UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

* 0 2 8 6 0 5 8 2 8 7 *

CHEMISTRY **0620/21**

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 Centre 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.

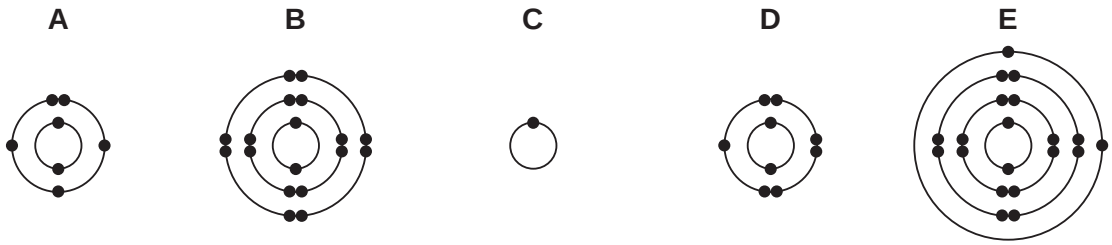
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **15** printed pages and **1** blank page.

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



Answer the following questions about these structures. Each structure may be used once, more than once or not at all.

(a) Which structure

(i) is in Period 4 of the Periodic Table, ☐

(ii) is a noble gas, ☐

(iii) is in Group II of the Periodic Table, ☐

(iv) has five electrons in its outer shell, ☐

(v) has a proton (atomic) number of 7, ☐

(vi) represents a fluorine atom? ☐ [6]

(b) Complete the following sentences about elements using words from the list below.

alkali **atom** **covalent** **ion**

monatomic **three** **transition** **two**

An element is a substance containing only one type of ..... .

The Group VII elements exist as molecules containing ..... atoms.

Carbon has a giant ..... structure with many strong bonds.

Elements such as iron and copper, which form coloured compounds, are called ..... elements. [4]

[Total: 10]

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2 The table below shows some properties of the Group I elements.

metal	density in g / cm^3	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium	0.97	98	883
potassium	0.86	63	
rubidium	1.53	39	686
caesium	1.88	29	669

(a) Use the information in the table to explain why caesium is a liquid when the temperature is 34 °C.

.....

..... [1]

(b) Suggest a value for the boiling point of potassium.

..... °C [1]

(c) **(i)** Describe the **general** trend in density down the group.

..... [1]

(ii) Which element does **not** follow this trend?

..... [1]

(d) State **three** physical properties of potassium, other than density, melting point and boiling point.

.....

.....

..... [3]

(e) Potassium reacts with water. The products are potassium hydroxide and hydrogen.

(i) Describe **two** observations when potassium reacts with water.

.....

.....

..... [2]

(ii) Complete the symbol equation for this reaction.

$$2K + ...H_2O \rightarrow 2KOH + ...$$ [2]

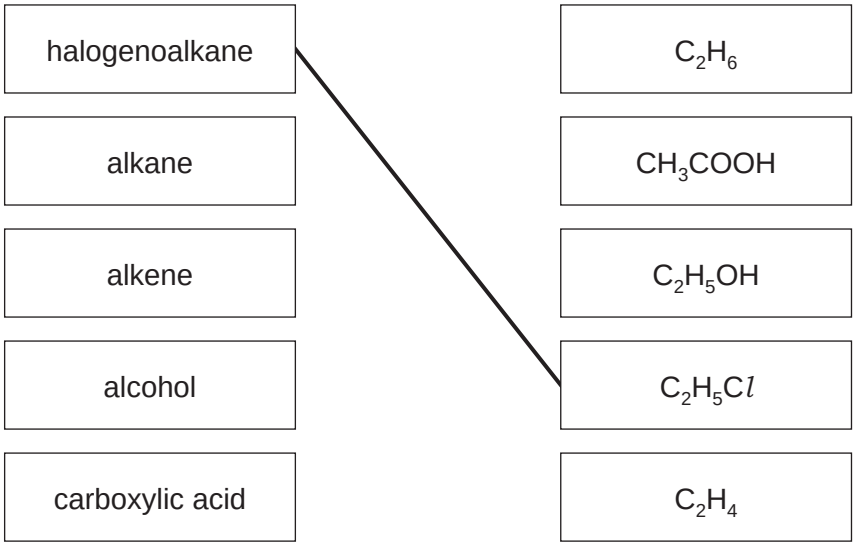
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3 **(a)** Match the name of the homologous series on the left with its formula on the right. The first one has been done for you.



[4]

(b) Draw the full structural formula of the compound, C_2H_6, showing all atoms and bonds.

[1]

(c) The compound with the formula C_2H_4 is an unsaturated hydrocarbon.
Describe the difference between a saturated and an unsaturated hydrocarbon in terms of the bonds they contain.

.....

..... [2]

(d) Describe a test to distinguish between a saturated and unsaturated hydrocarbon.

test .....

result with saturated hydrocarbon .....

.....

result with unsaturated hydrocarbon .....

..... [3]

[Total: 10]

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4 Farmers spread fertilisers on the soil where crops are to be grown.

(a) Why do farmers use fertilisers? In your answer, include

- the names of the essential elements present in most fertilisers,
- the reasons why farmers use fertilisers.

.....

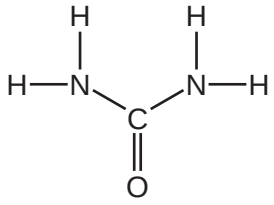
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.....

.....

..... [4]

(b) Urea can be used as a fertiliser.
The structure of urea is shown below.



(i) Deduce the molecular formula of urea.

..... [1]

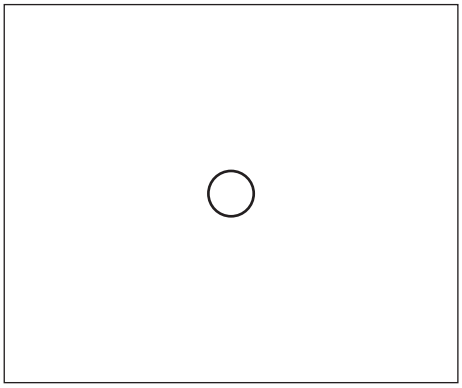
(ii) Calculate the relative molecular mass of urea. You must show all your working.

[2]

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(c) Urea is a solid at room temperature. Complete the diagram below to show the arrangement of the molecules in solid urea.

Show a molecule of urea as ◯



[2]

(d) When urea is heated with an alkali, ammonia is given off.
Describe a test for ammonia.

test .....

result ..... [2]

[Total: 11]

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5 The table shows some properties of four substances, **A**, **B**, **C** and **D**.

substance	melting point / °C	does the solid conduct electricity?	does a solution of the solid conduct electricity?
A	962	yes	does not dissolve
B	747	no	dissolves and conducts
C	113	no	does not dissolve
D	3550	no	does not dissolve

(a) Which one of these substances has

(i) a giant covalent structure, ☐

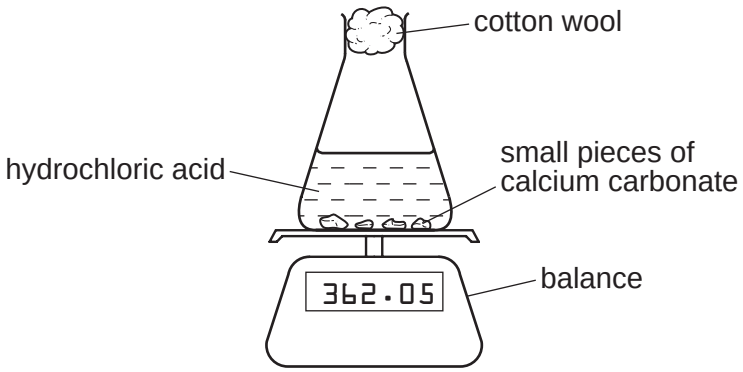
(ii) a simple molecular structure, ☐

(iii) a metallic structure? ☐ [3]

(b) A student carried out an experiment to determine the rate of reaction of calcium carbonate with excess hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

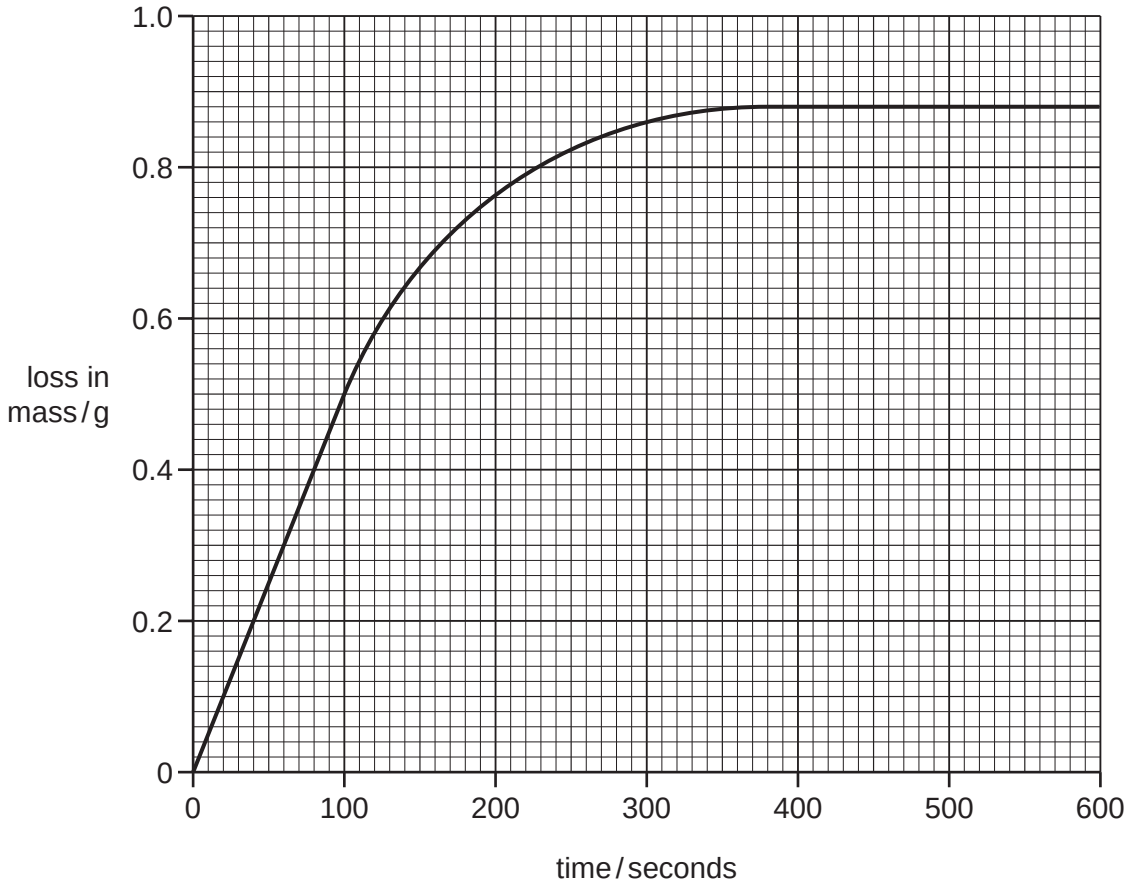
He recorded the loss of mass of the reaction mixture over a period of time.



(i) Explain why the reaction mixture decreases in mass.

..... [1]

He carried out the reaction at constant temperature using 2 g of calcium carbonate in small pieces. The hydrochloric acid was in excess.
He plotted his results on a grid. This is shown below.



(ii) At what time has the reaction just finished?

..... s [1]

(iii) From the graph, deduce the loss in mass in the first 100 seconds.

..... g [1]

(iv) The student repeated the experiment keeping everything the same except for the size of the pieces of calcium carbonate. He used smaller pieces of calcium carbonate but the mass used was the same.

On the grid above, draw a line to show how the loss of mass changes with time when smaller pieces of calcium carbonate are used. [2]

(v) State the effect of increasing the concentration of hydrochloric acid on the rate (speed) of this reaction when all other factors remain constant.

..... [1]

[Total: 9]

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6 **(a)** Propanol is a solvent.
Sugar is soluble in propanol. Salt (sodium chloride) is insoluble in propanol.
A student wants to separate a mixture of solid salt and solid sugar.

(i) Describe how she could separate the salt from the sugar.
You may draw a labelled diagram to help you answer this question.

.....

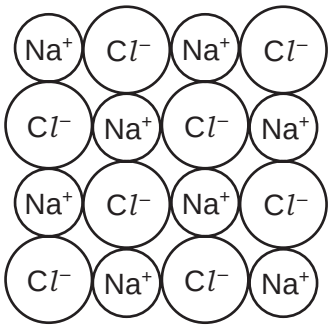
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..... [3]

(ii) Describe how the student could obtain solid sodium chloride from a solution of sodium chloride in water.

..... [1]

(b) The diagram shows the structure of sodium chloride.



(i) Deduce the simplest formula for sodium chloride.

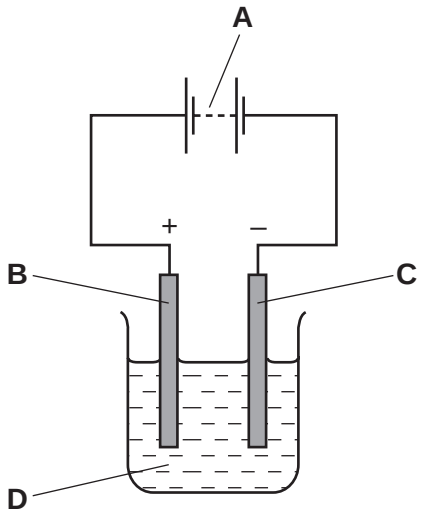
..... [1]

(ii) What type of bonding is present in sodium chloride?
Put a ring around the correct answer.

covalent **ionic** **metallic** **weak** [1]

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(c) The diagram shows the apparatus used to electrolyse a concentrated aqueous solution of sodium chloride.



(i) Which letter on the diagram, **A**, **B**, **C** or **D**, represents the electrolyte?

..... [1]

(ii) Name the product formed at

the positive electrode, ...

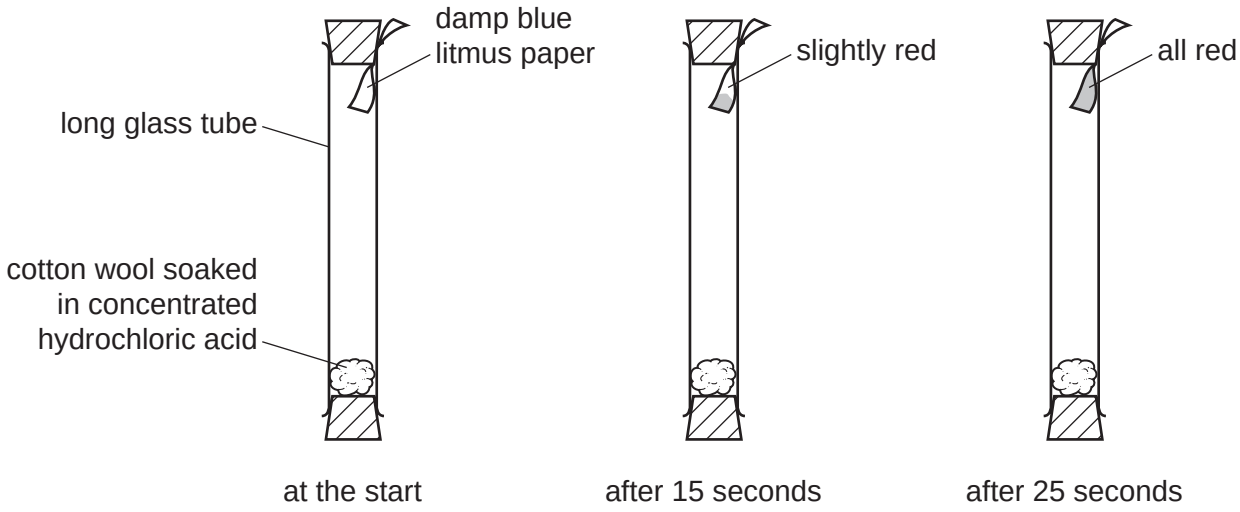
the negative electrode. ..... [2]

[Total: 9]

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7 **(a)** A student set up the apparatus shown below.
The concentrated hydrochloric acid gives off hydrogen chloride gas.
After 15 seconds, the damp blue litmus paper begins to turn red.
After 25 seconds, the litmus paper has turned completely red.



Use ideas about moving particles to explain these observations.

.....

.....

.....

.....

..... [4]

(b) Hydrogen chloride reacts with ammonia to form a salt which has the formula NH_4Cl.
State the name of this salt.

..... [1]

(c) **(i)** Hydrochloric acid reacts with iron to form iron(II) chloride and hydrogen.
Write a word equation for this reaction.

..... [1]

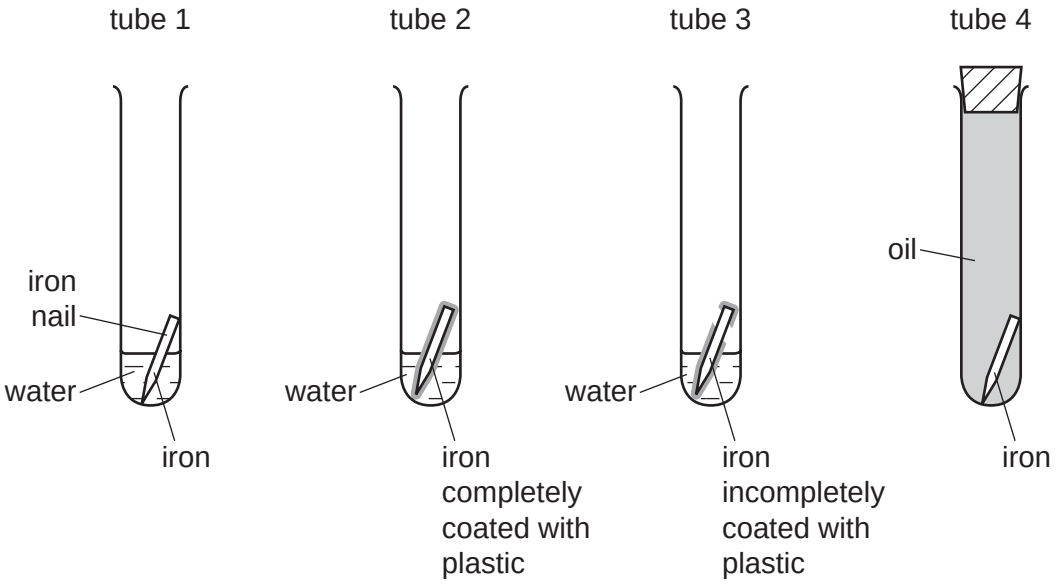
(ii) Describe a test for iron(II) ions.

test .....

result ..... [2]

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(d) A student investigates various methods of protecting iron from rusting. She sets up four tubes as shown in the diagram below.



(i) Tube 1 contains unprotected iron. What is the purpose of this experiment?

..... [1]

(ii) State the names of the **two** substances needed for iron to rust.

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

(iii) Explain why the iron in tube 4 does **not** rust.

.....

..... [1]

(iv) Explain why the iron in tube 3 eventually rusts.

.....

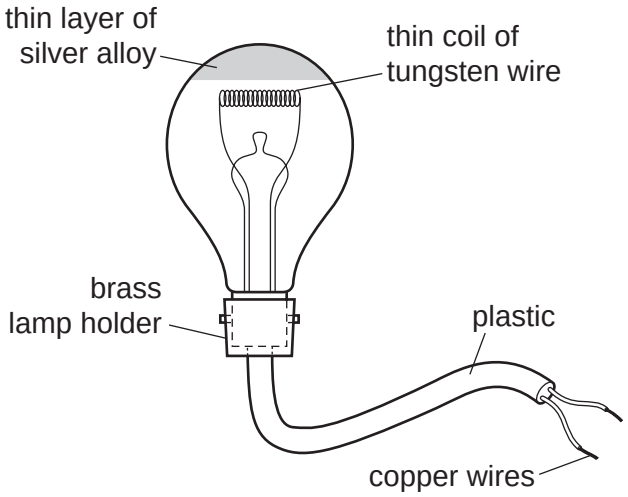
..... [1]

[Total: 13]

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8 The diagram shows a silvered light bulb.



Some properties of metals used in the light bulb are shown in the table below.

metal	hardness	electrical conductivity	melting point / °C	price / $ per tonne
brass	hard	good	about 1000	7 000
copper	fairly soft	very good	1083	9 600
silver	fairly soft	very good	962	1 300 000
tungsten	hard	good	3410	450

(a) (i) Suggest why copper rather than tungsten is used for electrical wiring?

..... [1]

(ii) Suggest why silver is **not** used for electrical wiring.

..... [1]

(iii) Suggest **two** reasons why tungsten rather than copper is used to make the bulb filament.

reason 1 .....

reason 2 ..... [2]

(iv) Explain why the copper wires are covered with plastic.

.....

..... [2]

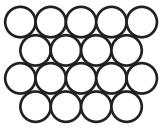
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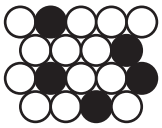
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(b) Brass is an alloy.
Which one of the following diagrams, **A**, **B**, **C** or **D**, best represents an alloy?

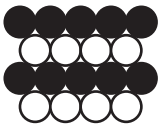
A



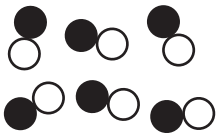
B



C



D



..... [1]

[Total: 7]

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DATA SHEET
The Periodic Table of the Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
																4 **He** Helium 2
					1 **H** Hydrogen 1											
	7 **Li** Lithium 3	9 **Be** Beryllium 4									11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
	23 **Na** Sodium 11	24 **Mg** Magnesium 12									27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
	39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
	85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
	133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
	Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key

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

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

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