

Ministry of Higher Education and  
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وزارة التعليم العالي والبحث العلمي

جامعة المثنى

كلية العلوم

قسم الكيمياء

# Electrochemistry

Lecture (12)

Stage 3

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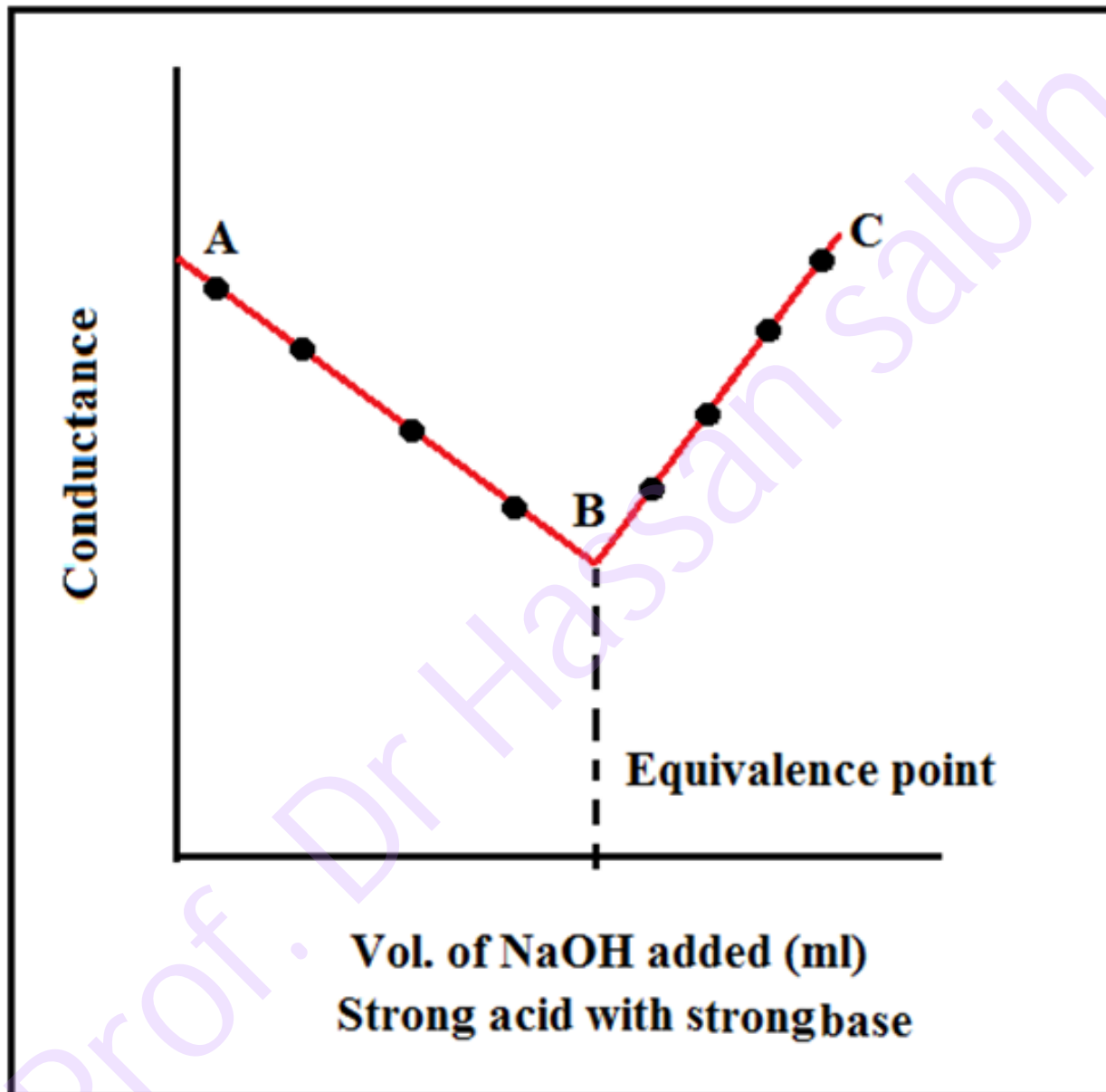
## Conductometric titration

### A. Conductometric titration of strong acid with strong base

Suppose a solution of HCl is to be titrated against NaOH solution. For this purpose, the acid solution is taken in a beaker and the NaOH solution in the burette. The conductance of the acid solution is noted initially as well as after successive additions of small amount of NaOH solution. Evidently, **the conductance of the acid solution in the beginning is very high because it contains highly mobile H<sup>+</sup> ions ( HCl → H<sup>+</sup> + Cl<sup>-</sup> )**. As NaOH solution is added to the HCl solution, the H<sup>+</sup> ions are replaced by the slow moving Na<sup>+</sup> ions and hence the conductance of the solution after all the H<sup>+</sup> ions are replaced by Na<sup>+</sup> ions decreases.

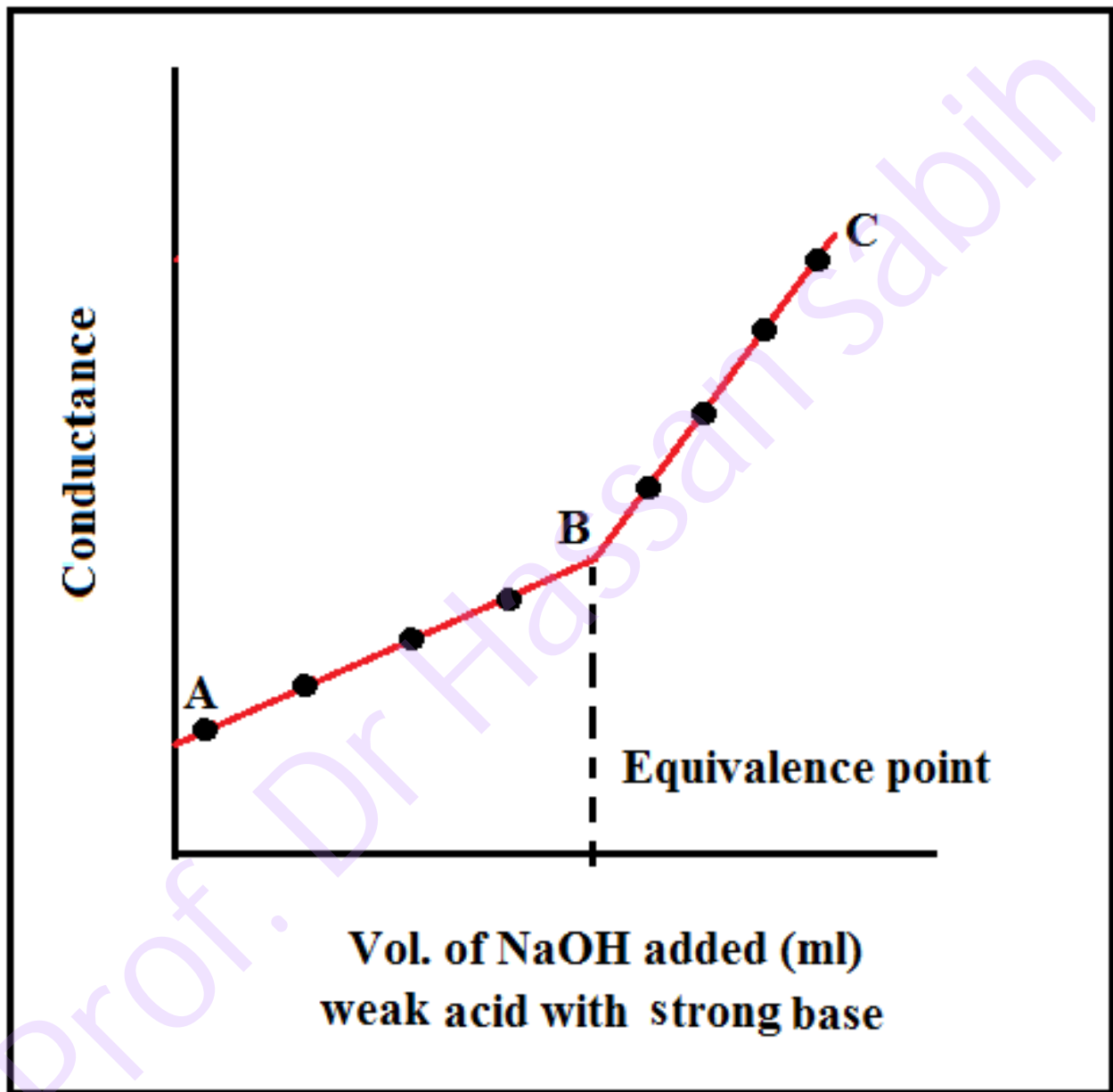


**After the end point**, further addition of NaOH solution brings in fast moving  $\text{OH}^-$  ions and hence the conductance of the solution again starts increasing. If conductance values are plotted against the volume of the alkali added, a curve of type ABC is obtained as shown fig below. Point of intersection (point B) corresponds to the end point.



## B. Conductometric titration weak acid with strong base

Suppose a weak acid like acetic acid is titrated against a strong base like NaOH. **The conductance of the acid initially is very low because of low ionization of the acid.** However as NaOH solution is added more and more to the acid solution, the salt produced ( $\text{CH}_3\text{COONa}$ ).  $\text{CH}_3\text{COONa}$  is highly ionized and hence the conductance keeps on increasing along the line AB as shown in figure below. **When the whole of acetic acid has been neutralized, further addition of NaOH solution causes the conductance to increase sharply along the line BC because the NaOH added introduces the fast moving  $\text{OH}^-$  ions.** Intersection of the two lines AB and BC, at the point B gives the equivalent point.

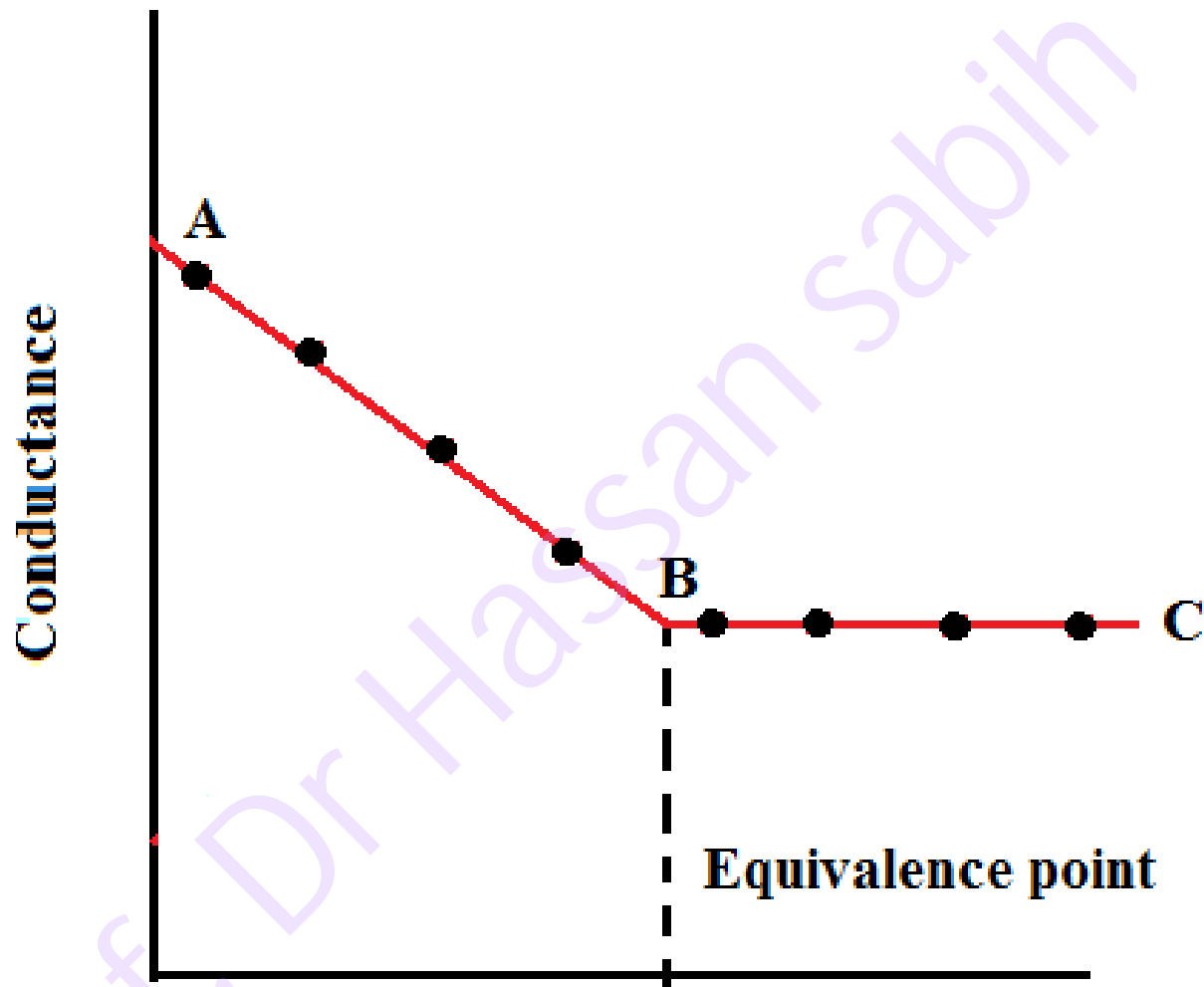


## C. Conductometric titration strong acid with weak base

Titration strong acid with a weak base let us consider the titration of HCl against  $\text{NH}_4\text{OH}$  solution. **The conductance of HCl solution is initially high because of the presence of the fast moving  $\text{H}^+$  ions.** As  $\text{NH}_4\text{OH}$  solution is added, the fast moving  $\text{H}^+$  ions are replaced by the slower  $\text{NH}_4^+$  ions and hence the conductance falls along the line AB.



**When the end point is passed,** further addition of  $\text{NH}_4\text{OH}$  does not cause much change in the conductance **because  $\text{NH}_4\text{OH}$  is a weakly ionized substance.** The line BC is thus almost horizontal (figure below).



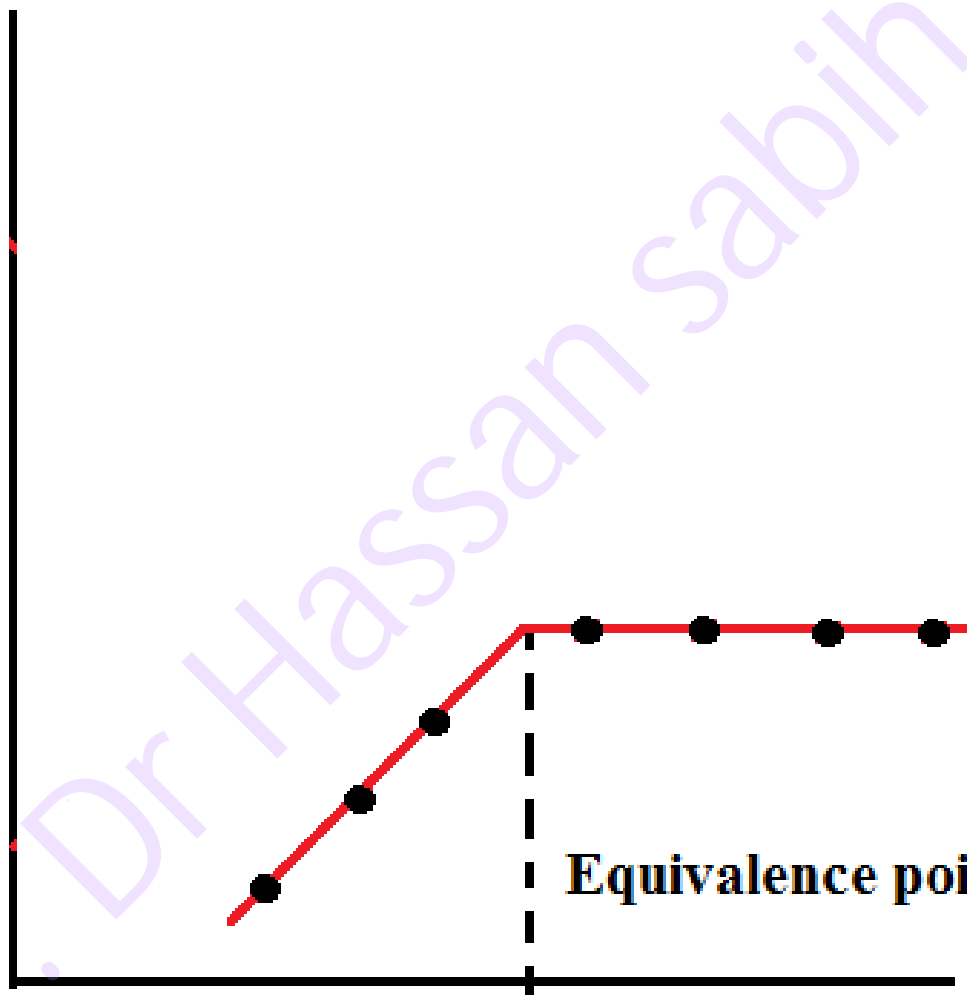
**Vol. of NaOH added (ml)**  
**strong acid with weak base**



## D. Conductometric titration weak acid with weak base

Conductometric titration are particularly valuable as we do not get sharp end points with indicators. Consider the titration of acetic acid with ammonium hydroxide. Initially, the conductance of the solution is low due to poor dissociation of acetic acid. As the base is added to it, the conductance starts picking up due to the formation of ionizable ammonium acetate. After the neutralization point, conductance remains almost constant, because the free base  $\text{NH}_4\text{OH}$  is a weak electrolyte. This is illustrated in the figure below.

**Conductance**



**Equivalence point**

**Vol. of NaOH added (ml)  
weak acid with weak base**

## **Advantages of conductometric titration**

- 1. These titrations can be used for colored solution where ordinary indicators fail.**
- 2. As the end point in these titrations is the intersection of two lines, no extra care is needed near the end point.**
- 3. These can be used for the titration of mixture of weak and strong acids. These can be used for the titration of even very dilute solutions.**