_2$	solid $MgCl_2$ containing no water

[2]

[Total: 8]

8 Excess dilute hydrochloric acid is added to aqueous sodium sulfide to form aqueous sodium chloride and gaseous hydrogen sulfide, H_2S.

$$2HCl(aq) + Na_2S(aq) \rightarrow 2NaCl(aq) + H_2S(g)$$

Fig. 8.1 shows the total volume of hydrogen sulfide gas, H_2S, produced as the reaction proceeds.

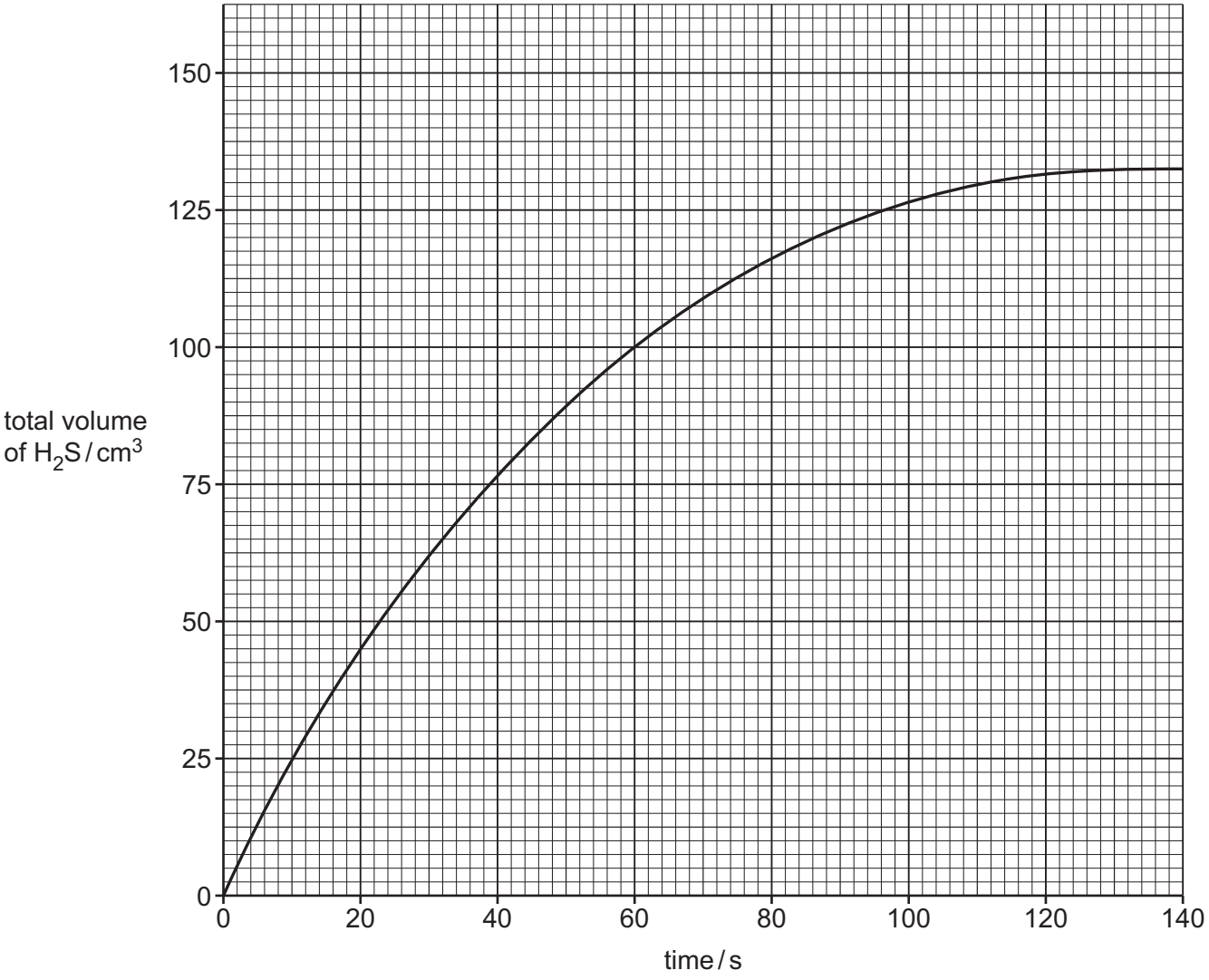

Fig. 8.1

(a) Use Fig. 8.1 to determine the total volume of H_2S produced when the reaction is complete.

total volume of H_2S = ... cm^3 [1]

(b) The reaction is repeated using hydrochloric acid of a higher concentration.

All other conditions stay the same.

State the effect, if any, on:

(i) the time taken for the reaction to finish

..... [1]

(ii) the total volume of H_2S produced when the reaction is complete.

..... [1]

(c) Fig. 8.2 shows the reaction pathway diagram for the reaction of dilute hydrochloric acid with aqueous sodium sulfide.

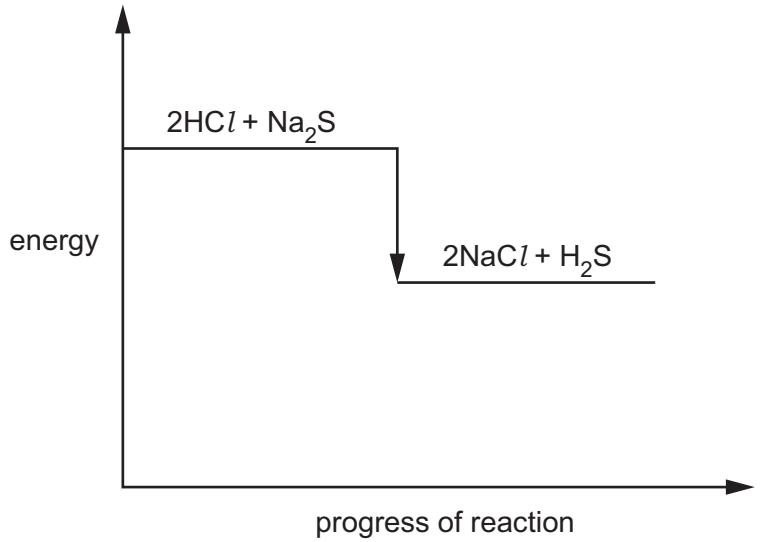

Fig. 8.2

Deduce the type of energy change shown in the diagram in Fig. 8.2.

Explain your answer.

.....

.....

.....

..... [2]

[Total: 5]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).