

CANDIDATE  
NAME

CENTRE  
NUMBER

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NUMBER

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**CHEMISTRY**

**0620/32**

Paper 3 Theory (Core)

**October/November 2016**

**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 20.

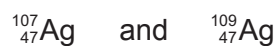
You may lose marks if you do not show your working or if you do not use appropriate units.

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.



(b) Silver has two naturally occurring isotopes.



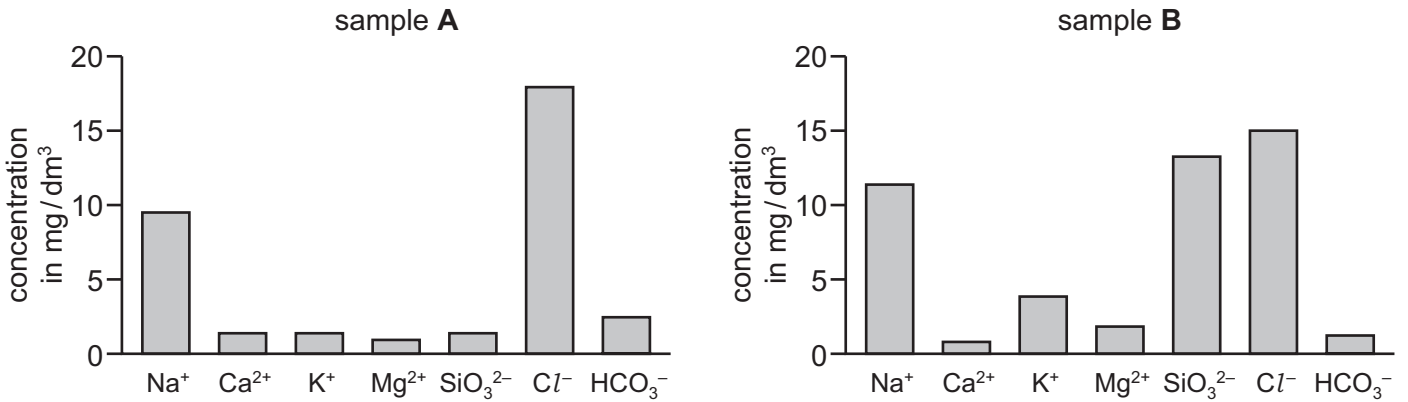
Complete the table to show the number of protons, electrons and neutrons in these **two** isotopes.

	${}_{47}^{107}\text{Ag}$	${}_{47}^{109}\text{Ag}$
number of protons		
number of electrons		
number of neutrons		

[3]

[Total: 8]

2 The bar charts compare the concentrations of ions in two samples of water, sample **A** and sample **B**.



(a) Use the information in the bar charts to answer the following questions.

(i) Describe **two** differences in the composition of sample **A** and sample **B**.

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

(ii) Which positive ion has the lowest concentration in sample **B**?

..... [1]

(iii) Calculate the mass of chloride ions present in 100 cm<sup>3</sup> of sample **B**.  
 Show all your working. [1 dm<sup>3</sup> = 1000 cm<sup>3</sup>]

mass = ..... mg [2]

(b) Describe a test for chloride ions.

test .....

result .....

[2]

- (c) River water contains small particles of clay.  
These particles show Brownian motion.

Which **one** of these statements best describes Brownian motion?

Tick **one** box.

the diffusion of gases

the random movement of particles in a suspension

the downward movement of particles in a suspension

[1]

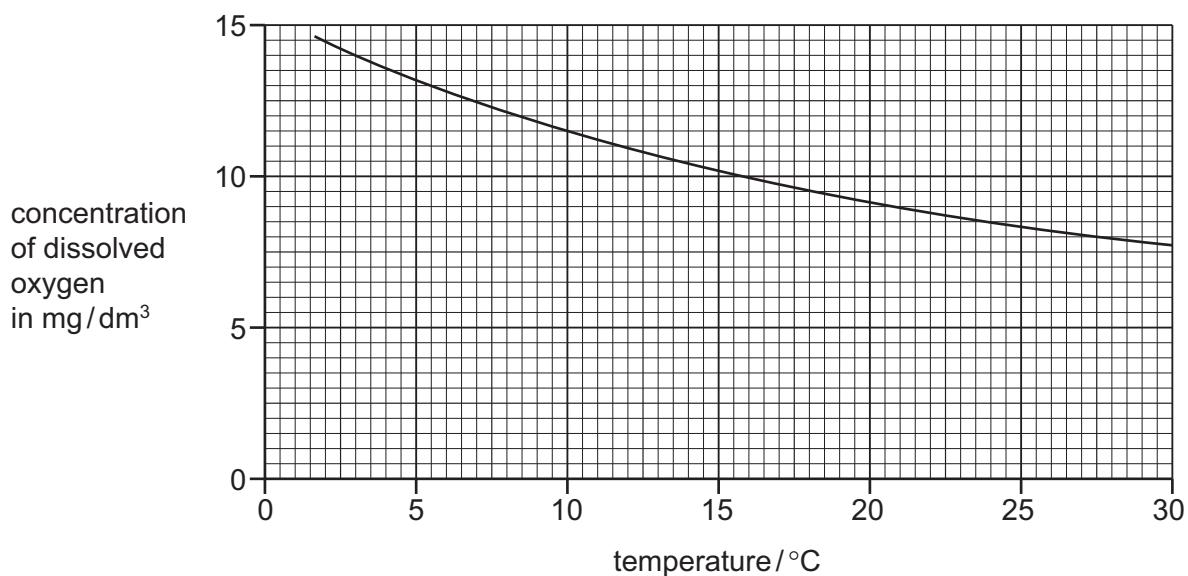
- (d) Silicon in river water comes from silicate rocks. Some of these contain silicon(IV) oxide.

Explain why silicon(IV) oxide is an acidic oxide.

..... [1]

(e) River water contains dissolved oxygen.

The graph shows how the concentration of dissolved oxygen changes with temperature.



(i) Describe how the concentration of dissolved oxygen changes with temperature.

..... [1]

(ii) Determine the concentration of oxygen present in the water at 10 °C.

..... [1]

(iii) Suggest how the rate of corrosion of iron water pipes changes with temperature.  
Explain your answer.

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

(f) Describe how water is treated to make it suitable to drink.

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

(g) Oxides of nitrogen are common pollutants in the air.

(i) State **one** source of oxides of nitrogen in the air.

..... [1]

(ii) State **one** adverse effect of oxides of nitrogen on health.

..... [1]

[Total: 16]

3 Iron is a metal.

(a) The equation for the reaction of iron with steam is shown.



Which substance is reduced in this reaction?

Explain your answer.

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

(b) Iron is extracted by heating iron ore with carbon in a blast furnace.

(i) What is the meaning of the term *ore*?

..... [1]

(ii) Air is blown into the blast furnace.

What is the purpose of this air?

..... [1]

(iii) The impurities in the iron ore are removed as slag.

Which **one** of the following is slag?

Tick **one** box.

iron(II) oxide

calcium silicate

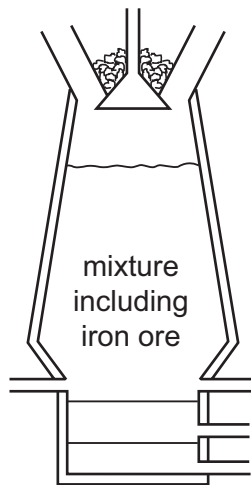
calcium carbonate

coke

[1]

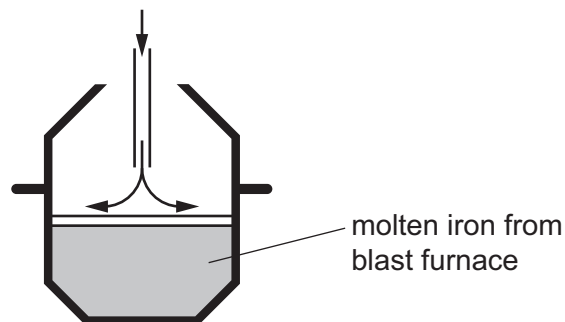
- (iv) Slag is less dense than iron.  
The diagram shows a blast furnace used to extract iron.

On the diagram, write the letter **S** to show where the slag is removed.



[1]

- (c) Iron from the blast furnace contains impurities.  
The diagram shows a converter used to make steel from iron.



Describe how iron is converted into steel.  
In your answer

- describe the impurities present,
- describe how the impurities are removed,
- include a relevant word equation.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]



4 Methyl orange and methyl red are both dyes which can be used as indicators.

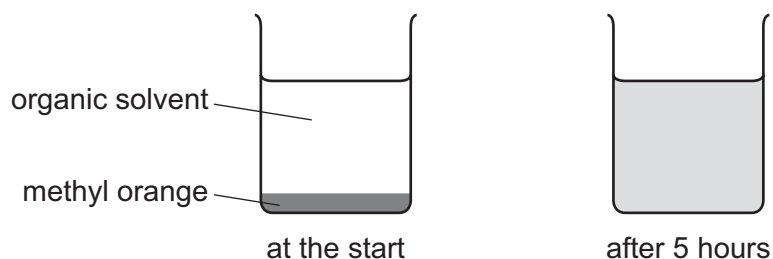
- (a) The actual value for the melting point of methyl red is  $180^{\circ}\text{C}$ .  
A chemist prepares a sample of methyl red and finds that it melts over the range  $173^{\circ}\text{C}$  to  $177^{\circ}\text{C}$ .

Suggest why the melting point of this sample was different from the actual value.

..... [1]

- (b) A concentrated solution of methyl orange was placed at the bottom of a beaker containing an organic solvent.

After 5 hours, the orange colour had spread throughout the solvent.



Use the kinetic particle model of matter to explain this observation.

.....  
 .....  
 .....  
 ..... [3]

- (c) Methyl orange is used as an indicator.

What colour is methyl orange when placed in dilute sulfuric acid?

..... [1]

(d) Sulfuric acid can be used to prepare copper(II) sulfate from copper(II) oxide.

(i) Complete the general word equation for this reaction.

metal oxide + acid → ..... + .....

[2]

(ii) Sulfuric acid is added to excess copper(II) oxide. The mixture is heated and the unreacted copper(II) oxide is removed.

Suggest how the unreacted copper(II) oxide is removed.

..... [1]

(iii) Put statements **A** to **E** about the preparation of pure dry crystals of copper(II) sulfate from copper(II) sulfate solution in the correct order.

- A** The crystals are filtered off.
- B** The heating is stopped when the point of crystallisation is reached.
- C** The mixture is left to form crystals.
- D** The crystals are dried with filter paper.
- E** The solution is heated gently.

correct order

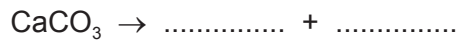
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[2]

[Total: 10]

- 5 Cement is made by heating clay with limestone. Some of the limestone (calcium carbonate) breaks down to form calcium oxide and a gas which turns limewater milky.

(a) (i) Complete the chemical equation for this reaction.



[2]

(ii) What type of chemical reaction is this?

..... [1]

(iii) Determine the relative formula mass of calcium carbonate. Show all your working.

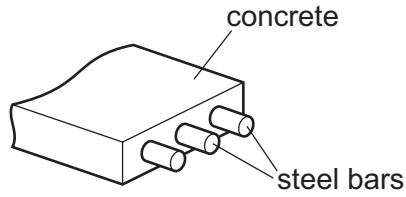
[2]

- (b) Concrete is a mixture of cement, sand, water and small stones.  
Calcium carbonate is a compound, but concrete is a mixture.

State **two** differences between a compound and a mixture.

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

(c) Reinforced concrete contains steel bars within the concrete.



Some properties of concrete and steel are shown in the table.

	relative strength	relative expansion when heated	relative heat conductivity	cost
concrete	60	12	1.5	low
steel	250	12	60.0	high

Use the information in the table to suggest why concrete must be reinforced with steel when it is used to make bridges.

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

(d) If reinforced concrete becomes cracked, liquids and gases can reach the steel bars. The steel bars rust.

Which **two** substances are needed for steel to rust?

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

[Total: 10]

6 Petroleum can be separated into useful hydrocarbon fractions by fractional distillation.

(a) (i) Explain the term *hydrocarbon fraction*.

hydrocarbon .....

fraction .....

..... [2]

(ii) State **one** use for each of the following hydrocarbon fractions.

naphtha .....

kerosene .....

[2]

(b) Organic compounds can be grouped into different homologous series.

Explain the term *homologous series* by referring to alkenes.

.....  
.....  
.....  
.....  
.....  
..... [4]

(c) The table shows some information about alkenes.

alkene	formula	density of liquid alkene in g/cm <sup>3</sup>	melting point /°C	boiling point /°C
ethene	C <sub>2</sub> H <sub>4</sub>	0.568	-169	-104
propene	C <sub>3</sub> H <sub>6</sub>	0.610	-185	-47
butene	C <sub>4</sub> H <sub>8</sub>	0.626	-185	-6
pentene	C <sub>5</sub> H <sub>10</sub>	0.640	-165	+30
hexene	C <sub>6</sub> H <sub>12</sub>	0.673	-140	

- (i) A student predicts that the density of the liquid alkenes increases as the number of carbon atoms increases.

Describe whether the data in the table support this prediction.

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

- (ii) Predict the boiling point of hexene.

..... [1]

- (iii) Deduce the state of pentene at -60 °C.  
 Explain your answer.

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

(d) Draw the structure of ethene. Show all of the atoms and all of the bonds.

[1]

- (e) Alkenes are manufactured by cracking.

When tetradecane, C<sub>14</sub>H<sub>30</sub>, is cracked the products are ethene, an alkene with four carbon atoms and an alkane.

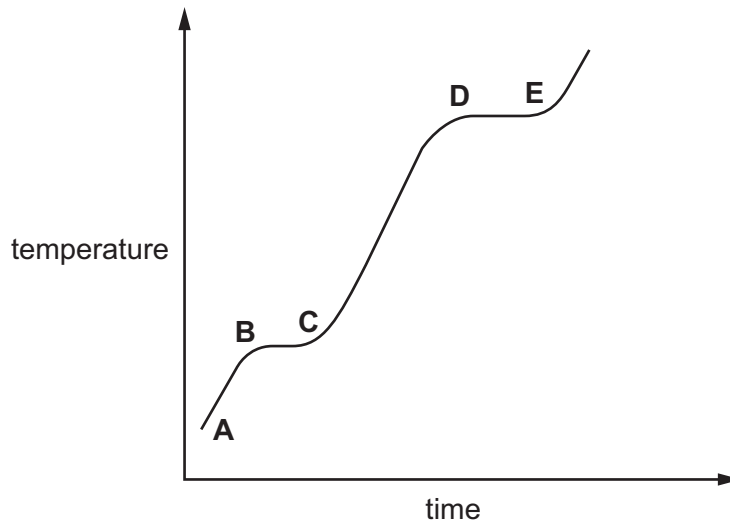
Complete the chemical equation for this reaction.



[2]

[Total: 15]

- 7 The graph shows how the temperature of sodium changes when it is heated at a constant rate in an atmosphere of argon.



- (a) Suggest why the sodium is heated in argon and **not** in air.

..... [1]

- (b) Which part of the graph above represents the boiling point of sodium?  
Tick **one** box.

A–B	
B–C	
C–D	
D–E	

[1]

- (c) (i) Describe **two** differences in the general properties of a liquid and a gas.

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

- (ii) Describe the arrangement and motion of the particles in a liquid.

arrangement .....

motion .....

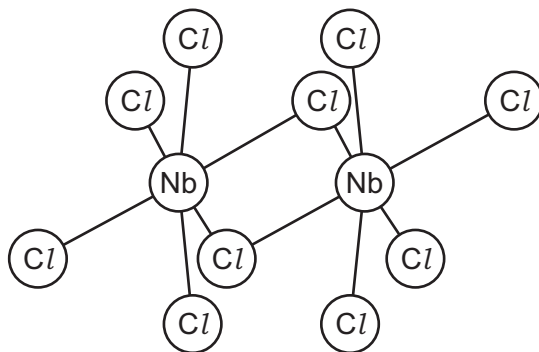
[2]

(d) Niobium is a transition element. Sodium is an element in Group I of the Periodic Table.

(i) Describe **two** properties of niobium which are different from sodium.

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

(ii) The structure of niobium chloride is shown.



Determine the formula of niobium chloride.

..... [1]

(iii) Niobium chloride is a covalent molecule.

Predict **two** physical properties of niobium chloride.

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

[Total: 11]







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## The Periodic Table of Elements

		Group																																																																																																																																																																																																																				
I	II	III	IV	V	VI	VII	VIII																																																																																																																																																																																																															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																																																																																																																																																																																					
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36																																																																																																																																																																																											
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																																																																																																																																																																																			
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222																																																																																																																																																																																			
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138																																																																																																																																																																																	
Fr francium	Ra radium	Ac actinium	Rf rutherfordium	Db dubnium	Sg seaborgium	Bh bohrium	Hs hassium	Mt meitnerium	Ds darmstadtium	Rg roentgenium	Cn copernicium	Fl flerovium	Lv livermorium	Uu ununoctium	Uub unubium	Uuc unucium	Uud unuduim	Uue unuekium	Uuq ununquium	Uur ununrium	Uus ununseptium	Uu8 ununoctium	Uu9 ununnonium	Uu10 unundecium	Uu11 ununundecium	Uu12 ununbium	Uu13 ununtrium	Uu14 ununquadrimum	Uu15 ununpentium	Uu16 ununhexium	Uu17 ununseptimum	Uu18 ununoctimum	Uu19 ununnonium	Uu20 unundecium	Uu21 ununbium	Uu22 ununtrium	Uu23 ununquadrimum	Uu24 ununpentium	Uu25 ununhexium	Uu26 ununseptimum	Uu27 ununoctimum	Uu28 ununnonium	Uu29 unundecium	Uu30 ununbium	Uu31 ununtrium	Uu32 ununquadrimum	Uu33 ununpentium	Uu34 ununhexium	Uu35 ununseptimum	Uu36 ununoctimum	Uu37 ununnonium	Uu38 unundecium	Uu39 ununbium	Uu40 ununtrium	Uu41 ununquadrimum	Uu42 ununpentium	Uu43 ununhexium	Uu44 ununseptimum	Uu45 ununoctimum	Uu46 ununnonium	Uu47 unundecium	Uu48 ununbium	Uu49 ununtrium	Uu50 ununquadrimum	Uu51 ununpentium	Uu52 ununhexium	Uu53 ununseptimum	Uu54 ununoctimum	Uu55 ununnonium	Uu56 unundecium	Uu57 ununbium	Uu58 ununtrium	Uu59 ununquadrimum	Uu60 ununpentium	Uu61 ununhexium	Uu62 ununseptimum	Uu63 ununoctimum	Uu64 ununnonium	Uu65 unundecium	Uu66 ununbium	Uu67 ununtrium	Uu68 ununquadrimum	Uu69 ununpentium	Uu70 ununhexium	Uu71 ununseptimum	Uu72 ununoctimum	Uu73 ununnonium	Uu74 unundecium	Uu75 ununbium	Uu76 ununtrium	Uu77 ununquadrimum	Uu78 ununpentium	Uu79 ununhexium	Uu80 ununseptimum	Uu81 ununoctimum	Uu82 ununnonium	Uu83 unundecium	Uu84 ununbium	Uu85 ununtrium	Uu86 ununquadrimum	Uu87 ununpentium	Uu88 ununhexium	Uu89 ununseptimum	Uu90 ununoctimum	Uu91 ununnonium	Uu92 unundecium	Uu93 ununbium	Uu94 ununtrium	Uu95 ununquadrimum	Uu96 ununpentium	Uu97 ununhexium	Uu98 ununseptimum	Uu99 ununoctimum	Uu100 ununnonium	Uu101 unundecium	Uu102 ununbium	Uu103 ununtrium	Uu104 ununquadrimum	Uu105 ununpentium	Uu106 ununhexium	Uu107 ununseptimum	Uu108 ununoctimum	Uu109 ununnonium	Uu110 unundecium	Uu111 ununbium	Uu112 ununtrium	Uu113 ununquadrimum	Uu114 ununpentium	Uu115 ununhexium	Uu116 ununseptimum	Uu117 ununoctimum	Uu118 ununnonium	Uu119 unundecium	Uu120 ununbium	Uu121 ununtrium	Uu122 ununquadrimum	Uu123 ununpentium	Uu124 ununhexium	Uu125 ununseptimum	Uu126 ununoctimum	Uu127 ununnonium	Uu128 unundecium	Uu129 ununbium	Uu130 ununtrium	Uu131 ununquadrimum	Uu132 ununpentium	Uu133 ununhexium	Uu134 ununseptimum	Uu135 ununoctimum	Uu136 ununnonium	Uu137 unundecium	Uu138 ununbium	Uu139 ununtrium	Uu140 ununquadrimum	Uu141 ununpentium	Uu142 ununhexium	Uu143 ununseptimum	Uu144 ununoctimum	Uu145 ununnonium	Uu146 unundecium	Uu147 ununbium	Uu148 ununtrium	Uu149 ununquadrimum	Uu150 ununpentium	Uu151 ununhexium	Uu152 ununseptimum	Uu153 ununoctimum	Uu154 ununnonium	Uu155 unundecium	Uu156 ununbium	Uu157 ununtrium	Uu158 ununquadrimum	Uu159 ununpentium	Uu160 ununhexium	Uu161 ununseptimum	Uu162 ununoctimum	Uu163 ununnonium	Uu164 unundecium	Uu165 ununbium	Uu166 ununtrium	Uu167 ununquadrimum	Uu168 ununpentium	Uu169 ununhexium	Uu170 ununseptimum	Uu171 ununoctimum	Uu172 ununnonium	Uu173 unundecium	Uu174 ununbium	Uu175 ununtrium	Uu176 ununquadrimum	Uu177 ununpentium	Uu178 ununhexium	Uu179 ununseptimum	Uu180 ununoctimum	Uu181 ununnonium	Uu182 unundecium	Uu183 ununbium	Uu184 ununtrium	Uu185 ununquadrimum	Uu186 ununpentium	Uu187 ununhexium	Uu188 ununseptimum	Uu189 ununoctimum	Uu190 ununnonium	Uu191 unundecium	Uu192 ununbium	Uu193 ununtrium	Uu194 ununquadrimum	Uu195 ununpentium	Uu196 ununhexium	Uu197 ununseptimum	Uu198 ununoctimum	Uu199 ununnonium	Uu200 unundecium

## Key

atomic number  
atomic symbol  
name  
relative atomic mass

lanthanoids

actinoids

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