16. Boiling Salt Solutions

The boiling temperature of aqueous salt solution is variable and may be higher than 100^oC. Formulate a problem requiring theoretical and experimental studies with chemical compositions of your choice.

Investigate the boiling point of aqueous salt solution for different salt concentrations and different group salts.

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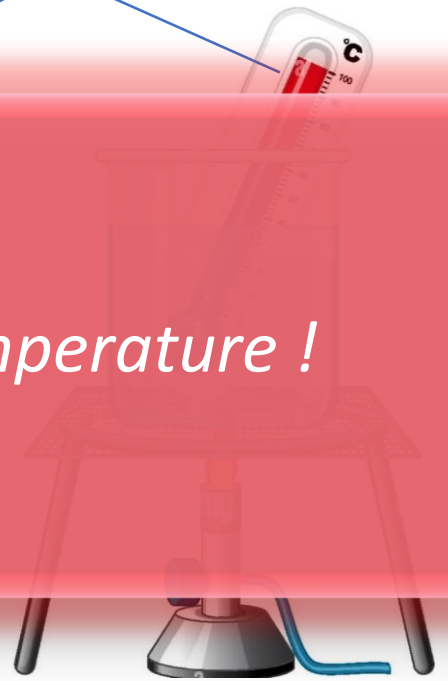
Plan

- Explanation of the phenomenon;
  - *What is the boiling point;*
  - *Why does the boiling temperature of an aqueous solution of salt increase;*
- Theoretical model;
  - *The formula for the change of boiling temperature;*
- Experiments;
  - *Experimental Setup;*
  - *Different types of salts;*
  - *Different concentrations of salts;*
- Comparison of theoretical and experimental results;
  - *Theoretical and experimental graphs;*
- Conclusion;
  - *Relevant parameters;*
  - *Analysis of results;*

Explanation of the phenomenon

Change in boiling temperature

$T_b > 100°C$

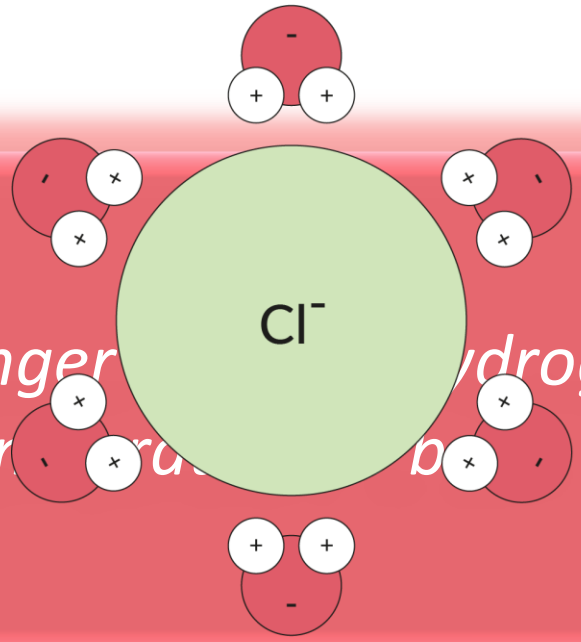


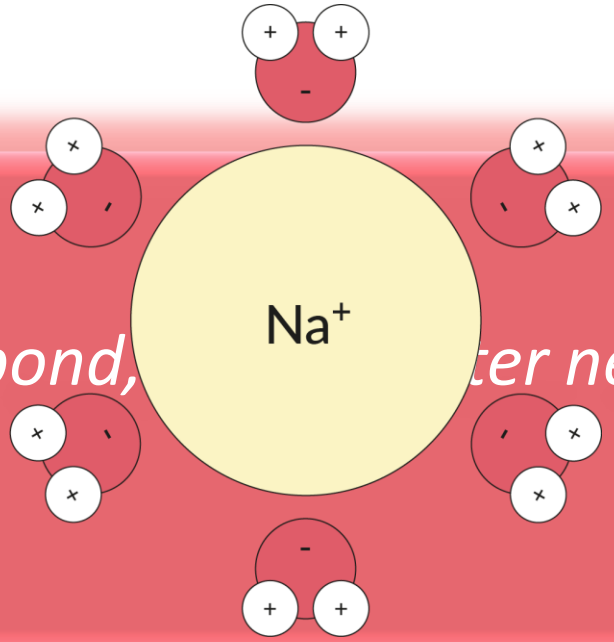
Adding salt to water changes the boiling temperature !

Why does the boiling point change

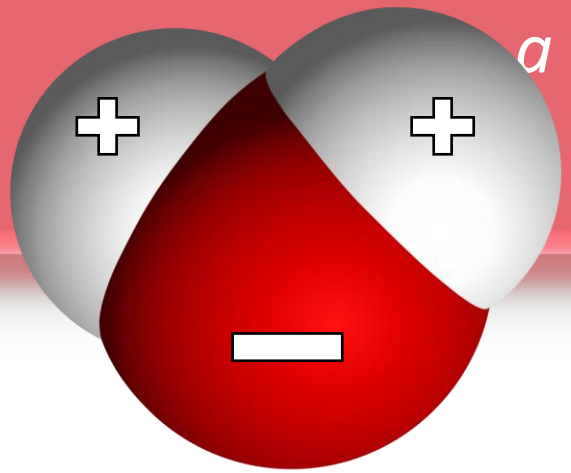
$NaCl$

Na^+ Cl^-





The Ion-dipole interaction is stronger [illegible] ydrogen bond, [illegible]ter needs a higher ter[illegible]ra[illegible] b[illegible]



Ion-dipole interaction

Theoretical Model

A change in the boiling point of the solution

Molar constant of the solvent

$K_b = 0.512[C * \frac{kg}{mole}]$

Van't Hoff factor

$$\Delta T = K_b * m * i$$

$$i = \alpha(n-1) + 1$$

Degree of dissociation

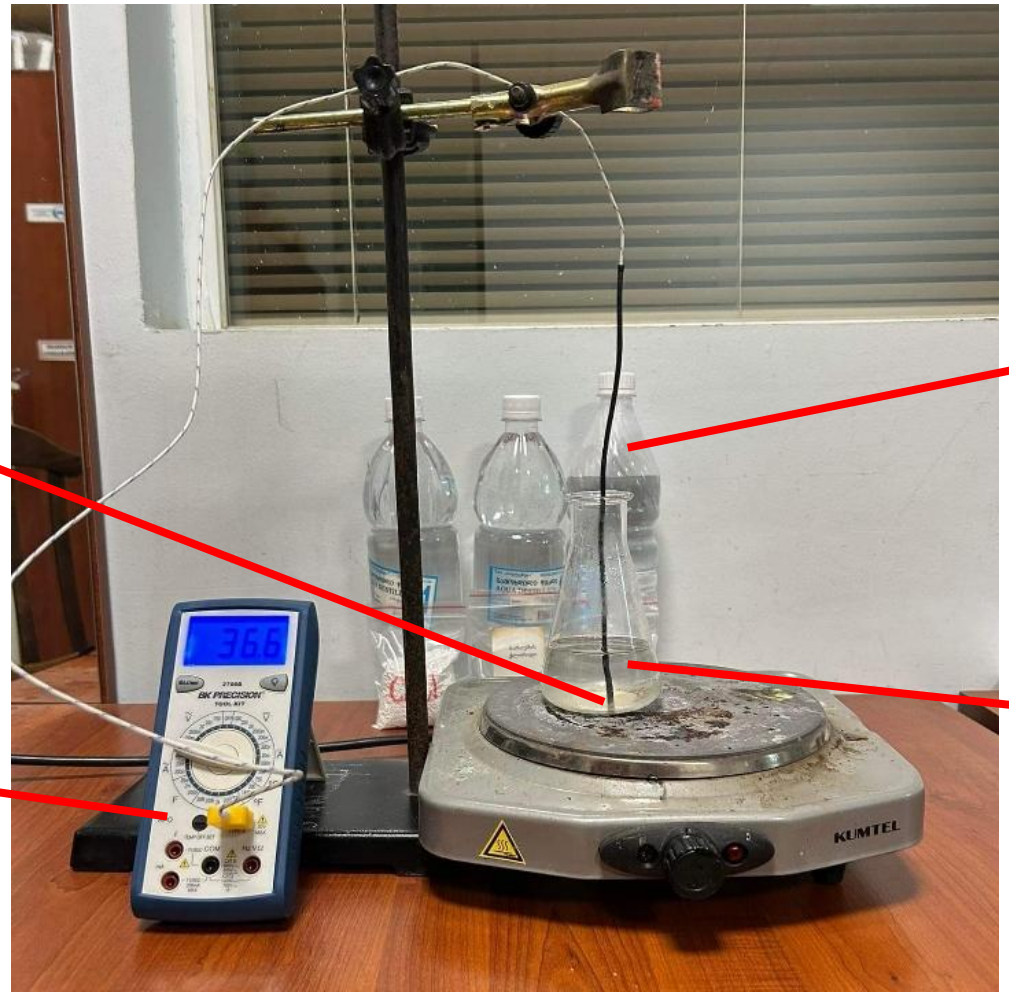
The number of ions after dissociation

Boiling temperature change $(T_b - 100°C)$

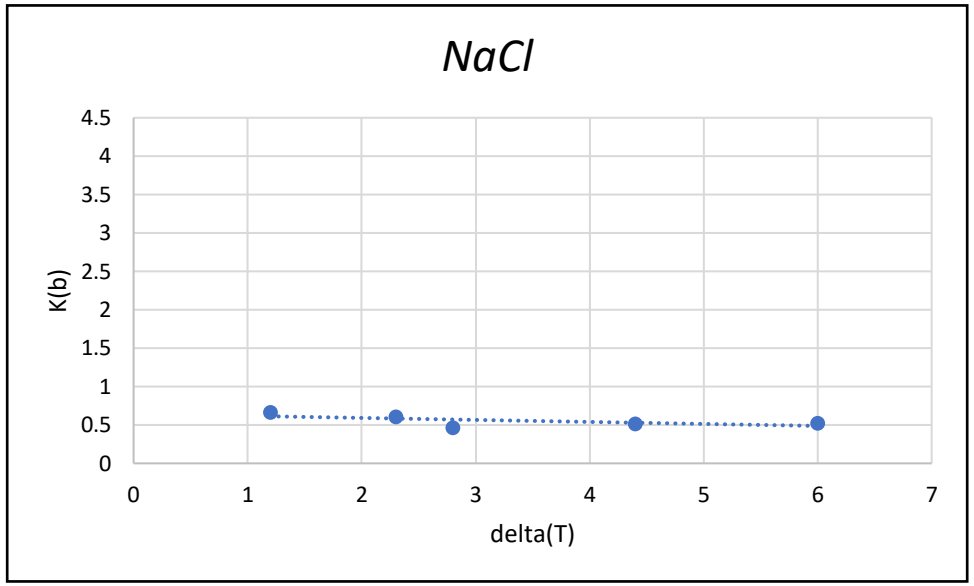
The molar concentration of the salt

Experimental Part

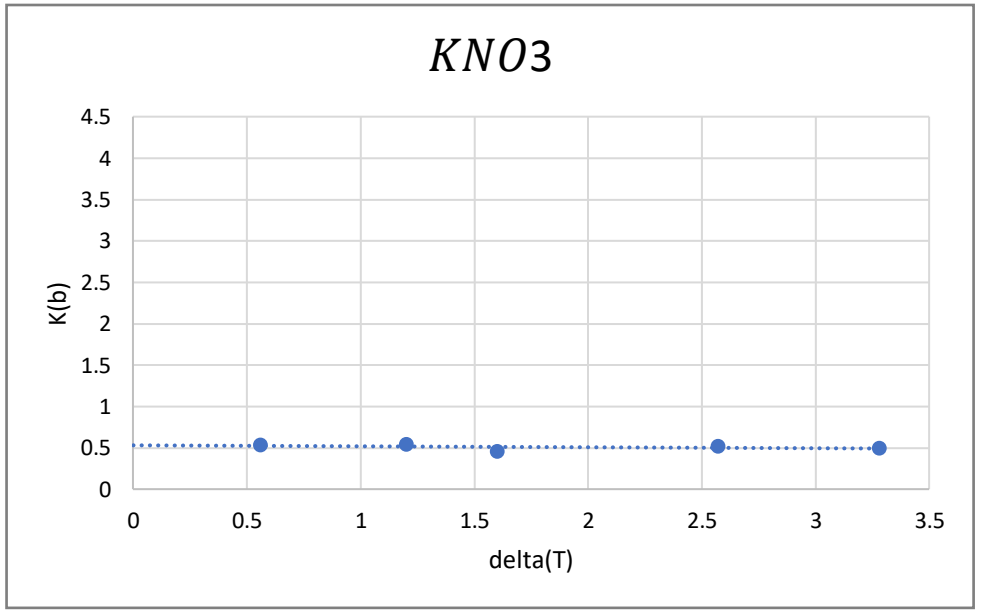
Experimental setup



Determination of K_b constancy



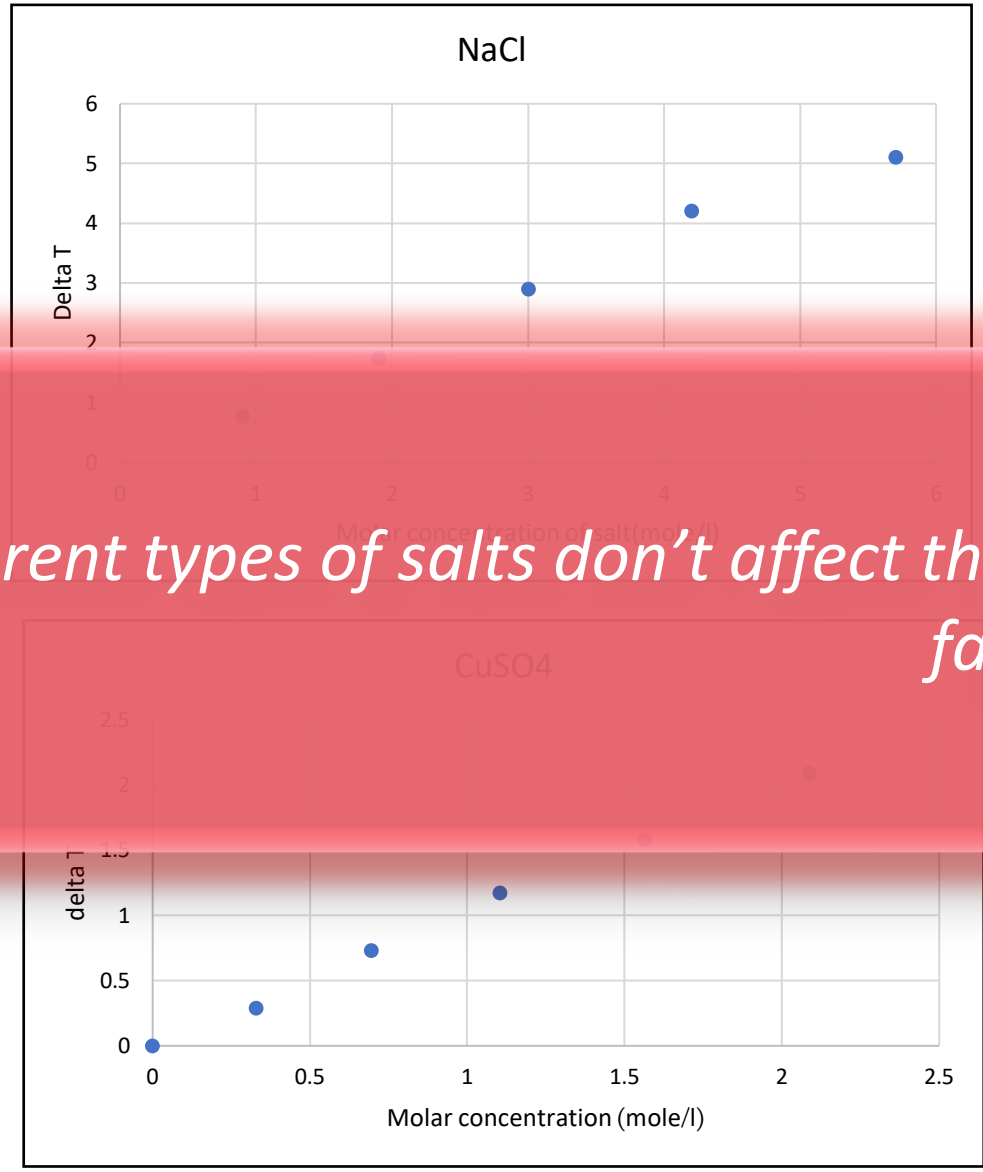
$$K_b = \frac{\Delta T}{m * i}$$

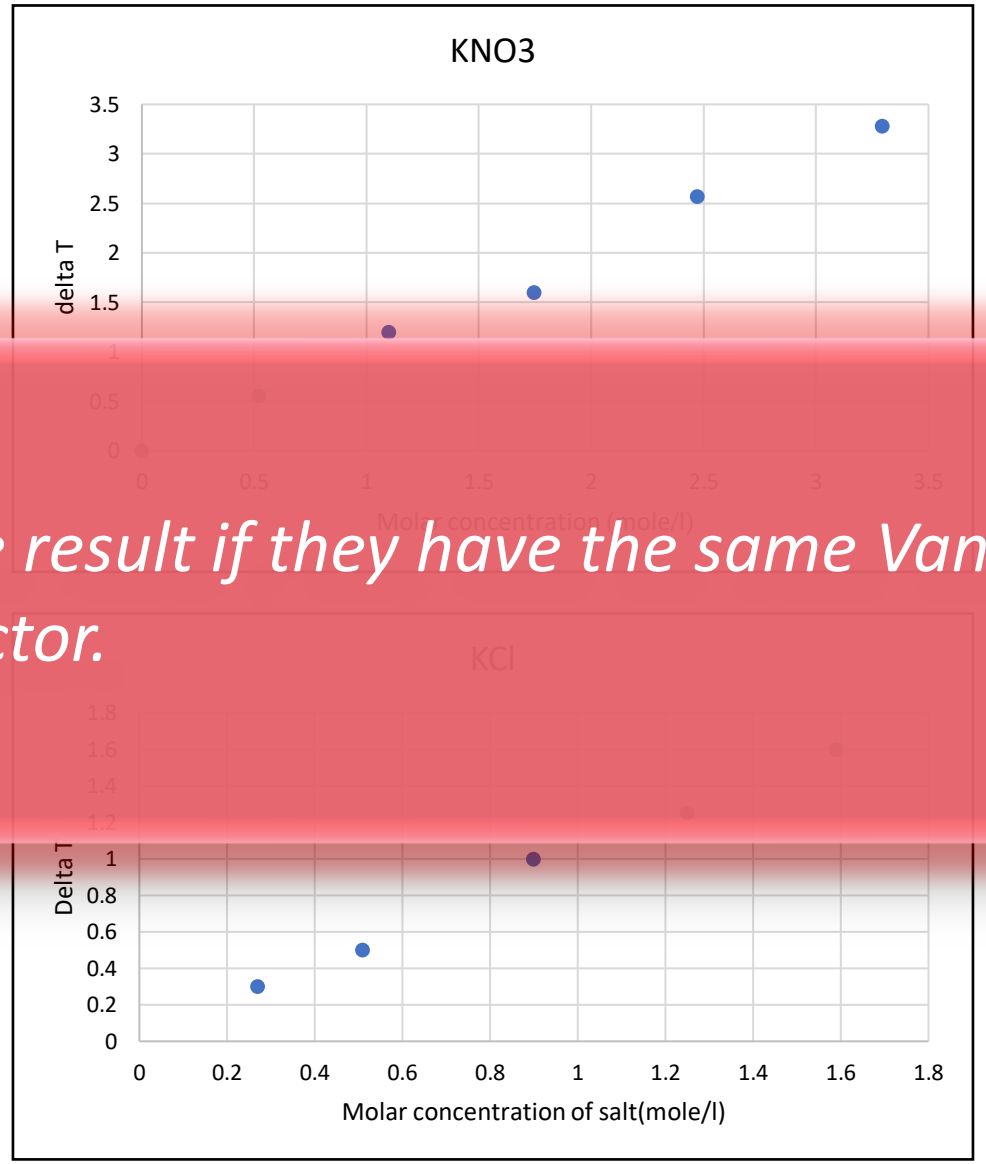


$$K_{b_{water}} = 0{,}512[C * \frac{kg}{mole}]$$ *Theoretical*

Experimental $$K_{b_{water}} = 0{,}533[C * \frac{kg}{mole}]$$

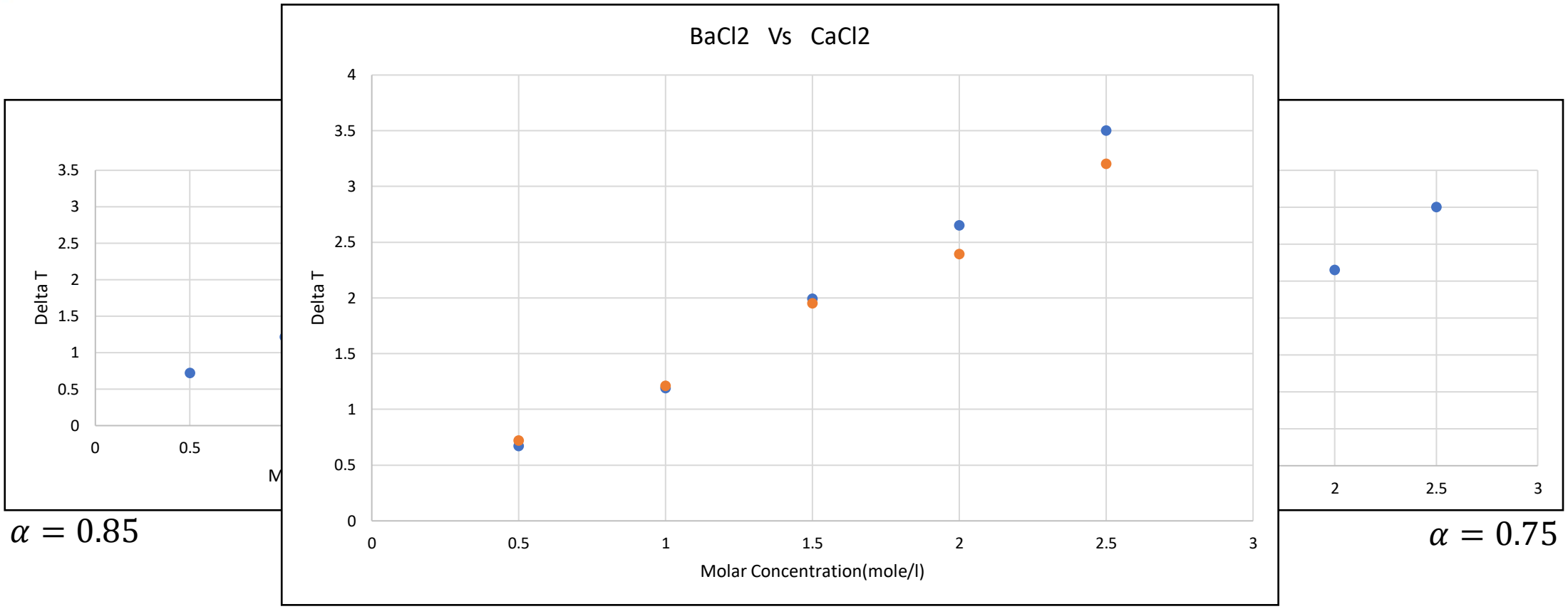
The influence of concentration





Different types of salts don't affect the result if they have the same Van't Hoff factor.

Salts with Van't Hoff factor 3



$\alpha = 0.85$

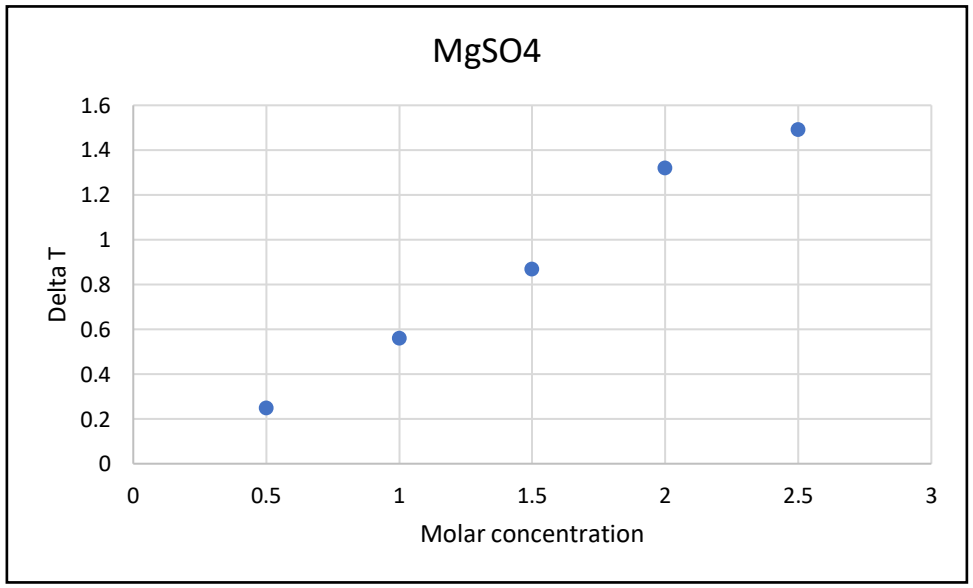
$\alpha = 0.75$

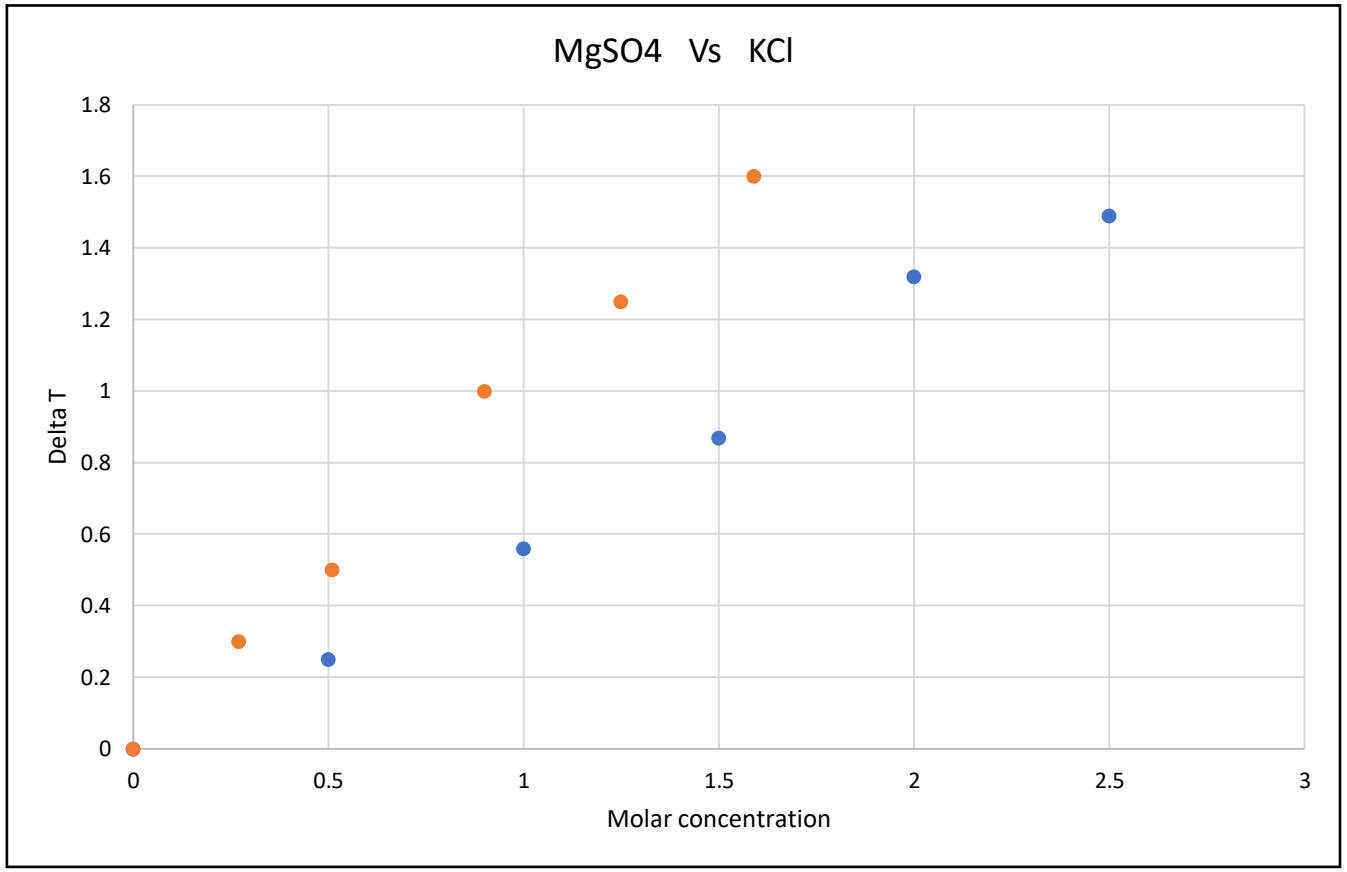
Salt with degree of dissociation 0.2

KCl

$MgSO_4$

$$\alpha = 0.2 \Rightarrow \mathrm{i} = 1.2$$





$$for\ KCl\ -\alpha = 0.92 \Rightarrow i = 1.92$$

The final part

Experimental results

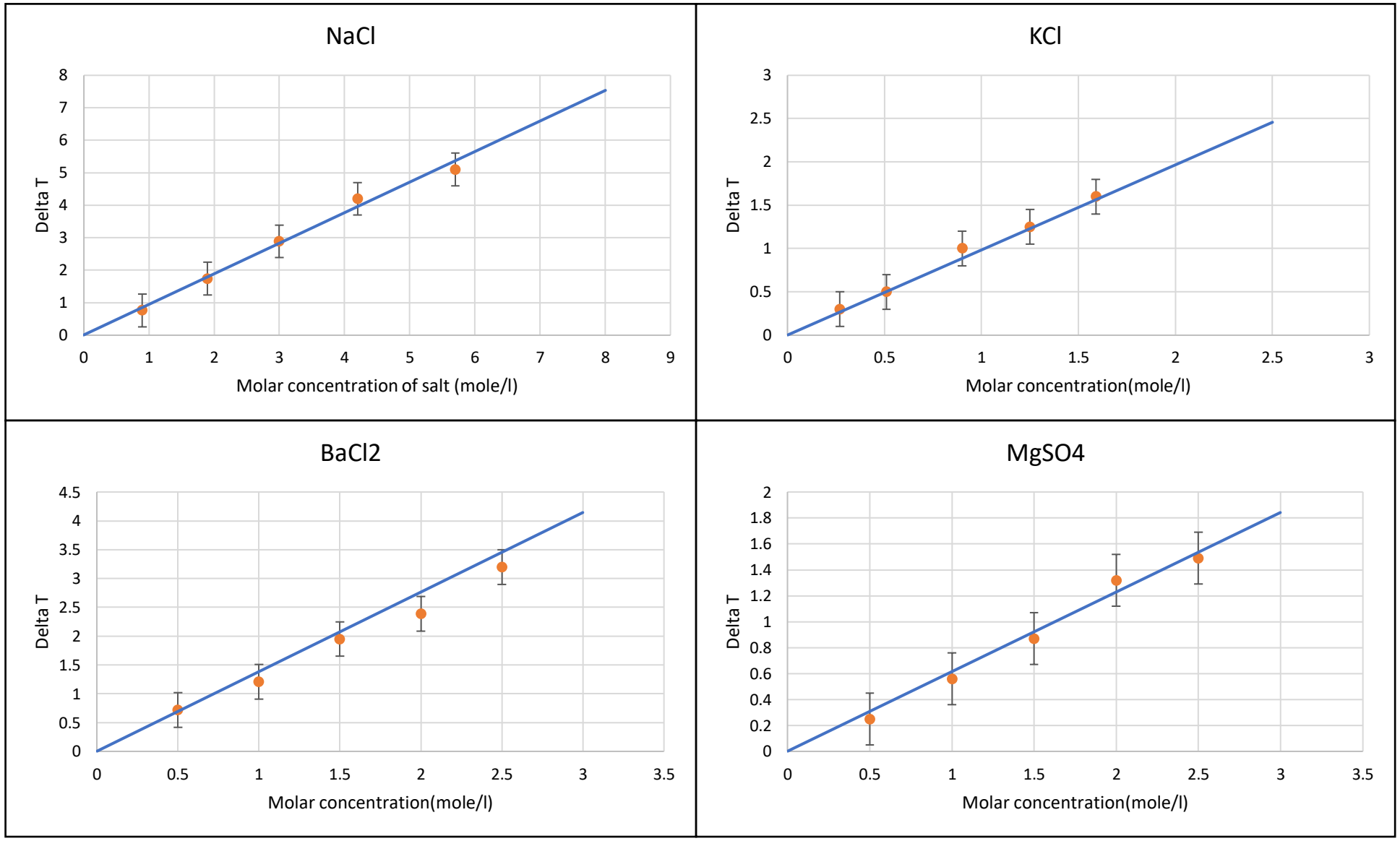
N	Temperature
1	103
2	102.7
3	103.3
4	103.1
5	102.9

$$a = \frac{a_1 + a_2 + a_3 + a_4 + a_5}{5}$$

$$error = \sqrt{\frac{(a-a_1)^2+(a-a_2)^2+(a-a_3)^2+(a-a_4)^2+(a-a_5)^2}{5}}$$

! Each experiment was conducted five times

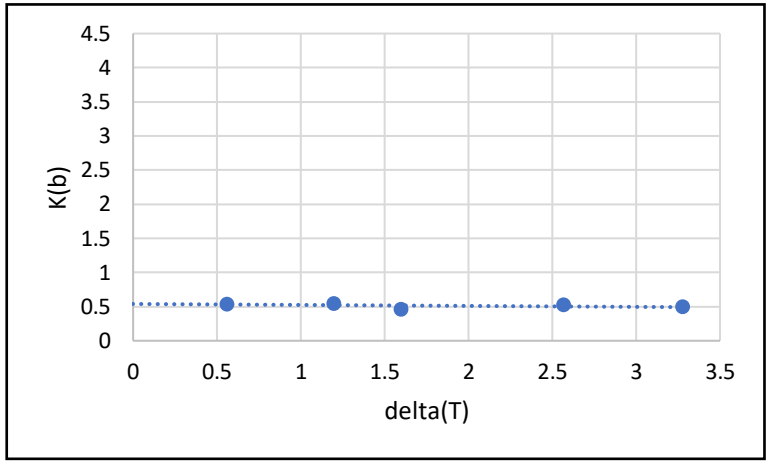
Comparison of theoretical and experimental results

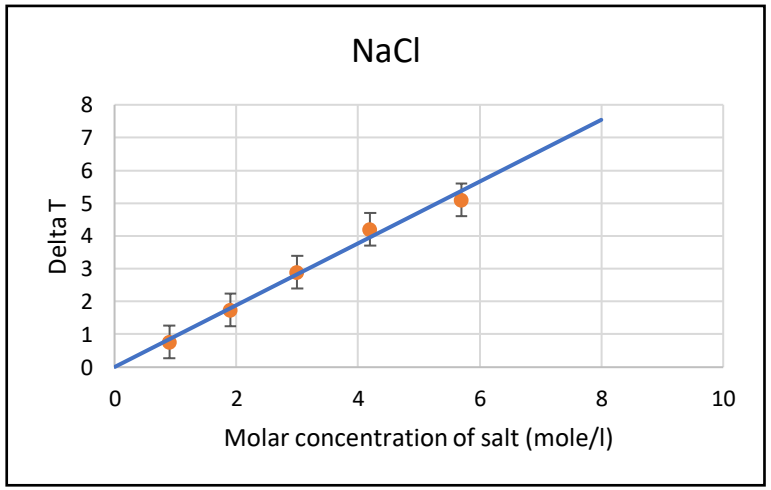


phenomenon | Theoretical model | experiment | conclusion

Conclusion

- Molar concentration;
- Molar constant of solvent;
- Van't Hoff factor;
  - Degree of dissociation





Molar concentration

!

$$\Delta T = K_b * m * i$$

Thanks for attention!

$m_{NaCl} - 25\ g$
$m_{H_2o} - 75\ g$
$m_{solution} - 100\ g$
$M_{NaCl} - 58.44\ g/mole$

$T_b = ?$

$$\Delta T = K_b * m * i$$

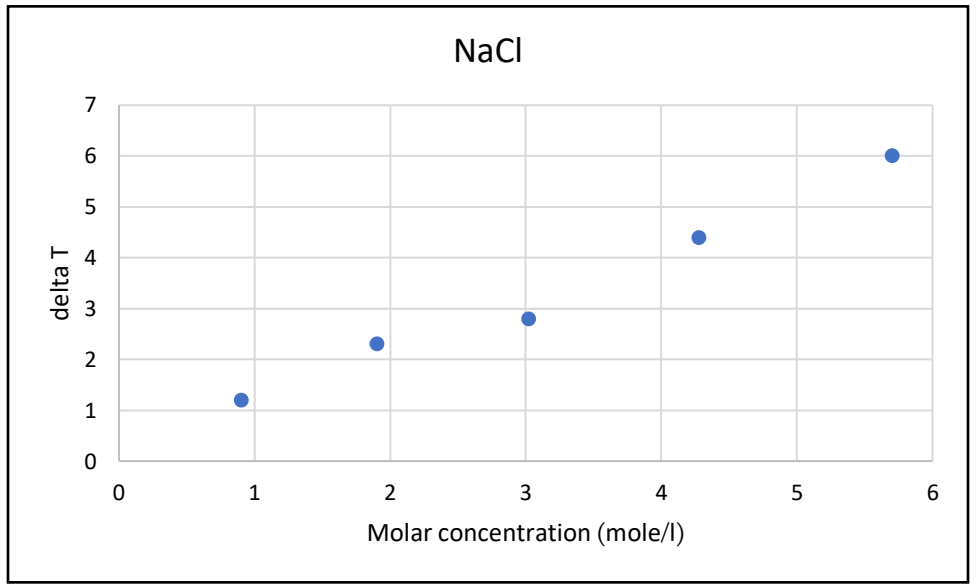
$$\frac{m_{NaCl}}{M_{NaCl} * V_{H_2o}}$$

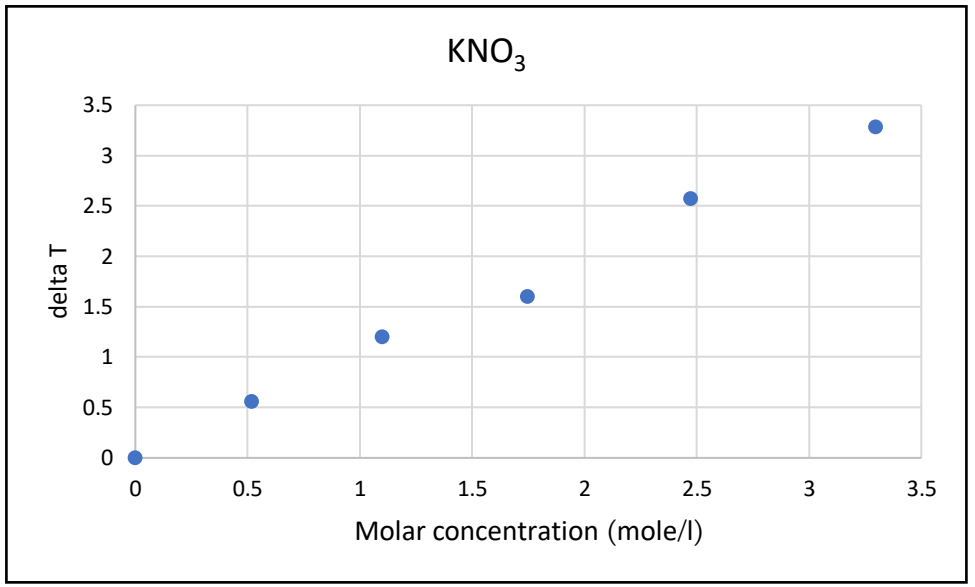
$$Na^+ \quad Cl^-$$

$$(T_b - 100°C) = 0{,}512 * \frac{\frac{25}{58.44}}{0.075} * 2 = 5.84\ °C$$

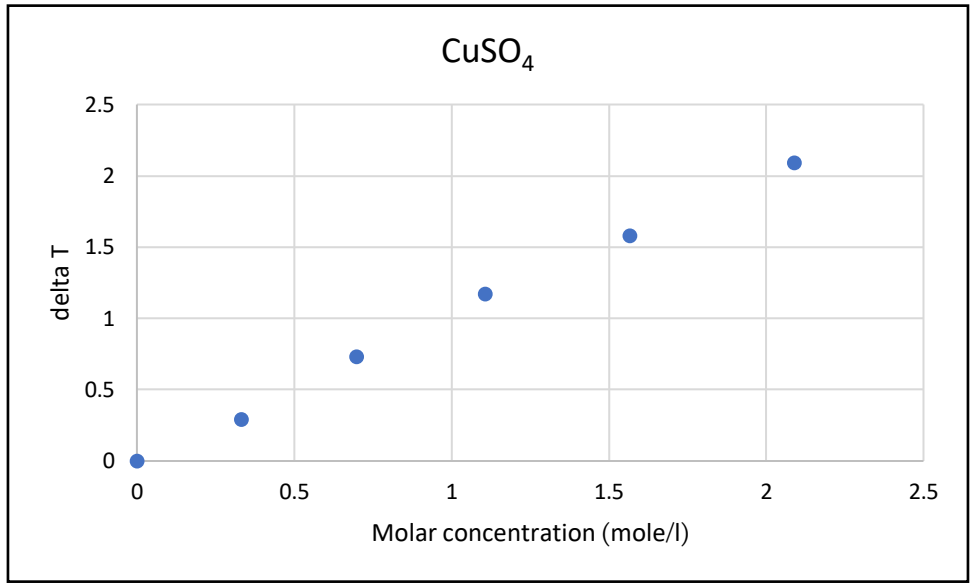
$$T_b = 105{,}84\ °C$$

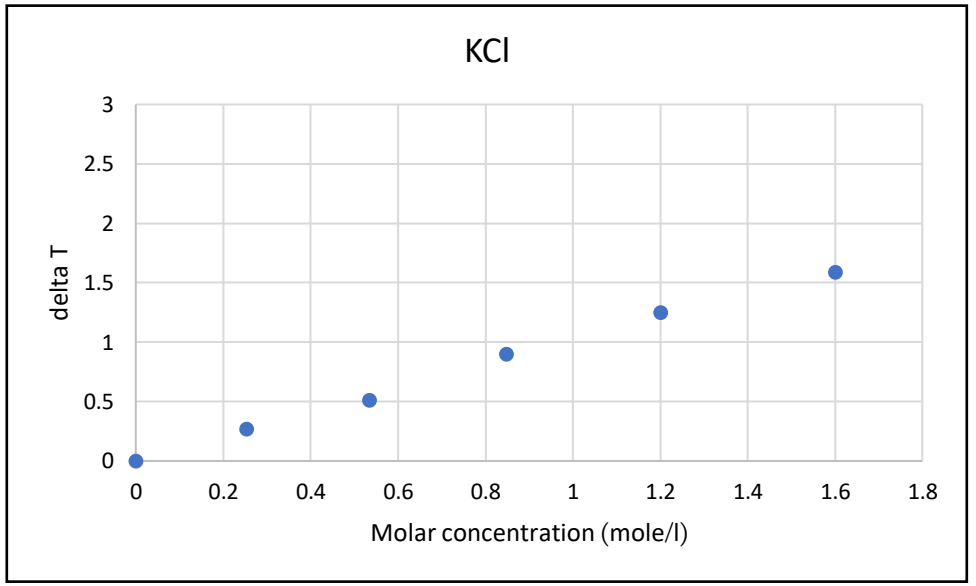
The influence of concentration

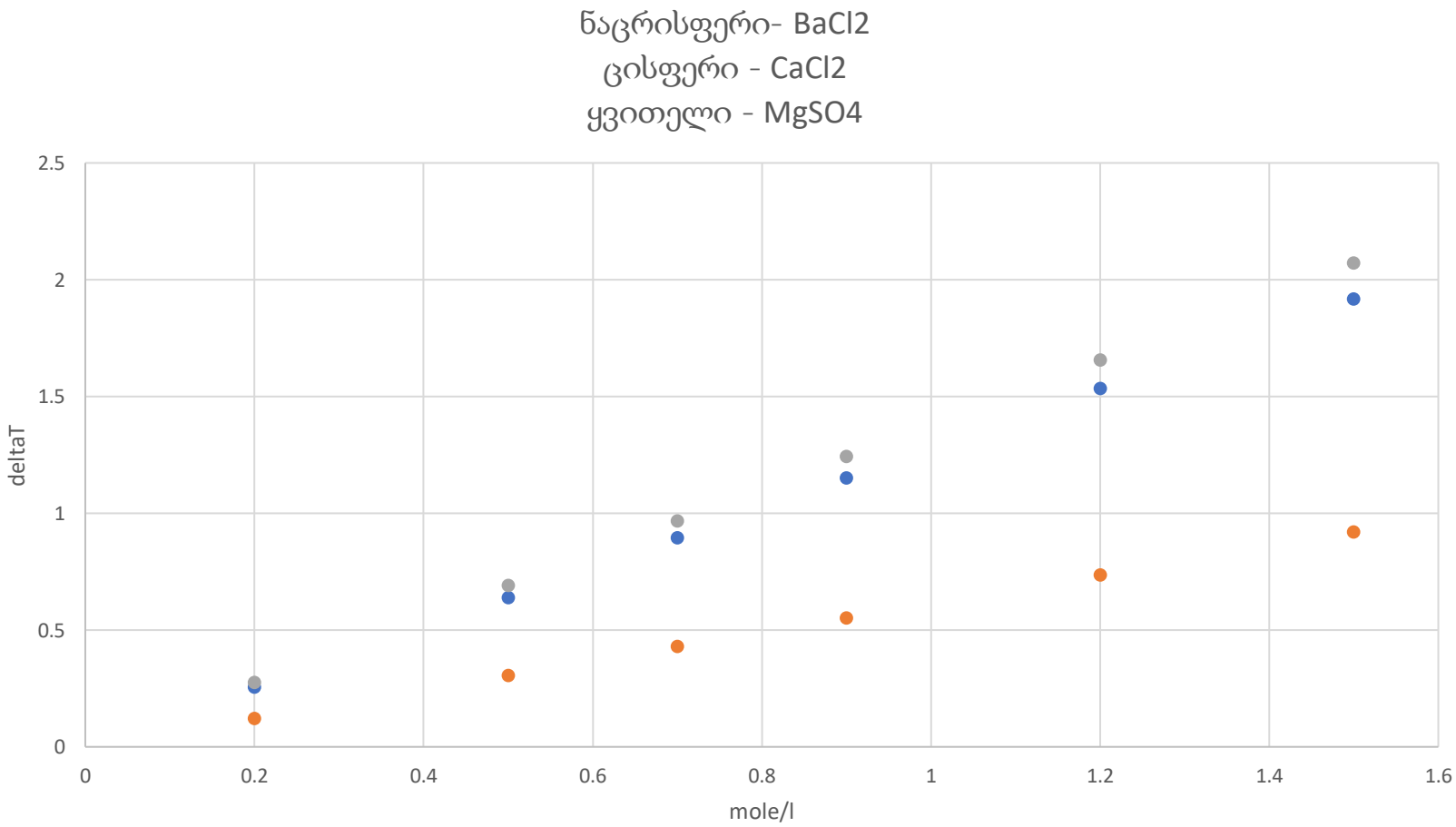




The influence of concentration






ნაცრისფერი- BaCl2
ცისფერი - CaCl2
ყვითელი - MgSO4
deltaT
mole/l
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6