



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTER  
NUMBER

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**CHEMISTRY (US)**

**0439/23**

Paper 2

**May/June 2013**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Center number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may need to use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, 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.

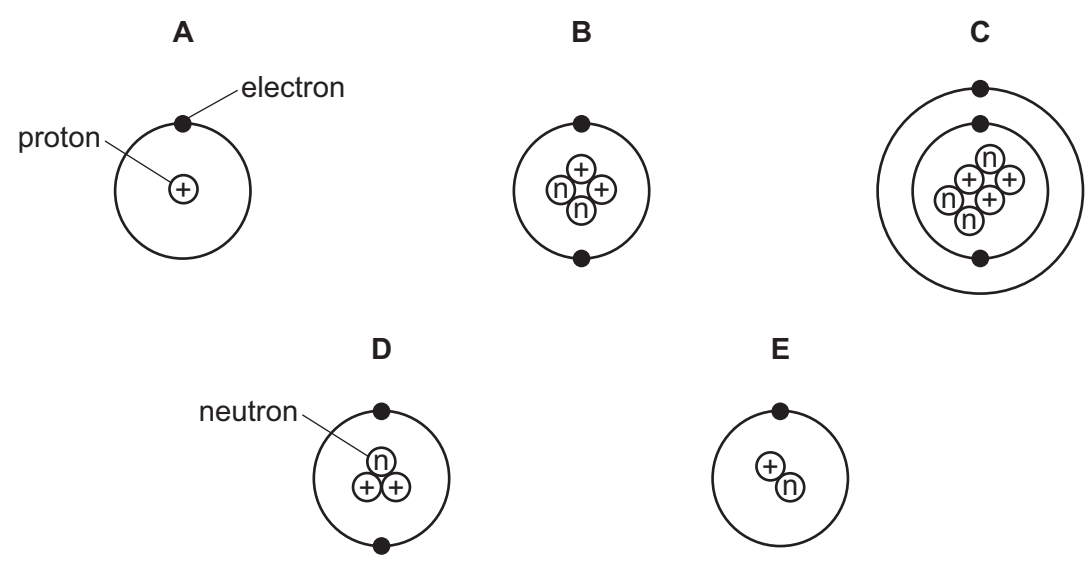
At the end of the examination, fasten all your work securely together.

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

This document consists of **14** printed pages and **2** blank pages.



1 The structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown below.



- (a) Answer the following questions about these structures. Each structure can be used once, more than once or not at all.
- (i) Which **two** structures are hydrogen atoms? ..... and .....
  - (ii) Which structure represents an atom of a metal? .....
  - (iii) Which structure has a proton (atomic) number of 3? .....
  - (iv) Which structure has two neutrons in its nucleus? ..... [5]

(b) The structure of carbon-12 can be written  $^{12}_6\text{C}$ .

Write the structure of atom **D** in a similar way.

[1]

(c) Complete the following sentences about isotopes using words from the list below.

- |          |         |             |           |
|----------|---------|-------------|-----------|
| atoms    | energy  | iron        | molecules |
| neutrons | protons | radioactive | stable    |

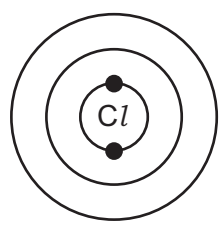
Isotopes are atoms of the same element with the same number of .....  
 and different numbers of ..... . Some isotopes such as uranium-235 are  
 ..... . Uranium-235 can be used as a source of ..... [4]

[Total: 10]

2 The table shows some physical properties of the Group VII elements.

halogen	melting point /°C	boiling point /°C	atomic radius /nanometers	color
fluorine	-220	-188		pale yellow
chlorine	-101	-35	0.099	
bromine	-7	+59	0.114	red-brown
iodine	+114	+184	0.133	grey-black

- (a) Use the information in the table to explain why
- (i) chlorine is a gas at room temperature, ..... [1]
  - (ii) bromine is a liquid at room temperature. .... [1]
- (b) Describe the trend in atomic radius going down the group from chlorine to iodine. .... [1]
- (c) Suggest a value for the atomic radius of fluorine. .... [1]
- (d) Describe the color of chlorine. .... [1]
- (e) A chlorine atom has 17 electrons. Complete the following structure to show how the electrons are arranged.



- ..... [2]
- (f) Chlorine reacts with potassium bromide to form potassium chloride and bromine.
- (i) Complete the symbol equation for this reaction.
 
$$Cl_2 + \dots\dots KBr \rightarrow 2KCl + \dots\dots$$
 [2]
  - (ii) Explain why iodine does **not** react with potassium bromide. .... [1]

[Total: 10]

3 Aluminum and gallium are in Group III of the Periodic Table.

(a) The heat from your hand is sufficient to melt gallium.  
Describe the change in state from solid to liquid in terms of the kinetic particle theory.  
In your answer include

- the difference in arrangement and closeness of the particles in a solid and a liquid,
- the difference in the motion of the particles in a solid and a liquid.

.....

.....

.....

.....

..... [5]

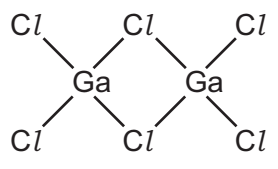
(b) Gallium is a metal. Describe **three** physical properties of gallium which are typical of most metals.

1. ....

2. ....

3. .... [3]

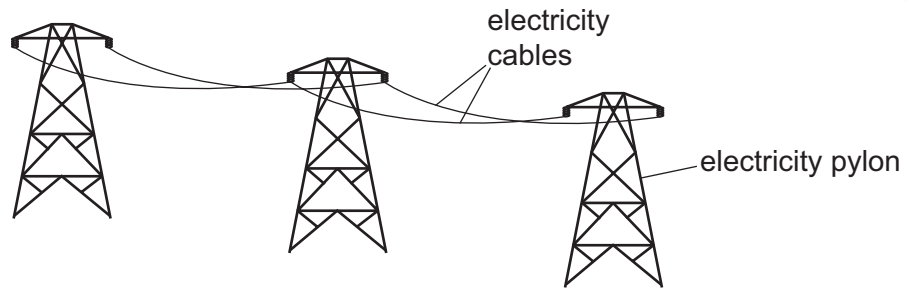
(c) When it is a gas, gallium(III) chloride has the structure shown below.



Write the molecular formula for gallium(III) chloride.

..... [1]

(d) Aluminum is used to make high voltage electricity cables.



The table shows some properties of four metals which could be used for overhead power cables.

metal	relative strength	density in g/cm <sup>3</sup>	relative electrical conductivity	price \$ per tonne
aluminum	9	2.70	0.4	2120
copper	30	8.92	0.7	9600
tungsten	100	19.35	0.2	450
steel	50	7.86	0.1	700

- (i) Suggest why aluminum, rather than tungsten, is used in overhead power cables?  
..... [1]
- (ii) Suggest why steel, rather than copper, is used as a core for overhead power cables.  
..... [1]
- (iii) Give **two** reasons why aluminum is used for overhead power cables rather than copper.
  - 1. ....
  - 2. .... [2]
- (e) State **one** use of aluminum other than as an electrical conductor.  
..... [1]

[Total: 14]

4 Impure water needs to be treated if it is to be used in the home.

(a) (i) Explain why filtration and chlorination are used in the water treatment process.

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

(ii) State **one** use of water in the home.

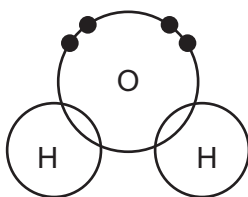
..... [1]

(b) Describe a chemical test for water.

test .....

result ..... [2]

(c) (i) Complete the diagram below to show the electron arrangement in a water molecule.



[1]

(ii) Is the bonding in water covalent or ionic?  
Give a reason for your answer.

..... [1]

(d) Pure water is neutral. Which one of these pH values is neutral?  
Put a ring around the correct answer.

pH 0      pH 6      pH 7      pH 9      pH 13

[1]

(e) Water reacts with sodium. The products are sodium hydroxide and hydrogen.  
Write a word equation for this reaction.

[1]

[Total: 9]

5 Energy is given out when fuels burn.

(a) State the name given to a chemical reaction which releases energy.

..... [1]

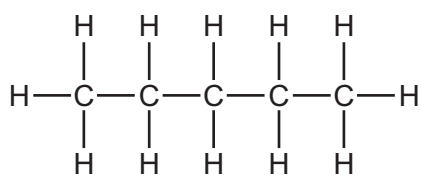
(b) Hydrogen can be used as a fuel.

Complete the symbol equation for the burning of hydrogen in oxygen.

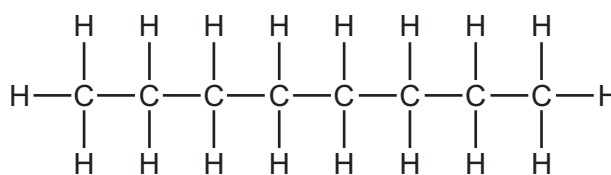


(c) Gasoline is a mixture of hydrocarbons containing between 5 and 10 carbon atoms.  
Four of these hydrocarbons are shown below.

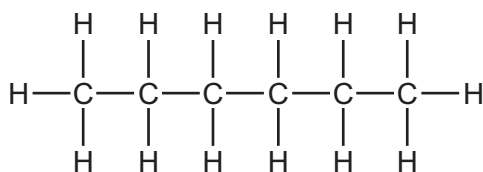
**A**



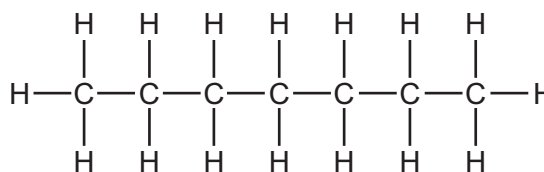
**B**



**C**



**D**



(i) Which **one** of these structures, **A**, **B**, **C** or **D**, has the highest relative molecular mass?

You are not expected to do any calculations.

..... [1]

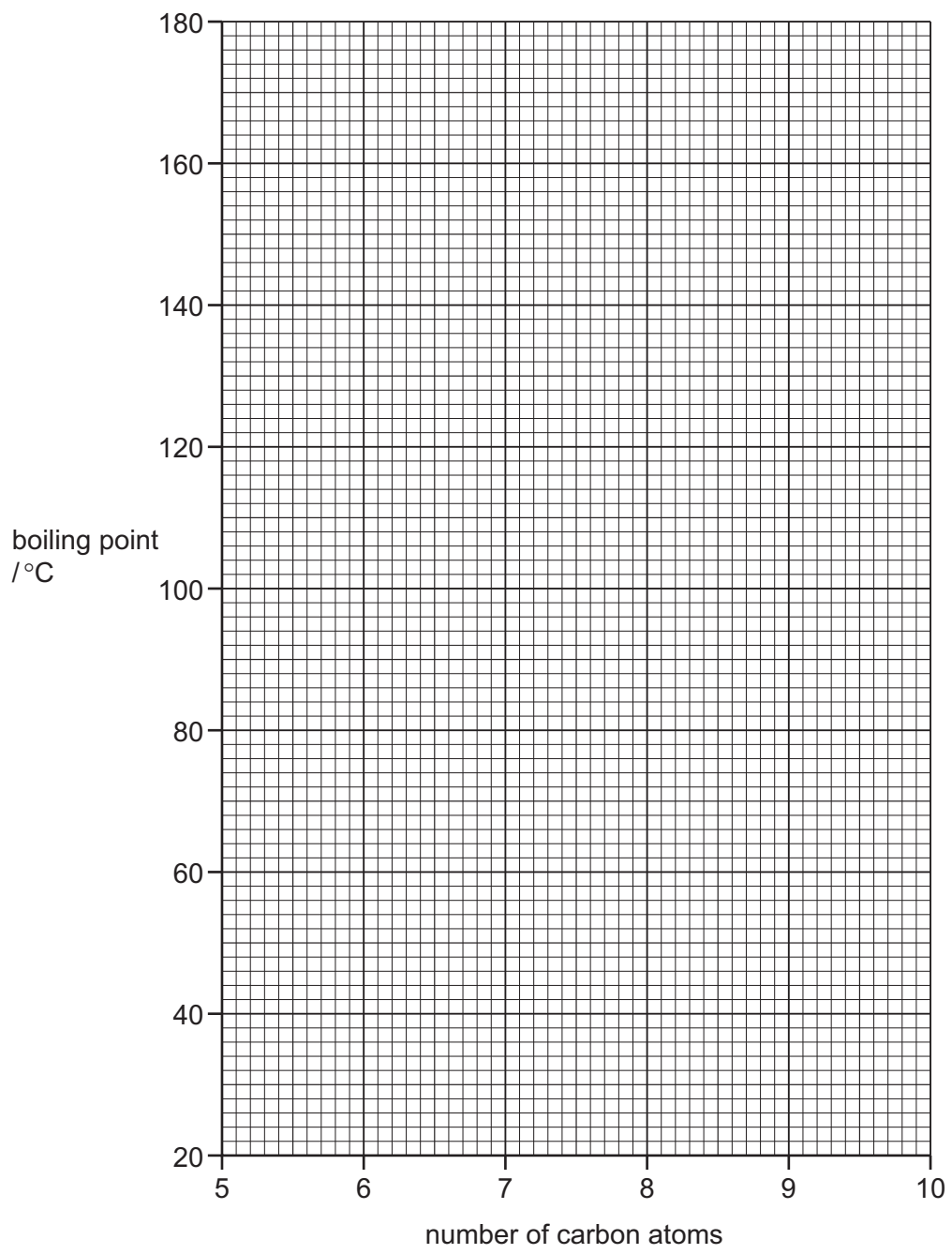
(ii) Give **one** use of gasoline.

..... [1]

(d) The table shows the boiling points of the straight-chain hydrocarbons in the g fraction.

number of carbon atoms	5	6	7	8	9	10
boiling point / °C	36	69		126	151	174

(i) On the grid below, plot a graph to show how the boiling point changes with the number of carbon atoms in these hydrocarbons. Draw a smooth curve through the points.

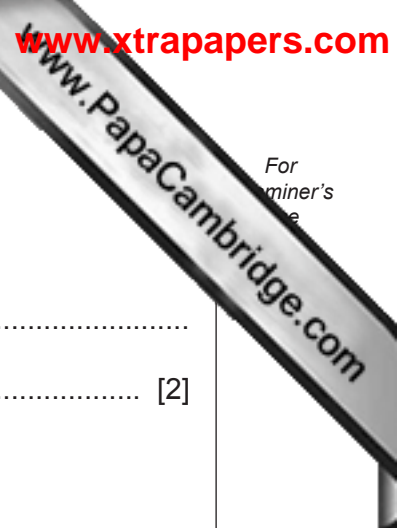


[3]

(ii) Use your graph to deduce the boiling point of the hydrocarbon with 7 carbon atoms.

boiling point ..... °C [1]





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(e) The alkanes are a homologous series of hydrocarbons.

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

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

(ii) Alkanes can be cracked to form alkenes and smaller alkanes.  
State the conditions needed for cracking.

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

[Total: 13]

6 Inks are mixtures of different dyes.

(a) A student used paper chromatography to separate the dyes in a particular ink. Describe how paper chromatography is carried out. You may draw a diagram to help explain your answer.

In your description include

- the apparatus you would use,
- how chromatography is carried out.

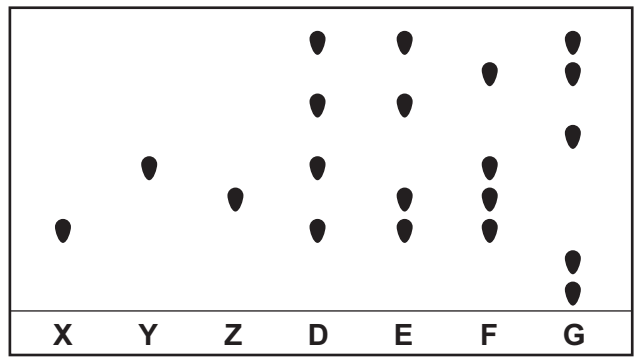
.....

.....

.....

..... [4]

(b) The chromatogram below shows the results of a chromatography experiment. X, Y and Z are pure dyes containing only one compound. The dyes present in four different inks, D, E, F and G are also shown.



(i) Which ink, D, E, F or G, contains all the dyes X, Y and Z?

..... [1]

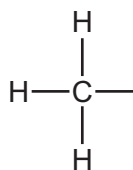
(ii) Which ink, D, E, F or G, does **not** contain any of the dyes X, Y and Z?

..... [1]

(iii) Which ink contains the greatest number of different dyes?

..... [1]

- (c) Some inks contain ethanoic acid.  
Complete the structure of ethanoic acid.

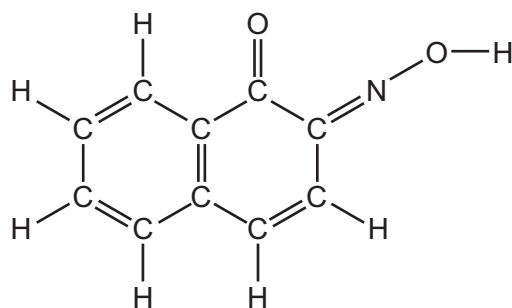


[1]

- (d) Ethanoic acid can be used as a solvent.  
What is the meaning of the term *solvent*?

..... [1]

- (e) The structure of a dye called Gambine R is shown below.



- (i) How many different types of atom are there in one molecule of Gambine R?

..... [1]

- (ii) How many carbon atoms are there in one molecule of Gambine R?

..... [1]

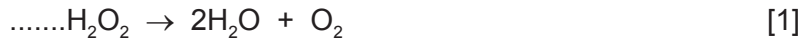
[Total: 11]

7 Hydrogen peroxide, H<sub>2</sub>O<sub>2</sub>, decomposes in the presence of an enzyme called peroxidase. The products of this reaction are water and oxygen.

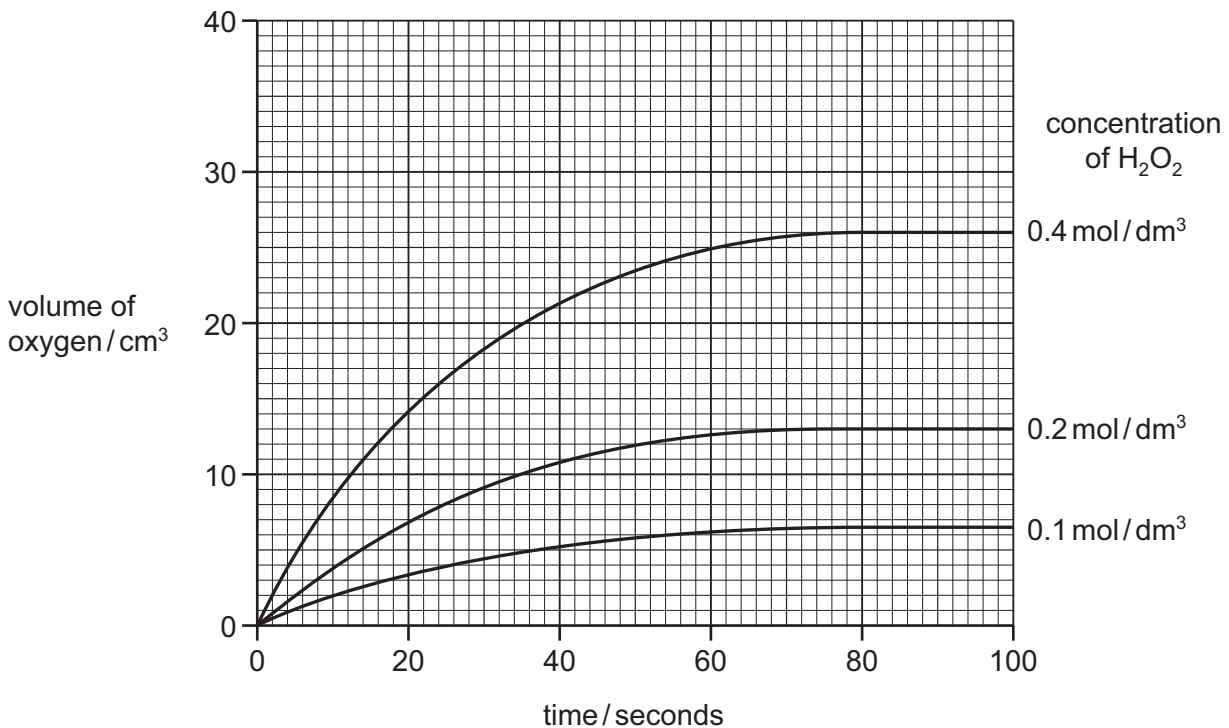
(a) (i) What is meant by the term *enzyme*?

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

(ii) Complete the symbol equation for this reaction.



(b) A student followed the course of this reaction by measuring the volume of oxygen released over a period of time. The diagram below shows some results that he obtained using hydrogen peroxide at three different concentrations.



(i) Describe how the concentration of hydrogen peroxide affects the rate of this reaction.

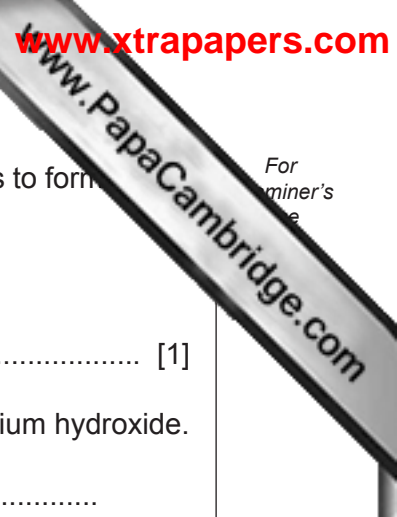
..... [1]

(ii) On the graph above, draw a line to show the course of the reaction when the starting concentration of hydrogen peroxide is 0.3 mol/dm<sup>3</sup>. [2]

(iii) For the concentration of hydrogen peroxide of 0.4 mol/dm<sup>3</sup>, deduce

- the volume of oxygen given off when the reaction is complete, ..... cm<sup>3</sup>

- the time it takes to produce 14 cm<sup>3</sup> of oxygen. .... seconds [2]



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(c) In the presence of sulfuric acid, hydrogen peroxide reacts with iodide ions to form iodine and water. This involves the reduction of hydrogen peroxide.

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

..... [1]

(ii) Complete the word equation for the reaction of sulfuric acid with calcium hydroxide.

sulfuric acid + calcium hydroxide → ..... + .....  
..... [2]

(iii) Describe a test for iodide ions.

test .....

result ..... [2]

[Total: 13]





**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																																																																		
I	II	III	IV	V	VI	VII	0																																																													
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminum 13	14 <b>N</b> Nitrogen 7	15 <b>O</b> Oxygen 8	16 <b>F</b> Fluorine 9	17 <b>Ne</b> Neon 10	18 <b>Ar</b> Argon 18	19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36	37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54	55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86	87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89	†
												140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	91 <b>Pa</b> Protactinium 91	92 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103																														

\*58-71 Lanthanoid series  
†90-103 Actinoid series

Key

a	X	b
a = relative atomic mass		
b = proton (atomic) number		

X = atomic symbol

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

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