Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/22**

Paper 2 Multiple Choice (Extended) **May/June 2020**

45 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

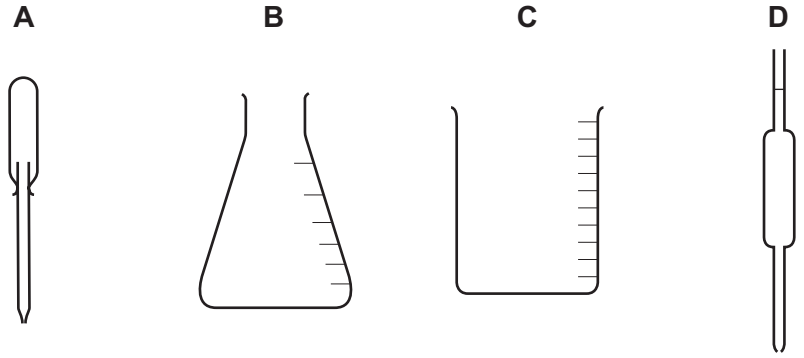
This document has **16** pages. Blank pages are indicated.

1 A mixture of ice and water is left to stand and the ice melts.

Which row describes what happens as the ice is melting?

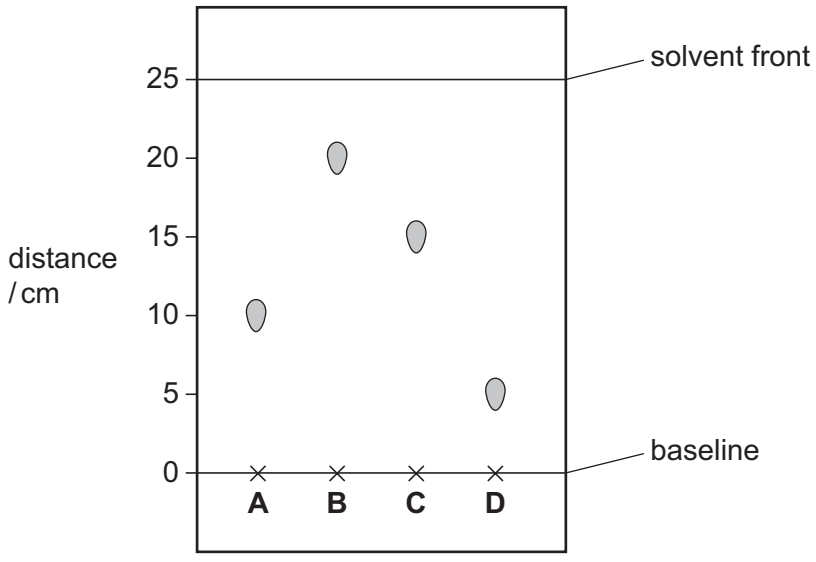
	temperature of mixture	energy changes
A	increases	average kinetic energy of particles increases
B	increases	energy is used to overcome attractive forces
C	stays the same	average kinetic energy of particles increases
D	stays the same	energy is used to overcome attractive forces

2 Which piece of apparatus is used to measure 25.0 cm^3 of aqueous sodium hydroxide?

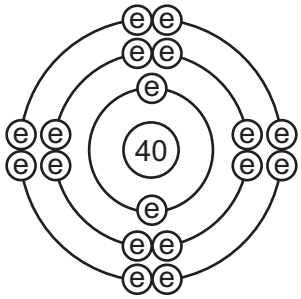


3 Paper chromatography is used to determine the R_f values for four different food colourings.

Which food colouring has an R_f value of 0.6?



4 The diagram shows the electronic structure of a particle with a nucleon number (mass number) of 40.



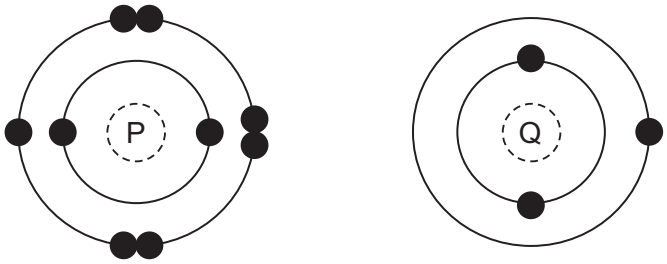
The table shows the suggestions that three students, 1, 2 and 3, made to identify the particle.

	student		
	1	2	3
particle	Ar	Cl	Ca^{2+}

Which students are correct?

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

5 The electronic structures of two atoms, P and Q, are shown.



P and Q combine together to form a compound.

What is the type of bonding in the compound and what is the formula of the compound?

	type of bonding	formula
A	ionic	PQ
B	ionic	PQ_2
C	covalent	PQ_2
D	covalent	PQ

6 Which statement about the structure of a metal explains why metals are malleable?

A The electrons can move freely throughout the lattice.

B The layers of metal ions can slide over each other.

C The metal ions are positively charged.

D There is a strong force of attraction between the metal ions and the electrons.

7 The bonding, structure and melting point of sodium chloride and sulfur dichloride are shown.

compound	bonding	structure	melting point / °C
sodium chloride	ionic	giant lattice	801
sulfur dichloride	covalent	simple molecular	–121

Why does sulfur dichloride have a lower melting point than sodium chloride?

A The covalent bonds in sulfur dichloride are weaker than the attractive forces between molecules in sodium chloride.

B The covalent bonds in sulfur dichloride are weaker than the ionic bonds in sodium chloride.

C The attractive forces between molecules in sulfur dichloride are weaker than the attractive forces between molecules in sodium chloride.

D The attractive forces between molecules in sulfur dichloride are weaker than the ionic bonds in sodium chloride.

8 Lead(II) nitrate, $Pb(NO_3)_2$, reacts with potassium iodide, KI, to form a yellow precipitate, PbI_2, and a soluble salt, KNO_3.

What is the equation for the reaction?

A $Pb(NO_3)_2 + KI \rightarrow PbI_2 + KNO_3$

B $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + KNO_3$

C $2Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

D $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

9 The Haber process is a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction has a 30% yield of ammonia.

Which volume of ammonia gas, NH_3, measured at room temperature and pressure, is obtained by reacting 0.75 moles of hydrogen with excess nitrogen?

A $3600\,cm^3$ **B** $5400\,cm^3$ **C** $12\,000\,cm^3$ **D** $18\,000\,cm^3$

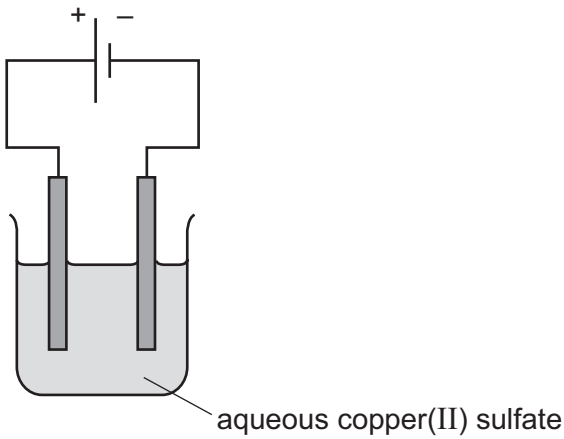
10 Electrolytes can be broken down by electrolysis.

Which rows are correct for each electrolyte?

	electrolyte	reaction at cathode	product at anode
1	dilute aqueous sodium chloride	$2H^+ + 2e^- \rightarrow H_2$	oxygen
2	concentrated hydrochloric acid	$2H^+ + 2e^- \rightarrow H_2$	chlorine
3	molten aluminium oxide	$2O^{2-} \rightarrow O_2 + 4e^-$	aluminium
4	concentrated aqueous sodium bromide	$Na^+ + e^- \rightarrow Na$	bromine

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

11 The electrolysis of aqueous copper(II) sulfate, using inert electrodes, is shown.



Which statement about a reaction at an electrode is correct?

A Copper ions gain electrons at the negative electrode.

B Copper ions gain electrons at the positive electrode.

C Hydrogen ions gain electrons at the negative electrode.

D Hydrogen ions gain electrons at the positive electrode.

12 Methane burns in excess oxygen.

The equation is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

Bond energies are shown.

bond	bond energy / kJ mol^{-1}
C=O	805
C–H	410
O=O	496
O–H	460

What is the energy change for the reaction?

A $(4 \times 410 + 2 \times 496) – (2 \times 805 + 4 \times 460)$

B $(2 \times 805 + 2 \times 460) – (410 + 2 \times 496)$

C $(410 + 2 \times 496) – (805 + 2 \times 460)$

D $(410 + 496) – (805 + 460)$

13 Which statements about hydrogen fuel cells are correct?

1 Water is formed as the only waste product.

2 Both water and carbon dioxide are formed as waste products.

3 The overall reaction is $2H_2 + O_2 \rightarrow 2H_2O$.

4 The overall reaction is endothermic.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

14 Which list contains **only** chemical changes?

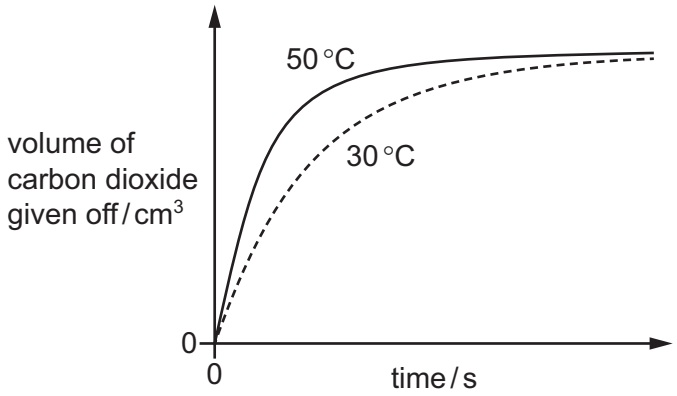
A melting, evaporating, dissolving

B rusting, freezing, subliming

C neutralisation, polymerisation, combustion

D boiling, condensing, distillation

15 The results of adding excess marble chips (calcium carbonate) to hydrochloric acid at 50 °C and at 30 °C are shown. Only the temperature is changed.



Which row describes the reacting particles at 30 °C compared to those at 50 °C?

	collision rate	collision energy
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

16 Methane reacts with steam and an equilibrium is reached.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The forward reaction is endothermic.

Which row shows how the amount of hydrogen at equilibrium changes when the pressure or temperature is changed as indicated?

	change in temperature	change in pressure	amount of hydrogen
A	decrease	no change	increase
B	increase	no change	decrease
C	no change	increase	decrease
D	no change	decrease	decrease

17 When aqueous iron(III) chloride is added to aqueous potassium iodide a chemical reaction occurs and iodine is formed.

Which statement is correct?

A Iodide ions are oxidised, they gain electrons in this reaction.

B Iodide ions are oxidised, they lose electrons in this reaction.

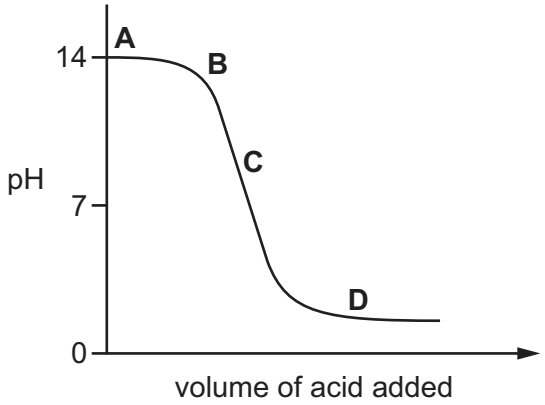
C Iron(III) chloride is oxidised in this reaction.

D Neither iodide ions nor iron(III) chloride is oxidised in this reaction.

18 The graph shows how the pH of a solution changes as an acid is added to an alkali.

$$\text{acid} + \text{alkali} \rightarrow \text{salt} + \text{water}$$

Which letter represents the area of the graph where both acid and salt are present?



19 Which statement describes a weak acid?

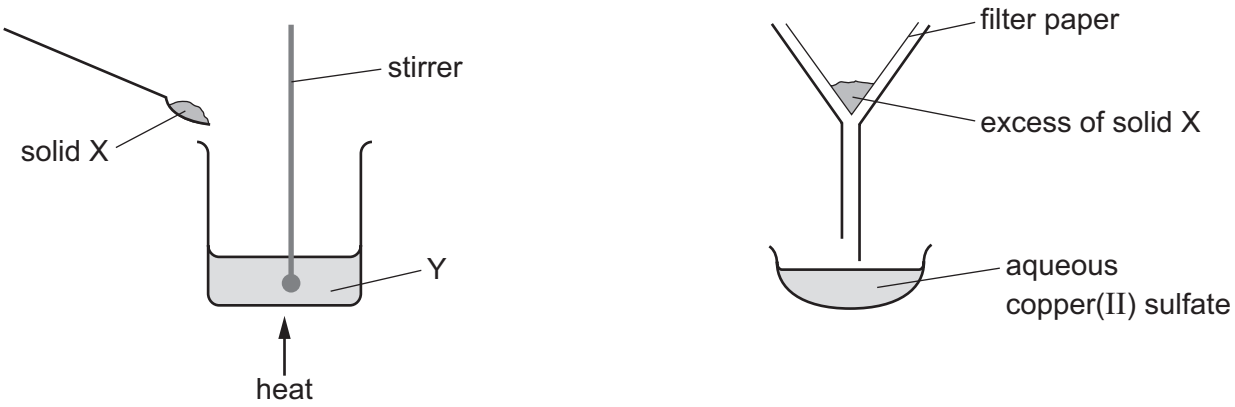
A It is a proton acceptor and is fully ionised in aqueous solution.

B It is a proton acceptor and is partially ionised in aqueous solution.

C It is a proton donor and is fully ionised in aqueous solution.

D It is a proton donor and is partially ionised in aqueous solution.

20 The apparatus shown is used to prepare aqueous copper(II) sulfate.



What are X and Y?

	X	Y
A	copper	aqueous iron(II) sulfate
B	copper(II) chloride	dilute sulfuric acid
C	copper(II) oxide	dilute sulfuric acid
D	sulfur	aqueous copper(II) chloride

21 Which process is **not** used in the preparation of an insoluble salt?

A filtration

B washing

C crystallisation

D drying

22 Which statement about Group I and Group VII elements is correct?

A Group VII elements are monoatomic non-metals.

B Lithium is more reactive with water than caesium.

C The melting points of Group I metals increase down the group.

D Potassium bromide reacts with chlorine to produce an orange solution.

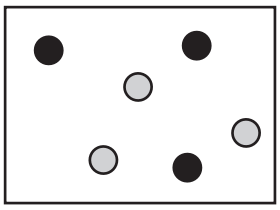
23 The properties of the element titanium, Ti, can be predicted from its position in the Periodic Table.

Which row identifies the properties of titanium?

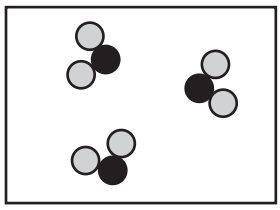
	can be used as a catalyst	conducts electricity when solid	has low density	forms coloured compounds
A	✓	✓	✓	✗
B	✓	✓	✗	✓
C	✓	✗	✓	✓
D	✗	✓	✓	✓

24 Which diagram shows a mixture of noble gases?

A



B



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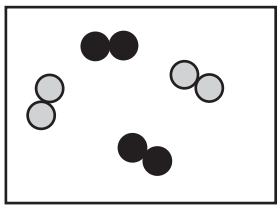
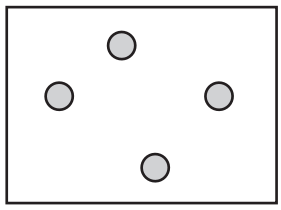


D



25 Which property is shown by **all** metals?

A They are extracted from their ores by heating with carbon.

B They conduct electricity.

C They form acidic oxides.

D They react with hydrochloric acid to form hydrogen.

26 Many metal carbonates decompose when they are heated.

Which row describes what happens when potassium carbonate, calcium carbonate and copper(II) carbonate are heated using a Bunsen burner?

	decomposes easily	decomposes with difficulty	does not decompose at Bunsen temperatures
A	calcium carbonate	copper(II) carbonate	potassium carbonate
B	copper(II) carbonate	calcium carbonate	potassium carbonate
C	copper(II) carbonate	potassium carbonate	calcium carbonate
D	potassium carbonate	calcium carbonate	copper(II) carbonate

27 Molten iron from the blast furnace contains impurities.

The process of turning the impure iron into steel involves blowing oxygen into the molten iron and adding calcium oxide.

What are the reasons for blowing in oxygen and adding calcium oxide?

	blowing in oxygen	adding calcium oxide
A	carbon is removed by reacting with oxygen	reacts with acidic impurities making slag
B	carbon is removed by reacting with oxygen	reacts with slag and so removes it
C	iron reacts with the oxygen	reacts with acidic impurities making slag
D	iron reacts with the oxygen	reacts with slag and so removes it

28 Four iron nails are added to four different metal sulfate solutions.

In which solution does a displacement reaction occur?

A copper(II) sulfate

B magnesium sulfate

C sodium sulfate

D zinc sulfate

29 Which statement about pure water is **not** correct?

A It condenses at 100 °C.

B It freezes at 0 °C.

C It turns cobalt(II) chloride paper blue.

D It turns anhydrous copper(II) sulfate blue.

[Turn over

30 Three processes in the carbon cycle are shown.

1 Methane reacts with oxygen producing carbon dioxide and water.

2 Carbon dioxide and water are absorbed and used by plants to make oxygen.

3 Oxygen is used by living things to release energy.

Which processes have taken place?

	1	2	3
A	combustion	photosynthesis	respiration
B	combustion	respiration	photosynthesis
C	photosynthesis	combustion	respiration
D	respiration	photosynthesis	combustion

31 In the Haber process, nitrogen and hydrogen are reacted to make ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which conditions produce the maximum yield of ammonia?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

32 Which process, used to prevent iron from rusting, involves sacrificial protection?

A alloying

B electroplating

C galvanising

D painting

33 A student suggests three uses of calcium carbonate (limestone).

1 manufacture of cement

2 manufacture of iron

3 treating alkaline soils

Which suggestions are correct?

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

34 One of the reactions used in the manufacture of sulfuric acid is shown.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

Which catalyst is used to increase the rate of this reaction?

A iron

B manganese(IV) oxide

C vanadium(V) oxide

D nickel

35 Ethanol is made on an industrial scale by the fermentation of sugars or by the reaction of ethene with steam in the presence of a suitable catalyst.

What is a **disadvantage** of making ethanol from ethene rather than by fermentation?

A A continuous production process is used.

B A non-renewable raw material is used.

C The product is very pure.

D The rate of reaction is very high.

36 Which statement about compounds in the same homologous series is correct?

A They have the same chemical properties because they have the same number of carbon atoms.

B They have the same physical properties because they have the same number of carbon atoms.

C They have different chemical properties because they have different numbers of carbon atoms.

D They have different physical properties because they have different numbers of carbon atoms.

37 Increasing the number of atoms in one molecule of a hydrocarbon increases the amount of energy released when it burns.

What is the correct order?

	less energy released →		more energy released
A	ethene	ethane	methane
B	ethene	methane	ethane
C	methane	ethane	ethene
D	methane	ethene	ethane

38 An organic compound, P, reacts with zinc to produce a gas, Q.

What are P and Q?

	P	Q
A	ethanoic acid	carbon dioxide
B	ethanoic acid	hydrogen
C	ethanol	carbon dioxide
D	ethanol	hydrogen

39 Alkanes undergo substitution reactions in the presence of UV light.

Which equation represents a substitution reaction of ethane?

A $C_2H_6 + Cl_2 \rightarrow C_2H_4 + 2HCl$

B $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

C $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

D $C_2H_6 + HCl \rightarrow C_2H_5Cl + H_2$

40 Which substances are natural polymers?

1 proteins

2 carbohydrates

3 nylon

4 poly(ethene)

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

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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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).