

Lab 2

Reactivity Series

Activity Series

- Pages 99 – 108
- Pre-lab, Page 102
- Post lab, Page 108
- Complete all questions

Activity Series

- Aim of the lab
 - To become familiar with the reactivity of metals and their position in the periodic table

Types of Elements

- Metals
- Metalloids
- Non Metals

Metals

- Metals make up the majority of the periodic table.
- Their physical properties are:
 - Metallic luster
 - High melting points
 - Good electrical conductors
 - Malleable and ductile

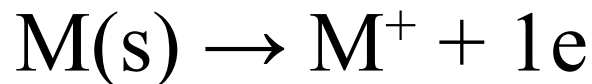
Metals

- Group 1: The alkali metals, are the most reactive
- They are the most reactive because they have one electron in their valence shell that on loss leave them with a full octet octet.
- They are the least electronegative elements (they are electropositive)

- Elements in the same group have similar properties.
- This is because they have the same valence electrons (outer electrons)
- Reactivity generally increases descending a group.

Metals as Reducing agents

- Metals are good reducing agents
- Reduction is gain of electrons and the metal provides the electrons.
- In doing so, it is oxidized itself.



Metalloids

- Metalloids have properties between that of metals and non-metals.
- They are found on the right hand side of the periodic table.
- They are generally good semiconductors.

Non metals

- These are found on the right hand side of the periodic table
- Many non metals are gases, for example, the halogens (group 17) and the noble gases (group 18).

Non metals

- These have high electron affinity and usually gain electrons in chemical reactions.
- This makes them good oxidizing agents (they accept electrons from another species and in the process are reduced themselves)



Types of Reactions

- Reactions with oxygen
- Reactions with water
- Reactions with acids
- Reactions with other metals

Reactions with Oxygen

- Oxygen is the most common oxidizing agent.
- Metal + oxygen \rightarrow Metal Oxide

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Oxidation is Loss, Reduction is Gain

Reactions with water

- Group 1 metals, the alkali metals, react vigorously with water releasing hydrogen gas.
- Other metals react very slowly with water.
- The product formed is the metal hydroxide.

Reactions with acids

- The reaction of metals with acid forms the corresponding metal anion salt:
 - Metal + HCl → Metal chloride
 - Metal + HNO₃ → Metal Nitrate

- The strength of an acid has to do with the percentage of the initial number of acid molecules that are ionized.
- If a higher percentage of the original acid molecules are ionized, and therefore, donated as hydrated protons (hydronium ions) then the acid will be stronger.
- Strong acids are HCl(aq) , HBr(aq) , HNO_3 , H_2SO_4 , and HClO_4 .
- In each of these molecular acids the percentage of ionization is almost 100%.

Nitric acid

- Nitric acid is a much more reactive acid than HCl.
- It is an oxidizing acid.
- In general oxidizing reactions occur favoring the formation of nitrogen dioxide (NO_2).
- $\text{Cu} + 4\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$

Reactions with Metals

- A more reactive metal will displace a less reactive metal from its complex.
- $2\text{Na(s)} + \text{Cu(NO}_3)_2 \rightarrow 2\text{NaNO}_3 + \text{Cu(s)}$
- In this case the sodium reduces the copper to copper metal.

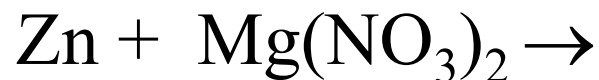
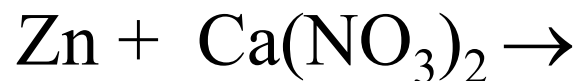
Experimental Procedure

- Reaction of metals with acid:
 - 6 metals: Ca, Cu, Fe, Mg, Sn and Zn
 - Add each metal to a 0.5M solution of HCl
 - Note your observations

Reactions of metals with metal complexes

- You will be provided with solutions of
 - $\text{Ca}(\text{NO}_3)_2$
 - FeSO_4
 - $\text{Fe}(\text{NO}_3)_2$
 - $\text{Mg}(\text{NO}_3)_2$
 - SnCl_4
 - $\text{Zn}(\text{NO}_3)_2$

- Taking each metal in turn you will add a small piece of metal to each of the solutions and observe the reactions.
- For example:



This is done for all metals

Place the metals in an activity series

- The most reactive metal is the one that reacts the most and the fastest.
- The least reactive metals are called the noble metals and include, silver, gold, platinum and palladium.
- Reactivity of metals increases descending a group and for transition elements (generally) decreases towards the right hand side of the periodic table.

Lab Precautions

- Care should be taken when using acids
- Discard waste solutions in appropriate containers