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**CHEMISTRY**

**0620/31**

Paper 3 Theory (Core)

**October/November 2018**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

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

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

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

You may lose marks if you do not show your working or if you do not use appropriate units.

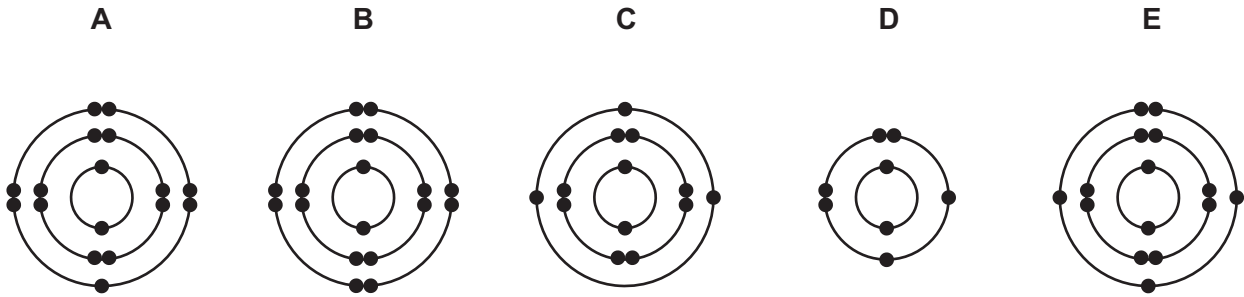
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

1 (a) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these structures.

Each structure may be used once, more than once or not at all.

State which structure, **A**, **B**, **C**, **D** or **E**, represents:

- (i) an atom of a metallic element ..... [1]
- (ii) an atom with a proton number of 13 ..... [1]
- (iii) an atom of phosphorus ..... [1]
- (iv) an atom with only **two** shells of electrons ..... [1]
- (v) an atom which forms a stable ion with a single negative charge. .... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the carbon atom and potassium ion shown.

	number of electrons	number of neutrons	number of protons
$^{14}_6\text{C}$	6		
$^{40}_{19}\text{K}^+$		21	

[3]

[Total: 8]

- 2 (a) The table shows the ions present in a  $1000\text{ cm}^3$  sample of blood plasma.

ion present	formula of ion	mass present in the $1000\text{ cm}^3$ sample/g
sodium	$\text{Na}^+$	3.25
potassium	$\text{K}^+$	0.16
calcium	$\text{Ca}^{2+}$	0.10
magnesium	$\text{Mg}^{2+}$	0.04
chloride	$\text{Cl}^-$	3.65
hydrogencarbonate	$\text{HCO}_3^-$	1.50
phosphate	$\text{PO}_4^{3-}$	0.64
sulfate	$\text{SO}_4^{2-}$	0.10

Answer these questions using only information from the table.

- (i) Which positive ion is present in the lowest concentration?

..... [1]

- (ii) Give the name of the compound formed from  $\text{K}^+$  and  $\text{Cl}^-$  ions.

..... [1]

- (iii) Calculate the mass of potassium ions present in  $200\text{ cm}^3$  of this blood plasma.

mass of potassium ions = ..... g [1]

- (iv) When the  $1000\text{ cm}^3$  sample of blood plasma is crystallised, several compounds are formed.

Suggest the name of the compound which forms the greatest mass of crystals.

..... [1]

- (b) Describe a test for potassium ions.

test .....

result .....

[2]

- (c) Blood plasma also contains proteins.  
Proteins are present in food.

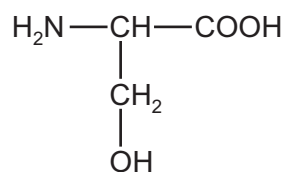
Which **one** of the following substances is also present in food?  
Draw a circle around the correct answer.

**carbohydrate      hematite      poly(ethene)      terylene**

[1]

- (d) Compound **S** is one of the monomer units used to make proteins. Its structure is shown.

compound **S**

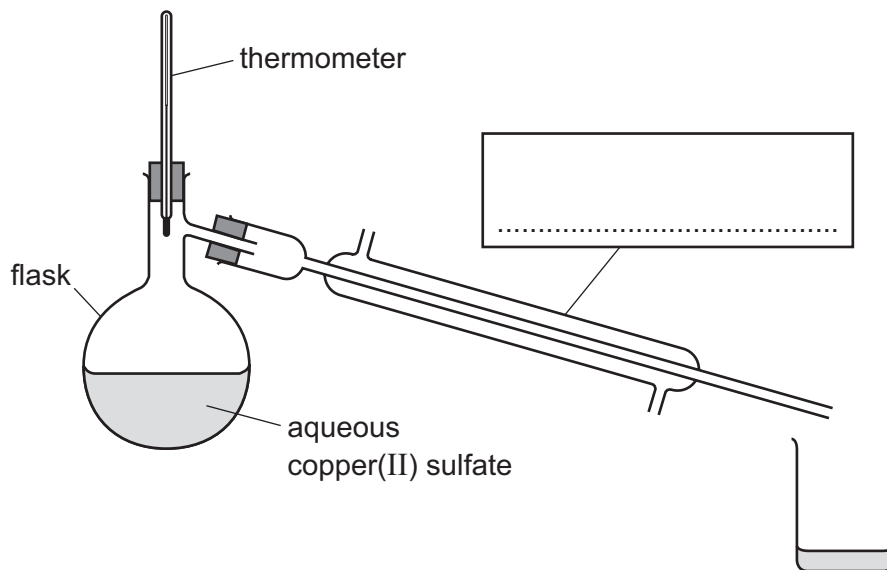


- (i) On the structure, draw a circle around the alcohol functional group. [1]
- (ii) Deduce the molecular formula of compound **S** showing the number of carbon, hydrogen, oxygen and nitrogen atoms.

..... [1]

[Total: 9]

- 3 (a) The apparatus used for distillation is shown.



- (i) Complete the box to name the apparatus. [1]
- (ii) Describe and explain how the water is separated from the aqueous copper(II) sulfate by distillation.

.....

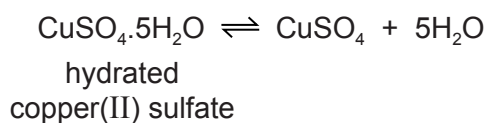
.....

.....

.....

..... [3]

- (b) A sample of solid hydrated copper(II) sulfate is heated gently in a test-tube.



Solid hydrated copper(II) sulfate is blue.

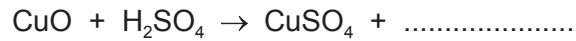
Describe **two** observations when the sample of solid hydrated copper(II) sulfate is heated gently in a test-tube.

- 1 .....
- 2 .....

[2]

(c) Copper(II) sulfate can be prepared by heating an excess of copper(II) oxide with dilute sulfuric acid.

(i) Complete the chemical equation for this reaction.

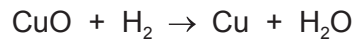


[1]

(ii) What method is used to separate the excess copper(II) oxide from the solution?

..... [1]

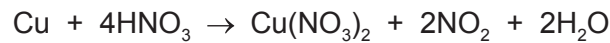
(d) Copper(II) oxide can be reduced by hydrogen.



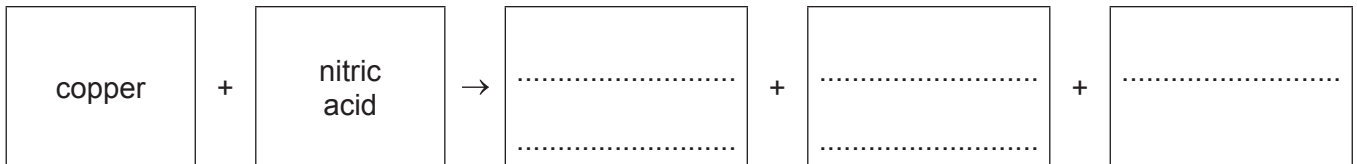
How does this equation show that copper(II) oxide is reduced?

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

(e) The chemical equation for the reaction of copper with concentrated nitric acid is shown.



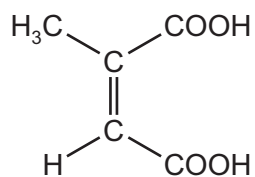
Complete the word equation for this reaction.



[2]

[Total: 11]

- 4 (a) The structure of citraconic acid is shown.



Citraconic acid is an unsaturated compound.

- (i) What feature of the structure of citraconic acid shows that it is unsaturated?

..... [1]

- (ii) Describe a test for an unsaturated compound.

test .....

result ..... [2]

- (b) Ethanoic acid has a carboxylic acid functional group.

Draw the structure of the carboxylic acid functional group. Show all of the atoms and all of the bonds.

[1]

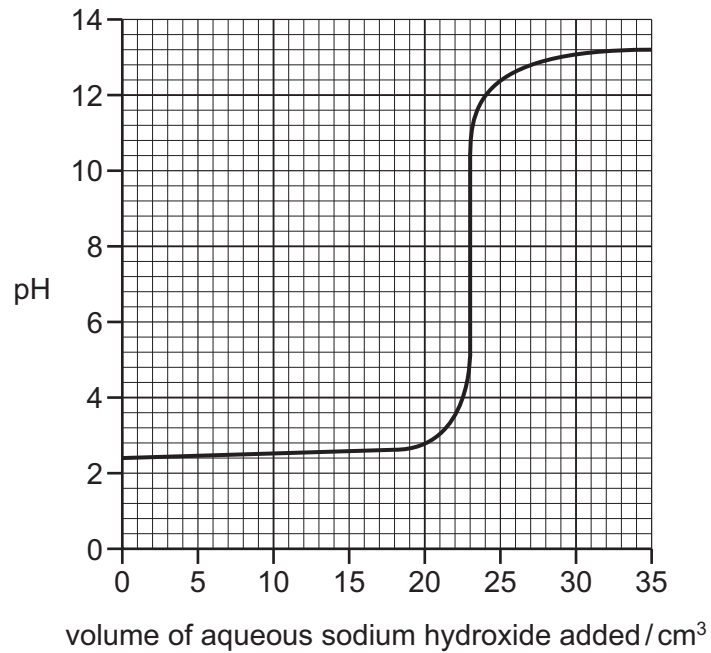
- (c) Complete the definition of a homologous series using words from the list.

**chemical    compounds    elements    functional    hydrocarbons    physical**

A homologous series is a family of similar ..... with similar .....

properties due to the presence of the same ..... group. [3]

- (d) The graph shows how the pH of a dilute acid in a conical flask changes as aqueous sodium hydroxide is added to it.



- (i) Describe how the pH changes as the aqueous sodium hydroxide is added.

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

- (ii) What is the pH of the dilute acid before the aqueous sodium hydroxide is added?

..... [1]

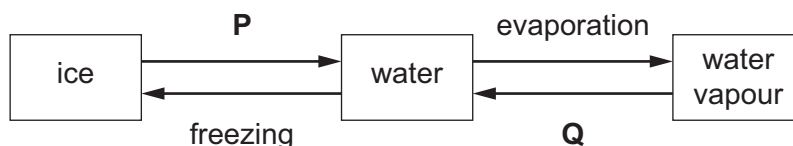
- (iii) What volume of aqueous sodium hydroxide has been added when the pH reaches pH7?

..... [1]

[Total: 11]



5 (a) Some of the changes of state of water are shown.



(i) Give the names of the changes of state represented by **P** and **Q**.

**P** .....

**Q** .....

[2]

(ii) Use the kinetic particle model to describe the separation **and** motion of the particles in water when it is:

- a liquid

.....  
 .....

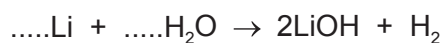
- a vapour

.....  
 .....

[4]

(b) When lithium reacts with water, hydrogen is produced and the solution formed is alkaline.

(i) Balance the chemical equation for this reaction.

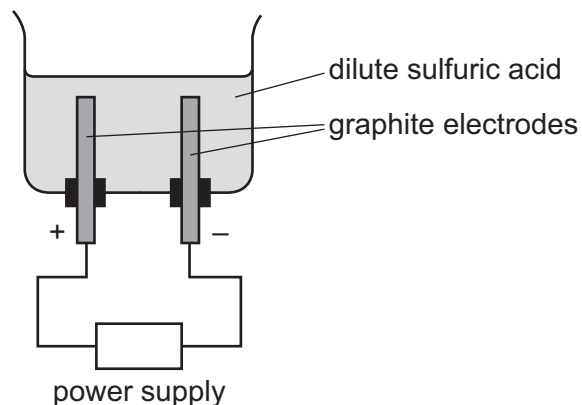


[2]

(ii) Give the name of the product which causes the solution to be alkaline.

..... [1]

(c) Dilute sulfuric acid can be electrolysed using the apparatus shown.



(i) State the products of this electrolysis at:

the positive electrode (anode) .....

the negative electrode (cathode). .....

[2]

(ii) What observation is made at the electrodes?

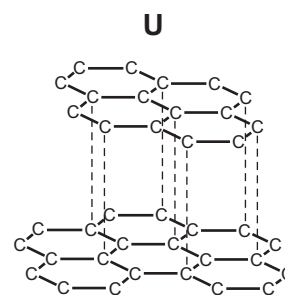
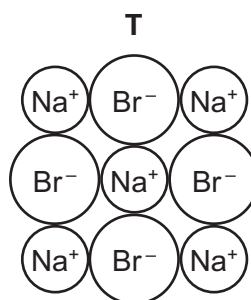
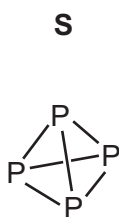
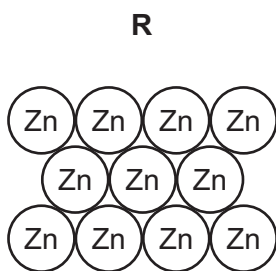
..... [1]

(iii) Suggest **one** reason why graphite is used for the electrodes rather than magnesium.

..... [1]

[Total: 13]

6 (a) The diagrams show the structures of four substances, **R**, **S**, **T** and **U**.



- (i) Which **two** of these substances, **R**, **S**, **T** or **U**, are covalently bonded?  
 ..... and ..... [2]
- (ii) Which **two** of these substances, **R**, **S**, **T** or **U**, conduct electricity when solid?  
 ..... and ..... [2]
- (iii) Which substance, **R**, **S**, **T** or **U**, has the lowest melting point? ..... [1]
- (iv) Which **one** of these substances, **R**, **S**, **T** or **U**, is soluble in water? ..... [1]

(b) Phosphorus burns in oxygen to form phosphorus(V) oxide.

- (i) Balance the chemical equation for this reaction.



- (ii) Is phosphorus(V) oxide an acidic oxide or a basic oxide?  
 Give a reason for your answer.

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

(c) Phosphate ions are present in many fertilisers.

- (i) Which **one** of the following ions is also present in many fertilisers?  
 Draw a circle around the correct answer.



- (ii) Why do farmers put fertilisers on their fields?

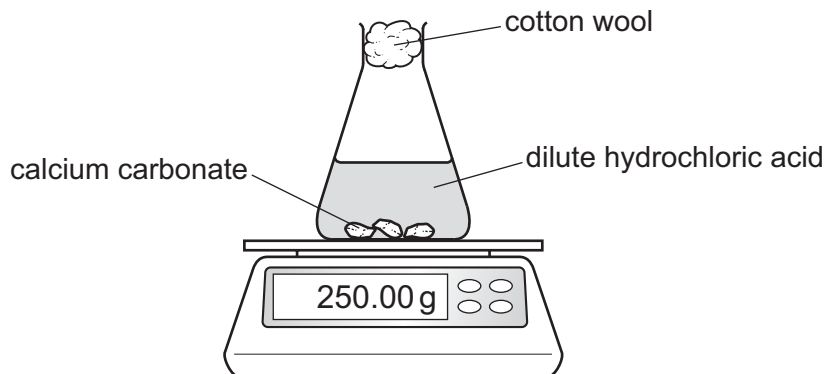
.....  
 ..... [1]

[Total: 10]

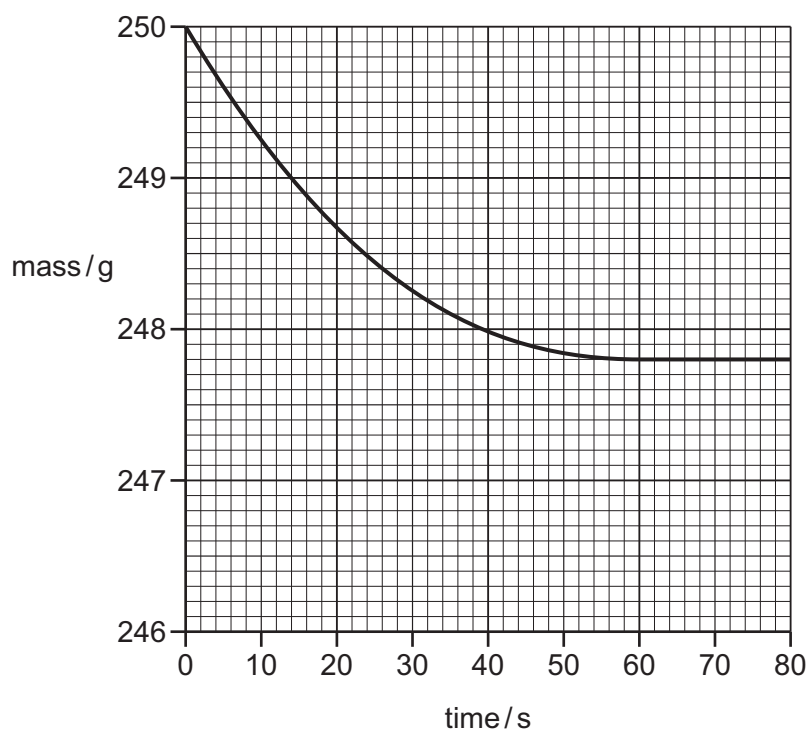
- 7 (a) A student investigates the reaction of calcium carbonate with dilute hydrochloric acid.



The student measures the mass of the reaction mixture at 10 second intervals using the apparatus shown.



The graph shows the results when 5.0 g of calcium carbonate is added to an **excess** of dilute hydrochloric acid.



- (i) Suggest why the reaction mixture decreases in mass as the reaction proceeds.

..... [1]

- (ii) Calculate the loss of mass in grams when the reaction is complete.

loss in mass = ..... g [1]

- (iii) The experiment is repeated using dilute hydrochloric acid of **twice** the concentration. All other conditions are kept the same.

**On the grid**, draw a graph to show how the mass changes with time using dilute hydrochloric acid of **twice** the concentration. [2]

- (iv) The original experiment is repeated at three different temperatures. All other conditions are kept the same. The three temperatures are 20 °C, 30 °C and 40 °C.

Complete the table by writing the temperatures in the first column.

temperature in °C	initial rate of reaction in g/s
	0.16
	0.64
	0.32

[1]

- (b) Complete the sentences about the use of calcium carbonate in the extraction of iron using words from the list.

**bauxite    dioxide    hematite    monoxide    silicon    slag**

The main ore of iron is called ..... . The main impurity in the iron ore is silicon(IV) oxide.

Calcium carbonate added to the blast furnace decomposes to form calcium oxide and carbon ..... . The calcium oxide reacts with the silicon(IV) oxide to form .....

[3]

[Total: 8]

8 Glass can be made by heating a mixture of sand, sodium carbonate and limestone (calcium carbonate).

- (a) (i) Calculate the relative formula mass of sodium carbonate,  $\text{Na}_2\text{CO}_3$ .  
Show all your working.  
Use your Periodic Table to help you.

relative formula mass = ..... [2]

- (ii) Sodium carbonate can be manufactured by the reaction between limestone and sodium chloride. The reaction is endothermic.

What is meant by the term *endothermic*?

..... [1]

- (iii) During this glass-making process, limestone decomposes into lime (calcium oxide).  
Lime is used to treat acidic soils.

What type of chemical reaction occurs when lime reacts with acidic soils?

Draw a circle around the correct answer.

**addition      neutralisation      oxidation      reduction**

[1]

(b) Charcoal (carbon) can be burned in an excess of clean, dry air to provide the heat needed to make glass.

(i) Which gas is 21% of clean, dry air?

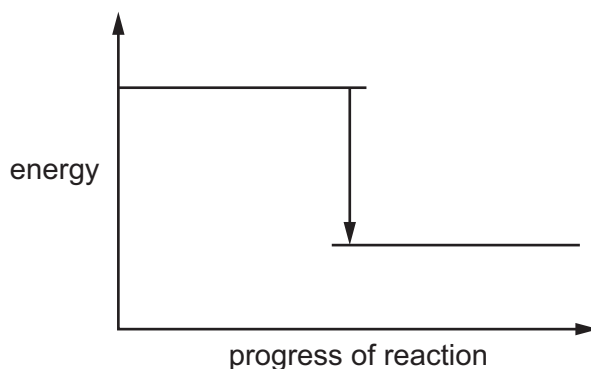
..... [1]

(ii) Write a word equation for carbon burning in an excess of air.

..... [1]

(iii) Complete the energy level diagram for this reaction by adding these **two** words:

- reactants
- product



[1]

(c) Argon is also present in clean, dry air.

(i) Give **one** use of argon.

..... [1]

(ii) Which **two** of the following statements about argon are correct?

Tick **two** boxes.

Argon is unreactive.

Argon is diatomic.

Argon is monatomic.

Argon forms ionic compounds.

Argon is a greenhouse gas.

[2]

[Total: 10]

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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	1 <b>H</b> hydrogen 1	5 <b>B</b> boron 11	6 <b>C</b> carbon 12	7 <b>N</b> nitrogen 14	8 <b>O</b> oxygen 16	9 <b>F</b> fluorine 19	10 <b>Ne</b> neon 20				
11 <b>Na</b> sodium 23	12 <b>Mg</b> magnesium 24	<b>Key</b> atomic number atomic symbol name relative atomic mass										
19 <b>K</b> potassium 39	20 <b>Ca</b> calcium 40	26 <b>Fe</b> iron 56	27 <b>Co</b> cobalt 59	28 <b>Ni</b> nickel 59	29 <b>Cu</b> copper 64	30 <b>Zn</b> zinc 65	31 <b>Al</b> aluminium 27	32 <b>Si</b> silicon 28	33 <b>P</b> phosphorus 31	34 <b>S</b> sulfur 32	35 <b>Cl</b> chlorine 35.5	36 <b>Ar</b> argon 40
37 <b>Rb</b> rubidium 85	38 <b>Sr</b> strontium 88	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	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
55 <b>Cs</b> caesium 133	56 <b>Ba</b> barium 137	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	49 <b>In</b> indium 115	50 <b>Sn</b> tin 119	51 <b>Sb</b> antimony 122	52 <b>Te</b> tellurium 128	53 <b>I</b> iodine 127	54 <b>Xe</b> xenon 131
87 <b>Fr</b> francium —	88 <b>Ra</b> radium —	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 —	81 <b>Tl</b> thallium 204	82 <b>Pb</b> lead 207	83 <b>Bi</b> bismuth 209	84 <b>Po</b> polonium —	85 <b>At</b> astatine —	86 <b>Rn</b> radon —

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
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 —

lanthanoids

actinoids

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