Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S23-3430U50-1

3430U50-1

MONDAY, 22 MAY 2023 – MORNING

SCIENCE (Double Award)
Unit 5 – CHEMISTRY 2
FOUNDATION TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**6**	
3.	**12**	
4.	**6**	
5.	**6**	
6.	**6**	
7.	**15**	
Total	**60**	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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. If you run out of space, use the additional page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

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

Question **6** is a quality of extended response (QER) question where your writing skills will be assessed.

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

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Answer **all** questions.

1. (a) (i) The box below contains the names of some common types of smart material.

photochromic pigment	**hydrogel**	**shape memory alloy**
shape memory polymer	**thermochromic pigment**	

Choose from the box the type of smart material that is used in:

I. disposable nappies, [1]

.....

II. lenses for sunglasses. [1]

.....

(ii) What must be done to a thermochromic pigment for it to change colour? [1]

Tick (✓) the box next to the correct answer.

heat it ☐

add water ☐

place it in sunlight ☐

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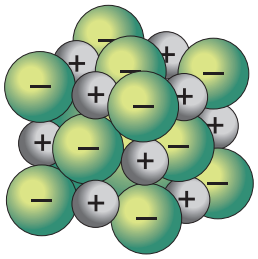
(b) (i) The following diagram shows a giant ionic structure.



Giant ionic structures have high melting points and conduct electricity when dissolved or molten.

Use the diagram and your knowledge to draw **one** line from each property to its correct explanation. [2]

Property	**Explanation**
	ions are regularly arranged
high melting point	strong bonds between ions
	ions are free to move
conducts electricity when dissolved or molten	ions cannot move
	weak bonds between ions

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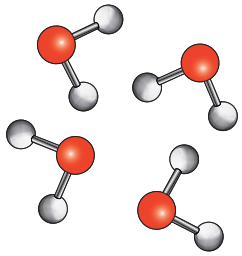
(ii) The following diagram shows a simple covalent structure.



Simple covalent structures have low melting points and do not conduct electricity.

Use the diagram and your knowledge to draw **one** line from each property to its correct explanation. [2]

Property	**Explanation**
	strong forces between molecules
low melting point	molecules cannot move
	weak forces between molecules
does not conduct electricity	molecules are not charged
	molecules are tightly packed

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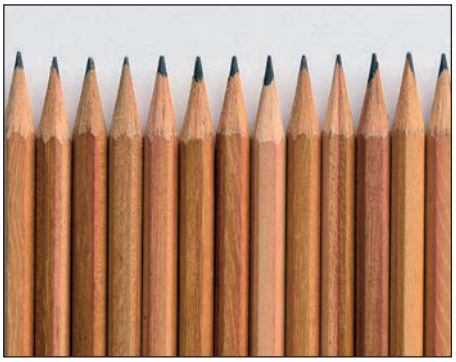
(c) Diamond and graphite have giant covalent structures. Diamond is commonly used in drill tips, whereas graphite is used in pencils.

drill tips



pencils

Use your knowledge of the properties of diamond and graphite to underline the correct word in the brackets to complete each sentence. [2]

Diamond is used in drill tips because it is (**hard / soft / malleable**) and has a high melting point.

Graphite is used in pencils because the layers of atoms are held together weakly and are able to slide (**through / into / over**) each other.

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2. Iron is extracted from iron oxide inside the blast furnace.

(a)

iron ore	**steel**	**limestone**	**hot air**
slag	**iron**	**coke**	**waste gases**

Choose substances from the box to complete the following sentences. [2]

Iron oxide, coke and ..... are the materials fed in at the **top** of the furnace.

The furnace is heated by burning the coke in ..... .

(b) Balance the symbol equation that represents the main reaction taking place inside the furnace. [1]

$$Fe_2O_3 + 3CO \longrightarrow \square\ Fe + 3CO_2$$

Examiner only

(c) Some of the impurities are removed from the furnace as slag. Slag contains calcium silicate which has the chemical formula $CaSiO_3$.

Tick (✓) the box next to the calculation used to find the correct relative formula mass of calcium silicate, $CaSiO_3$. [1]

A_r(Ca) = 40 A_r(Si) = 28 A_r(O) = 16

40 + 28 + 16 ☐

40 + 40 + 40 + 28 + 28 + 28 + 16 + 16 + 16 ☐

40 + 28 + 16 + 16 + 16 ☐

40 + 16 + 16 + 16 ☐

40 + 28 + 28 + 28 + 16 + 16 + 16 ☐

(d) 820 tonnes of iron was extracted from 1750 tonnes of iron ore. Calculate the percentage of iron in the ore. Give your answer to **one** decimal place. [2]

Percentage = ... %

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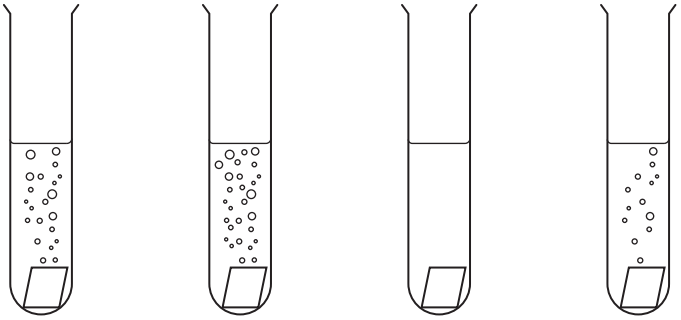
3. Nathan and Simon were investigating the reactivity of metals.

(a) In one experiment, they investigated the effect of adding dilute hydrochloric acid to four different metals, **A**, **B**, **C** and **D**.

The diagram shows the observations made.



(i) They used the same **volume** of acid in each tube. Give **two other** ways they controlled the dilute hydrochloric acid to ensure a fair test. [2]

1. .....

2. .....

(ii) Use the observations to list the metals in order of their reactivity. Give the reason for your choice. [2]

Most reactive .....

.....

.....

Least reactive .....

Reason .....

.....

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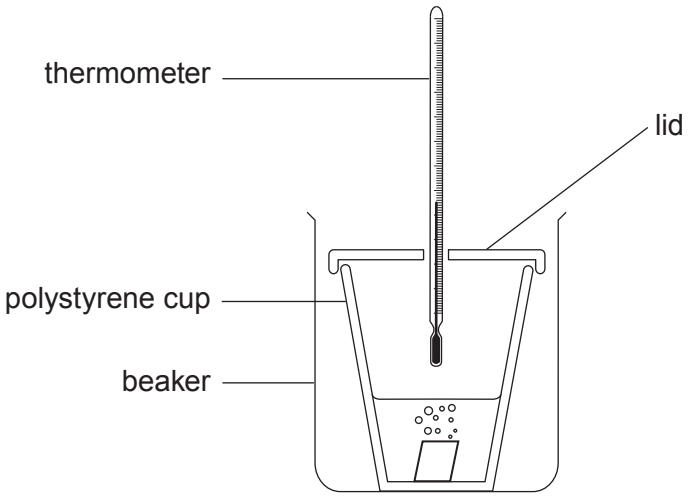
(b) In a second experiment, Nathan and Simon used the following apparatus to investigate the temperature rise when metals **A**, **B**, **C** and **D** were added to hydrochloric acid.



(i) Identify the error in the way the apparatus is set up and state how this would affect the results collected. [2]

Error .....

Effect .....

.....

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(ii) Once they had set up their apparatus correctly, they obtained the following results.

Metal	Temperature rise (°C)			
	Test 1	Test 2	Test 3	Mean
A	22	21	.....	22
B	40	38	36	38
C	0	0	0	0
D	15	9	13	14

I. Identify the anomalous result from metals **B**, **C** and **D**. [1]

Metal ..... Test .....

II. Calculate the missing result for metal **A**. [1]

Temperature rise for test 3 = ... °C

III. Zinc is more reactive than metals **C** and **D** but less reactive than metals **A** and **B**. Use this information to predict the temperature rise that would be expected for zinc. [1]

Temperature rise for zinc ..... °C

Examiner only

(c) The reaction of a metal with an acid is summarised by the following equation.

metal + acid ⟶ salt + hydrogen

(i) Complete the equation for the reaction between magnesium and hydrochloric acid by

- giving the formula of the salt magnesium chloride,
- balancing the equation. [2]

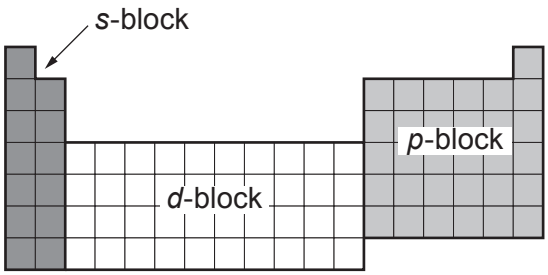
Mg + ☐ HCl ⟶ ..... + H_2

(ii) Give the name of the salt formed when magnesium reacts with nitric acid. [1]

.....

4. The Transition Metals

The elements in the Periodic Table can be divided into three blocks: the *s*-block, the *d*-block and the *p*-block.



The *s*-block and *d*-block contain only metallic elements. The *p*-block contains both metallic and non-metallic elements.

The transition metals are found within the *d*-block and are the metallic elements that serve as a bridge or 'transition' between the two sides of the table. They include the elements iron, silver, gold, vanadium and titanium.

The transition metals have similar properties to each other. These include high melting point, high density, good conductivity and malleability. The transition metals also have unique properties, making them different from the main group metals, including the ability to form compounds with different colours and different oxidation states.

Table 1 gives the properties of some transition metals and some Group 1 metals.

Element	Melting point (°C)	Boiling point (°C)	Oxidation states	Colours of compounds formed
iron	1536	2861	+2, +3	green and brown
lithium	180	1342	+1	white
potassium	63	760	+1	white
sodium	98	883	+1	white
titanium	1660	3287	+3, +4	violet and white
vanadium	1910	3407	+3, +4, +5	green, blue and yellow

Table 1

Examiner only

(a) Tick (✓) the statement that **best** describes where metals are positioned within the Periodic Table. [1]

the *s*-block, *p*-block and *d*-block ☐

the *s*-block and *p*-block only ☐

the *s*-block only ☐

the *d*-block and *p*-block only ☐

the *p*-block only ☐

(b) Name the element in **Table 1** that is a liquid over the biggest temperature range. [1]

.....

(c) Tick (✓) the **two** statements that correctly describe the oxidation states of the metals listed in **Table 1**. [2]

the Group 1 metals and transition metals all have a +1 oxidation state ☐

the transition metals all have a +3 oxidation state ☐

the Group 1 metals all have a +1 oxidation state ☐

iron and lithium have the same oxidation states ☐

the Group 1 metals and transition metals all have a +4 oxidation state ☐

Examiner only

(d) Consider the following statement.

'It is possible to tell the Group 1 and transition metals apart by the colour of the compounds they form.'

Use the information in **Table 1** to give **one** reason to agree and **one** reason to disagree with this statement. [2]

Reason to agree .....

.....

.....

Reason to disagree .....

.....

.....

6

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5. (a) The first stage in the preparation of a salt from an acid and an alkali often involves carrying out a titration.

A-**F** below are the steps of the method that can be used to prepare a salt from an acid and an alkali. However, these steps are **not** in the correct order.

A Repeat without the indicator using the same volumes of alkali and acid

B Add 2-3 drops of indicator

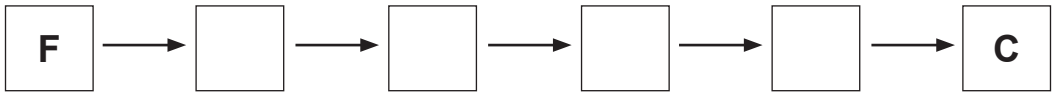
C Allow the solution to cool and crystallise naturally

D Place the salt solution into an evaporating dish and heat until half the volume of solution remains

E Add the acid to the alkali until the indicator changes colour

F Measure 25.0 cm^3 of alkali into a conical flask

(i) Place the steps of the method into the correct order. The first and last steps have already been added. [2]



(ii) Give the **letter** of the step where error is **most** likely to occur. Give the reason for your choice. [2]

Step .....

Reason .....

.....

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(b) The reaction between an acid and an alkali produces a salt and water. The following equation shows how potassium sulfate is produced from an acid and an alkali.

potassium hydroxide + ... ? ..... ⟶ potassium sulfate + water

(i) Give the name of the missing acid. [1]

.....

(ii) Give the chemical formula of potassium sulfate. [1]

.....

6

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6. The table shows some properties of aluminium, copper and titanium.

Metal	Melting point	Electrical conductivity	Thermal conductivity	Density	Resistance to corrosion
aluminium	high	good	good	low	good
copper	high	good	good	high	good
titanium	high	good	good	low	good

Describe how **these** properties are linked to the uses of aluminium, copper and titanium.

You should **not** give more than two uses for any one metal. [6 QER]

6

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7. (a) The molecular formulae of five carbon compounds, **A**, **B**, **C**, **D** and **E** are shown below.

C_3H_6	C_2H_5OH	C_4H_8	C_2H_6	C_3H_8
A	**B**	**C**	**D**	**E**

(i) Alkanes are compounds with the general formula C_nH_{2n+2}.

Give the **letters** of the **two** compounds that are alkanes. [1]

..... and .....

(ii) Give the **name** for compound **A**. [1]

.....

(iii) Draw the structural formula of compound **E**. [1]

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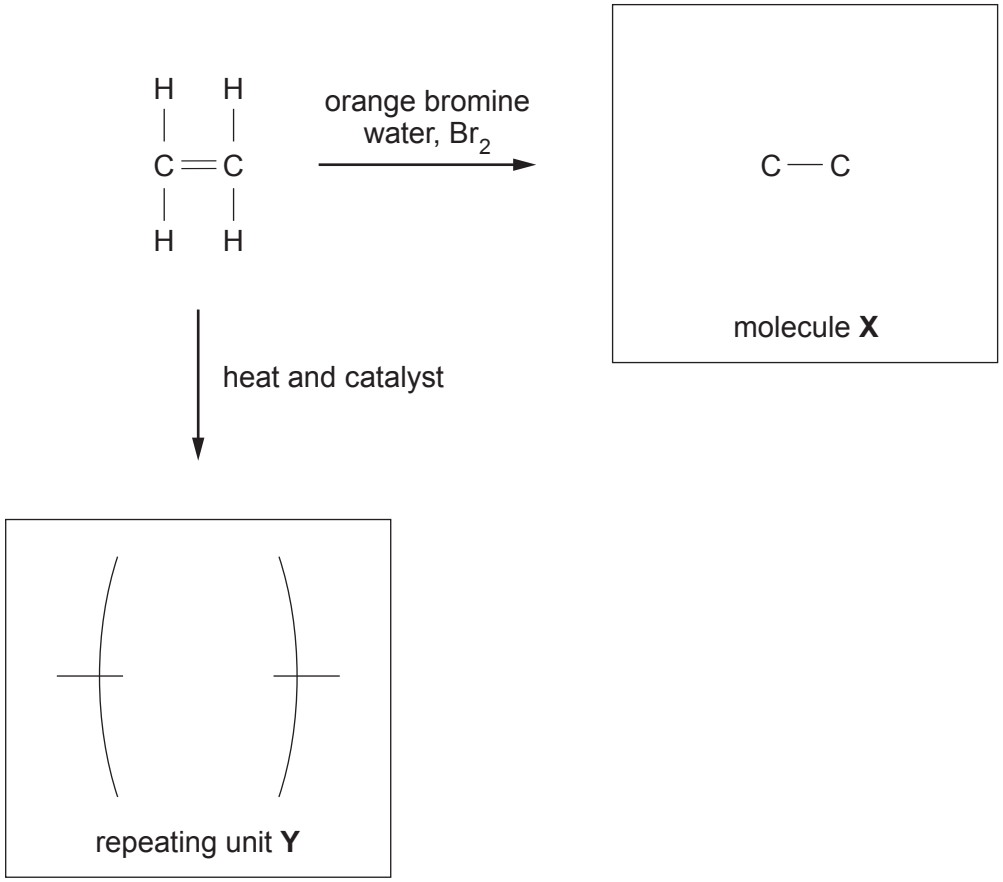
(b) The following diagram shows two reactions of ethene.



(i) **Complete the structural formulae** for molecule **X** and repeating unit **Y**. [2]

(ii) Describe the change that would be seen in the orange bromine water when molecule **X** is formed. [1]

.....

(iii) Name the type of reaction that takes place to form repeating unit **Y**. [1]

.....

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(c) Paper and plastic are both used to make disposable shopping bags.

The table compares the percentages of disposable paper and plastic bags used by consumers in a Welsh town between 1988 and 2018.

Type of bag	Percentage of disposable bags used (%)						
	1988	1993	1998	2003	2008	2013	2018
paper	73	63	31	12	8	13	21
plastic	27	37	69	88	92	87	79

(i) In 2003, the consumers of the town used a total of 1.25 million disposable bags.

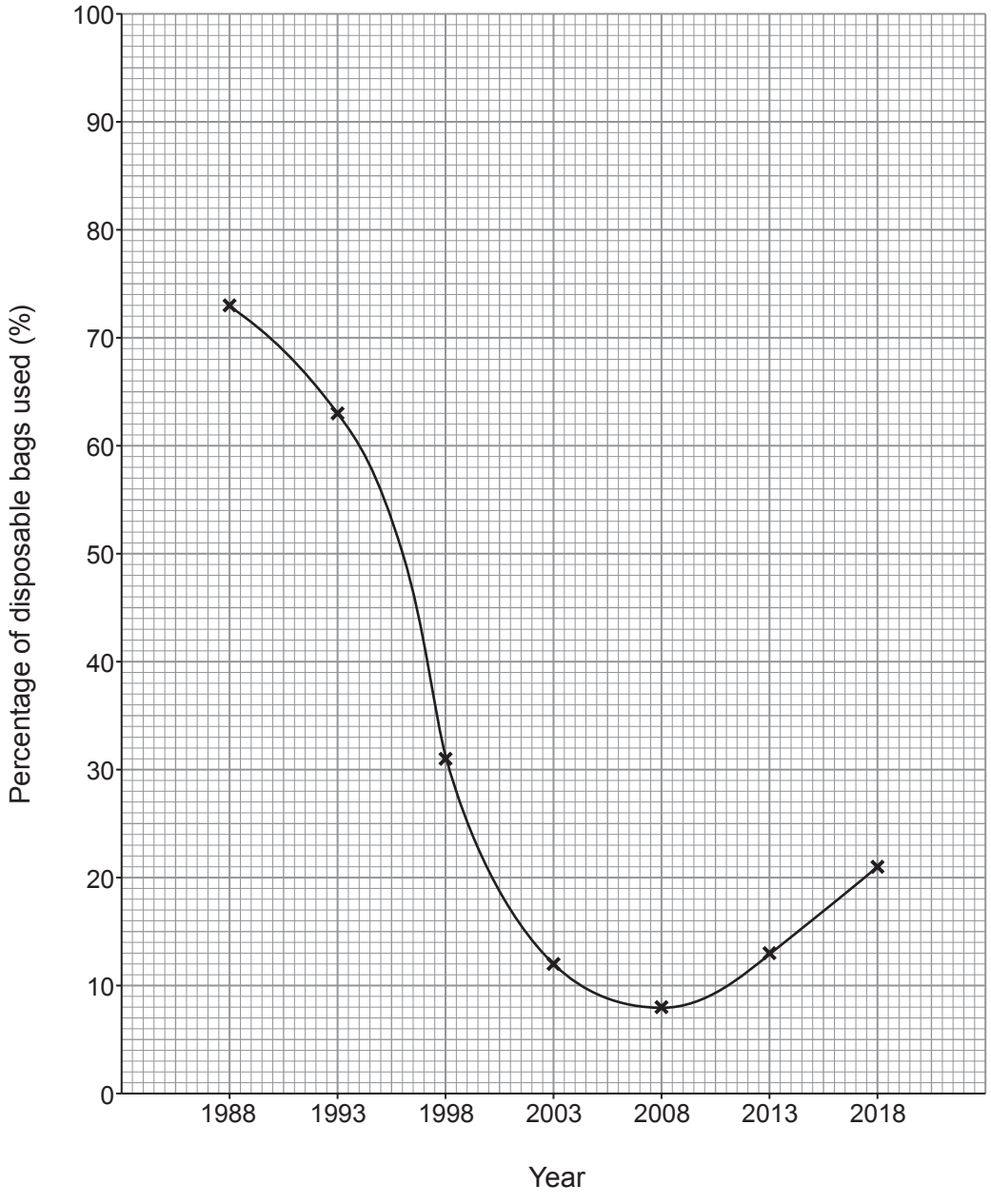
Use the information in the table to calculate the number of **paper** bags used. [2]

Number of paper bags = ... million

Examiner only

(ii) The graph below shows the percentage of **paper** bags used between 1988 and 2018.

Plot on the **same grid** the percentage of **plastic** bags used between 1988 and 2018. Draw a suitable line. [3]



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(iii) **Use the graph** to answer the following questions.

I. Give the year when **equal** numbers of plastic bags and paper bags were used. [1]

Year .....

II. Circle the **simplest** ratio that compares the use of paper bags to plastic bags in 2000. [1]

2 : 8 **1 : 4** **4 : 1** **8 : 2** **20 : 80**

(iv) Give **one** reason that explains the change seen in plastic bag usage in Wales between 2008 and 2018. [1]

.....

.....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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+}		

THE PERIODIC TABLE

Group	1	2										3	4	5	6	7	0
								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
	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key