

# Engineering Chemistry – Unit 5 Premium Notes

## Phase Equilibrium and Corrosion

### RGPV Engineering Chemistry Notes

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## Unit Overview

This unit is very important in Engineering Chemistry because questions related to:

- Phase Rule
- Water Phase Diagram
- Eutectic System
- Corrosion
- Corrosion Prevention

are repeatedly asked in RGPV examinations.

This unit is scoring because:

- Diagrams are frequently asked
  - Definitions are direct
  - Theory questions are repeated
  - Corrosion mechanisms are important for long answers
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## Phase Equilibrium

### Definition

Phase equilibrium is the study of balance between different phases of a system under equilibrium conditions.

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# Important Terms

## 1. Phase

### Definition

A homogeneous and physically distinct part of a system is called a phase.

### Examples

- Ice
- Water
- Steam

These are different phases of water.

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## 2. Component

### Definition

Minimum number of chemically independent substances required to define a system.

Example:

For water system:

Component = 1

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## 3. Degree of Freedom

### Definition

Number of independent variables like temperature and pressure that can be changed without disturbing equilibrium.

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# Phase Diagram of Water System

## Water as One Component System

Water exists in three phases:

- Ice (solid)
  - Water (liquid)
  - Steam (vapour)
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## Important Curves in Water Phase Diagram

### 1. Fusion Curve

Represents equilibrium between:

- Ice and Water
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### 2. Vaporization Curve

Represents equilibrium between:

- Water and Steam
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### 3. Sublimation Curve

Represents equilibrium between:

- Ice and Steam
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## Triple Point

### Definition

Point at which all three phases coexist in equilibrium.

For water:

- Temperature = 0.0075°C
  - Pressure = 4.58 mm Hg
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## Critical Point

### Definition

Point above which liquid and vapour phases become identical.

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## Important Features of Water System

- One component system
  - Three phases present
  - Triple point important
  - Follows phase rule
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## Binary Eutectic System (Cu-Ag System)

### Definition

A binary eutectic system contains two components and forms eutectic mixture.

Example:

Copper-Silver system.

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## Eutectic Point

### Definition

Lowest temperature at which liquid mixture solidifies into two solid phases.

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# Characteristics of Eutectic System

- Two components present
  - Lowest melting point
  - Simultaneous solidification
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# Applications of Cu-Ag Eutectic System

- Alloys
  - Soldering materials
  - Electrical applications
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# Corrosion

## Definition

Gradual destruction of metal due to chemical or electrochemical reactions with environment is called corrosion.

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## Examples of Corrosion

- Rusting of iron
  - Tarnishing of silver
  - Green coating on copper
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## Types of Corrosion

Mainly two types:

1. Dry Corrosion
  2. Wet Corrosion
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# 1. Dry Corrosion

## Definition

Corrosion caused due to direct reaction of metal with gases in absence of moisture.

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## Characteristics

- Occurs at high temperature
  - Slow process
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## Example

Formation of oxide layer on metals.

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# 2. Wet Corrosion

## Definition

Corrosion occurring in presence of moisture or electrolyte.

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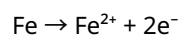
## Characteristics

- Electrochemical process
  - More common
  - Faster than dry corrosion
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## Mechanism of Rusting of Iron

### Step 1 → Oxidation

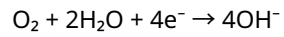
Iron loses electrons.



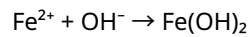
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## Step 2 → Reduction

Oxygen reacts with water.



## Step 3 → Formation of Rust



Further oxidation produces rust.

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## Factors Affecting Corrosion

- Presence of moisture
  - Temperature
  - Impurities
  - pH of medium
  - Presence of oxygen
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## Prevention of Corrosion

Main prevention methods are:

1. Protective Coating
  2. Galvanization
  3. Cathodic Protection
  4. Alloy Formation
  5. Painting
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### 1. Protective Coating

Metal surface is coated to prevent contact with environment.

Examples:

- Paint

- Grease
  - Oil
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## 2. Galvanization

### Definition

Coating iron with zinc.

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### Advantages

- Prevents rusting
  - Increases life of metal
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## 3. Cathodic Protection

### Definition

Metal is protected by making it cathode.

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### Methods

- Sacrificial anode method
  - Impressed current method
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## 4. Alloy Formation

Corrosion resistant alloys are prepared.

Examples:

- Stainless steel
  - Brass
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# Numerical Concept – Degree of Freedom

## Formula

$$F = C - P + 2$$

Where:

- F = Degree of freedom
  - C = Number of components
  - P = Number of phases
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## Example

For water system at triple point:

$$C = 1 \quad P = 3$$

$$F = 1 - 3 + 2$$

$$F = 0$$

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## Final Answer

Degree of freedom at triple point = 0

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## Most Important 14 Marks Questions

1. Explain phase diagram of water system.
2. Explain Cu-Ag eutectic system.
3. Define phase, component and degree of freedom.
4. Explain dry and wet corrosion.
5. Explain electrochemical mechanism of rusting.
6. Explain factors affecting corrosion.
7. Explain methods of corrosion prevention.
8. Explain galvanization and cathodic protection.
9. Derive phase rule equation.
10. Numerical problems based on phase rule.

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