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.

$$M(s) \rightarrow M^{+} + 1e$$

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)

$$M + e \rightarrow M^-$$

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

OILRIG

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 $\rightarrow$ Metal chloride
  - Metal + HNO_3 $\rightarrow$ 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).
- $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

Reactions with Metals

- A more reactive metal will displace a less reactive metal from its complex.

- $2Na(s) + Cu(NO_3)_2 \rightarrow 2NaNO_3 + Cu(s)$

- 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
  - $Ca(NO_3)_2$
  - $FeSO_4$
  - $Fe(NO_3)_2$
  - $Mg(NO_3)_2$
  - $SnCl_4$
  - $Zn(NO_3)_2$

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

$Zn + Ca(NO_3)_2 \rightarrow$

$Zn + FeSO_4 \rightarrow$

$Zn + Mg(NO_3)_2 \rightarrow$

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