Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4493/02

S15-4493-02

CHEMISTRY

CHEMISTRY 3
HIGHER TIER

A.M. THURSDAY, 14 May 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**8**	
3.	**6**	
4.	**6**	
5.	**6**	
6.	**8**	
7.	**5**	
8.	**5**	
9.	**6**	
Total	**60**	

4493
020001

ADDITIONAL MATERIALS

In addition to this paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

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

You are reminded of the necessity for good English and orderly presentation in your answers.

Assessment will take into account the quality of written communication (QWC) used in your answers to questions **3** and **9**.

The Periodic Table is printed on the back cover of the examination paper and the formulae for some common ions on the inside of the back cover.

Examiner only

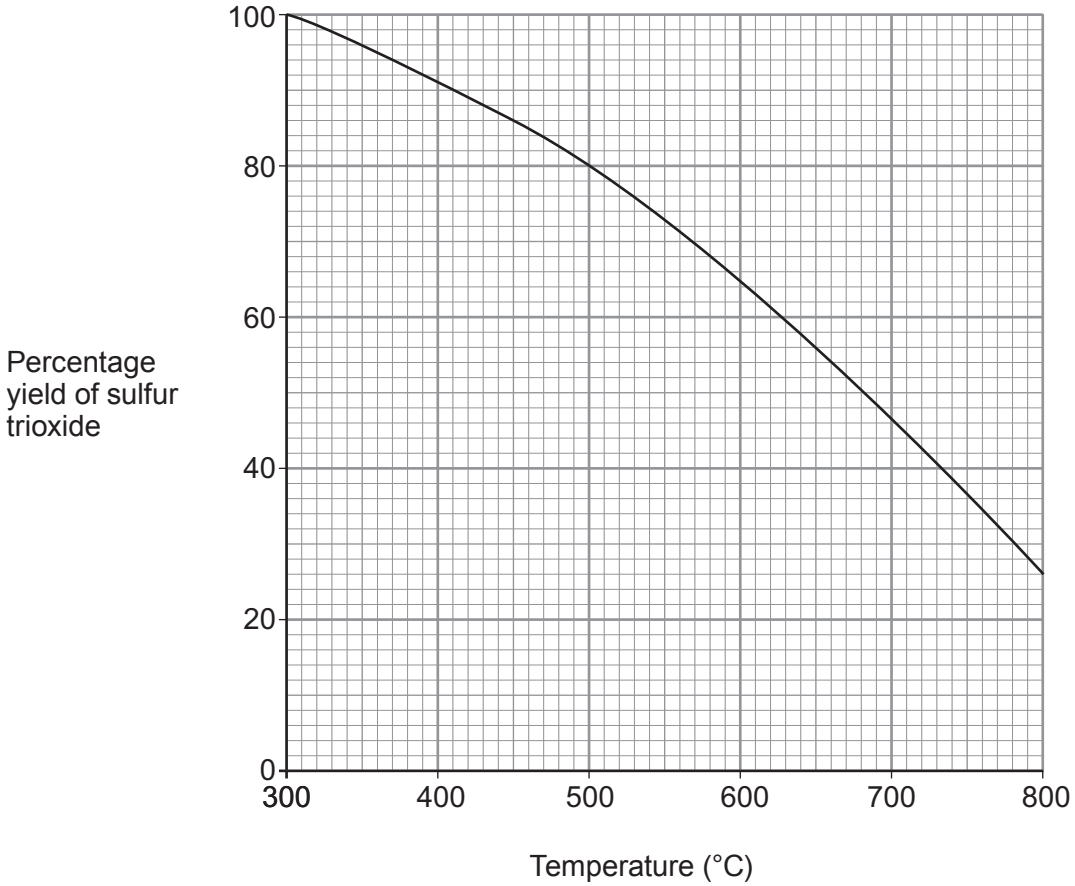
Answer **all** *questions.*

1. *(a)* One of the main stages in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to form sulfur trioxide.

(i) Write the balanced **symbol** equation which represents this reaction. [3]

..... + ... ⇌ .....

(ii) The graph below shows how the percentage yield of sulfur trioxide changes with temperature between 300 °C and 800 °C.



Use the graph to find the increase in percentage yield if the temperature is reduced from 650 °C to 450 °C. [2]

Increase in percentage yield = ... %

(iii) One molecule of sulfur trioxide reacts with one molecule of sulfuric acid to form one molecule of oleum as the **only** product.

Write a balanced **symbol** equation for this reaction. [2]

..... + ... ⟶ .....

Examiner only

(b) State what you would observe when a few drops of concentrated sulfuric acid are added to a beaker containing a small amount of sugar. Name the product left in the beaker. [3]

.....

.....

.....

.....

10

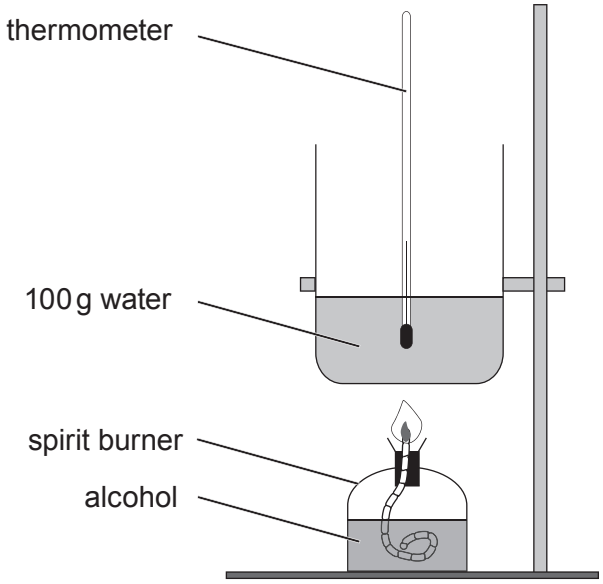
4493
020003

Turn over.

Examiner only

2. Methanol, ethanol, propanol and butanol belong to the alcohol family.

An experiment was carried out to discover which alcohol gives out the most energy when burned. The diagram below shows the apparatus used.



1 g of each alcohol was used to heat 100 g of water. The results are shown below.

Alcohol	Initial temperature of water (°C)	Final temperature of water (°C)	Temperature change (°C)	Energy given out (J / g)
methanol	18	31	13	5 460
ethanol	20	45	25	10 500
propanol	19	48	29	12 180
butanol	20	50	30	

Examiner only

(a) The energy given out by each alcohol can be calculated using the formula:

energy given out = mass of water × 4.2 × temperature change

Calculate the energy given out in burning 1 g of butanol. [2]

Energy given out = ... J / g

(b) Apart from using 1 g of each alcohol and 100 g of water, give **one** other step that should be taken to ensure a fair test. [1]

.....

(c) The theoretical values for the energy given out by each alcohol are given in the table below.

Alcohol	Theoretical value for energy given out (J / g)
methanol	22 700
ethanol	29 700
propanol	33 600
butanol	36 100

Compare the experimental and theoretical values and give the **main** reason for the difference between them. [3]

.....

.....

.....

.....

(d) Some people are opposed to the large-scale use of bioethanol as a fuel. Describe briefly why someone could take this view. [2]

.....

.....

.....

Examiner only

3. Describe the benefits of the use of nitrogenous fertilisers and the problems that arise when they are washed into rivers. [6 QWC]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6

Examiner only

4. Fire fighters use their understanding of the fire triangle to put out fires. Every year thousands of acres of moorland are destroyed by fire. Fire fighters use several different methods to put out this type of fire.

Suggest **three** *different* methods that could be used to put out moorland fires. Each method should refer to a different part of the fire triangle. State how **each** method is effective. [6]

Method 1

.....

.....

Method 2

.....

.....

Method 3

.....

.....

6

4493 020007

Examiner only

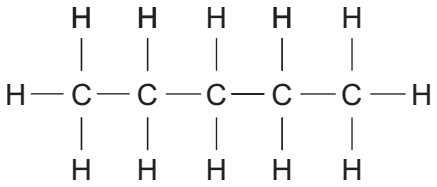
5. *(a)* The table below shows the first five members of the alkane family.

Alkane	Molecular formula
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
butane	C_4H_{10}
pentane	C_5H_{12}

(i) Give the molecular formula for the alkane which contains 18 hydrogen atoms. [1]

.....

(ii) C_5H_{12} has three isomers. The diagram below shows one of these isomers. Draw the other **two** isomers. [2]



Isomer 1

Isomer 2

Isomer 3

Examiner only

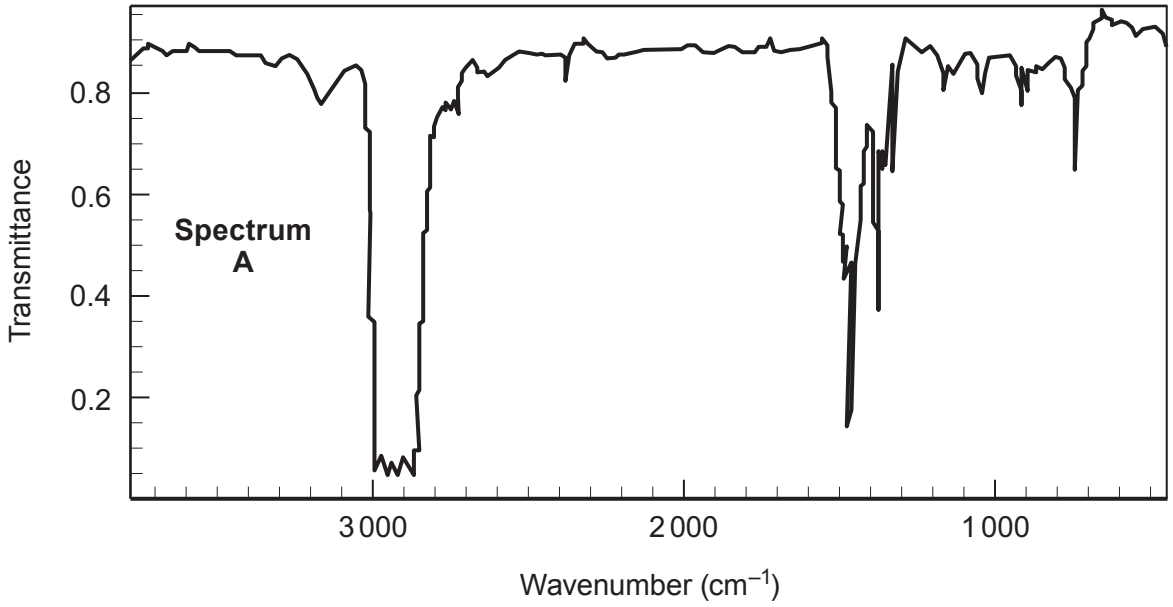
(b) (i) The first two members of the alkene family are ethene, C_2H_4, and propene, C_3H_6. Give the general formula for the alkene family. [1]

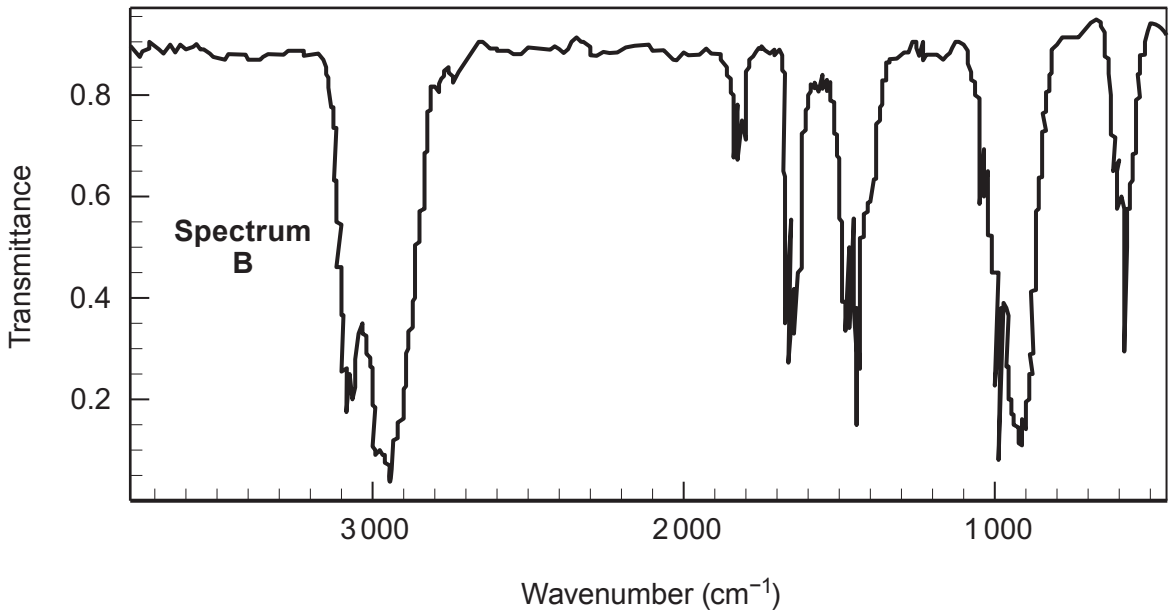
.....

(ii) Draw the structural formula for propene. [1]

Examiner only

(c) Study the infrared spectra of propane and propene below. Using the information in the table opposite, identify the spectrum of propene and give a reason for your answer. [1]





Examiner only

Bond	Wavenumber / cm^{-1}
C═C	1620 to 1670
C═O	1650 to 1750
C—H	2800 to 3100
O—H	2500 to 3550

Spectrum .....

Reason .....

.....

6

Examiner only

6. *(a)* Ammonia is made industrially from nitrogen and hydrogen by the Haber process.

The table below shows the yield of ammonia under different pressure and temperature conditions.

Pressure (atmospheres)	Temperature (°C)				
	100	200	300	400	500
	Yield of ammonia (%)				
10	88.2	50.7	14.7	3.9	1.2
50	94.5	75.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	40.0	18.3
400	99.4	94.6	79.7	55.4	31.9
1 000	99.9	98.3	92.6	79.8	57.5

(i) Using **only** the data in the table suggest the conditions that should be chosen for the process. [1]

Pressure ..... atmospheres *Temperature* ..... °C

(ii) Give the disadvantage of using a low temperature in the process and state how this problem is overcome. [2]

.....

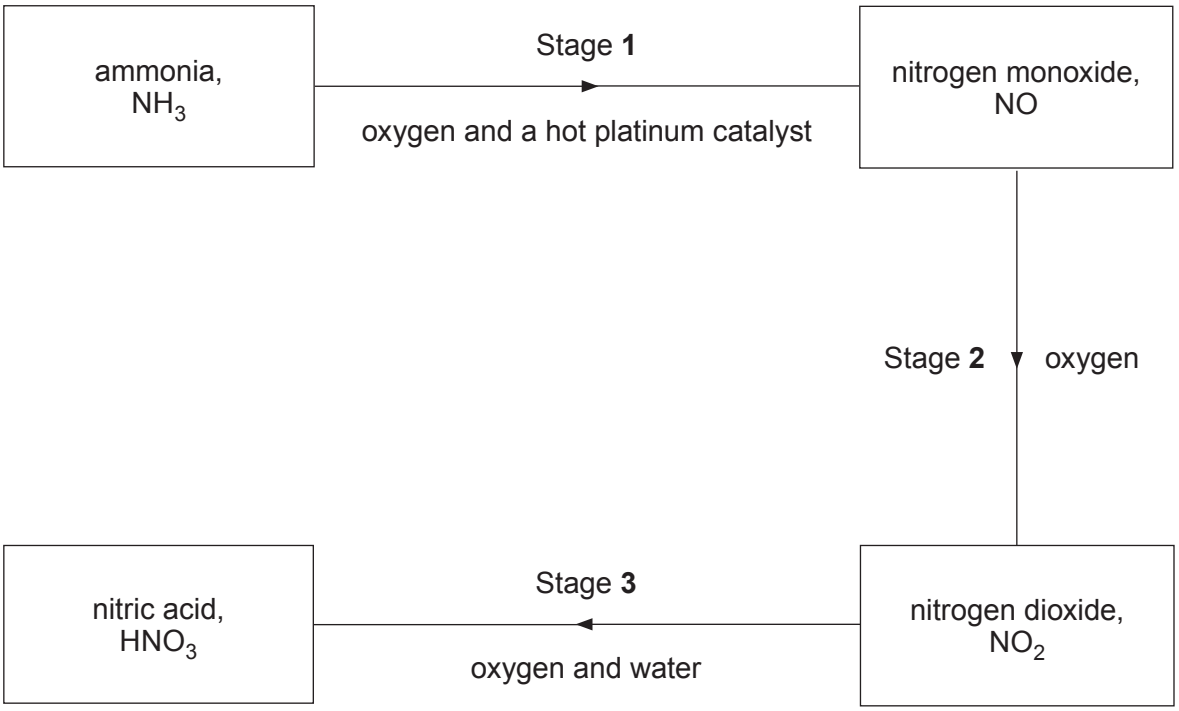
.....

(iii) The actual pressure used in the process is 200 atmospheres. Apart from safety issues, suggest a disadvantage of using a higher pressure. [1]

.....

Examiner only

(b) Ammonia is used to form nitric acid in a three-stage reaction.



(i) Once the reaction in stage **1** has started there is sufficient heat to maintain the reaction. Give the term used to describe a reaction that produces heat. [1]

.....

(ii) Balance the symbol equation below that represents the reaction taking place in stage **3**. [1]

$$\square\ NO_2 + O_2 + 2H_2O \longrightarrow \square\ HNO_3$$

(iii) Write a balanced symbol equation for the reaction that occurs when nitric acid is added to copper(II) carbonate. [2]

.....

8

Examiner only

7. *(a)* A pupil used the following tests to identify unknown compounds **A**, **B**, **C** and **D**.

add sodium hydroxide solution and warm mixture, test gas given off with damp litmus paper

add dilute hydrochloric acid, bubble gas given off into limewater

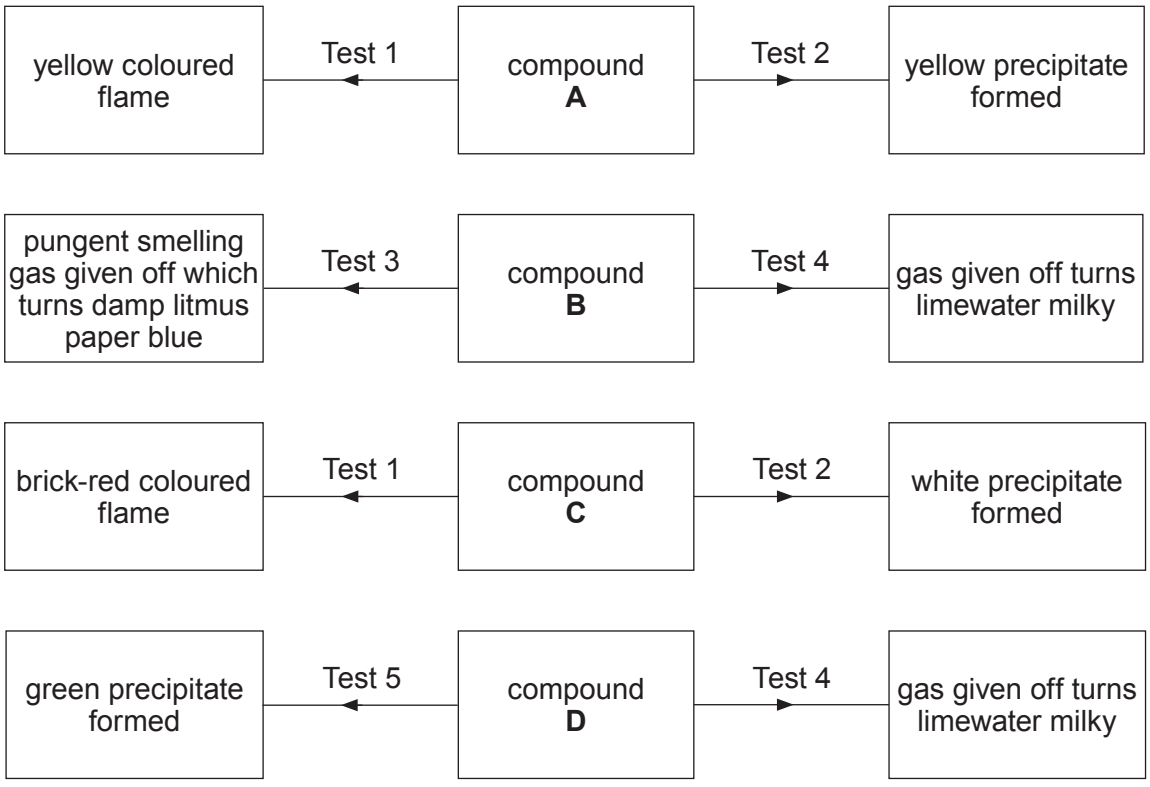
add silver nitrate solution

add sodium hydroxide solution

flame test

These are described as tests 1 to 5 but not necessarily in this order.

The flow charts show the results obtained for each compound.



Deduce which test is which and hence give the **names** of compounds **A**, **B**, **C** and **D**. [4]

A .....

B .....

C .....

D .....

(b) Describe the test for sulfate ions in solution. Include the result for your test. [1]

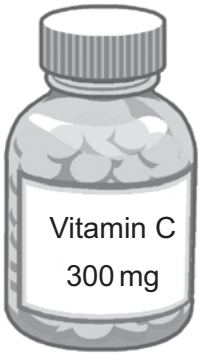
.....

Examiner only

8. An analytical chemist was asked to check the amount of vitamin C in a tablet. Vitamin C tablets contain ascorbic acid, $C_6H_8O_6$, and a starch "filler" which holds them together.

Ascorbic acid reacts with sodium hydroxide solution according to the equation below:

$$C_6H_8O_6 + NaOH \longrightarrow NaC_6H_7O_6 + H_2O$$



To determine how much vitamin C is present, a tablet was dissolved in water and titrated with sodium hydroxide solution of concentration 0.10 mol/dm^3. The endpoint was determined using the indicator phenolphthalein. The procedure was repeated three times and the mean value of sodium hydroxide solution needed to neutralise a vitamin C tablet was found to be 17.5 cm^3.

(a) Calculate the number of moles of sodium hydroxide in 17.5 cm^3 of the 0.10 mol/dm^3 solution. [2]

Number of moles = ... mol

(b) Calculate the relative molecular mass, M_r, of ascorbic acid, $C_6H_8O_6$. [1]

A_r(H) = 1 A_r(O) = 16 A_r(C) = 12

M_r = ...

(c) The label on the bottle states that each tablet contains 300 mg (0.3 g) of vitamin C. Using your answers to parts *(a)* and *(b)* show whether this statement is correct. [2]

Examiner only

9. Sodium chloride is made when sodium hydroxide solution reacts with dilute hydrochloric acid.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Describe a laboratory method for making **crystals** of pure sodium chloride from sodium hydroxide solution and dilute hydrochloric acid. [6 QWC]

Diagrams may be used as part of your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6

END OF PAPER

BLANK PAGE

BLANK PAGE

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		
Zinc	Zn^{2+}		

PERIODIC TABLE OF ELEMENTS

1	2											3	4	5	6	7	0
								$^{1}_{1}$H Hydrogen									$^{4}_{2}$He Helium
$^{7}_{3}$Li Lithium	$^{9}_{4}$Be Beryllium											$^{11}_{5}$B Boron	$^{12}_{6}$C Carbon	$^{14}_{7}$N Nitrogen	$^{16}_{8}$O Oxygen	$^{19}_{9}$F Fluorine	$^{20}_{10}$Ne Neon
$^{23}_{11}$Na Sodium	$^{24}_{12}$Mg Magnesium											$^{27}_{13}$Al Aluminium	$^{28}_{14}$Si Silicon	$^{31}_{15}$P Phosphorus	$^{32}_{16}$S Sulfur	$^{35}_{17}$Cl Chlorine	$^{40}_{18}$Ar Argon
$^{39}_{19}$K Potassium	$^{40}_{20}$Ca Calcium	$^{45}_{21}$Sc Scandium	$^{48}_{22}$Ti Titanium	$^{51}_{23}$V Vanadium	$^{52}_{24}$Cr Chromium	$^{55}_{25}$Mn Manganese	$^{56}_{26}$Fe Iron	$^{59}_{27}$Co Cobalt	$^{59}_{28}$Ni Nickel	$^{64}_{29}$Cu Copper	$^{65}_{30}$Zn Zinc	$^{70}_{31}$Ga Gallium	$^{73}_{32}$Ge Germanium	$^{75}_{33}$As Arsenic	$^{79}_{34}$Se Selenium	$^{80}_{35}$Br Bromine	$^{84}_{36}$Kr Krypton
$^{86}_{37}$Rb Rubidium	$^{88}_{38}$Sr Strontium	$^{89}_{39}$Y Yttrium	$^{91}_{40}$Zr Zirconium	$^{93}_{41}$Nb Niobium	$^{96}_{42}$Mo Molybdenum	$^{99}_{43}$Tc Technetium	$^{101}_{44}$Ru Ruthenium	$^{103}_{45}$Rh Rhodium	$^{106}_{46}$Pd Palladium	$^{108}_{47}$Ag Silver	$^{112}_{48}$Cd Cadmium	$^{115}_{49}$In Indium	$^{119}_{50}$Sn Tin	$^{122}_{51}$Sb Antimony	$^{128}_{52}$Te Tellurium	$^{127}_{53}$I Iodine	$^{131}_{54}$Xe Xenon
$^{133}_{55}$Cs Caesium	$^{137}_{56}$Ba Barium	$^{139}_{57}$La Lanthanum	$^{179}_{72}$Hf Hafnium	$^{181}_{73}$Ta Tantalum	$^{184}_{74}$W Tungsten	$^{186}_{75}$Re Rhenium	$^{190}_{76}$Os Osmium	$^{192}_{77}$Ir Iridium	$^{195}_{78}$Pt Platinum	$^{197}_{79}$Au Gold	$^{201}_{80}$Hg Mercury	$^{204}_{81}$Tl Thallium	$^{207}_{82}$Pb Lead	$^{209}_{83}$Bi Bismuth	$^{210}_{84}$Po Polonium	$^{210}_{85}$At Astatine	$^{222}_{86}$Rn Radon
$^{223}_{87}$Fr Francium	$^{226}_{88}$Ra Radium	$^{227}_{89}$Ac Actinium															

Group

Key: