# Reactivity series of metals: supporting resources

This resource supports the practical video Reactivity series of metals, available here: <rsc.li/3baSTPO>

## Using the follow-up worksheets

Three follow-up worksheets are provided, one for each experiment in the video. These worksheets could be used to consolidate learning following the practical activity, for example as homework or a revision exercise.

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## **Follow-up worksheet: alkali metals**

1. Group 1 metals react by losing an electron. The diagrams below show a lithium atom and a lithium ion. Complete the electron configuration diagrams for sodium and potassium atoms and ions.

**X X**

+

**X**

**X**

**X**

**Li (atom)**

**Electron configuration: 2,1**

**Li+ (ion)**

**2,0**

7

Li

Lithium

3

**Na (atom)**

**Na+ (ion)**

**Electron configuration:**

23

Na

Sodium

11

**K (atom)**

**K+ (ion)**

**Electron configuration:**

39

K

Potassium

19

Look at the electron diagrams that you have drawn and answer the following questions:

1. What do you notice about the electron configuration of the ions?
2. Why do the group 1 metals lose an electron when they react?
3. Is losing an electron, oxidation or reduction?
4. Use your answer to Q3 to identify whether the group 1 metals are good reducing agents or oxidising agents. Explain your answer.
5. How can you tell from the electron configuration that these atoms are in group 1?
6. By looking at the electron configuration how can you tell which period atoms are in?
7. Identify which period the following elements belong to:
	1. Lithium
	2. Sodium
	3. Potassium
8. As you go down group 1 what happens to the size of the atoms? How can you tell this?
9. From the video, which group 1 metal was the most reactive?
10. Use the information above and the diagrams you have drawn in Q1 to explain why potassium is the most reactive of these three alkali metals.
11. From the video, describe the pattern for how easy it was to cut the Li, Na and K.
12. Using your answer from Q12, describe the pattern in softness as you move down group 1. Make a prediction linking softness to melting point.

1. All three alkali metals, Li, Na, K float on water. What does this indicate about the density of these alkali metals compared to water?
2. The density of water = 1.0 g cm-3. The density of the alkali metals is as follows:

|  |  |
| --- | --- |
| **Element** | **Density g cm-3** |
| Lithium, Li | 0.534 |
| Sodium, Na | 0.971 |
| Potassium, K | 0.862 |
| Rubidium, Rb | 1.532 |
| Caesium, Cs | 1.873 |

Do all the alkali metals float on water? Explain your answer.

1. When a group 1 metal reacts with water a metal hydroxide is formed. This is an ionic compound containing two ions, a negative and a positive ion, in a giant lattice.

Which ions are in sodium hydroxide?

1. Draw a simple diagram to show how these ions are arranged in the giant lattice for the sodium hydroxide. You can use one circle for each type of ion.
2. Challenge: draw a dot and cross diagram for the hydroxide ion. You can draw outer shells only. Remember to include the charge on the ion.

## **Follow-up worksheet: alkali metals**

1. Group 1 metals react by losing an electron. The diagrams below show a lithium atom and a lithium ion. Complete the electron configuration diagrams for sodium and potassium atoms and ions.

**X X**

+

**X**

**X**

**X**

**Li (atom)**

**Electron configuration: 2,1**

**Li+ (ion)**

**2,0**

7

Li

3

**X**

**X X X**

**X X X**

+

**X X X X**

**X X X X**

**X X**

**X X X X**

**Na (atom)**

**Electron configuration: 2,8,1**

**Na+ (ion)**

**2,8**

23

Na

11

**X X**

**X**

+

**X X X**

**X X**

**X X X**

**XX XX**

**X X X X**

**XX XX**

**X X X X**

**X X**

**X X X X**

**X X X X**

**K (atom)**

**Electron configuration: 2,8,8,1**

**K+ (ion)**

**2,8,8**

39

K

19

Look at the electron diagrams that you have drawn and answer the following questions:

1. What do you notice about the electron configuration of the ions?

###### It is the electron configuration of a noble gas.

1. Why do the group 1 metals lose an electron when they react?

###### The atom then has a full outer shell of electrons.

1. Is losing an electron, oxidation or reduction

###### Oxidation is loss of an electron.

1. Use your answer to Q2 to identify whether the group 1 metals are good reducing agents or oxidising agents. Explain your answer.

###### The metal loses an electron which it can give to another atom. The group 1 metals are therefore good reducing agents.

1. How can you tell from the electron configuration (or the diagram with added electrons in), that these atoms are in group 1?

###### The atoms have one electron in their outer shell

1. By looking at the electron configuration, how can you tell which period the atoms are in?

###### The period corresponds to the number of shells that have electrons in.

1. Identify which period Li, Na and K are in.

###### Li – period 2 Na – period 3 K – period 4

1. As you go down group 1 what happens to the size of the atoms? How can you tell this?

###### The atoms get bigger. The atoms have more electrons filling more shells.

1. From the video which group 1 metal (Li, Na or K) was the most reactive.

###### Potassium

1. Use the information above and the diagrams you have drawn in Q1 to explain why potassium is the most reactive out of these three alkali metals.

###### The atoms get bigger as you go down the group, and there are more shells filled with electrons. These electrons layers shield the outer electron from the nucleus, so we say it has increased shielding. The outer electron is further from the nucleus so there is less attraction, and it is more easily removed.

1. From the video, describe the pattern for how easy it was to cut the Li, Na and K.

###### It was easier to cut each alkali metal as you went down the group (Li was the hardest to cut, K the easiest).

1. Using your answer from Q12, describe the pattern in softness as you move down group 1. Make a prediction linking softness to melting point.

###### The alkali metals get softer as you go down the group. The softer metals are easier to melt so melting point decreases down the group.

|  |  |
| --- | --- |
| **Element** | **Melting point °C** |
| **Lithium, Li** | **180** |
| **Sodium, Na** | **98** |
| **Potassium, K** | **63** |
| **Rubidium, Rb** | **39** |
| **Caesium, Cs** | **28** |

1. All three alkali metals, Li, Na, K float on water. What does this indicate about the density of these alkali metals?

###### The density of Li, Na and K must be less than the density of water.

1. The density of water = 1.0 g cm-3. The density of the alkali metals is as follows:

|  |  |
| --- | --- |
| **Element** | **Density g cm-3** |
| Lithium, Li | 0.534 |
| Sodium, Na | 0.971 |
| Potassium, K | 0.862 |
| Rubidium, Rb | 1.532 |
| Caesium, Cs | 1.873 |

Do all the alkali metals float on water? Explain your answer.

###### No, Rb and Cs have a density greater than 1 (water) and so they will sink.

1. When a group 1 metal reacts with water a metal hydroxide is formed. This is an ionic compound containing two ions, a negative and a positive ion, in a giant lattice.

Which ions are in sodium hydroxide?

###### Na+ (sodium ion) and OH- (hydroxide ion).

1. Draw a simple diagram to show how these ions are arranged in the giant lattice for the sodium hydroxide. You can use one circle for each type of ion.

###### The positive and negative ions are arranged alternatively in rows in a giant 3D lattice.

**Na+ OH- Na+**

**OH- Na+ OH-**

1. Challe**-**nge: dra**+**w a dot a**-**nd cross diagram for the hydroxide ion. You can draw outer shells only.

Remember to include the charge on the ion.

###  **–**

**XX**

**X**

**X**

**O**

**X**

**X**

**H**

## **Follow up worksheet: reactions of metals with acids**

1. What is the general equation for the reaction of a metal with an acid?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What type of reaction is this? (Circle all that are correct.)

displacement neutralisation redox decomposition

1. Match the acid to the salt produced.

hydrochloric acid nitrate salts

sulfuric acid chloride salts

nitric acid sulfate salts

1. Balance the following symbol equations for reactions of metals with acid:

\_\_\_\_Mg + \_\_\_\_\_HCl → \_\_\_\_\_MgCl2 + \_\_\_\_H2

\_\_\_\_Fe + \_\_\_\_\_HCl → \_\_\_\_\_FeCl2 + \_\_\_\_H2

\_\_\_\_Zn + \_\_\_\_\_H2SO4 → \_\_\_\_\_ZnSO4 + \_\_\_\_H2

\_\_\_\_Na + \_\_\_\_H2CO3 → \_\_\_\_\_Na2CO3 + \_\_\_\_H2\*

*Challenge 1*

\_\_\_\_Ca + \_\_\_\_HNO3 → \_\_\_\_\_Ca(NO3)2 + \_\_\_\_H2

\_\_\_\_Zr + \_\_\_\_H2SO4 → \_\_\_\_\_Zr(SO4)2 + \_\_\_\_H2\*\*

*Challenge 2*

\_\_\_\_Fe + \_\_\_\_HCl → \_\_\_\_\_FeCl3 + \_\_\_\_H2

\_\_\_\_Al + \_\_\_\_H2SO4 → \_\_\_\_\_Al2(SO4) + \_\_\_\_H2

\_\_\_\_Fe + \_\_\_\_HNO3 → \_\_\_\_\_Fe(NO3)3 + \_\_\_\_H2

**Fun trivia!**

**\*H2CO3 is carbonic acid. You don’t come across this acid very often at 14–16, but it follows the same general equation when reacting with a metal.**

**\*\*Zirconium does not readily react with sulfuric acid unless at very high temperatures and in a sealed container.**

1. Iron can react with hydrochloric acid to give iron(II) chloride or iron(III) chloride. What is the charge

on the iron(II) and iron(III) ions?

* 1. Iron(II):
	2. Iron(III):

## **Follow up worksheet: reactions of metals with acids ANSWERS**

1. What is the general equation for the reaction of a metal with an acid?

###### metal + acid → a salt + hydrogen

1. What type of reaction is this? (Circle all that are correct.)

displacement decomposition

**neutralisation**

**redox**

1. Match the acid to the salt produced.

hydrochloric acid nitrate salts

sulfuric acid chloride salts

nitric acid sulfate salts

1. Balance the following symbol equations for reactions of metals with acid:

 Mg + **2**

 Fe + **2**

 Zn +

\_ **2** \_ Na +

*Challenge 1*

 Ca + **2**

 Zr + **2**

*Challenge 2*

\_ **2** \_ Fe + **6**

\_ **2** \_ Al + **3**

\_ **2** \_ Fe + **6**

**Fun Trivia!**

HCl → MgCl2 + H2

HCl → FeCl2 + H2

H2SO4 → ZnSO4 + H2 *no balancing required*

H2CO3 → Na2CO3 + H2\*

HNO3 → Ca(NO3)2 + H2

H2SO4 → Zr(SO4)2 + **2** H2\*\*

HCl → **2** FeCl3 + **3** H2 H2SO4 → Al2(SO4) + **3** H2 HNO3 → **2** Fe(NO3)3 + **3** H2

**\*H2CO3 is carbonic acid. You don’t come across this acid very often at 14–16, but it follows the same general equation when reacting with a metal.**

**\*\*Zirconium does not readily react with sulfuric acid unless at very high temperatures and in a sealed container.**

1. Iron can react with hydrochloric acid to give iron(II) chloride or iron(III) chloride. What is the charge on the iron(II) and iron(III) ions?
	1. Iron(II): **Fe2+**
	2. Iron(III): **Fe3+**

## **Follow up worksheet: metal displacement reactions**

The following word equations show a reaction of metals with a metal salt. Using the reactivity series of metals decided whether or not a displacement reaction would occur.

If a reaction would occur then complete the word equation and balanced symbol equations.

1. magnesium + zinc chloride → +

Reaction?

✔ or ✘

 Mg + ZnCl2 → +

1. copper + zinc sulphate → +

 Cu + ZnSO4 → +

1. lithium + sodium chloride → +

 Li + NaCl → +

1. iron(III) + copper(II) sulfate → +

 Fe + CuSO4 → +

1. potassium + lithium nitrate → +

 K + LiNO3 → +

1. copper + gold(II) sulfate → +

 Cu + AuSO4 → +

1. zinc + iron(III) sulfate → +

 Zn + Fe2(SO4)3 → +

1. sodium + potassium nitrate → +

 Na + KNO3 → +

1. magnesium + iron(III) chloride → +

 Mg + FeCl3 → +

1. iron(III) + lead(II) sulfate → +

 Fe + PbSO4 → +

##

## **Follow up worksheet: metal displacement reactions ANSWERS**

The following word equations show a reaction of metals with a metal salt. Using the reactivity series of metals decided whether or not a displacement reaction would occur.

If a reaction would occur then complete the word equation and balanced symbol equations.

1. magnesium + zinc chloride → **magnesium chloride + zinc**

 Mg + ZnCl2 → **MgCl2 + Zn**

1. copper + zinc sulphate → +

 Cu + ZnSO4 → +

1. lithium + sodium chloride → +

Reaction?

✔ or ✘

✔

✘

✘

 Li + NaCl → +

1. iron(III) + copper(II) sulfate → **iron(II) sulfate + copper**

✔ ✔

 Fe + CuSO4 → **FeSO4 + Cu**

1. potassium + lithium nitrate → **potassium nitrate + lithium**

✔ ✔

 K + LiNO3 → **KNO3 + Li**

1. copper + gold(II) sulfate → **copper(II) sulfate + gold**

✔ ✔

 Cu + AuSO4 → **CuSO4 + Au**

1. zinc + iron(III) sulfate → **zinc sulfate + iron 3**Zn + Fe2(SO4)3 → **3ZnSO4 + 2Fe**

✔ ✔

1. sodium + potassium nitrate → +

✘

✘

 Na + KNO3 → +

1. magnesium + iron(III) chloride → **magnesium chloride + iron 3**Mg + **2**FeCl3 → **3MgCl2 + 2Fe**

✔ ✔✔

1. iron(III) + lead(II) sulfate → **iron(III) sulfate + lead 2**Fe + **3**PbSO4 → **Fe2(SO4)3 + 3Pb**

✔ ✔