Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0963380272

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: 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 20.
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 **19** printed pages and **1** blank page.

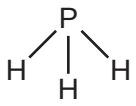
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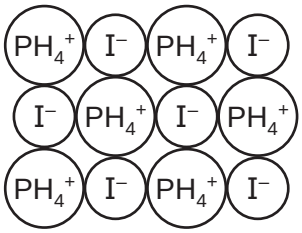
[Turn over

1 The structures of some substances containing phosphorus are shown.

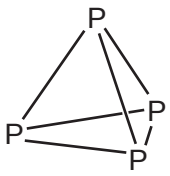
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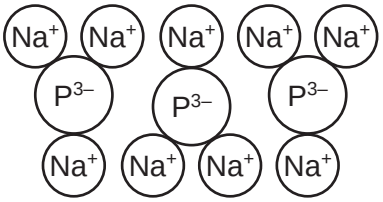
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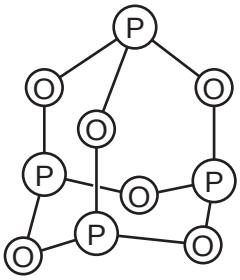
C



D



E



(a) Answer the following questions about these substances.

(i) Which **two** of these substances are ionic?

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

(ii) Which **one** of these substances is an element?

Explain your answer.

.....

..... [2]

(iii) Determine the simplest formula for substance **D**.

..... [1]

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(b) Phosphorus has one naturally occurring isotope.

(i) Determine the number of neutrons present in one atom of the isotope $^{31}_{15}P$.

..... [1]

(ii) How many electrons are there in the outer shell of one phosphorus atom?

..... [1]

(iii) Determine the **total** number of electrons present in a phosphorus molecule, P_4.

..... [1]

(c) What type of oxide is phosphorus(V) oxide?

Explain your answer.

.....

..... [2]

[Total: 9]

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2 **(a)** The table describes the ease of reduction of some metal oxides with carbon.

metal oxide	ease of reduction on heating
lead oxide	moderate heating at 200 °C needed
nickel oxide	high temperature at 750 °C needed
titanium oxide	very high temperatures above 1700 °C needed
zinc oxide	very high temperature at 900 °C needed

Put the metals in order of their reactivity. Put the least reactive metal first.

least reactive ⟶ most reactive

[2]

(b) Aluminium is extracted by the electrolysis of molten aluminium oxide.

Predict the products of this electrolysis at the

positive electrode (anode),.....

negative electrode (cathode)..... [2]

(c) When iron reacts with dilute hydrochloric acid, an aqueous solution containing iron(II) ions is formed.

Describe a test for iron(II) ions.

test.....

result..... [2]

(d) Iron rusts very easily.

(i) Complete the following sentence.

Iron rusts in the presence of ..... and ..... . [2]

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(ii) Describe **one** method of rust prevention and explain how it works.

.....

.....

..... [2]

[Total: 10]

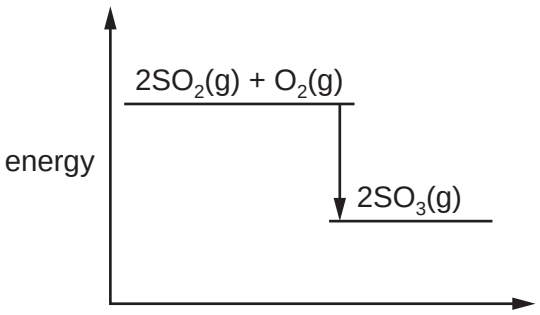
3 Sulfur dioxide reacts with excess oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(a) What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(b) The energy level diagram for the reaction is shown.



Is this reaction exothermic or endothermic?

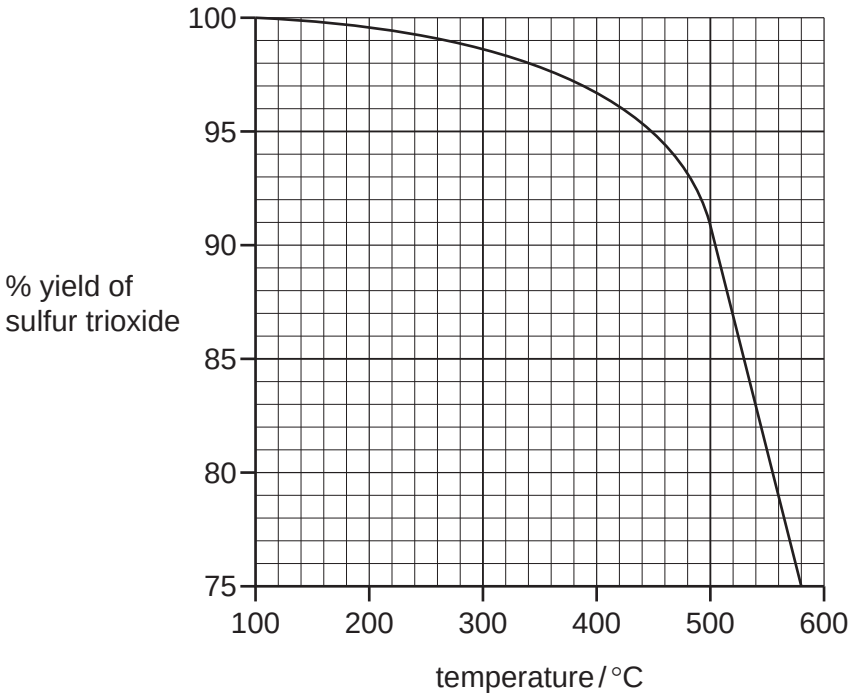
Give a reason for your answer.

.....

..... [1]

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(c) The graph shows how the percentage yield of sulfur trioxide changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of sulfur trioxide changes with temperature.

..... [1]

(ii) Determine the percentage yield of sulfur trioxide when the temperature is 500 ºC.

..... [1]

(d) Describe a test for sulfur dioxide.

test .....

result ..... [2]

(e) Give one **use** of sulfur dioxide.

..... [1]

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(f) Sulfur dioxide reacts with magnesium.

$$2Mg + SO_2 \rightarrow 2MgO + S$$

Which substance is reduced in this reaction?

Explain your answer.

.....

..... [2]

(g) Sulfur dioxide reacts with water to form sulfurous acid, H_2SO_3. Sulfurous acid reacts with hydrogen sulfide to form water and sulfur.

Complete the chemical equation for this reaction.

$$H_2SO_3 + 2H_2S \rightarrow .....H_2O + 3S$$

[1]

[Total: 10]

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4 Alkanes, alkenes and alcohols are three different homologous series of organic compounds.

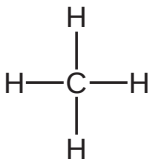
(a) What is meant by the term *homologous series*?

.....

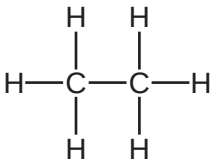
..... [2]

(b) The structures of some alkanes, alkenes and alcohols are shown below.

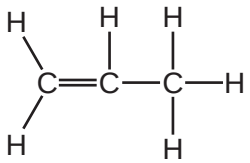
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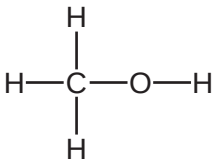
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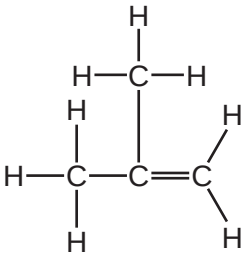
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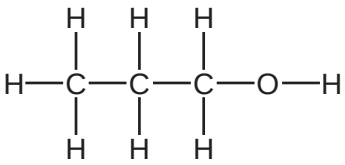
I



J



K



(i) Which **two** of these compounds, **F**, **G**, **H**, **I**, **J** and **K**, are saturated hydrocarbons?

Explain your answer.

.....

..... [3]

(ii) Which **one** of these compounds is the main constituent of natural gas?

..... [1]

(iii) Which **two** of these compounds are alkenes?

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

(iv) Why are two compounds, **I** and **K**, not hydrocarbons?

..... [1]

(c) The table gives some information about four alcohols.

alcohol	molecular formula	density in g / cm^3	boiling point / °C
methanol	CH_4O	0.793	
	C_2H_6O	0.789	79
propanol	C_3H_8O	0.804	98
butanol	$C_4H_{10}O$	0.810	117

(i) Give the name of the alcohol with the formula C_2H_6O.

..... [1]

(ii) A student predicts that the density of the alcohols increases as the number of carbon atoms increases.
Does the data in the table support this prediction?

Explain your answer.

.....

.....

..... [1]

(iii) Suggest a value for the boiling point of methanol.

..... [1]

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(d) The alcohol with the formula C_2H_6O burns in a limited supply of air to form carbon monoxide and water.

(i) Complete the chemical equation for this reaction.

$$C_2H_6O \ + \ 2O_2 \rightarrow \ .....CO \ + \ .....H_2O$$

[2]

(ii) State an adverse effect of carbon monoxide on health.

..... [1]

[Total: 15]

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5 Chlorine, bromine and iodine are halogens.

(a) The melting point of bromine is –7 ºC. The boiling point of bromine is +59 ºC.

Deduce the state of bromine at +6 ºC. Explain your answer.

.....

..... [2]

(b) **(i)** Complete the word equation for the reaction of chlorine with potassium iodide.

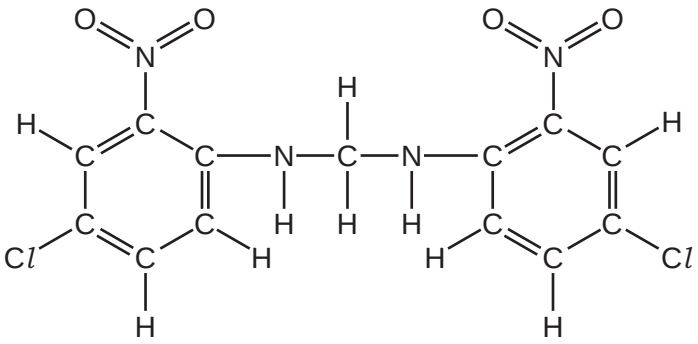
chlorine + potassium iodide → ..... + ... [2]

(ii) Suggest why iodine does **not** react with aqueous potassium bromide.

.....

..... [1]

(c) The structure of the dye Lithol fast yellow is shown.



Complete the table and calculate the relative molecular mass of Lithol fast yellow.

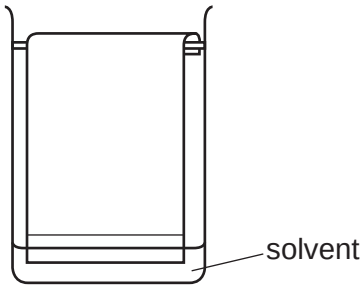
type of atom	number of atoms	atomic mass	
carbon	13	12	13 × 12 = 156
hydrogen	10	1	10 × 1 = 10
nitrogen	4	14	4 × 14 = 56
oxygen			
chlorine			

relative molecular mass = ... [2]

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(d) Chromatography is used to separate a mixture of dyes.

(i) Draw a cross on the diagram to show where the mixture of dyes is placed at the start of the chromatography.



[1]

(ii) Suggest a suitable solvent that could be used.

..... [1]

(iii) Describe what you would observe as the experiment proceeds.

.....

..... [1]

[Total: 10]

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6 Sodium is a metal in Group I of the Periodic Table.

(a) Describe some physical and chemical properties of sodium. In your answer include

- any observations about the reactions of sodium,
- at least one word equation.

.....

.....

.....

.....

.....

.....

..... [5]

(b) The presence of sodium in compounds can be confirmed using a flame test.

Describe how a flame test is carried out and give the result of the test for sodium.

test .....

.....

result ..... [2]

(c) Aqueous sodium hydroxide is strongly alkaline.

(i) Which one of the following values is the pH of a strongly alkaline solution?

Put a ring around the correct answer.

pH 1 pH 2 pH 7 pH 13

[1]

(ii) Describe how you could use litmus to show that aqueous sodium hydroxide is alkaline.

.....

..... [2]

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(d) Sodium sulfite, Na_2SO_3, reacts with hydrochloric acid.

$$Na_2SO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + SO_2(g) + H_2O(l)$$

Explain why this reaction could have an adverse effect on health if not carried out in a fume cupboard.

.....

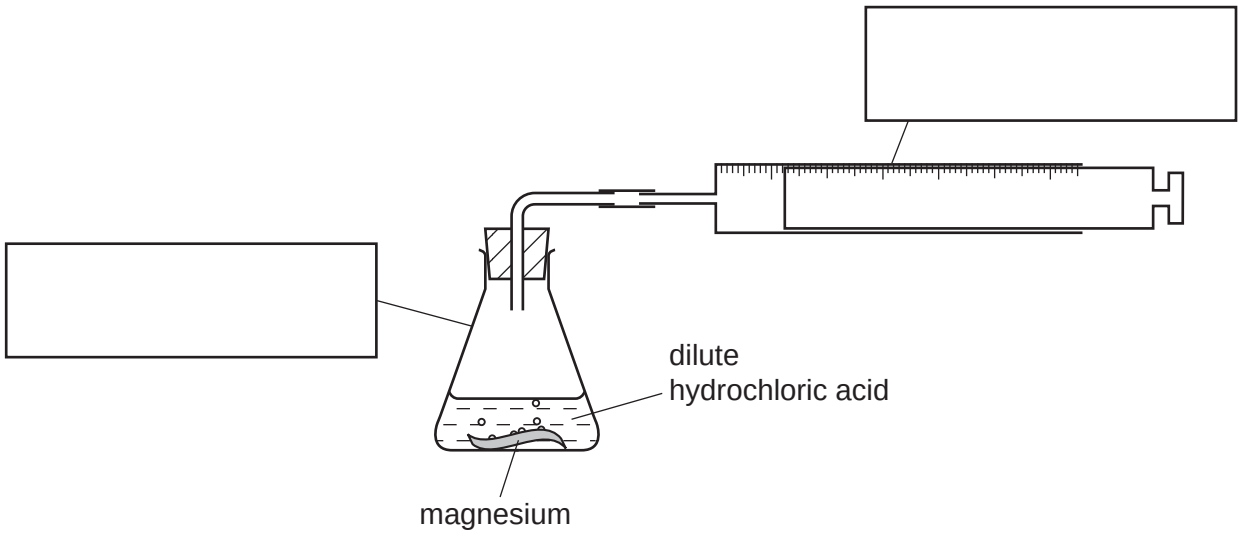
..... [2]

[Total: 12]

7 When magnesium reacts with hydrochloric acid, the products are aqueous magnesium chloride and hydrogen.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

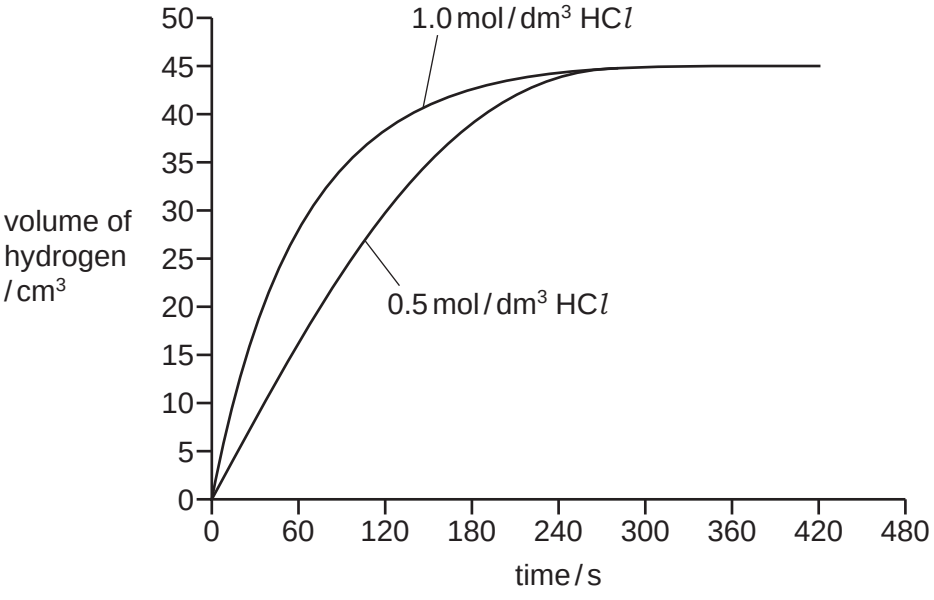
A student used the apparatus shown to follow the progress of this reaction.



(a) Complete the diagram by putting the correct labels in the boxes.

[2]

(b) The student conducted two experiments using the same mass of magnesium in each experiment and two different concentrations of hydrochloric acid. The hydrochloric acid was in excess. All other conditions were kept constant.
The student measured the volume of hydrogen produced over a period of time. The graph shows the results.



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(i) Which concentration of hydrochloric acid gave the faster initial rate of reaction?

Use the graph to explain your answer.

.....

..... [1]

(ii) Draw a curve **on the graph on page 16** to show how the volume of hydrogen would change if a third experiment was carried out using 1.5 mol / dm^3 hydrochloric acid and the same mass of magnesium.

[2]

(c) Give **one** use of hydrogen.

..... [1]

(d) Explosions have occasionally been reported where tiny particles of metal dust escape into the air.

Explain why metal dust can form an explosive mixture with air.

.....

..... [1]

[Total: 7]

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8 Solder is an alloy of lead and tin.

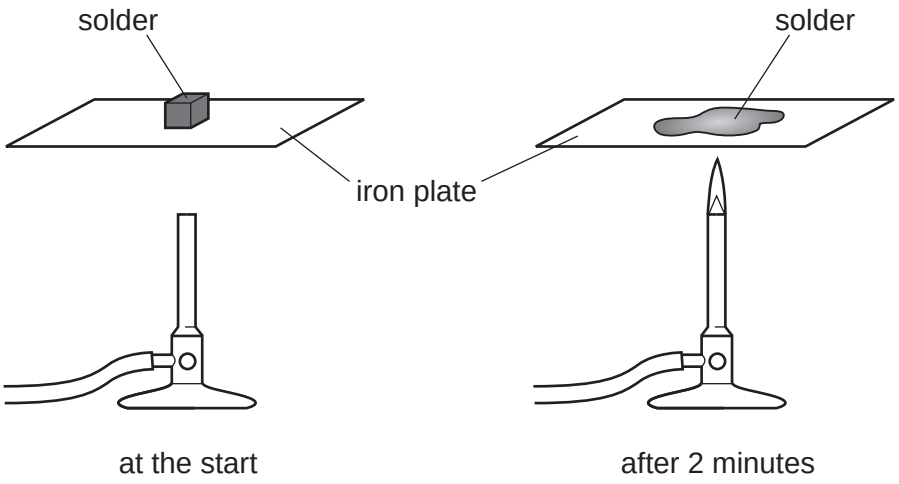
(a) What is the meaning of the term *alloy*?

..... [1]

(b) State the name of another alloy.

..... [1]

(c) A student heated a piece of solder carefully.
The diagram shows what happens to the solder.



Use the kinetic particle theory to describe and explain what happens to the solder as it changes state.

.....

.....

.....

.....

..... [4]

(d) When heated above 1744 °C, lead forms a vapour.

Describe a general property of a vapour (gas) which is not shown by a solid.

..... [1]

[Total: 7]

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[Turn over

The Periodic Table of Elements

	Group																	
	I	II									III	IV	V	VI	VII	VIII
																2 He helium 4
						1 H hydrogen 1					5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
											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
	3 Li lithium 7	4 Be beryllium 9														
	11 Na sodium 23	12 Mg magnesium 24														
	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	114 Fl flerovium –	115	116 Lv livermorium –	117	118

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.)

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