

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE

A172/02

TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A

Modules C4 C5 C6

(Higher Tier)

MONDAY 10 JUNE 2013: Afternoon

DURATION: 1 hour
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:


Pencil
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer ALL the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 60.
- Any blank pages are indicated.
- The Periodic Table is printed on page 35.
- A list of qualitative tests for ions is printed on pages 4 and 5.

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TWENTY FIRST CENTURY SCIENCE DATA SHEET

QUALITATIVE ANALYSIS

TESTS FOR IONS WITH A POSITIVE CHARGE

Ion	Test	Observation
calcium Ca²⁺	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu²⁺	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe²⁺	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe³⁺	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn²⁺	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

TESTS FOR IONS WITH A NEGATIVE CHARGE

Ion	Test	Observation
carbonate CO_3^{2-}	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl^-	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br^-	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I^-	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO_4^{2-}	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

Answer ALL the questions.

- 1 Hydrogen reacts with the elements in Group 7 of the Periodic Table.**

Hydrogen and fluorine explode when they are mixed together.

The word equation for the reaction is

hydrogen + fluorine \rightarrow hydrogen fluoride

- (a) The formula for hydrogen fluoride is HF.**

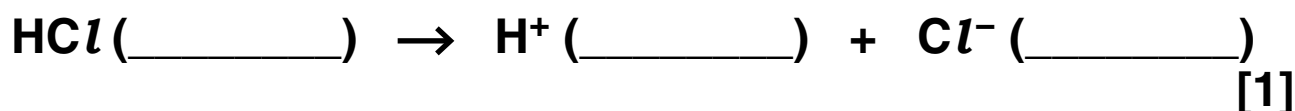
Write a balanced SYMBOL equation for the reaction between hydrogen and fluorine.

_____ [2]

- (b) Chlorine reacts with hydrogen to make hydrogen chloride gas (HCl).**

When hydrogen chloride gas dissolves, it forms ions in the water.

- (i) Complete the symbol equation for the reaction by filling in the missing STATE SYMBOLS.**



(ii) How does the equation show that the reaction produces an acid?

Put a tick (✓) in the box next to the correct answer.

The reaction makes both positive and negative ions.

☐

One of the ions made is a hydrogen ion.

☐

Chloride ions are very acidic.

☐

A gas dissolves to make a solution.

☐

[1]

(c) Iodine is another element in Group 7.

Predict the NAME and the FORMULA of the compound that is made when IODINE reacts with hydrogen.

name _____

formula _____

[2]

- (d) The table shows what happens when fluorine, chlorine and iodine react with hydrogen.**

Element	Reaction when mixed with hydrogen
fluorine	explodes at room temperature
chlorine	a small spark is enough to make the mixture explode
iodine	reacts slowly when heated strongly

- (i) Describe the trend in reactivity of the Group 7 elements with hydrogen.**

_____ **[1]**

- (ii) Bromine reacts steadily with hydrogen when it is heated.**

Does this fit the trend of reactivity of the other halogens?

Explain your reasoning.

_____ **[2]**

[TOTAL: 9]

2 Sodium and potassium are elements in Group 1 of the Periodic Table.

Jake watches a video of the reaction between sodium and water.

A small piece of the sodium bursts into flames on top of the water.

(a) Complete the word equation for the reaction between sodium and water.

**sodium + water → _____ +
_____ [2]**

(b) Jake thinks that the reaction makes an alkali.

How could you show that a solution has an alkaline pH?

_____ [2]

(c) Jake watches another video. This video shows the reaction of POTASSIUM with water.

How is this reaction different from the reaction of sodium with water?

Put ticks (✓) in the boxes next to the TWO correct answers.

The two reactions make different gases.

☐

The reaction of sodium takes less time than the reaction of potassium.

☐

The reaction with potassium makes an acid.

☐

The two reactions have different rates.

☐

The two reactions make different alkalis.

☐

[1]

[TOTAL: 5]

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QUESTION 3 BEGINS ON PAGE 12

- 3 Alex plans to write an article about flame colours for a school science magazine.**

He researches the flame colours of some compounds of metals from Group 1 in the Periodic Table.

He talks about his findings with other science students in an internet chat room.

ALEX **Hi everyone. Have any of you done any research into flame test colours for Group 1? I have found out that potassium and rubidium both give purple flames. I think that each group has its own flame colour.**

BEA **I've checked out your research and I agree about the flame colours for potassium and rubidium. I just looked up caesium and that's purple too!**

CARL **I flame tested some Group 2 elements, none of them were purple. They were all different colours.**

DAN **Sodium is in Group 1 and gives a yellow flame.**

ELLY **I've looked on the internet and I can't find any elements that give purple flame colours except the ones in Group 1.**

FAY **Lithium doesn't have a purple flame.**

(a) Alex's ideas are that in flame tests:

**all the elements in a group of the Periodic Table
have the same flame colour**

each group has its own flame colour.

**Explain how each piece of evidence in the chat
SUPPORTS or DOES NOT SUPPORT Alex's ideas.**



**The quality of written communication will
be assessed in your answer.**

[6]

(b) The students' chat is NOT an example of peer review.

Explain why.

[2]

[TOTAL: 8]

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QUESTION 4 BEGINS ON PAGE 16

4 Joe knows that ‘hard’ water contains dissolved calcium ions.

(a) Joe does some research about the concentration of calcium ions in ‘hard’ water.

Water	Concentration of calcium ions in mg/dm^3
very hard	>180
hard	121–180
moderately hard	61–120
soft	0–60

He also finds out the concentration of calcium ions in water from different places.

Water	Concentration of calcium ions in mg/dm^3
water from Joe’s town	200
water from Plymouth	40
water from London	160

What conclusions can Joe make from the data in the two tables?

[4]

- (b) Joe does an experiment to find out the TOTAL MASS of dissolved solid in a sample of water from his local town.**

He takes 50 cm³ of the water and evaporates it to leave a solid.

He stores the solid in a desiccator and finds its mass a few days later.

- (i) Why is it important that he uses a desiccator?**

Put ticks (✓) in the boxes next to the TWO best answers.

to keep the solid dry

☐

to keep the solid warm

☐

to make sure that the mass reading is accurate

☐

to allow ions in the solid to separate

☐

to neutralise the solid

☐

[2]

(ii) The table shows Joe's results.

Volume of water in cm³	Total mass of solid in g
50	0.02

**Calculate the amount of solid in 1 dm³ of water.
Give your answer in g/dm³.**

(1 dm³ = 1000 cm³)

_____ g/dm³ [2]

**(iii) Use your answer to work out the number of
MILLIGRAMS (mg) of solid in 1 dm³ of water.**

(1 g = 1000 mg)

_____ mg/dm³ [1]

- (iv) Joe uses the same technique to analyse a sample of water from London.

He finds that the sample contains 450 mg/dm^3 of dissolved solid.

Joe's research found that London water contains 160 mg/dm^3 of calcium ions.

Why are the two values different?

Put a tick (✓) in the box next to the best answer.

Joe overheated the solid so that it decomposed.

☐

The water contained ions other than calcium.

☐

Joe used too small a volume of water in his experiment.

☐

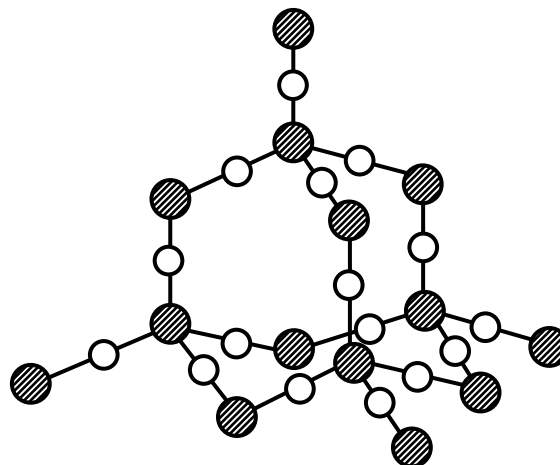
The relative atomic mass of calcium is higher than Joe realised.

☐

[1]

[TOTAL: 10]

- 5 Carbon dioxide and silicon dioxide are compounds that occur naturally on Earth.
The structures are shown below.



The table shows some information about the two compounds.

	CARBON DIOXIDE	SILICON DIOXIDE
formula	CO_2	SiO_2
melting point in $^{\circ}\text{C}$	-78	1710
boiling point in $^{\circ}\text{C}$	-57	2230
electrical conductivity	does not conduct	does not conduct

- (a) Use ideas about structure and bonding to explain the similarities and differences between the properties of carbon dioxide and silicon dioxide.



The quality of written communication will be assessed in your answer.

[6]

(b) Which statement about where carbon dioxide and silicon dioxide are found is correct?

Put a tick (✓) in the box next to the correct answer.

They are both found in the atmosphere.

☐

Silicon dioxide is only found in the hydrosphere, carbon dioxide is only found in the lithosphere.

☐

Both carbon dioxide and silicon dioxide are only found in the lithosphere.

☐

Carbon dioxide is found in the atmosphere, silicon dioxide is found in the lithosphere.

☐

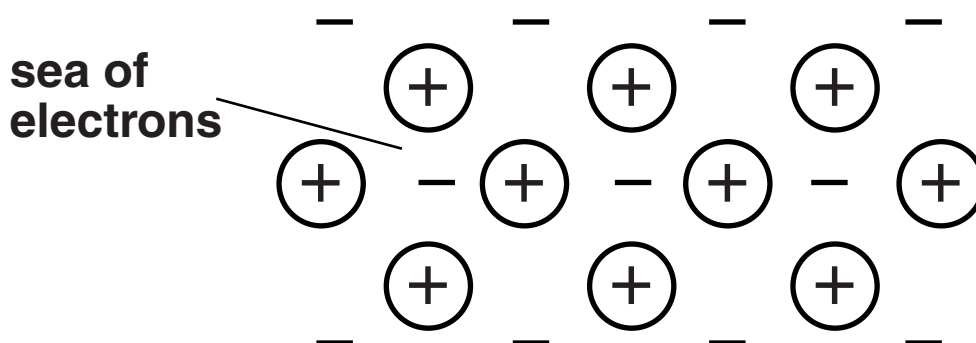
[1]

[TOTAL: 7]

- 6 Aluminium is a metal with a low density and a high electrical conductivity.

It is used to make overhead power cables.

(a) The diagram shows the bonding in a metal.



What does the symbol \oplus represent?

Put a tick (✓) in the box next to the best answer.

protons from metal atoms

☐

positively charged metal ions

☐

the nucleus of a metal atom

☐

the positive metal electrode

☐

[1]

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

Complete and balance the ionic equations to show what happens during the electrolysis of molten aluminium oxide.



- (c) Aluminium is a metal but aluminium oxide is an ionic compound.**

Aluminium metal and molten aluminium oxide conduct electricity in different ways. Describe and explain the differences.

[3]

[TOTAL: 6]

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QUESTION 7 BEGINS ON PAGE 26

- 7 (a) Two different copper compounds react with sulfuric acid to make copper sulfate.**

Complete the word equations opposite.

Choose from this list.

COPPER CARBONATE

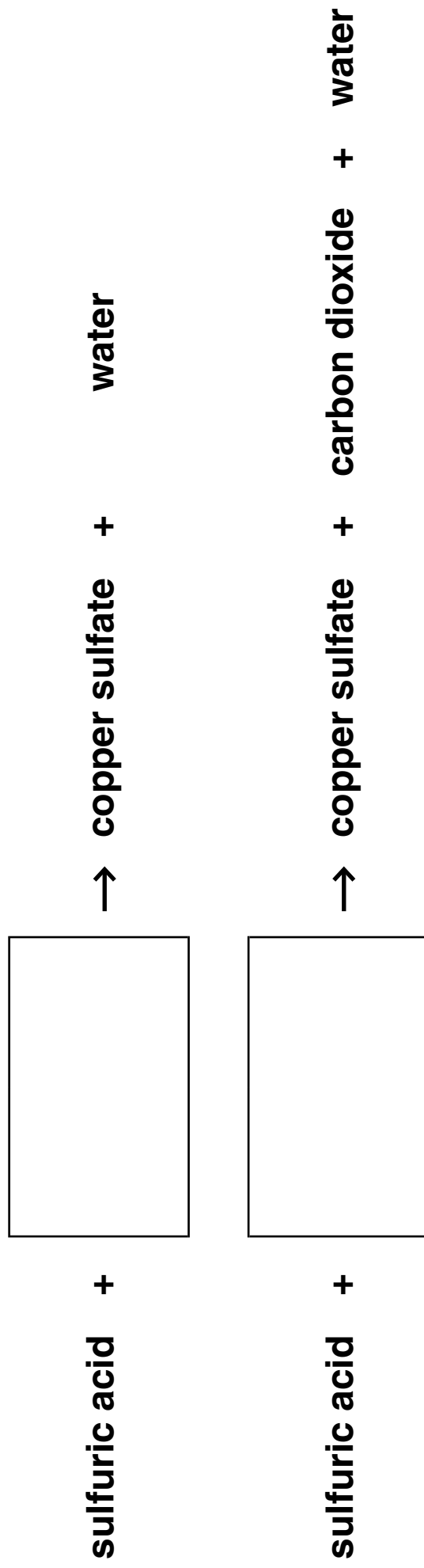
COPPER CHLORIDE

COPPER OXIDE

COPPER NITRATE

COPPER SULFATE

[2]



(b) Complete the table of information about copper compounds.

Name of compound	Formula of positive ion in compound	Formula of negative ion in compound	Formula of compound
copper chloride	Cu^{2+}	Cl^{-}	
copper sulfate	Cu^{2+}		CuSO_4
copper hydroxide	Cu^{2+}		$\text{Cu}(\text{OH})_2$

[2]

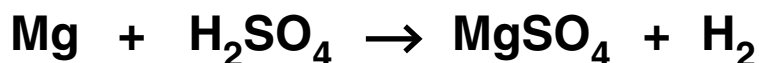
- (c) Eve makes some magnesium sulfate by reacting magnesium with sulfuric acid.

She uses 2.4 g of magnesium.

She wants to work out the maximum mass of magnesium sulfate that she can make.

The equation for the reaction and part of Eve's calculation is shown below.

Complete the calculation.



Relative mass of Mg = 24 g

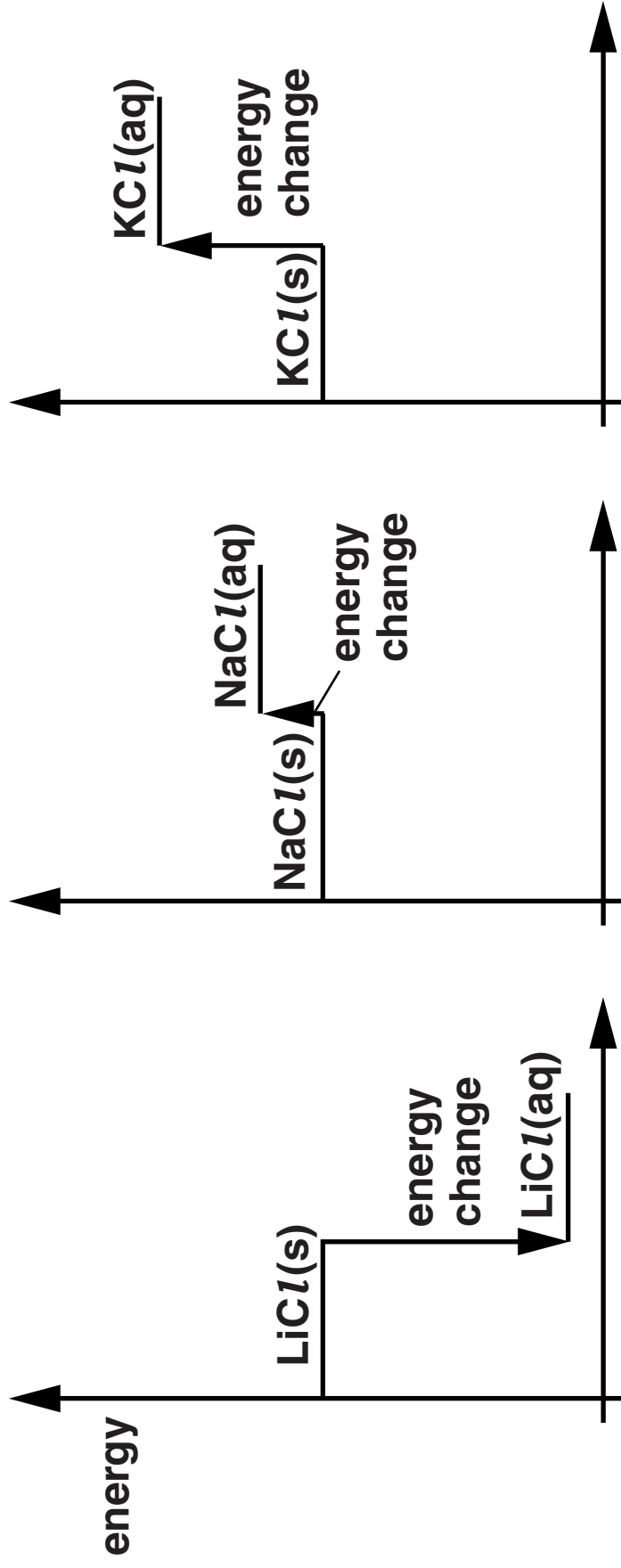
Mass of Mg used in experiment = 2.4 g

Mass of MgSO_4 made = _____ g [2]

[TOTAL: 6]

- 8 Lithium chloride, sodium chloride and potassium chloride are all soluble in water.**

The diagrams opposite show the energy change when each salt dissolves in water.



(a) Tom does an experiment.

He dissolves each compound in water and measures the temperature change that happens when the compound dissolves.

He uses the same amount of each compound and water each time.

Use the energy level diagrams to help you to explain the results Tom should expect from his experiment.



The quality of written communication will be assessed in your answer.

[6]

(b) Draw straight lines from the boxes on the left to the boxes on the right to show the correct input and output variable in Tom's experiment.

	temperature
input variable	volume of water
output variable	solubility
	compound

[1]

- (c) The energy changes for reactions in industry are carefully controlled.
Why is this important?**

Put ticks (✓) in the boxes next to the TWO best answers.

Energy given out by reactions can be used to heat buildings. ☐

Reactions that give out energy use too much fuel to keep them hot. ☐

Energy changes in reactions affect the rate. ☐

Containers for reactions may be damaged by extreme temperatures. ☐

Reactions that take in energy need to be continuously cooled. ☐

[2]

[TOTAL: 9]

END OF QUESTION PAPER

The Periodic Table of the Elements

1	2	Key										3	4	5	6	7	0						
		relative atomic mass atomic symbol name atomic (proton) number																1 H hydrogen 1		4 He helium 2			
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	63.5 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	[98] 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	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86						
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated												

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1
H
hydrogen
1

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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