**Week 5:**

**Oxidation/Reduction Reactions**

**Introduction:**

**Oxidation/Reduction Reactions** :is the Reactions in which electrons are transferred from one reactant to another

**Example**

**Cu2+ + Zn (s) <====> Cu (s) + Zn2+**

**Oxidizing** **reagent :** A reagent which tends to remove electrons from

another reactant. its oxidation number becomes less positive after it

reacts.

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In the above reactant Cu2+ is the oxidizing agent. It has been reduced.

Cu2+ + 2e <=> Cu (s)

**Reducing agent:** A reagent which tends to give up electrons to another reactant. Its oxidation number becomes more positive after it reacts.

In the above reaction Zn is the reducing agent. It has been oxidized.

Zn (s) <=> Zn2++ 2e

**Examples of Oxidizing agents:**

1-. **KMnO4**  ,

Permanganate ion in the acidic medium is a very strong oxidizing agent

MnO4￣ + 8H+ + 5e- → Mn2+ + 4H2O

2**-. K2Cr2O7** in dil. H2SO4 is moderately strong oxidizing agent;

oxidizing ability depends strongly on pH, decreasing rapidly as solution becomes more neutral

Cr2O72– + 14H+ + 6e– → 2Cr3+ + 7 H2O

3-. **Iodine solution**

I2 + +2 e- 2I–

**Type of Redox Indicators:**

**Self Indicators**: the titrant itself may be so strongly coloured that after the

equivalence point, a single drop of the titrant produces an intense colour in the reaction. e.g. potassium permanganate

Such Indicators are called self indicators.

**starch indicator**: this indicator is used for titration involving iodine.

**Redox indicators:** such as Diphenylamine

**Titration of Oxalic acid (H2C2O4) by Potassium permanaganate**

Oxalic acid and Potassium permanaganate react in an acid medium according to the following half-cell reactions:

C2O42- → 2CO2 + 2e- (oxidation half-cell) (1)

8H+ + MnO4- + 5e- → Mn2+ + 4H2O (reduction half-cell) (2)

The two half-cell reactions are combined to obtain the complete redox reaction:

5C2O42- + 16 H + + 2MnO4- → 10CO2 + 2Mn2+ + 8H2O (3)

From this balanced equation, you can see that there is a 5:2 stoichiometric ratio between the moles of oxalate and the moles of permanganate.

**pH dependence of oxidizing behavior**

It is important to note that for many oxidants the pH of the medium is of great importance and hence their oxidizing strength may vary depending on the medium in which its reaction is studied. For example potassium permanganate is oxidizing agent in all three mediums, acid, alkaline and neutral. However it is strongest

in acidic medium.

a. **Strongly alkaline medium**

MnO4￣ + e- → MnO42-

Permanganate ion Manganate ion

b. **Neutral medium**

MnO4￣ + 2H2O + 3e-- → MnO2↓ + 4OH-

Manganese dioxide ppt.

c. **Acidic medium**

MnO4￣ + 8H+ + 5e- → Mn2+ + 4H2O

**Procedure**

1-pipette a 10 ml of H2C2O4 to the conical flask.

2- Add10 ml of H2SO4 acid

3- Heat the solution to 60-90оC to speed the reaction.

4- Titrate the hot solution till reach the end point (pink color of the KMnO4)

5- Calculate the concentration of the Oxalic acid.

**Titration of FeSO4.(NH4)2SO4.6H2O. sample by Potassium dichromate solution.**

Potassium dichromate (K2Cr2O7)is a very strong oxidizing agent . However it is not as strong oxidizing agent as permanganate is. Potassium dichromate acts as oxidizing agent in acidic medium only.

**it can’t be used as a self indicator like KMnO4**. this is because its reduction product (**Cr3+**) is green whichhinders in the visual detection of end point by observing dichromate colour. Thus an indicator is must in this titration.

**Mohr’s Salt**

The reducing agent used in this titration is **Mohr’s salt** which is a double salt. Its

composition is **FeSO4.(NH4)2SO4.6H2O.** the redox active species in this compound is Fe2+ whose oxidation can be represented as:

**Fe2+ → Fe3+ + e-**

**The reaction:**

**K2Cr2O7 + 6FeSO4 + 7H2SO4 → K2SO4 + Cr2(SO4)3 + 3Fe2(SO4)3+ 7H2O**

In ionic form the reaction can be written as

**Cr2O72- + 6Fe2+ + 14 H+ → 2 Cr3+ + 6Fe3++ 7H2O**

Orange green

This redox reaction can be split apart in two parts- one showing the oxidation and the

other reduction

**Cr2O72-+ 6e￣ + 14H+ = 2 Cr3+ + 7H2O reduction**

+ VI +III (Oxidation number has decreased)

**6 Fe2+ → 6 Fe3+ + 6 e- oxidation**

+II +III (Oxidation number has increased)

The end point of the titration as indicated earlier has to be defined with the help of an

indicator.

**Diphenylamine** is use as redox indicator

The end point is marked with an intense blue violet color.

**Procedure:**

1-Pipette 10 ml of FeSO4.(NH4) 2SO4.6H2O to the conical flask.

2-Add 10 ml of H2SO4(2M) ,5 ml of Phosphoric acid and 1ml of Diphenyl Amine

indicator.

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3- Titrate the solution by standard solution of K2Cr2O7 till reach the end point (dark blue).

4- Calculate the concentration of the FeSO4.(NH4) 2SO4.6H2O sample.