Name: _____ **Form:** ____

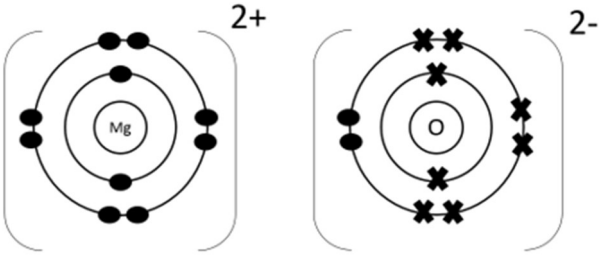
Science Group: _____ **Science Teacher:** _____

Year 9 Chemistry: Unit 3
Metals, Ions and the Periodic Table

The grade I would like to get is:

9 8 7 6 5

4 3 2 1



Year 7	Particles and properties	Atoms and reactions	Chemistry of the Earth	
Year 8	Acids, bases and alkalis	Reactivity	Chemistry in action	
Year 9	Properties of the atom	Separation chemistry	**Metals, Ions and the periodic table**	
Year 10	Groups of the periodic table	The chemistry of metals	Moles	Rates and energy
Year 11	Industrial Chemistry		Sustainable chemistry	

Lesson Title	Date of Lesson	Homework
Models of the Atom		HW 7: Models of the Atom Timeline
Chemical History – The Periodic Table		SS 5: Electronic Structure and the Periodic Table
Introduction to Chemical bonding		HW 8: Synoptic Quiz
Metals, Alloys and Metallic Bonding		SS 6: Metals and Alloys
Properties of Metals and Group 1		SS 7: Acid, Base, Alkali or Salt?!
Ionic Bonding – The Basics		SS 8: Ionic bonding (ONLINE)
Properties of Ionic Compounds		SS 9: Writing Ionic Formulae
Electrolysis		HW 9: Revision SS 10: Writing Equations
End of Year Test		

Where have we been? Why are we learning this now?

In the first topic this year we looked at atoms and their structure. This topic uses that knowledge to start to understand some of the materials in the world around us and why they behave the way they do.

To understand why compounds behave how they do we need two tools: a model of what an atom is like and the periodic table. We will look at these and how they came to exist.

We will then look at how atoms join together to form compounds – we call this chemical bonding.

You will start to look at the three types of chemical bond and this will help you understand everything coming in year 10!

AQA

The Periodic Table of Elements

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
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	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

Key: relative atomic mass / **atomic symbol** / name / atomic (proton) number

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

Glossary

What is an atom?	The smallest part of an element that can still be recognised as that element
What is an element?	A substance made of only one type of atom
What is a compound?	A substance made of two or more different types of atom chemically bonded together
What is a molecule?	A substance made of more than one atom chemically bonded together (can be atoms of the same type!)
What is a mixture?	A substance made of more than one element or compound not chemically bonded together
State the three subatomic particles	Proton, Neutron and Electron
State the masses of the subatomic particles	Proton = 1, Neutron = 1, Electron = 1/2000
State the relative charges of the subatomic particles	Proton = +1, Neutron = 0, Electron = -1
How are the subatomic particles arranged in an atom?	Protons and neutrons are in the nucleus Electrons are in the shells around the nucleus
What is the atomic number of an atom?	The number of protons in the atom The number of electrons (in a neutral atom)
What is the mass number of an atom?	The number of protons + neutrons in an atom
How do you calculate the number of neutrons in an atom?	Mass number – atomic number
How are the electrons arranged in atoms?	In shells. Up to 2 in the first shell, up to 8 in all other shells
How many electrons can go in the first shell?	2
How many electrons can go in the second and third shells?	8
What are groups in the periodic table?	The columns
What can the group tell you about the electrons in an atom?	The group number = number of electrons on the outer shell
What are periods in the periodic table?	The rows
What can the period tell you about the electrons in an atom?	The period number = the number of shells

What is an ion?	An atom with a charge
Who discovered the electron?	J. J. Thompson in 1897
What was the gold foil experiment?	An experiment by Ernest Rutherford which fired alpha particles at gold foil. It disproved the plum pudding model and led to the nuclear model.
Who discovered the neutron?	James Chadwick in 1932
Why did Mendeleev leave gaps in the periodic table?	To add in newly discovered elements. He grouped the periodic table by atomic weight and the properties of elements.
How was the original periodic table organised?	By atomic weight
How is the current periodic table organised?	By atomic number (number of protons)
What is an ionic bond?	An electrostatic attraction between oppositely charged ions. This forms a giant ionic lattice.
What is a covalent bond?	A shared pair of electrons between two atoms
Why do atoms form chemical bonds?	To gain a full outer shell of electrons
Why do metals conduct electricity?	Because they have electrons that are free to move (delocalised)
Why do metals have high melting points?	The ions are in a lattice held together by strong electrostatic attractions to the delocalised electrons. These take a lot of energy to break.
Why do solid ionic compounds not conduct electricity?	They have no free electrons and the ions cannot move.
Why do molten ionic compounds conduct electricity?	The ions are now free to move
Why do ionic compounds have a high melting point?	They are in a giant ionic lattice held together by strong electrostatic attractions. These take a lot of energy to break.
What is electrolysis?	Breaking up a compound into elements using electricity

Retrieval Practice – What can you remember?

1. **What are the two main areas in an atom? What do we find in them?**

2. **What do the two numbers on a periodic table tell us about an element?**

3.

4.

Lesson 1: Models of the Atom

Date: ___ / ___ / ___

In science we use models to describe things which are too small to see or are difficult to explain without pictures or diagrams.

Atoms are EXTREMELY small (nanometres in diameter) so we need a model to describe them.

This model has changed over time as our ideas and understanding get better.

You need to know some of the key people who developed our model of the atom and their discoveries.

The History of the Atom

Name: …….. **Date of theory:** …….. What was 'the smallest quantity of matter' according to this scientist? ……	Sketch this scientist's model of the atom here:

Name: ……..

Date of theory: ……..

Whose idea did this scientist revive?

……

How did this scientist describe atoms?

……

What did this scientist theorise about compounds?

……

……

……

Sketch this scientist's model of the atom here:

Name: ……..

Date of discovery: ……..

What did this scientist discover?

……

……

……

What is the name of this scientist's model of the atom?

……

……

What did this scientist disprove about Dalton's theory?

……

……

Sketch this scientist's model of the atom here:

Name: ……

Date of discovery: ……..

What did this scientist discover?

……

……

What is the name of this scientist's model of the atom?

……

……

What experiment did this scientist use to develop his theory?

……

……

Sketch this scientist's model of the atom here:

Names: …… and

……

Date of experiment: ……..

Who were these scientists working for?

……..

What experiment did they carry out?

……..

Which model of the atom did their work disprove?

……..

How did their experiment disprove it?

……..

……..

……..

……..

Sketch the experiment here:

Name: …… **Date of discovery:** …….. What is the name of this scientist's model of the atom? …… …… Whose theory did this scientist build upon? …… …… How did this scientist suggest electrons are arranged? …… …… ……	Sketch this scientist's model of the atom here:

Retrieval Practice – What can you remember?

1. **What was the name of J.J Thompson's model of the atom? What did it look like?**

2. **What experiment did Geiger and Marsden do for Ernest Rutherford? Why was it important?**

3.

4.

Lesson 2: Chemical History - The Periodic Table Date: ___ / ___ / ___

The Development of the Periodic Table

These questions go with https://edpuzzle.com/media/5f1ecb96cfa3e43f4b18c080

1. **Dobereiner** looked at element's chemical properties. He noted there were groups of 3 elements which he called …….. .

2. Lithium, Sodium and Potassium are all called …….. Metals.

3. Describe the reaction of Sodium with water.

   ……

   ……

4. What changes when you react Lithium, Sodium and potassium?
   Do they all react in the same way?

   ……

   ……

5. **Canizzaro** finally determined precise …… …… .

6. **John Newlands** found that if the elements were placed in order of atomic weight, a pattern emerged with every …… element having similar properties. He called this the law of …… .

7. Describe the smell of Chlorine.

   ……

8. …and the smell of the eighth element after Chlorine, which is …… .

   ……

9. This repeating pattern is now called the Law of …… .

10. Why was **Mendeleev** using an incomplete deck of cards?

    ……

11. **Mendeleev** combined …… …… and ……
    …… to design the periodic table.

12. To make his table work, **Mendeleev** had to do what?

……

……

13. When the missing elements were discovered did they match **Mendeleev's** predictions?

……

REIHEN	Gruppe I - R^2O	Gruppe II - RO	Gruppe III - R^2O^3	Gruppe IV RH^4 RO^2	Gruppe V RH^3 R^2O^5	Gruppe VI RH^2 RO^3	Gruppe VII RH R^2O^7	Gruppe VIII - RO^4
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	-=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59 Ni=59 Cu=63
5	(Cu=63)	Zn=65	-=68	-=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	-=100	Ru=104, Rh=104 Pd=106, Ag=108
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	-	-	-	- - - -
9	(-)	-	-	-	-	-	-	
10	-	-	?Er=178	?La=180	Ta=182	W=184	-	Os=195, Ir=197 Pt=198, Au=199
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	-	-	
12	-	-	-	Th=231	-	U=240	-	- - - -

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4		Key: relative atomic mass; atomic symbol; name; atomic (proton) number									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	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

The Modern Periodic Table

You will need an AQA Periodic Table to complete this sheet (front of your booklet!)

1. Look closely at your periodic table. How are the elements ordered? What increases from left to right?

   ……

   ……

2. Which elements don't follow the pattern? Why? (**HINT:** Look in groups 6 and 7)

   ……

   ……

3. Most of the elements on the periodic table are metals. Draw the dividing line between the metals and non-metals onto your periodic table. Label the metals and the non-metals.

4. Label the groups and periods on your periodic table. Which is horizontal and which is vertical?

   ……..

5. Groups on the periodic table contain elements with similar properties or reactivity. What are the names of these groups? Label them on your periodic table.

   Group 1: ……..

   Group 2: ……..

   Group 7: ……..

   Group 0: ……..

6. Some groups get more or less reactive as you go down the group. The table below shows some information for group 1 and group 7 elements. What is the pattern? Mark it on your periodic table.

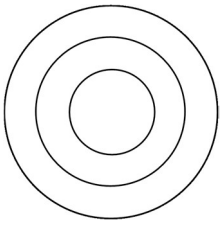
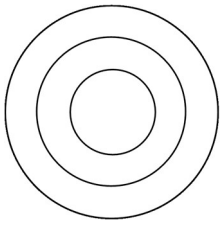
Group 1	
Element	**Reaction with water**
Lithium	Fizzes gently
Sodium	Fizzes vigorously
Potassium	Fizzes vigorously, melts, may ignite
Rubidium	Explodes after a few seconds
Caesium	Explodes immediately

Group 7	
Element	**Reaction with iron**
Fluorine	Burns very vigorously
Chlorine	Burns vigorously
Bromine	Reacts quickly
Iodine	Reacts slowly
Astatine	Not tested (radioactive)

Group 1 elements are …… reactive as you go down the group.

Group 7 elements are …… reactive as you go down the group.

7. The periodic table can be used to predict the electronic structure of any atom. Complete the electronic configurations and questions below.

F	What group is Fluorine in?	**Li**	What group is Lithium in?
p = n = e =	…….	p = n = e =	…….
	What period is Fluorine in? …….		What period is Lithium in? …….

8. What do you notice about the **electronic configuration** and the **group number**?

   ……..

9. What do you notice about the **electronic configuration** and the **period number**?

   ……..

10. Use the electronic structures to identify group numbers and period numbers. Then find the element!

Electronic structure	Group	Period	Element
2,8,4			
2,6			
2			
2,8,8			
2,8,2			
2,3			
2,7			
2,8,5			

The Periodic Table Exam Practice

1. John Newlands was a chemist who worked in a sugar factory.

   In 1866 he designed a periodic table. He arranged the elements in order of their relative atomic masses.

   He found a repeating pattern for some of the elements. Newlands wrote, 'the eighth element starting from a given one, is a kind of repetition of the first, like the eighth note in an octave of music'.

H	**Li**	**G**	**Bo**	**C**	**N**	**O**
F	**Na**	**Mg**	**Al**	**Si**	**P**	**S**
Cl	**K**	**Ca**	**Cr**	**Ti**	**Mn**	**Fe**
Co, Ni	**Cu**	**Zn**	**Y**	**In**	**As**	**Se**
Br	**Rb**	**Sr**	**Ce, La**	**Zr**	**Di, Mo**	**Ro, Ru**
Pd	**Ag**	**Cd**	**U**	**Sn**	**Sb**	**Te**
I	**Cs**	**Ba, V**	**Ta**	**W**	**Nb**	**Au**
Pt, Ir	**Tl**	**Pb**	**Th**	**Hg**	**Bi**	**Os**

Newlands' periodic table

(a) In Newlands' periodic table, the elements lithium, sodium and potassium are grouped together.

Give **two** properties of these elements which support the idea that they should be grouped together.

1 .....

.....

2 .....

.....

(2)

(b) Newlands' periodic table was not accepted by most chemists in 1866.

Suggest reasons why.
Use the Newlands' periodic table above to help you to answer this question.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(c) State **and** explain **one** way in which Mendeleev improved Newlands' periodic table.

.....

.....

.....

.....

(2)

2. Use the periodic table on the Data Sheet to answer these questions.
The table below gives the electronic structures of four elements, **W**, **X**, **Y** and **Z**.

Element	Electronic structure
W	2,5
X	2,7
Y	2,8,8
Z	2,8,8,1

(a) Which element **W**, **X**, **Y** or **Z**:

(i) is a Group 0 gas? .....

(ii) is nitrogen? .....

(iii) is a Group 7 gas? .....

(iv) reacts violently with water? .....

(3)

(b) Which **two** Groups of the periodic table do **not** contain any non-metals?

.....

(1)

Retrieval Practice – What can you remember?

1. **How were the elements ordered in the first periodic tables?**

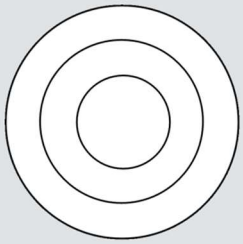
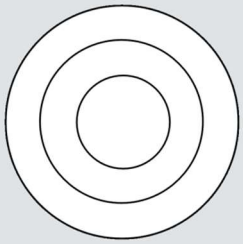
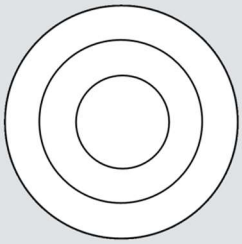
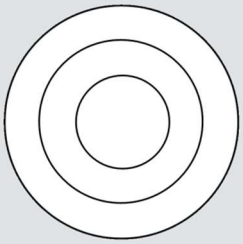
2. **Why did Mendeleev leave gaps in his periodic table?**

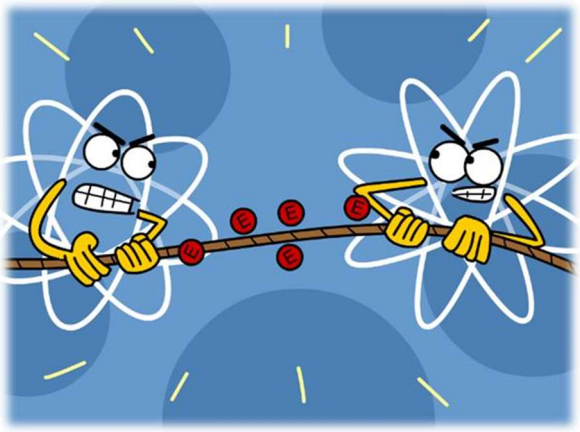
3.

4.

Lesson 3: Introduction to Chemical Bonding

Date: ___ / ___ / ___

Na	Mg	O	Cl
p =	p =	p =	p =
n =	n =	n =	n =
e =	e =	e =	e =
			
Electron Structure:	Electron Structure:	Electron Structure:	Electron Structure:



Recognising Types of Chemical Bond

1. Why do atoms react to form chemical bonds?

   ……

   ……

2. Do these atoms need to gain or lose electrons to have a full outer shell?

Atom	Gain? Lose? How Many?
Sulfur (S)	
Xenon (Xe)	
Rubidium (Rb)	
Bromine (Br)	

Atom	Gain? Lose? How Many?
Boron (B)	
Caesium (Cs)	
Phosphorus (P)	
Fluorine (F)	

3. Complete this table by naming the elements/compounds, deducing their formulas and predicting their bonding.

Name	Formula	Type of Bonding
Sodium Metal	$Na_{(s)}$	
Lithium Chloride		
	CO_2	
	Fe_2O_3	
Water		
Graphite (Pencil lead)	C(s)	
	$ZnCl_2$	
	SO_3	
	NaO	
	F_2	

Name	Formula	Type of Bonding
	$PbBr_2$	
Magnesium Oxide		
Diamond	$C_{(s)}$	
Gold		
	Cl_2	
Argon gas		
	O_2	
	SF_6	
	Na_2CO_3	
	KNO_3	

4. Match the types of bonding with their descriptions.

Metallic Bonding	‘Electron exchange’
Covalent Bonding	Two metal atoms bonding
Ionic Bonding	Two non-metals bonding
	‘Electron sharing’
	A metal and a non-metal bonding
	‘Ions in a sea of electrons’

5. Think about how many electrons each of the atoms in the box ‘want’ to lose or gain. Write as many combinations as you can that would be stable (have full outer shells). An example has been done for you.

Fluorine Chlorine Lithium Iodine Oxygen Magnesium Hydrogen Aluminium

Atom 1	**Needs to lose/gain …. electrons**	**Atom 2**	**Needs to lose/gain …. electrons**	**Compound Name**	**Compound Formula**
Lithium	*Lose 1*	*Fluorine*	*Gain 1*	*Lithium Fluoride*	*LiF*

Retrieval Practice – What can you remember?

1. **What is the difference between an ionic and a covalent bond?**

2. **What type of chemical bond would NaCl have? How do you know?**

3.

4.

Lesson 4: Metals, Alloys and Metallic Bonding Date: ___ / ___ / ___

1. Fill in the names of the common properties of a metal from their descriptions

Description	Property
Can transfer electrical energy easily	
Can be shaped without breaking	
Can take a large force without damage	
Can be drawn into wires	
Makes a ringing sound when struck	
Can transfer heat energy easily	
Changes state from solid to liquid at a high temperature	
Solid and rigid	

2. Fill in the blanks to describe metallic bonding. Then, draw a diagram using the description to help you.

Metallic bonding is sometimes described as 'metal …….. in a sea of ……..'.

A solid metal is a …….. of …….. metal ions.

Normally the positive …….. ions would …….. because they have the same …….. .

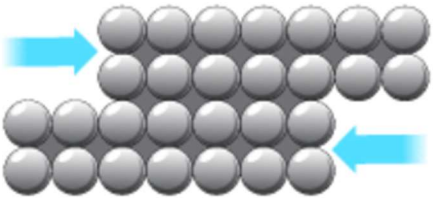
The positive metal ions are held together by a strong …….. attraction to the electrons.

The …….. are free to move in a metallic bond.

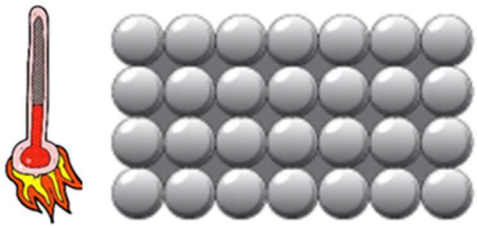
Charge Lattice Electrons (x2) Ions Repel Metal Electrostatic Positive

Explaining the properties of metals

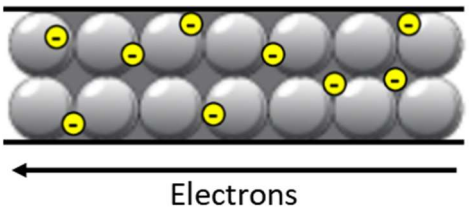
Malleable



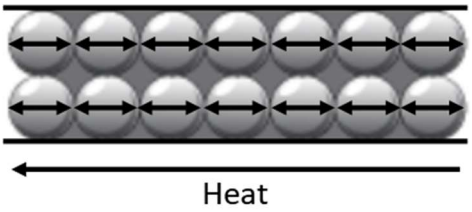
High Melting Point



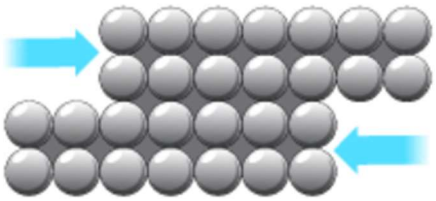
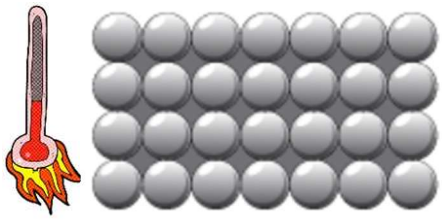
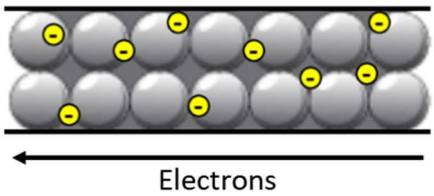
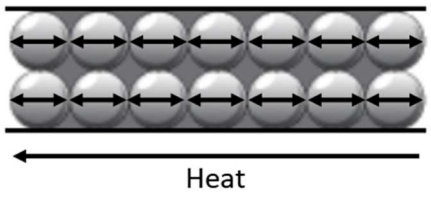
Conducts Electricity



Conducts Heat



3. The structure of metals (metallic bonds) can explain their properties. Which properties are these diagrams showing? Explain how the structure leads to these properties.

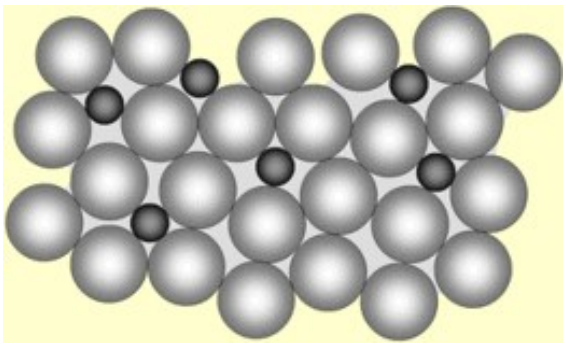
Diagram	Property	Explanation
	…… …… ……	…… …… …… …… …… (Use these words: lattice, easily, electrons, move)
	…… …… ……	…… …… …… …… …… (Use these words: melting, high, electrostatic, energy)
	…… …… ……	…… …… …… …… …… (Use these words: electrons, move, charge, conductor)
	…… …… ……	…… …… …… …… …… (Use these words: strong, electrostatic, vibration, easily)

4. What is an alloy?

……

……

5. Using the diagram to help you, explain why an alloy is likely to be harder than a pure metal.



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6. Using the data in the table, answer the questions below.

	Al	**Ti**	**Pb**	**Cu**	**Fe**
Density (g/cm^3)	2.7	4.5	11.3	8.9	7.9
Electrical Conductivity (siemens/m)	0.382	0.024	0.046	0.593	0.100
Tensile Strength (MPa)	50 - 110	230	15	220 - 430	210

a. Which would be the better material for overhead electricity cables – aluminium or titanium? Give reasons for your choice.

……

……

……

……

b. Explain why lead is not used for overhead electricity cables.

……

……

c. Use the data to suggest why aluminium and titanium are used to make aeroplanes.

……

……

……

……

Retrieval Practice – What can you remember?

1. **How do we describe the bonding in a lump of metal?**

2. **Pick a property of a metal and explain why metals have that property?**

3.

4.

Lesson 5: Properties of Metals and Group 1 Date: ___ / ___ / ___

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									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	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

Lithium

Sodium

Potassium

	Reactivity	Hardness	Melting Point
7 **Li** lithium 3 23 **Na** sodium 11 39 **K** potassium 19 85 **Rb** rubidium 37 133 **Cs** caesium 55 [223] **Fr** francium 87	↓	↓	↓

Retrieval Practice – What can you remember?

1. **What is an alloy?**
2. **Why do metals have a high melting point?**
3.
4.

Lesson 6: Ionic Bonding – The Basics

Date: ___ / ___ / ___

What is an ionic compound?

What is an ion again?

How do I work out the charge on an ion?

Which ions do I have to memorise?

Name	Formula
Hydrogen ion	H^+
Sodium ion	Na^+
Magnesium ion	Mg^{2+}
Aluminium ion	Al^{3+}
Copper ion	Cu^{2+}

Name	Formula
Chlor***ide***	Cl^-
Hydroxide	OH^-
Nitrate	NO^{3-}
Sulfate	SO_4^{2-}
Oxide	O^{2-}

What is an ionic bond?

How do I work out which ions are in an ionic compound?

An ionic bond is a strong ……. attraction between ……. charged metal ions and ……. charged non-metal ions.

To form an ionic bond, a metal atom ……. electrons to a non-metal atom to give both a ……. ……. ……. of electrons.

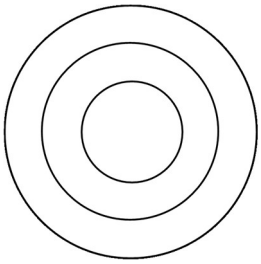
positively	negatively	full	electrostatic	shell	transfers	outer

How do I draw an ionic bond?

We will use Lithium Chloride (LiCl) as an example.

Step 1: Think about the electron configuration of the metal and non-metal.

Lithium



p = ……

n = ……

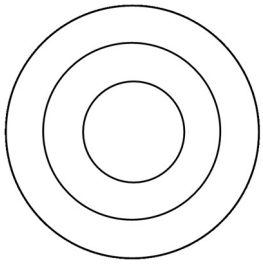
e = ……

Number of electrons to lose/gain to get a full outer shell:

Electronic Structure:

……. ……..

Chlorine



p = ……

n = ……

e = ……

Number of electrons to lose/gain to get a full outer shell:

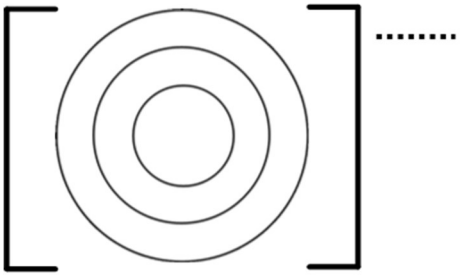
Electronic Structure:

……. ……..

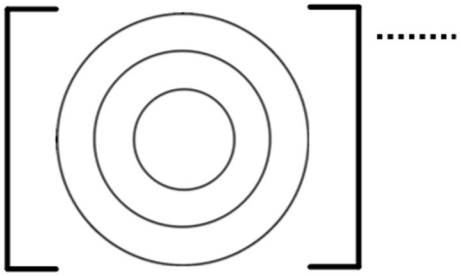
Step 2: Check the number of electrons the **metal needs to lose** is the **same** as the amount the **non-metal needs to gain**.

Atom	Lose or gain electrons?	How many electrons?
Lithium		
Chlorine		

Step 3: Draw the two ions. Make sure you show the **electrons** that have been **transferred** (use dots and crosses) and the **charges** on the ions.



Li^+



Cl^-

1. Use the method to draw the ionic bonding in these ionic compounds.

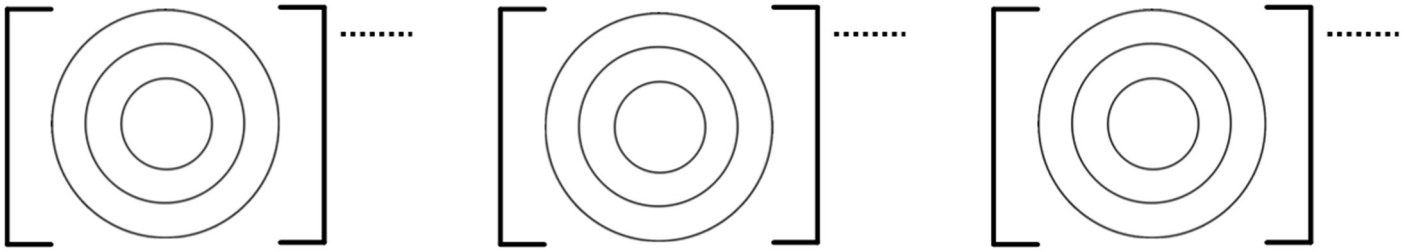
a. Sodium Chloride (NaCl)

b. Magnesium Oxide (MgO)

c. Beryllium Oxide (BeO)

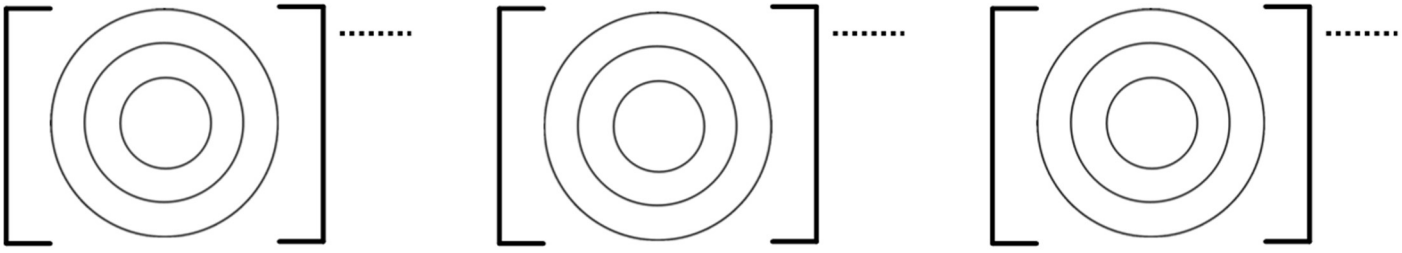
2. Sometimes the number of electrons that the metal needs to lose will not be enough for the non-metal to gain a full outer shell. If this happens, use two metal ions!

   Draw the ionic bonding in Lithium Oxide. (HINT: there is a template to help you)



3. Sometimes the number of electrons that the metal needs to lose will be too many for the non-metal to gain a full outer shell. If this happens, use two non-metal ions!

   Draw the ionic bonding in Beryllium Chloride. (HINT: there is a template to help you)



Ionic Bond Diagrams Drilling

1. Draw ionic bond diagrams for the following compounds. (**HINT:** You only need to show the outer shells)

a. Sodium Fluoride

b. Magnesium Chloride

c. Potassium Fluoride

d. Potassium Oxide

e. Magnesium Iodide

f. Lithium Bromide

g. Aluminium Oxide

h. Aluminium Fluoride

i. Beryllium Fluoride

j. Potassium Bromide

k. Sodium Iodide

Retrieval Practice – What can you remember?

1. **Underneath this box draw a diagram of the ionic bonding between sodium and chlorine in sodium chloride**

2. **Underneath this box draw a diagram of the ionic bonding in lithium oxide**

3.

4.

Lesson 7: Properties of Ionic Compounds Date: ___ / ___ / ___

What does the structure of an ionic compound look like?

Practical – Testing the properties of compounds

Why are we doing this?

This experiment demonstrates some of the properties of an ionic compound (sodium chloride) and a covalent compound (candle wax).

You should consider what your lab results mean for the properties of ionic compounds.

Equipment

Candle wax

Sodium chloride

Distilled water

Bunsen burner

Tripod

Heatproof mat

Tongs

Power pack, wires and crocodile clips

Carbon electrodes

9v bulb

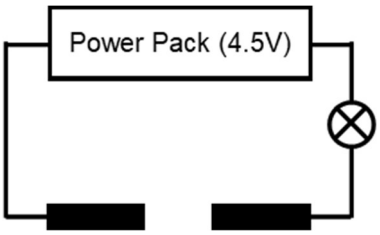
2 x 100 cm^3 beakers

Method

Testing melting point

1. Take a spatula of the compound you are testing and put into a crucible.
2. Heat the crucible over a Bunsen burner for 30 seconds – **DO NOT** overheat the compounds as they may 'spit' or catch fire.
3. Does the compound melt?
4. Take the crucible off the heat using a pair of tongs and let it cool on a heatproof mat – it will be **VERY HOT!!**

Testing conductivity



1. Connect a circuit as shown in the diagram to the right.
2. Turn the power pack to 4.5 volts.
3. Place the electrodes in a beaker containing your solid compounds.
4. Does the bulb light up? Does the compound conduct while solid?

Testing solubility in water

1. Put a spatula of the compound into a 100 cm^3 beaker.
2. Add around 20 cm^3 of distilled water.
3. Stir with the spatula.
4. Does the compound dissolve?
5. Use your equipment from the conductivity test to see if the 'solution' conducts electricity.

Compound	Melting point (low or high)	Conduct electricity while solid?	Soluble in water?	Conduct electricity while dissolved?
Sodium chloride				
Candle wax				

Why do ionic compounds have high melting points?

Why do ionic compounds only conduct electricity when molten or dissolved?

Why do ionic compounds dissolve in water?

1. Sodium Chloride ("table salt") is a very common ionic compound.

   Sodium ions are **0.00000000116 m** (1.16×10^{-9} m) in diameter and chloride ions are **0.00000000167 m** (1.67×10^{-9} m) in diameter.

a. How is it possible that you can "see" sodium chloride when you sprinkle it on food? (HINT: Think about the structure of sodium chloride)

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b. **Suggest**, using your knowledge of atoms and ions, why the chloride ion is bigger in diameter than the sodium ion.

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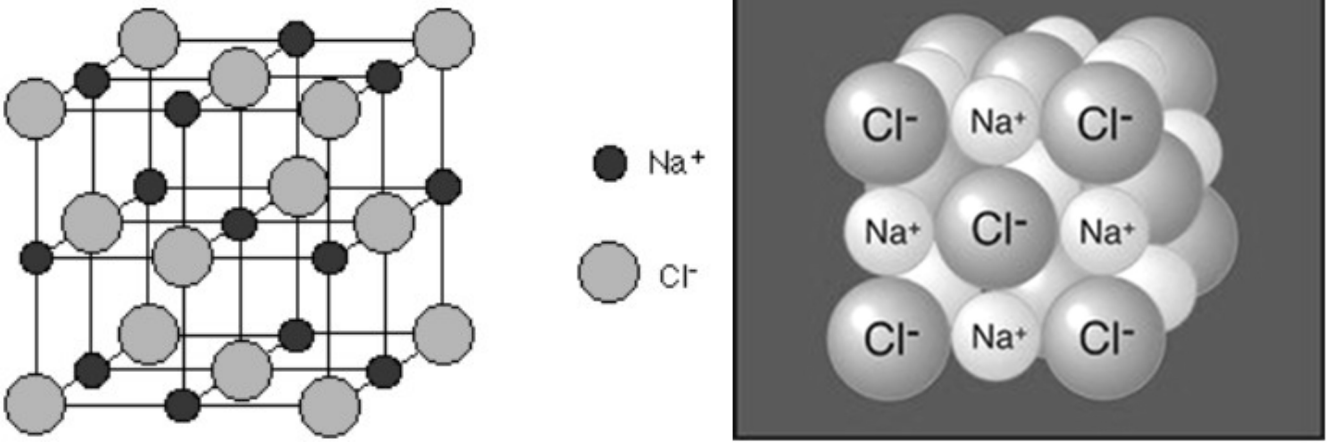
2. Below are 2 "models" representing the compound sodium chloride (known as a crystal lattice).

   Look at them closely.



a. **Suggest** which is the most accurate, in your opinion, and **explain** your answer

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b. Imagine the centre of one of these sodium chloride crystal lattices, how many chloride ions surround each sodium ion (or vice-versa)?

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c. Sodium chloride melts at a temperature of 801^{o}C. **Explain** what happens to the sodium chloride crystal lattice (and the ions in it) when it melts.

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d. **Explain** why the melting point of this lattice is so high (given that water melts at **0^{o}C** and carbon dioxide melts at a temperature of **-78^{o}C**)?

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e. Solid sodium chloride does **NOT** conduct electricity. Predict whether this property changes (*or not*) when you melt the sodium chloride. Explain your answer.

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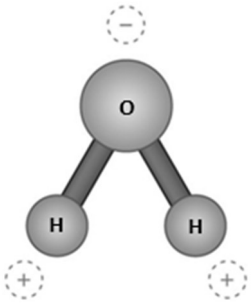
3. So, the sodium chloride crystal lattice is strong!

   Suggest how salt dissolves in water and why can't you see the salt anymore (when it's dissolved).

   HINT: It may help you to use a diagram in your answer and to bear in mind that water has a secret up its sleeve. See the diagram on the right.



Retrieval Practice – What can you remember?

1. **Why do ionic compounds have high melting points?**

2. **Why do ionic compounds not conduct electricity when they are solid?**

3.

4.

Lesson 8: Electrolysis Date: ___ / ___ / ___

What is electrolysis?

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What do we need for electrolysis to work?

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What STATE must the compound be in? Why?

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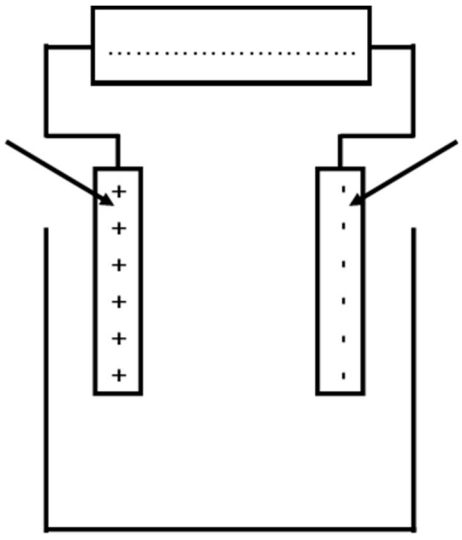
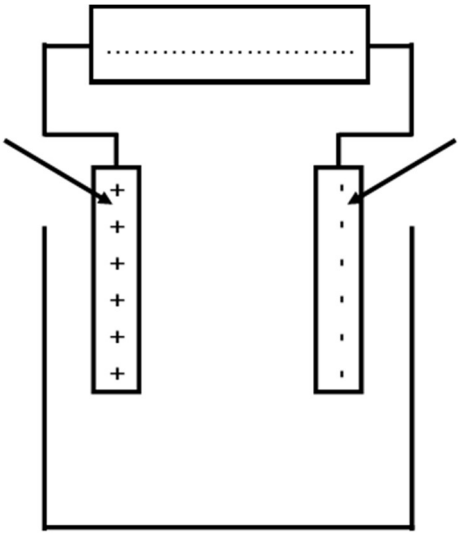


Fill in the diagram AND predict what will be made at the anode and cathode in these examples:

1. Molten lithium chloride



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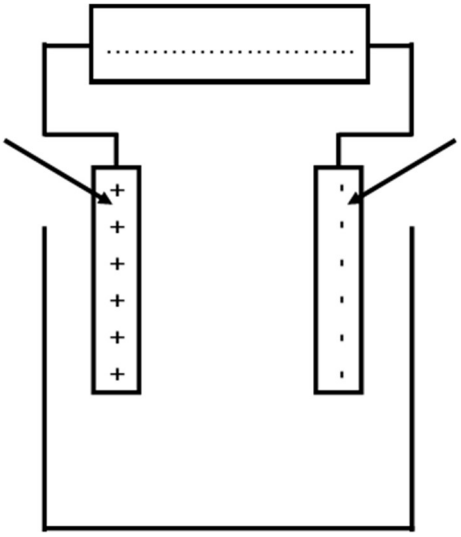
2. Molten zinc bromide ($ZnBr_2$)



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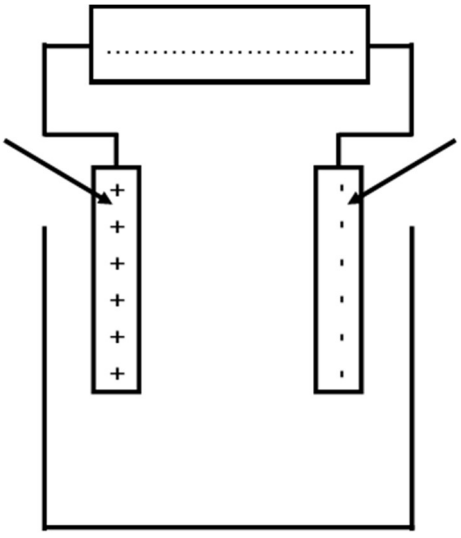
3. Molten copper oxide (CuO)



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