



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education (9–1)

CHEMISTRY

0971/22

Paper 2 Multiple Choice (Extended)

October/November 2018

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

* 3 0 8 7 8 8 1 5 1 4 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 16.

Electronic calculators may be used.

This document consists of **16** printed pages.

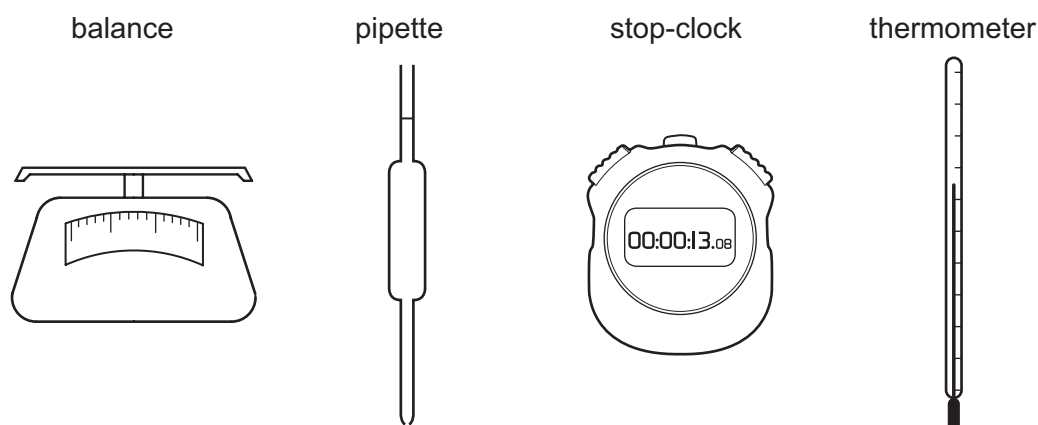
- 1 Oxygen and fluorine are gaseous elements next to each other in the Periodic Table.

Under the same conditions of temperature and pressure, oxygen diffuses1..... than fluorine because its2..... is less than that of fluorine.

Which words correctly complete gaps 1 and 2?

	1	2
A	faster	molecular mass
B	faster	reactivity
C	slower	molecular mass
D	slower	reactivity

- 2 The diagrams show four pieces of laboratory equipment.



Which equipment is essential to find out if dissolving a salt in water is an exothermic process?

	balance	pipette	stop-clock	thermometer
A	x	x	x	✓
B	✓	x	x	✓
C	x	✓	x	✓
D	✓	x	✓	x

- 3 How many neutrons are present in the atom ${}_{21}^{45}\text{X}$?

A 21 **B** 24 **C** 45 **D** 66

- 4 Two naturally occurring isotopes of oxygen are ^{16}O and ^{17}O .

Which statement is correct?

- A** Both isotopes react with iron to form rust.
B Neither isotope reacts with iron to form rust.
C Only ^{16}O reacts with iron to form rust.
D Only ^{17}O reacts with iron to form rust.

- 5 How many electrons are used to form covalent bonds in a molecule of methanol, CH_3OH ?

- A** 5 **B** 6 **C** 8 **D** 10

- 6 Potassium bromide and methanol are both compounds.

Their melting points are different.

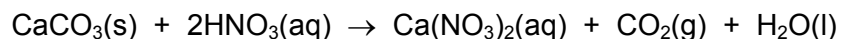
Which row is correct?

	substance with the higher melting point	reason why the melting points are different
A	methanol	the attractive forces between oppositely charged ions is greater than the attractive forces between molecules
B	methanol	the attractive forces between molecules is greater than the attractive forces between oppositely charged ions
C	potassium bromide	the attractive forces between oppositely charged ions is greater than the attractive forces between molecules
D	potassium bromide	the attractive forces between molecules is greater than the attractive forces between oppositely charged ions

- 7 Which gas sample contains the smallest number of molecules?

- A** 4 g of helium
B 16 g of oxygen
C 28 g of carbon monoxide
D 28 g of nitrogen

- 8 The equation for the reaction between calcium carbonate and dilute nitric acid is shown.



25 g of calcium carbonate is reacted with an excess of dilute nitric acid.

Which mass of calcium nitrate and which volume of carbon dioxide is produced at room temperature and pressure?

	mass of calcium nitrate / g	volume of carbon dioxide / dm ³
A	29	6
B	29	12
C	41	6
D	41	12

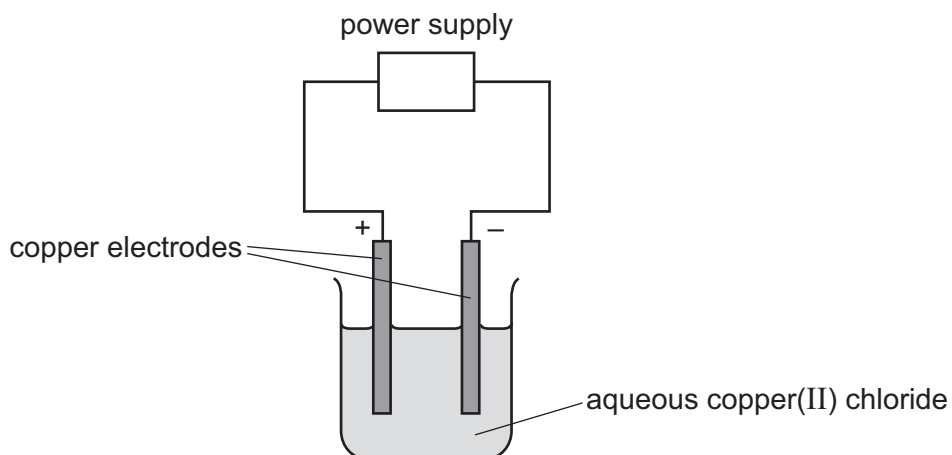
- 9 The formulae of some ions are shown.

positive ion	negative ion
Ti ⁴⁺	PO ₄ ³⁻
Al ³⁺	SO ₄ ²⁻
Mg ²⁺	NO ₃ ⁻
K ⁺	Cl ⁻

Which formula is **not** correct?

- A** Al₃(SO₄)₂ **B** K₃PO₄ **C** Mg(NO₃)₂ **D** TiCl₄

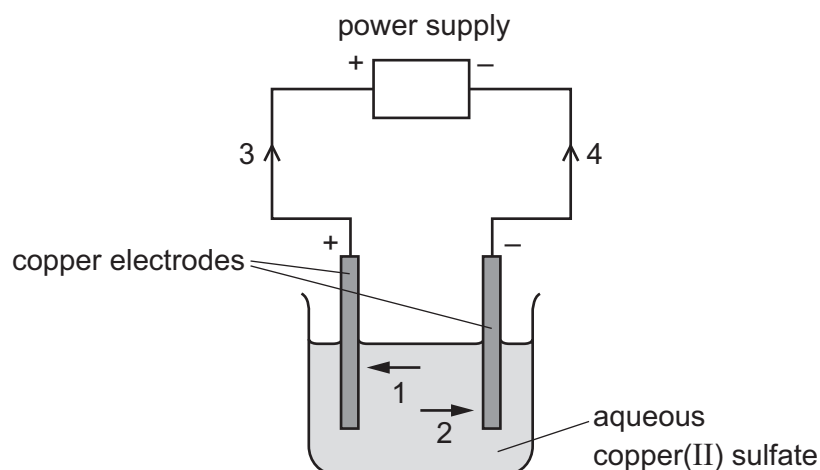
10 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes as shown.



What happens to the mass of each electrode during this process?

	positive electrode	negative electrode
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

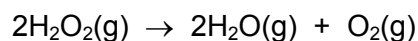
11 The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

	copper ions	electrons
A	1	3
B	1	4
C	2	3
D	2	4

12 Hydrogen peroxide, H–O–O–H, decomposes to form water and oxygen.



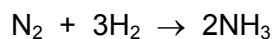
The bond energies are shown in the table. The reaction is exothermic.

bond	bond energy in kJ/mol
O–H	+460
O–O	+150
O=O	+496

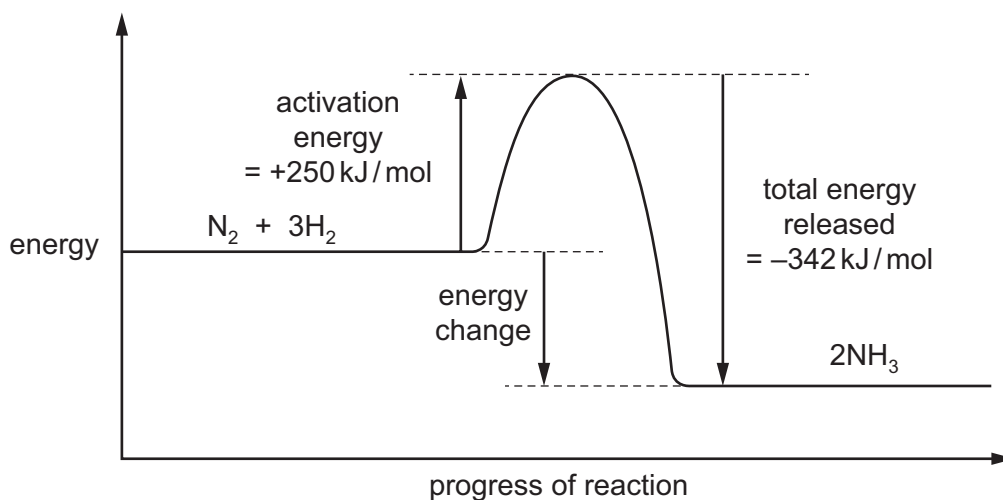
What is the energy change for the reaction?

- A** –346 kJ/mol **B** –196 kJ/mol **C** +196 kJ/mol **D** +346 kJ/mol

- 13 The equation for the formation of ammonia is shown.



The energy level diagram for the reaction is shown.



What is the energy change for the reaction?

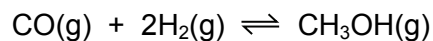
- A -592 kJ/mol
 B -92 kJ/mol
 C $+92 \text{ kJ/mol}$
 D $+592 \text{ kJ/mol}$
- 14 The rate of reaction between magnesium ribbon and 2 mol/dm^3 hydrochloric acid at 25°C to produce hydrogen gas is measured.

In another experiment, either the concentration of the hydrochloric acid or the temperature is changed. All other conditions are kept the same.

Which conditions increase the rate of reaction?

- A 1 mol/dm^3 hydrochloric acid at 25°C
 B 2 mol/dm^3 hydrochloric acid at 10°C
 C 2 mol/dm^3 hydrochloric acid at 20°C
 D 3 mol/dm^3 hydrochloric acid at 25°C

15 Methanol is prepared by the reversible reaction shown.



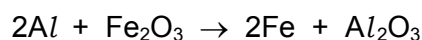
The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol?

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

16 The thermite reaction can be used to produce iron from iron(III) oxide.

The equation for the reaction is shown.



Which statements about this reaction are correct?

- 1 Aluminium is the oxidising agent.
- 2 Aluminium is less reactive than iron.
- 3 Electrons are transferred from aluminium to iron.
- 4 The iron in the iron(III) oxide is reduced.

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

17 In which row are the oxides correctly identified?

	acidic	basic
A	magnesium oxide, calcium oxide	sulfur dioxide, carbon dioxide
B	magnesium oxide, sulfur dioxide	carbon dioxide, calcium oxide
C	sulfur dioxide, carbon dioxide	calcium oxide, magnesium oxide
D	sulfur dioxide, magnesium oxide	calcium oxide, carbon dioxide

- 18 When dilute sulfuric acid is added to solid X, a colourless solution is formed and a gas is produced.

What is X?

- A copper(II) oxide
- B sodium oxide
- C copper(II) carbonate
- D sodium carbonate

- 19 A few drops of methyl orange are added to a reaction mixture.

During the reaction, a gas is produced and the methyl orange turns from red to orange.

What are the reactants?

- A aqueous sodium hydroxide and ammonium chloride
- B aqueous sodium hydroxide and calcium carbonate
- C dilute hydrochloric acid and magnesium
- D dilute hydrochloric acid and aqueous sodium hydroxide

- 20 Some general rules for the solubility of salts in water are listed.

- Carbonates are insoluble (except ammonium carbonate, potassium carbonate and sodium carbonate).
- Chlorides are soluble (except lead(II) chloride and silver chloride).
- Nitrates are soluble.
- Sulfates are soluble (except barium sulfate, calcium sulfate and lead(II) sulfate).

Which substances produce an insoluble salt when aqueous solutions of them are mixed?

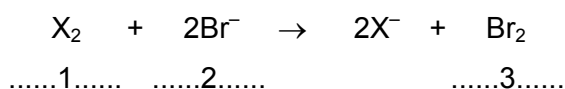
- A barium chloride and magnesium nitrate
- B calcium chloride and ammonium nitrate
- C silver nitrate and zinc chloride
- D sodium carbonate and potassium sulfate

21 Elements in Group I of the Periodic Table react with water.

Which row describes the products made in the reaction and the trend in reactivity of the elements?

	products	trend in reactivity
A	metal hydroxide and hydrogen	less reactive down the group
B	metal hydroxide and hydrogen	more reactive down the group
C	metal oxide and hydrogen	less reactive down the group
D	metal oxide and hydrogen	more reactive down the group

22 The equation shows the reaction between a halogen and aqueous bromide ions.



Which words complete gaps 1, 2 and 3?

	1	2	3
A	chlorine	brown	colourless
B	chlorine	colourless	brown
C	iodine	brown	colourless
D	iodine	colourless	brown

23 An inert gas R is used to fill weather balloons.

Which descriptions of R are correct?

	number of outer shell electrons in atoms of R	structure of gas R
A	2	diatomic molecules
B	2	single atoms
C	8	diatomic molecules
D	8	single atoms

24 Heating copper(II) carbonate produces copper(II) oxide and carbon dioxide.

Heating the copper(II) oxide formed with carbon produces copper.

Which processes are involved in this conversion of copper(II) carbonate to copper?

- A sublimation followed by oxidation
- B sublimation followed by reduction
- C thermal decomposition followed by oxidation
- D thermal decomposition followed by reduction

25 Four metals, W, X, Y and Z, are separately reacted with water and dilute hydrochloric acid.

The results are shown.

	metal			
	W	X	Y	Z
reaction with water	fizzes	no reaction	fizzes vigorously	no reaction
reaction with dilute hydrochloric acid	fizzes	no reaction	fizzes violently	fizzes

What is the order of reactivity of the four metals starting with the least reactive?

	least reactive		→	most reactive	
A	X	W		Z	Y
B	X	Z		W	Y
C	Y	W		Z	X
D	Y	Z		W	X

26 Which statement about the uses of metals is **not** correct?

- A Aluminium is used in aircraft because of its strength and good electrical conductivity.
- B Copper is used in electrical wiring because of its good electrical conductivity.
- C Stainless steel resists corrosion and is used to make cutlery.
- D Transition elements are often used as catalysts.

27 Bauxite contains aluminium oxide.

Aluminium is extracted from aluminium oxide by electrolysis.

Why is cryolite added to the electrolytic cell used to extract aluminium?

- A Cryolite prevents the carbon anodes being burned away.
- B Cryolite removes impurities from the bauxite.
- C Cryolite increases the rate at which aluminium ions are discharged.
- D Molten cryolite dissolves the aluminium oxide.

28 Which statement about the Haber process is correct?

- A The hydrogen used is obtained from the air.
- B The nitrogen used is obtained from nitrates in the soil.
- C Nitrogen reacts with hydrogen to make ammonia.
- D The reaction takes place at room temperature and pressure.

29 Which statements about sulfur dioxide pollution are correct?

- 1 It increases the pH of rivers.
- 2 It damages limestone buildings.
- 3 It causes respiratory problems.

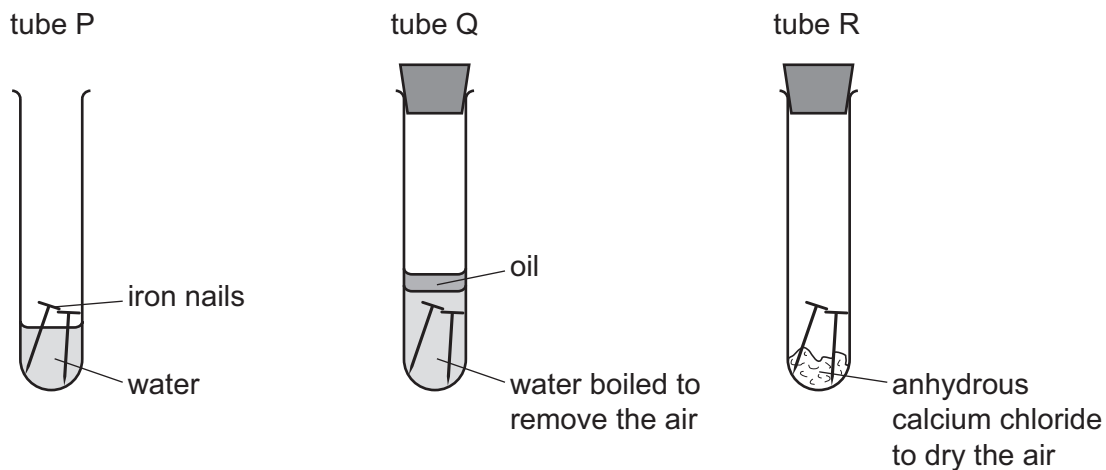
- A 1 only B 2 only C 1 and 3 D 2 and 3

30 Argon is a noble gas used to fill light bulbs.

What is the approximate percentage of argon in air?

- A 1% B 20% C 79% D 99%

31 The diagrams show experiments involving the rusting of iron.



A student predicted the following results.

- 1 In tube P, the iron nails rust.
- 2 In tube Q, the iron nails do not rust.
- 3 In tube R, the iron nails do not rust.

Which predictions are correct?

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

32 In the carbon cycle, which two processes add carbon dioxide to the atmosphere?

- A** combustion and carbonate formation
B combustion and photosynthesis
C combustion and respiration
D respiration and photosynthesis

33 Which statement about sulfur or one of its compounds is correct?

- A** Sulfur occurs naturally as the element sulfur.
B Sulfur dioxide is used to kill bacteria in drinking water.
C Sulfuric acid is a weak acid.
D Dilute sulfuric acid is a dehydrating agent.

34 What is **not** a use of lime?

- A It is used as a bleach in the manufacture of wood pulp.
- B It is used to desulfurise flue gases.
- C It is used to neutralise acidic industrial waste.
- D It is used to treat acidic soil.

35 Which equation representing a reaction of methane is correct?

- A $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- B $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_4\text{Cl}_2$
- C $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + \text{H}_2$
- D $2\text{CH}_4 + 2\text{Cl}_2 \rightarrow 2\text{CH}_3\text{Cl} + \text{Cl}_2 + \text{H}_2$

36 Which two compounds are molecules which both contain a double bond?

- A ethane and ethanoic acid
- B ethane and ethanol
- C ethene and ethanoic acid
- D ethene and ethanol

37 Ethanol can be formed by:

- 1 fermentation
- 2 reaction between steam and ethene.

Which of these processes use a catalyst?

	1	2
A	✓	✓
B	✓	x
C	x	✓
D	x	x

38 Ethanol is manufactured from ethene.

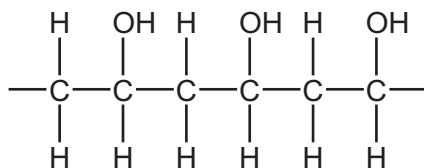
What is an advantage of this process?

- A It is a continuous process.
- B It has high labour costs.
- C It needs high temperature and pressure.
- D It uses non-renewable materials.

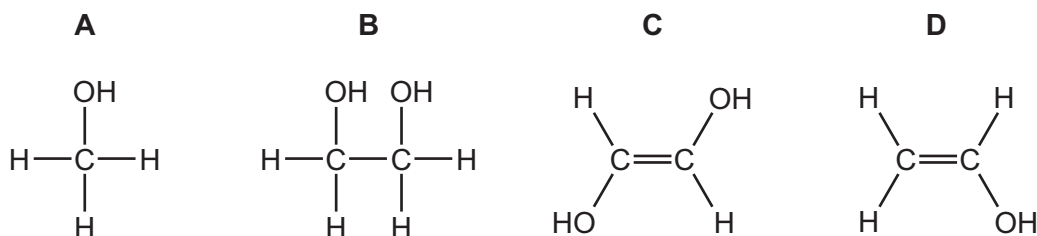
39 Which reaction can be used to make ethanoic acid?

- A oxidation of ethanol
- B oxidation of ethene
- C reduction of ethanol
- D reduction of ethene

40 The structure of an addition polymer is shown.



Which monomer is used to make this polymer?



Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

The Periodic Table of Elements

		Group																																																																																																																																																																																																						
I	II	III	IV	V	VI	VII	VIII																																																																																																																																																																																																	
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	19 K potassium 39	20 Ca calcium 40	37 Rb rubidium 85	55 Cs caesium 133	87 Fr francium —	1 H hydrogen 1	2 He helium 4	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 Ac actinium —	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 —	119 Uu unbinilium —	120 Uub unbinilium —	121 Uut ununilium —	122 Uuq ununilium —	123 Uuq ununilium —	124 Uuq ununilium —	125 Uuq ununilium —	126 Uuq ununilium —	127 Uuq ununilium —	128 Uuq ununilium —	129 Uuq ununilium —	130 Uuq ununilium —	131 Uuq ununilium —	132 Uuq ununilium —	133 Uuq ununilium —	134 Uuq ununilium —	135 Uuq ununilium —	136 Uuq ununilium —	137 Uuq ununilium —	138 Uuq ununilium —	139 Uuq ununilium —	140 Uuq ununilium —	141 Uuq ununilium —	142 Uuq ununilium —	143 Uuq ununilium —	144 Uuq ununilium —	145 Uuq ununilium —	146 Uuq ununilium —	147 Uuq ununilium —	148 Uuq ununilium —	149 Uuq ununilium —	150 Uuq ununilium —	151 Uuq ununilium —	152 Uuq ununilium —	153 Uuq ununilium —	154 Uuq ununilium —	155 Uuq ununilium —	156 Uuq ununilium —	157 Uuq ununilium —	158 Uuq ununilium —	159 Uuq ununilium —	160 Uuq ununilium —	161 Uuq ununilium —	162 Uuq ununilium —	163 Uuq ununilium —	164 Uuq ununilium —	165 Uuq ununilium —	166 Uuq ununilium —	167 Uuq ununilium —	168 Uuq ununilium —	169 Uuq ununilium —	170 Uuq ununilium —	171 Uuq ununilium —	172 Uuq ununilium —	173 Uuq ununilium —	174 Uuq ununilium —	175 Uuq ununilium —	176 Uuq ununilium —	177 Uuq ununilium —	178 Uuq ununilium —	179 Uuq ununilium —	180 Uuq ununilium —	181 Uuq ununilium —	182 Uuq ununilium —	183 Uuq ununilium —	184 Uuq ununilium —	185 Uuq ununilium —	186 Uuq ununilium —	187 Uuq ununilium —	188 Uuq ununilium —	189 Uuq ununilium —	190 Uuq ununilium —	191 Uuq ununilium —	192 Uuq ununilium —	193 Uuq ununilium —	194 Uuq ununilium —	195 Uuq ununilium —	196 Uuq ununilium —	197 Uuq ununilium —	198 Uuq ununilium —	199 Uuq ununilium —	200 Uuq ununilium —	201 Uuq ununilium —	202 Uuq ununilium —	203 Uuq ununilium —	204 Uuq ununilium —	205 Uuq ununilium —	206 Uuq ununilium —	207 Uuq ununilium —	208 Uuq ununilium —	209 Uuq ununilium —	210 Uuq ununilium —	211 Uuq ununilium —	212 Uuq ununilium —	213 Uuq ununilium —	214 Uuq ununilium —	215 Uuq ununilium —	216 Uuq ununilium —	217 Uuq ununilium —	218 Uuq ununilium —	219 Uuq ununilium —	220 Uuq ununilium —	221 Uuq ununilium —	222 Uuq ununilium —	223 Uuq ununilium —	224 Uuq ununilium —	225 Uuq ununilium —	226 Uuq ununilium —	227 Uuq ununilium —	228 Uuq ununilium —	229 Uuq ununilium —	230 Uuq ununilium —	231 Uuq ununilium —	232 Uuq ununilium —	233 Uuq ununilium —	234 Uuq ununilium —	235 Uuq ununilium —	236 Uuq ununilium —	237 Uuq ununilium —	238 Uuq ununilium —	239 Uuq ununilium —	240 Uuq ununilium —	241 Uuq ununilium —	242 Uuq ununilium —	243 Uuq ununilium —	244 Uuq ununilium —	245 Uuq ununilium —	246 Uuq ununilium —	247 Uuq ununilium —	248 Uuq ununilium —	249 Uuq ununilium —	250 Uuq ununilium —	251 Uuq ununilium —	252 Uuq ununilium —	253 Uuq ununilium —	254 Uuq ununilium —	255 Uuq ununilium —	256 Uuq ununilium —	257 Uuq ununilium —	258 Uuq ununilium —	259 Uuq ununilium —	260 Uuq ununilium —	261 Uuq ununilium —	262 Uuq ununilium —	263 Uuq ununilium —	264 Uuq ununilium —	265 Uuq ununilium —	266 Uuq ununilium —	267 Uuq ununilium —	268 Uuq ununilium —	269 Uuq ununilium —	270 Uuq ununilium —	271 Uuq ununilium —	272 Uuq ununilium —	273 Uuq ununilium —	274 Uuq ununilium —	275 Uuq ununilium —	276 Uuq ununilium —	277 Uuq ununilium —	278 Uuq ununilium —	279 Uuq ununilium —	280 Uuq ununilium —	281 Uuq ununilium —	282 Uuq ununilium —	283 Uuq ununilium —	284 Uuq ununilium —	285 Uuq ununilium —	286 Uuq ununilium —	287 Uuq ununilium —	288 Uuq ununilium —	289 Uuq ununilium —	290 Uuq ununilium —	291 Uuq ununilium —	292 Uuq ununilium —	293 Uuq ununilium —	294 Uuq ununilium —	295 Uuq ununilium —	296 Uuq ununilium —	297 Uuq ununilium —	298 Uuq ununilium —	299 Uuq ununilium —	300 Uuq ununilium —

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 dm³ at room temperature and pressure (r.t.p.).