



# Cambridge IGCSE™ (9–1)

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## CHEMISTRY

0971/21

Paper 2 Multiple Choice (Extended)

May/June 2022

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)

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## INSTRUCTIONS

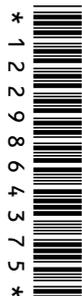
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple 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.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

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This document has **16** pages. Any blank pages are indicated.



## 2

- 1 Which two gases will diffuse at the same rate, at the same temperature?
- A** carbon monoxide and carbon dioxide  
**B** carbon monoxide and nitrogen  
**C** chlorine and fluorine  
**D** nitrogen and oxygen
- 2 A student measures the time taken for 2.0g of magnesium to dissolve in 50 cm<sup>3</sup> of dilute sulfuric acid.

Which apparatus is essential to complete the experiment?

- 1 stop-clock  
 2 measuring cylinder  
 3 thermometer  
 4 balance

- A** 1, 2 and 4      **B** 1 and 2 only      **C** 1 and 4 only      **D** 2, 3 and 4
- 3 The numbers of protons and neutrons and the electronic structures of four particles, W, X, Y and Z, are shown.

	number of protons	number of neutrons	electronic structure
W	8	8	2,8
X	8	10	2,6
Y	8	8	2,6
Z	10	8	2,8

Which particles have the same chemical properties?

- A** W and Y      **B** W and Z      **C** X and Y      **D** X and Z
- 4 Which substance should be pure for the intended use?
- A** a drug for curing disease  
**B** limestone for iron extraction  
**C** petroleum for fractional distillation  
**D** water for washing a car

- 5 Metals and ionic compounds have similarities and differences in their structure and properties.

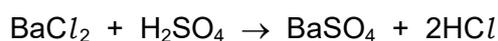
Which row about metals and ionic compounds is correct?

	similarity	difference
<b>A</b>	both contain positive ions	only ionic compounds contain anions
<b>B</b>	both contain positive ions	ionic compounds conduct using a 'sea of electrons'
<b>C</b>	both are malleable	only ionic compounds contain anions
<b>D</b>	both are malleable	ionic compounds conduct using a 'sea of electrons'

- 6 Which diagram represents the outer-shell electron arrangement in a nitrogen molecule?



- 7 The equation for the reaction between barium chloride and dilute sulfuric acid is shown.



Which row shows the state symbols for this equation?

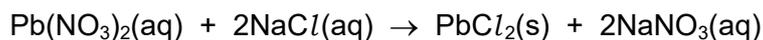
	$\text{BaCl}_2$	$\text{H}_2\text{SO}_4$	$\text{BaSO}_4$	$2\text{HCl}$
<b>A</b>	(aq)	(aq)	(s)	(aq)
<b>B</b>	(aq)	(l)	(s)	(aq)
<b>C</b>	(l)	(aq)	(s)	(l)
<b>D</b>	(aq)	(l)	(aq)	(l)

- 8 The relative atomic mass,  $A_r$ , of an element is determined by comparing the mass of one atom of the element with the mass of one atom of element Q.

What is Q?

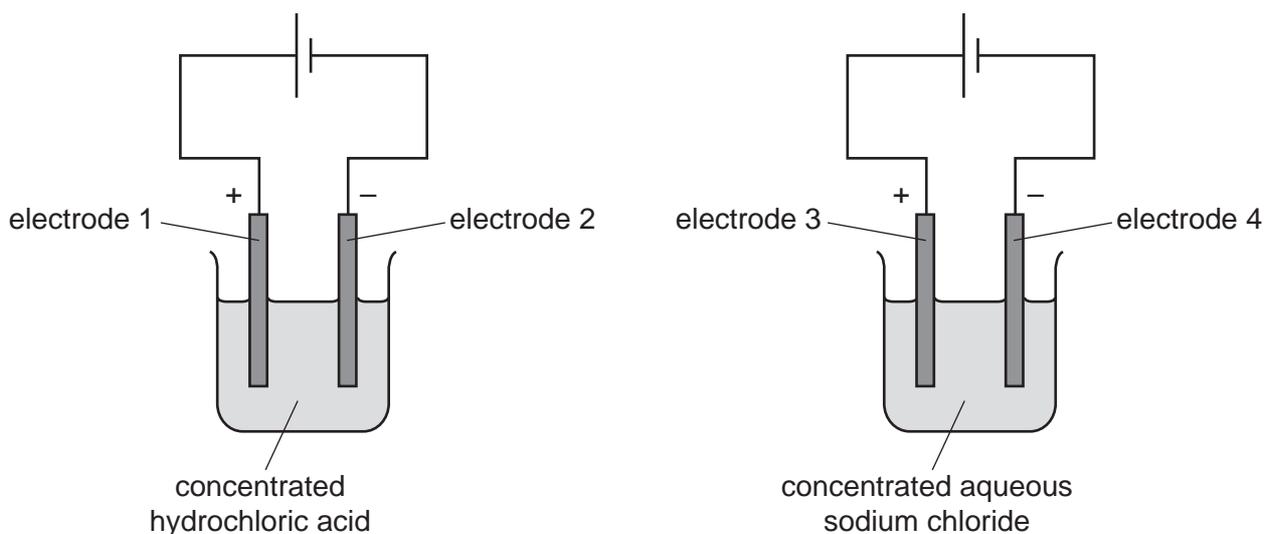
- A** carbon
- B** chlorine
- C** hydrogen
- D** oxygen

- 9 The equation for the reaction between aqueous lead(II) nitrate and aqueous sodium chloride is shown.



If  $100\text{ cm}^3$  of aqueous lead(II) nitrate of concentration  $0.1\text{ mol/dm}^3$  is reacted with an excess of aqueous sodium chloride, which mass of lead(II) chloride is obtained?

- A 1.16 g      B 2.42 g      C 2.78 g      D 3.31 g
- 10 The diagram shows the electrolysis of concentrated hydrochloric acid and concentrated aqueous sodium chloride using carbon electrodes.



At which electrodes is hydrogen produced?

- A electrode 1 only  
 B electrodes 1 and 3  
 C electrode 2 only  
 D electrodes 2 and 4
- 11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

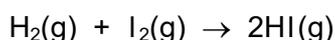
What is the ionic half-equation for the reaction at the cathode?

- A  $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$   
 B  $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$   
 C  $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$   
 D  $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$

12 Which row identifies a chemical change and a physical change?

	chemical change	physical change
<b>A</b>	boiling ethanol	burning ethanol
<b>B</b>	burning ethanol	evaporating ethanol
<b>C</b>	dissolving ethanol in water	burning ethanol
<b>D</b>	evaporating ethanol	dissolving ethanol in water

13 The equation for the reaction between gaseous hydrogen and gaseous iodine to form gaseous hydrogen iodide is shown.



The reaction is exothermic.

Which statement explains why the reaction is exothermic?

- A** Energy is released when H–H and I–I bonds are broken.
  - B** The bond energies of the reactants are larger than the bond energies of the products.
  - C** The products are at a higher energy level than the reactants.
  - D** More energy is released when two HI bonds are formed than is used when the H–H and I–I bonds are broken.
- 14 Acidified aqueous silver nitrate is added to a test-tube containing aqueous chloride ions.

The test-tube is then left in direct sunlight.

Which row describes the observations and explains what happens to the reaction mixture?

	observation on adding aqueous silver nitrate	observation after leaving in sunlight	explanation
<b>A</b>	yellow precipitate	precipitate dissolves	silver chloride forms
<b>B</b>	yellow precipitate	precipitate turns grey	silver ions are reduced
<b>C</b>	white precipitate	precipitate dissolves	silver chloride forms
<b>D</b>	white precipitate	precipitate turns grey	silver ions are reduced

15 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

- A The copper(II) sulfate turns blue and the solution formed gets colder.
- B The copper(II) sulfate turns blue and the solution formed gets hotter.
- C The copper(II) sulfate turns white and the solution formed gets colder.
- D The copper(II) sulfate turns white and the solution formed gets hotter.

16 Aqueous iron(III) chloride,  $\text{FeCl}_3$ , reacts with aqueous potassium iodide, KI.



Which statements are correct?

- 1 In the balanced equation,  $v$ ,  $w$ ,  $x$  and  $y$  have the same value.
- 2 Potassium iodide is an oxidising agent.
- 3 A dark brown solution is produced in the reaction.

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

17 Which statement about acids is correct?

- A A strong acid has a higher pH than a weak acid of the same concentration.
- B A strong acid is a proton acceptor.
- C A weak acid is a proton donor.
- D A weak acid is fully ionised in aqueous solution.

- 18 The oxides of two elements, X and Y, are separately dissolved in water and the pH of each solution tested.

oxide tested	pH of solution
X	1
Y	13

Which information about X and Y is correct?

	oxide is acidic	oxide is basic	metal	non-metal
<b>A</b>	X	Y	X	Y
<b>B</b>	X	Y	Y	X
<b>C</b>	Y	X	X	Y
<b>D</b>	Y	X	Y	X

- 19 An acid is neutralised by adding an excess of an insoluble solid base.

A soluble salt is formed.

How is the pure salt obtained from the reaction mixture?

- A** crystallisation → evaporation → filtration  
**B** evaporation → crystallisation → filtration  
**C** filtration → crystallisation → evaporation  
**D** filtration → evaporation → crystallisation

- 20 The electronic structure of element Z is 2,8,1.

Which statements about Z are correct?

- 1 It is a metal.  
 2 It has two outer-shell electrons.  
 3 It is in Period 3.

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

21 Elements in Group IV of the Periodic Table are shown.

carbon  
silicon  
germanium  
tin  
lead

What does **not** occur in Group IV as it is descended?

- A The proton number of the elements increases.
- B The elements become more metallic.
- C The elements have more electrons in their outer shell.
- D The elements have more electron shells.

22 Element M forms both  $M^+$  and  $M^{2+}$  ions.

In which part of the Periodic Table is M placed?

- A Group I
- B Group II
- C Group III
- D transition elements

23 In the extraction of aluminium by electrolysis, cryolite is added to the bauxite ore.

Which row describes the role of cryolite and gives the ionic half-equation at the cathode?

	role of cryolite	ionic half-equation at the cathode
<b>A</b>	catalyst	$Al^{3+} + 3e^- \rightarrow Al$
<b>B</b>	catalyst	$Al^{3+} + 3e^- \rightarrow 3Al$
<b>C</b>	lowers melting point of electrolyte	$Al^{3+} + 3e^- \rightarrow Al$
<b>D</b>	lowers melting point of electrolyte	$Al^{3+} + 3e^- \rightarrow 3Al$

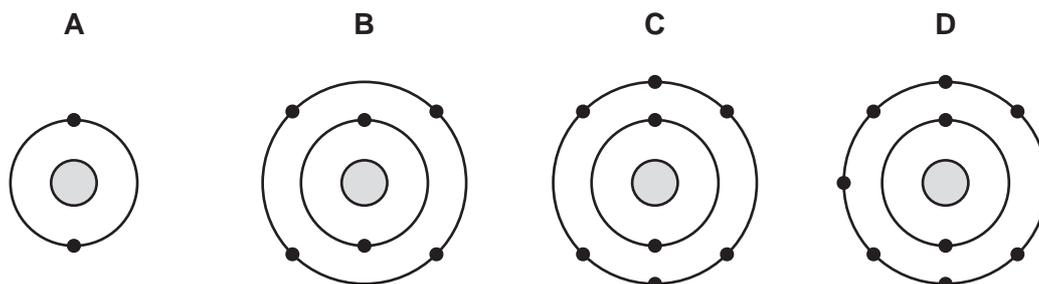
24 Mild steel is galvanised to prevent corrosion of the iron.

Which statements about galvanising are correct?

- 1 Galvanising prevents corrosion because the zinc forms an alloy.
- 2 If the coating is damaged, water and oxygen do not corrode the iron.
- 3 Zinc is a sacrificial metal and corrodes in preference to iron.

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

25 Which diagram represents the arrangement of the outer-shell electrons of a noble gas?



26 Which statements about the general properties of metals are correct?

- 1 They are good conductors of heat and electricity.
- 2 They have low melting points.
- 3 They react with dilute acids to form a salt and water.
- 4 They react with oxygen to form basic oxides.

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

27 Reactions of three metals and their oxides are shown.

metal	add dilute hydrochloric acid to metal	heat metal oxide with carbon	
1	✓	✓	key ✓ = reacts ✗ = does not react
2	✓	✗	
3	✗	✓	

What is the order of reactivity of these metals, from most reactive to least reactive?

**A** 1 → 2 → 3      **B** 1 → 3 → 2      **C** 2 → 1 → 3      **D** 2 → 3 → 1

28 Three metal compounds, J, K and L, are heated using a Bunsen burner.

The results are shown.

J colourless gas produced, which relights a glowing splint

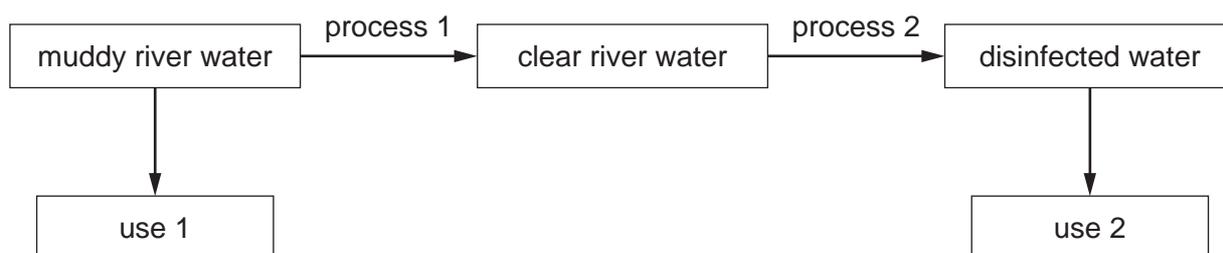
K colourless gas produced, which turns limewater milky

L no reaction

Which row identifies J, K and L?

	J	K	L
<b>A</b>	magnesium carbonate	potassium carbonate	potassium nitrate
<b>B</b>	magnesium carbonate	potassium nitrate	potassium carbonate
<b>C</b>	potassium nitrate	magnesium carbonate	potassium carbonate
<b>D</b>	potassium nitrate	potassium carbonate	magnesium carbonate

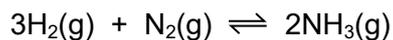
29 The diagram shows the uses and treatment processes of muddy river water.



Which row identifies uses 1 and 2 and processes 1 and 2?

	use 1	use 2	process 1	process 2
<b>A</b>	drinking	watering crops	chlorination	filtration
<b>B</b>	drinking	watering crops	filtration	chlorination
<b>C</b>	watering crops	drinking	chlorination	filtration
<b>D</b>	watering crops	drinking	filtration	chlorination

- 30 The equation for the manufacture of ammonia in the Haber process is shown.



The forward reaction is exothermic.

Which row describes the effect of the stated change on the reaction rate and the yield of ammonia?

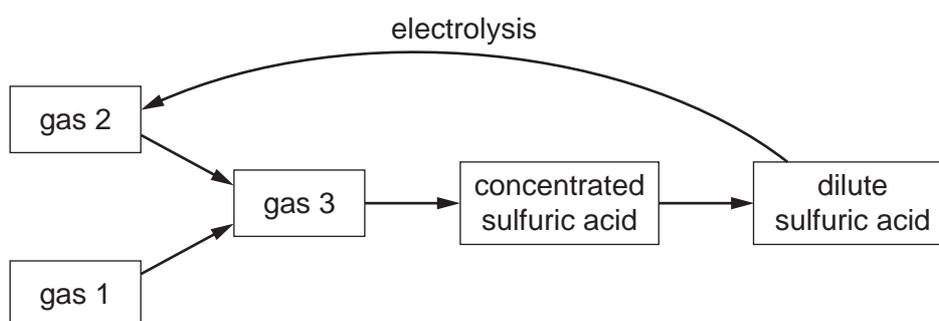
	change	effect on reaction rate	effect on yield of ammonia
<b>A</b>	decrease pressure	increases	decreases
<b>B</b>	decrease temperature	decreases	increases
<b>C</b>	increase pressure	increases	decreases
<b>D</b>	increase temperature	increases	increases

- 31 Fertilisers are used to provide three of the elements needed for plant growth.

Which two compounds would give a fertiliser containing all three of these elements?

- A**  $\text{Ca}(\text{NO}_3)_2$  and  $(\text{NH}_4)_2\text{SO}_4$   
**B**  $\text{Ca}(\text{NO}_3)_2$  and  $(\text{NH}_4)_3\text{PO}_4$   
**C**  $\text{KNO}_3$  and  $(\text{NH}_4)_2\text{SO}_4$   
**D**  $\text{KNO}_3$  and  $(\text{NH}_4)_3\text{PO}_4$

- 32 The flow chart shows part of the process for the manufacture of sulfuric acid and its electrolysis.



What are gases 1, 2 and 3?

	gas 1	gas 2	gas 3
<b>A</b>	sulfur dioxide	hydrogen	sulfur trioxide
<b>B</b>	sulfur dioxide	oxygen	sulfur trioxide
<b>C</b>	sulfur trioxide	hydrogen	sulfur dioxide
<b>D</b>	sulfur trioxide	oxygen	sulfur dioxide

33 Which statements about sulfur dioxide are correct?

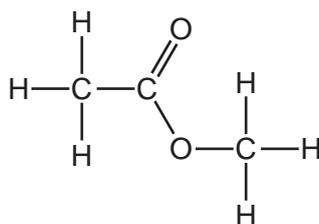
- 1 Sulfur dioxide decolourises acidified potassium manganate(VII).
- 2 Sulfur dioxide forms when acids react with carbonates.
- 3 Sulfur dioxide is used as a bleach.
- 4 Sulfur dioxide is used to treat acidic soil.

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

34 What are the products when limestone (calcium carbonate) is heated strongly?

- A** calcium hydroxide and carbon dioxide
- B** calcium hydroxide and carbon monoxide
- C** calcium oxide and carbon dioxide
- D** calcium oxide and carbon monoxide

35 The structure of ester W is shown.



Which row gives the names of ester W and the carboxylic acid and alcohol from which it is made?

	name of ester W	carboxylic acid	alcohol
<b>A</b>	ethyl methanoate	ethanoic acid	methanol
<b>B</b>	ethyl methanoate	methanoic acid	ethanol
<b>C</b>	methyl ethanoate	ethanoic acid	methanol
<b>D</b>	methyl ethanoate	methanoic acid	ethanol

36 Ethanol is made industrially by the fermentation of glucose or by the catalytic addition of steam to ethene.

Which statement describes an advantage of fermentation compared to catalytic addition?

- A** Ethanol is the only product of fermentation.
- B** Fermentation uses a batch process but catalytic addition is continuous.
- C** Fermentation uses a higher temperature than catalytic addition.
- D** Fermentation uses a renewable resource.

37 Some properties of colourless liquid L are listed.

- It boils at 65 °C.
- When added to water, two layers form which do not mix.
- It does not react with sodium carbonate.
- It has no effect on bromine water.

What is L?

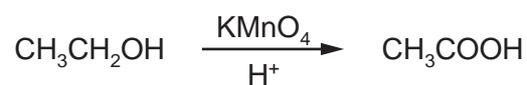
- A** ethanol  
**B** hexane  
**C** hexene  
**D** ethanoic acid

38 A molecule of compound P contains two carbon atoms and four hydrogen atoms.

Which row represents P?

	name of compound	$M_r$	reacts with aqueous bromine
<b>A</b>	ethane	30	✗
<b>B</b>	ethene	16	✓
<b>C</b>	ethene	28	✓
<b>D</b>	ethene	28	✗

39 The reaction of ethanol with acidified potassium manganate(VII) is shown.



Which type of reaction is taking place?

- A** addition  
**B** condensation  
**C** hydrolysis  
**D** oxidation

40 Which polymer is a synthetic polyamide?

- A nylon
- B poly(ethene)
- C protein
- D *Terylene*

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## The Periodic Table of Elements

Group															
I	II	III						IV	V	VI	VII	VIII			
3 <b>Li</b> lithium 7	4 <b>Be</b> beryllium 9	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> <b>Key</b>            atomic number            atomic symbol            name            relative atomic mass         </div>										2 <b>He</b> helium 4			
11 <b>Na</b> sodium 23	12 <b>Mg</b> magnesium 24											5 <b>B</b> boron 11	6 <b>C</b> carbon 12	7 <b>N</b> nitrogen 14	8 <b>O</b> oxygen 16
19 <b>K</b> potassium 39	20 <b>Ca</b> calcium 40	13 <b>Al</b> aluminium 27	14 <b>Si</b> silicon 28	15 <b>P</b> phosphorus 31	16 <b>S</b> sulfur 32	17 <b>Cl</b> chlorine 35.5	18 <b>Ar</b> argon 40	33 <b>As</b> arsenic 75	34 <b>Se</b> selenium 79	35 <b>Br</b> bromine 80	36 <b>Kr</b> krypton 84				
37 <b>Rb</b> rubidium 85	38 <b>Sr</b> strontium 88	39 <b>Y</b> yttrium 89	40 <b>Zr</b> zirconium 91	41 <b>Nb</b> niobium 93	42 <b>Mo</b> molybdenum 96	43 <b>Tc</b> technetium —	44 <b>Ru</b> ruthenium 101	45 <b>Rh</b> rhodium 103	46 <b>Pd</b> palladium 106	47 <b>Ag</b> silver 108	48 <b>Cd</b> cadmium 112	51 <b>Sb</b> antimony 122	52 <b>Te</b> tellurium 128	53 <b>I</b> iodine 127	54 <b>Xe</b> xenon 131
55 <b>Cs</b> caesium 133	56 <b>Ba</b> barium 137	57–71 lanthanoids	72 <b>Hf</b> hafnium 178	73 <b>Ta</b> tantalum 181	74 <b>W</b> tungsten 184	75 <b>Re</b> rhenium 186	76 <b>Os</b> osmium 190	77 <b>Ir</b> iridium 192	78 <b>Pt</b> platinum 195	79 <b>Au</b> gold 197	80 <b>Hg</b> mercury 201	83 <b>Bi</b> bismuth 209	84 <b>Po</b> polonium —	85 <b>At</b> astatine —	86 <b>Rn</b> radon —
87 <b>Fr</b> francium —	88 <b>Ra</b> radium —	89–103 actinoids	104 <b>Rf</b> rutherfordium —	105 <b>Db</b> dubnium —	106 <b>Sg</b> seaborgium —	107 <b>Bh</b> bohrium —	108 <b>Hs</b> hassium —	109 <b>Mt</b> meitnerium —	110 <b>Ds</b> darmstadtium —	111 <b>Rg</b> roentgenium —	112 <b>Cn</b> copernicium —	116 <b>Lv</b> livermorium —	—	—	—

lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —	62 <b>Sm</b> samarium 150	63 <b>Eu</b> europium 152	64 <b>Gd</b> gadolinium 157	65 <b>Tb</b> terbium 159	66 <b>Dy</b> dysprosium 163	67 <b>Ho</b> holmium 165	68 <b>Er</b> erbium 167	69 <b>Tm</b> thulium 169	70 <b>Yb</b> ytterbium 173	71 <b>Lu</b> lutetium 175
actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —	94 <b>Pu</b> plutonium —	95 <b>Am</b> americium —	96 <b>Cm</b> curium —	97 <b>Bk</b> berkelium —	98 <b>Cf</b> californium —	99 <b>Es</b> einsteinium —	100 <b>Fm</b> fermium —	101 <b>Md</b> mendelevium —	102 <b>No</b> nobelium —	103 <b>Lr</b> lawrencium —

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).