

Salts and Solubility

Spoken Tutorial Project

<https://spoken-tutorial.org>

National Mission on Education through ICT

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Learning Objectives



Learning Objectives

We will learn about,



Learning Objectives

We will learn about,

► **Solubility of different Salts**



Learning Objectives

We will learn about,

- ▶ Solubility of different Salts
- ▶ Create a neutral compound from anions and cations



Learning Objectives

We will learn about,

- ▶ Solubility of different Salts
- ▶ Create a neutral compound from anions and cations
- ▶ Equilibrium expression for dissolution of salt in water



Learning Objectives



Learning Objectives

- Calculate the molarity of solutions



Learning Objectives

- ▶ Calculate the molarity of solutions
- ▶ Calculate Solubility Product of the salts



Learning Objectives

- ▶ Calculate the molarity of solutions
- ▶ Calculate Solubility Product of the salts
- ▶ Application of Le Chaterlier's principle to the dissolution of salts



Learning Objectives



Learning Objectives

- ▶ **Design a salt with various combinations of charges and Solubility Products**



Learning Objectives

- ▶ **Design a salt with various combinations of charges and Solubility Products**
- ▶ **Use Solubility Product values to predict solubility**



System Requirement



System Requirement

Here I am using



System Requirement

Here I am using

► **Windows 11 (64 bit)**



System Requirement

Here I am using

- ▶ Windows 11 (64 bit)
- ▶ Java version 1.8



Prerequisites



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- ▶ Learner should be familiar with topics in high school science



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- ▶ Learner should be familiar with topics in high school science
- ▶ Please use the link below to access the tutorials on PhET Simulations
<https://spoken-tutorial.org>



PhET Simulations



PhET Simulations

- ▶ Please use the given link to download the PhET simulation
<https://phet.colorado.edu/en/simulations/soluble-salts>



Solubility Product Expression: Sodium Chloride



Solubility Product Expression: Sodium Chloride

- ▶ **Table salt is scientifically called Sodium Chloride**



Solubility Product Expression: Sodium Chloride

- ▶ Table salt is scientifically called Sodium Chloride
- ▶ It ionizes in water as sodium and chloride ions



Solubility Product Expression: Sodium Chloride



Solubility Product Expression: Sodium Chloride

- ▶ $NaCl_{(s)} \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)}$
- ▶ $[Na^+]: [Cl^-]$
- ▶ 1: 1
- ▶ $[Na^+] = S, [Cl^-] = S$
- ▶ $K_{sp} = [Na^+][Cl^-]$
- ▶ *Solubility Product* (K_{sp}) = $S \times S = S^2$



Solubility Product Expression: Sodium Chloride



Solubility Product Expression: Sodium Chloride

- ▶ **The smaller the Solubility Product, the lower the solubility**



Calculations: Molar Solubility



Calculations: Molar Solubility

Table 1.0

S. No	Name of the salt	Mol.Wt	No. of cations at saturation	No. of anions at saturation	Solubility in 100 mL	Solubility in moles/L
1	Sodium Chloride	58.44	180	180	35 gm	6 M



Calculations: Solubility Product of NaCl



Calculations: Solubility Product of NaCl

Table 1.1

S.No	Name of the salt	Solubility Product (K_{sp}) expression S is Solubility	Solubility in moles/L	Solubility Product (K_{sp})
1	Sodium Chloride	S^2	6	36



Calculations: Solubility Product of NaCl



Calculations: Solubility Product of NaCl

- ▶ Please refer to **Additional reading material** for details of calculations



Solubility Product Expression: Strontium Phosphate



Solubility Product Expression: Strontium Phosphate

- ▶ $Sr_3(PO_4)_2 \rightleftharpoons 3Sr_{(aq)}^{+2} + 2(PO_4)_{(aq)}^{-3}$
- ▶ $3[Sr^{+2}] : 2[PO_4^{-3}]$
- ▶ $3 : 2$
- ▶ $3[Sr^{+2}] = 3S^3, 2[PO_4^{-3}] = 2S^2$
- ▶ $K_{sp} = [Sr^{+2}][PO_4^{-3}]$
- ▶ $Solubility\ Product\ (K_{sp}) = 3S^3 \times 2S^2$
 $= 108S^5$



Solubility Product Expression: Strontium Phosphate



Solubility Product Expression: Strontium Phosphate

► The stoichiometry is 3:2



Solubility Product Expression: Strontium Phosphate

- ▶ The stoichiometry is 3:2
- ▶ Strontium phosphate molecule consists of:
3 atoms of strontium and 2 units of phosphate



Calculations: Molar Solubility



Calculations: Molar Solubility

Table 2.0

S.No	Name of the salt	Mol.Wt	No. of cations at saturation	No. of anions at saturation	Solubility in 100 mL	Solubility in moles/L
1	Sodium Chloride NaCl	58.44	180	180	35 gm	6 M
2	Strontium Phosphate $\text{Sr}_3(\text{PO}_4)_2$	452.8	45	30	1.13×10^{-5}	2.5×10^{-7}



Calculations: Solubility Product



Calculations: Solubility Product

Table 2.1

S.No	Name of the salt	Solubility Product (K_{sp}) expression S is Solubility	Solubility (S) in moles/L	Solubility Product (K_{sp})
1	Sodium Chloride	S^2	6	36
2	Strontium Phosphate $Sr_3(PO_4)_2$	$(3S)^3(2S)^2 = 108S^5$	2.5×10^{-7}	1×10^{-31}



Assignment I

- ▶ Add more water to the container and observe the dissolved and bound ions in water
- ▶ Check the solubility of the salts given in the salt drop-down on the right panel



Assignment II

- ▶ **Note the ratio of ions in each salt**
- ▶ **Note the number of ions at saturation for each salt**



Summary

We have learnt about,



Summary

We have learnt about,

- ▶ **Solubility of different Salts**
- ▶ **Create a neutral compound from anions and cations**
- ▶ **Equilibrium expression for dissolution of salt in water**



Summary

- ▶ **Calculated the molarity of solutions**
- ▶ **Calculated Solubility Product of salts**
- ▶ **Application of Le Chaterlier's principle to the dissolution of salts**



Summary

- ▶ Designed a salt with various combinations of charges and Solubility Products
- ▶ Use Solubility Product values to predict solubility



Assignment

As an assignment,

- ▶ **Explore more salts with various combinations of charges and Solubility Products**



Assignment

Table 2.2

S.No	Name of the salt	Solubility Product (K_{sp}) expression S is Solubility	Solubility (S) in moles/L	Solubility Product (K_{sp})
1	Silver Bromide			
2	Thalium(I) Sulfide			
3	Copper(I) Iodide			
4	Silver Arsenate			
5	Mercury(II) Bromide			



About the Spoken Tutorial Project

- ▶ Watch the video available at http://spoken-tutorial.org/What_is_a_Spoken_Tutorial
- ▶ It summarises the Spoken Tutorial project



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Spoken Tutorial Workshops

The Spoken Tutorial Project Team

- ▶ Conducts workshops using spoken tutorials
- ▶ Gives certificates to those who pass an online test
- ▶ For more details, please write to contact@spoken-tutorial.org



Answers for THIS Spoken Tutorial

- ▶ Questions in THIS Spoken Tutorial?
- ▶ Visit <https://forums.spoken-tutorial.org>
- ▶ Choose the minute and second where you have the question
- ▶ Explain your question briefly
- ▶ The Spoken Tutorial project will ensure an answer



Acknowledgements

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Thank you

- ▶ The script for this tutorial is contributed by Snehalatha Kaliappan from IIT Bombay
- ▶ This is Vidhi Thakur, a FOSSEE summer fellow 2022, IIT Bombay signing off

