LESSON:

THE INFLUENCE OF TEMPERATURE ON SOLUBILITY OF SOLID SUBSTANCES

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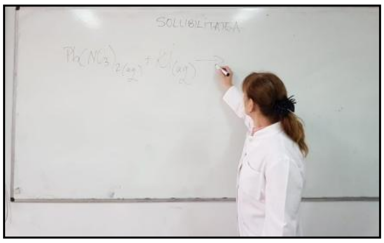
9^{th} grade (A and B)

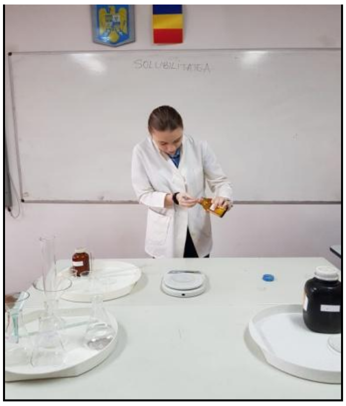


Solubility is the property of a chemical substance called "solute" to dissolve in a solvent. The solubility of a substance depends on the physical and chemical properties of the solute and solvent as well as on temperature, pressure and presence of other chemicals. The extent of the solubility of a substance in a specific solvent is measured as the saturation concentration, where adding more solute does not increase the concentration of the solution and begins to precipitate the excess amount of solute. The solubility of a substance is the amount of that substance that is required to form a saturated solution in a given amount of solvent at a specified temperature. Solubility is often measured as the grams of solute per 100 g of solvent.

Under certain conditions, the equilibrium solubility can be exceeded to give a so-called supersaturated solution. A supersaturated solution generally crystallizes when "seed" crystals are introduced and rapid equilibration occurs.

Solubility depends on the physical conditions: temperature, pressure and concentration. The most common solvent in chemistry is water.

The solubility of a given solute in a given solvent typically depends on *temperature*. Depending on the nature of the solute the solubility may increase or decrease with temperature. The solubility of the majority of solid substances increases as the temperature increases. In liquid water at high temperatures, the solubility of ionic solutes tends to decrease due to the change of properties and structure of liquid water.



THE INFLUENCE OF TEMPERATURE ON SOLUBILITY OF SOLID SUBSTANCES

WORKSHEET No. 1

EXPERIMENT: HOT ICE

1. Reagents and necessary tools: CH_3-COONa (sodium acetate), distilled water, scale, Berzelius glass, a spatula, a calibrated pipette, an asbestos strainer, a heating source, a thermometer, a watch glass and a match.

2. Steps:

- weigh 30g CH_3-COONa·3H_2O in a Berzelius glass;
- add with the calibrated pipette 10 ml distilled water over $CH_3COONa \cdot 3H_2O$ from the glass;
- heat the glass with the composition up to 90^0 C;
- cover up the glass containing the hot composition with a clock glass;
- wait until the mix gets cool up to 20^0 C;
- add carefully a crystal of $CH_3COONa \cdot 3H_2O$ in the cold solution;
- measure the temperature of the glass.

3. Observations:

- after adding the water……………………………………………………………………
- at 90^0C…………………………………………………………………………………
- after cooling………………………………………………………………………………
- when adding the crystal…………………………………………………………..

4. Conclusions:

- the solubility for CH_3-COONa·3H_2O at 20^0C is……………………………………..
- the solubility for CH_3-COONa·3H_2O at 90^0C is……………………………………..
- the solution obtained after cooling is a ………………………………………...solution
- the crystallization of CH_3-COONa·3H_2O takes place with……………………of heat.

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5. Uses: This solution CH_3-COONa·3H_2O can be use to make a portable heat source.

6. Problem: Knowing that solubility of CH_3-$COONa \cdot 3H_2O$ is 46.5g/100g H_2O determine the crystallized amount of CH_3-$COONa \cdot 3H_2O$ at 20^0C and the percent concentration of the solution at 90^0C.

THE INFLUENCE OF TEMPERATURE ON SOLUBILITY OF SOLID SUBSTANCES

WORKSHEET No. 1

EXPERIMENT: HOT ICE

1. Reagents and necessary tools: CH_3-COONa (sodium acetate), distilled water, scale, Berzelius glass, a spatula (stirring rod), a calibrated pipette, an asbestos strainer, a heating source, a thermometer, a watch glass and a match.

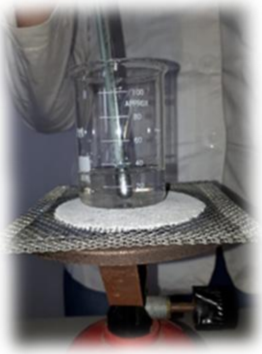
2. Steps:

- weigh 30g CH_3-$COONa{\cdot}3H_2O$ in a Berzelius glass;
- add with the calibrated pipette 10ml distilled water over $CH_3COONa{\cdot}3H_2O$ from the glass;
- heat the glass with the composition up to 90^0C;
- cover up the glass containing the hot composition with a clock glass;
- wait until the mix gets cool up to 20^0C;
- add carefully a crystal of $CH_3COONa{\cdot}3H_2O$ in the cold solution;
- measure the temperature of the glass.

3. Observations:

- after adding the water **only a part of $CH_3COONa{\cdot}3H_2O$ dissolves**

- at 90^0 C **all $CH_3COONa\cdot3H_2O$ dissolves and a water-clean solution is obtained**



- after cooling **the solution remains water-clean**

- when the crystal is added **mass crystallization is obtained and heat is released**

4. Conclusions:

- the solubility for CH_3-$COONa\cdot3H_2O$ at 20^0C is **smaller than 30g/10ml water**
- the solubility for CH_3-$COONa\cdot3H_2O$ at 90^0C is **bigger than 30g/10ml water**
- the solution obtained after cooling is a **supersaturated** solution
- the crystallization of CH_3-$COONa\cdot3H_2O$ takes place with **emission** of heat.

Solubility of sodium acetate increases with increasing temperature.

Solubility of solid substances rises with temperature growth.

5. Uses: This solution CH_3-$COONa \cdot 3H_2O$ can be use to make a portable heat source.

6. Problem: Knowing that solubility of CH_3-$COONa \cdot 3H_2O$ is 46.5g/100g H_2O determine the crystallized amount of CH_3-$COONa \cdot 3H_2O$at 20^0C and the percent concentration of the solution at 90^0C.

At 20^0 C 10 ml H_2O dissolves 4.65g CH_3-$COONa \cdot 3H_2O$

mCH_3-$COONa \cdot 3H_2O$ crystallized at 20^0 C = 30 – 4.65 = 25.35g

136g CH_3-$COONa \cdot 3H_2O$ .... 82g CH_3-COONa

30g CH_3-$COONa \cdot 3H_2O$.......................... xg CH_3-COONa

X = 18.088g CH_3-COONa

C % = 18.088 · 100 / 40 = 45.22%

THE INFLUENCE OF TEMPERATURE ON SOLUBILITY OF SOLID SUBSTANCES

WORKSHEET No.2

EXPERIMENT: GOLDEN RAIN

1. Reagents and necessary tools: $Pb(NO_3)_2$ (lead nitrate), KI (potassium iodide), distilled water, scale, 3 Erlenmeyer glasses, 2 clock glasses, an asbestos strainer, a thermometer, a spatula, a calibrated cylinder, a heating source, matches, a cone funnel, filter paper.

2. Steps:

- weigh 0.5g $Pb(NO_3)_2$ on a clock glass and dissolve it in 150ml distilled water in an Erlenmeyer glass;
- weigh 0.6g KI on a clock glass;
- dissolve it in 150ml distilled water in an Erlenmeyer glass;
- add carefully the $Pb(NO_3)_2$ solution over the KI solution;
- heat the glass with the obtained composition up to 90^0C;
- filter the hot mix;
- let it cool slowly.

3. Observations:

- when dissolving $Pb(NO_3)_2$ in water we obtain……………………………………………
- when dissolving KI in water we obtain…………………………………………………
- when adding the $Pb(NO_3)_2$solution over the KI we obtain……………………………..
- at 90^0C we obtain…………………………………………………………………….
- after about 15min of cooling we can notice………………………………………...
  ……………………………………………………………………………………..

4. Conclusions: $Pb(NO_3)_{2(aq)} + KI_{(aq)} \rightarrow$

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5. Uses: This reaction is used in the analytical chemistry to identify the I^-iodine anion.

6. Problem: Knowing that solubility of PbI_2 at 20^0C is 0.0756g/100g H_2O determine the mass of crystals at 20^0C.

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WORKSHEET No.2

EXPERIMENT: GOLDEN RAIN

1.Reagents and necessary tools: $Pb(NO_3)_2$ (lead nitrate), KI (potassium iodide), distilled water, scale, 3 Erlenmeyer glasses, 2 clock glasses, an asbestos strainer, a thermometer, a spatula, a calibrated cylinder, a heating source, matches, a cone funnel, filter paper.

2. Steps:

- weigh 0.5g $Pb(NO_3)_2$ on a clock glass;
- dissolve it in 150ml distilled water in an Erlenmeyer glass;
- weigh 0.6g KI on a clock glass;
- dissolve it in 150ml distilled water in an Erlenmeyer glass;
- add carefully the $Pb(NO_3)_2$ solution over the KI solution;
- heat the glass with the obtained composition up to 90^0C;
- filter the hot mix;
- let it cool slowly.

3. Observations:

- when dissolving $Pb(NO_3)_2$ in water we obtain **a water-clear solution**

- when dissolving KI in water we obtain **a water-clear solution**

- when adding the $Pb(NO_3)_2$ solution over the KI we obtain **a yellow precipitate**

- at 90^0C we obtain **a pale yellow solution**

- after about 15min of cooling we can notice **the formation of bright golden crystals falling to the bottom of the glass like "golden rain"**

4. Conclusions: $Pb(NO_3)_{2(aq)}$+ 2$KI_{(aq)}$ →$PbI_{2(s)}$ + 2$KNO_{3(aq)}$

PbI_2 is a poorly soluble salt, the solubility is low.

The solubility of lead iodine increases with the increasing of temperature

5. Uses: This reaction is used in the analytical chemistry to identify the I^- iodine anion.

6. Problem: Knowing that solubility of PbI_2 at 20^0C is 0.0756g/100g H_2O determine the mass of crystals at 20^0C.

Solution:

331g$Pb(NO_3)_2$..................................461g PbI_2

0.5g$Pb(NO_3)_2$..................................xg PbI_2

X = 0.696g PbI_2

La 20^0 C: 100g H_2O ....0.0756g PbI_2 dissolved

300g H_2O .... yg PbI_2 dissolved

Y= 0.2268g PbI_2 dissolved

$m_{criystalls}$ = 0.696 – 0.2268 = 0.4692g PbI_2 crystallized