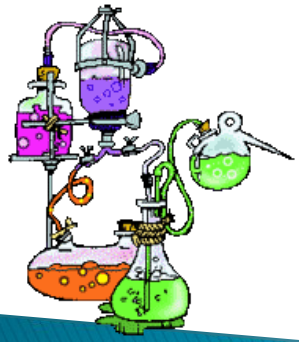
IYNT

Puzzle in a beaker



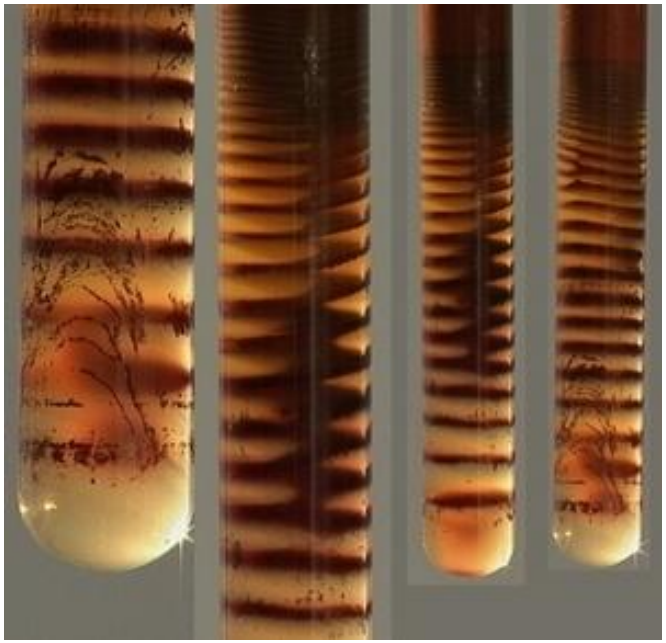
Croatian team

Problem

11. Puzzle in a beaker : A researcher decided to measure the diffusion rate of ammonia in gelatin. He added some magnesium sulfate to the hot gelatin solution which set to a gel on cooling. He then poured some aqueous solution of ammonia onto the gel and left the beaker for two days. The researcher was surprised to discover white layers of precipitate in the beaker, as depicted in the Figure. Explain this phenomenon and determine what does the number of bands depends upon

Terms

- Liesagang rings
- Gel



Agat

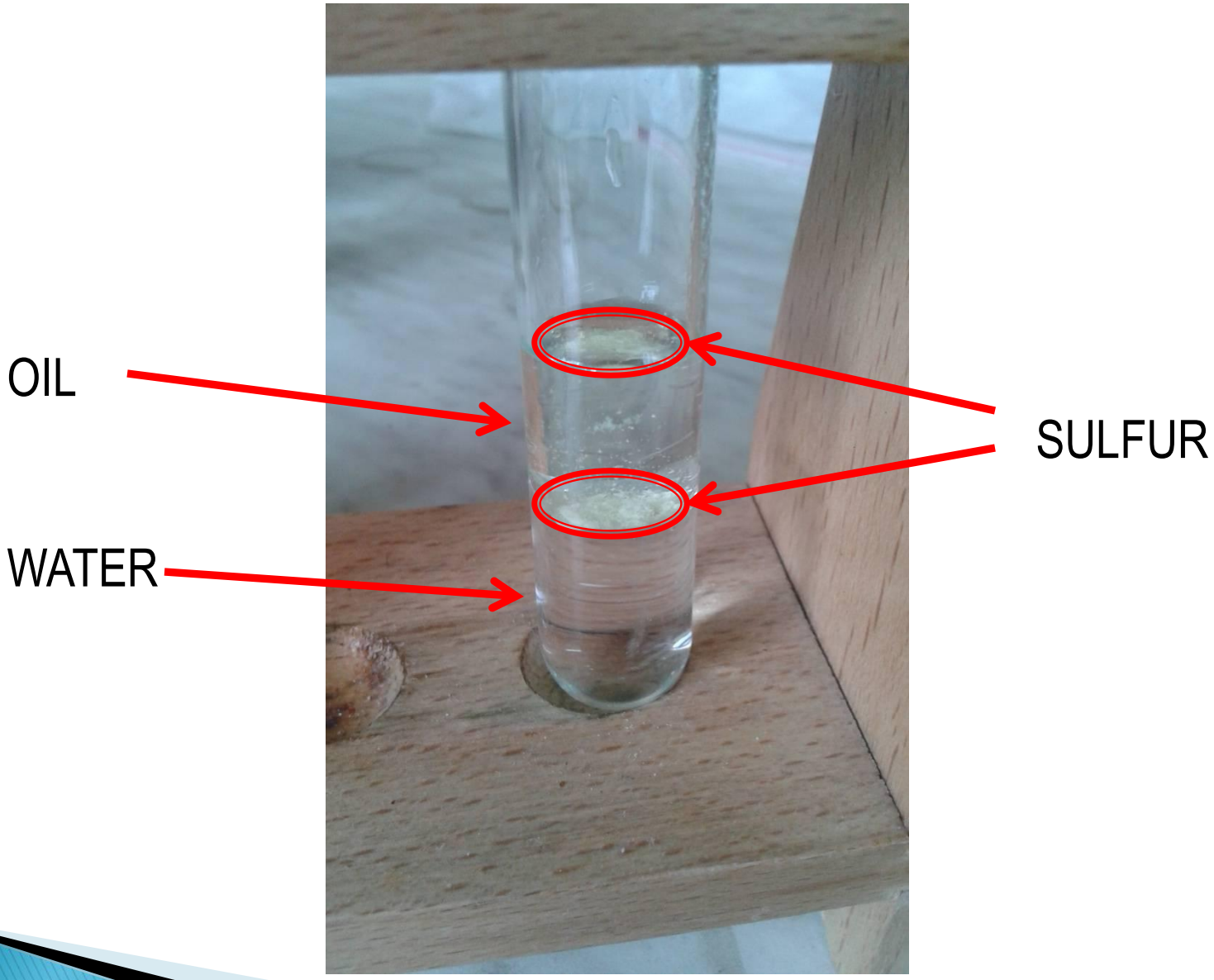
Planing the experimentation

- 1. finding the optimal gel density
- 2. determinating the influance of magnesium sulfate in the solution
- 3. temperature influance on the ring making
- 4. determinating the density of the gel in different sections

$$MgSO_4(aq) + 2NH_3(aq) + 2H_2O(l) \rightarrow Mg(OH)_2(s) + (NH_4)_2SO_4(aq)$$

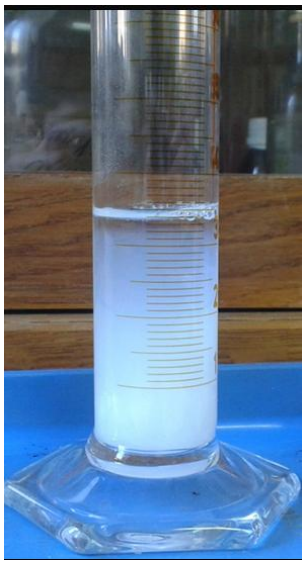
Hypothesis

- Most rings will probably appear in vials/measuring beakers with the biggest density of magnesium sulfate and in the more deluted gel with the higher temperature than the room one
- The gel has differently dense rows so the magnesium hydroxide setles on the path from the more deluted to the denser gel


OIL
WATER
SULFUR

1. Part of the experiments: finding the optimal density of the gel

0,5%



1.

1,17%

2.

1,75%

3.

2,33%

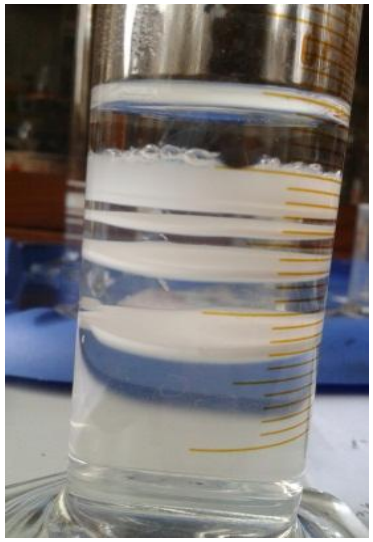
4.

Number of stripes in the measuring beakers

Beaker number	Gel solution ratio	Ring number
1	0,5%	0
2	1,17%	3 irregular
3	1,75%	4
4	2,33%	3 irregular

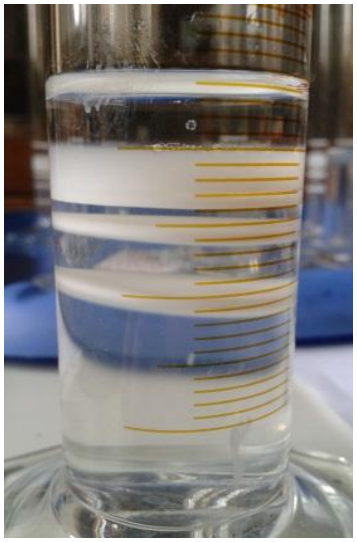
2. Part of the experiment: concluding the effect of magnesium sulfate concentration in the solution

0,1mol/L



1.

0,5mol/L



2.

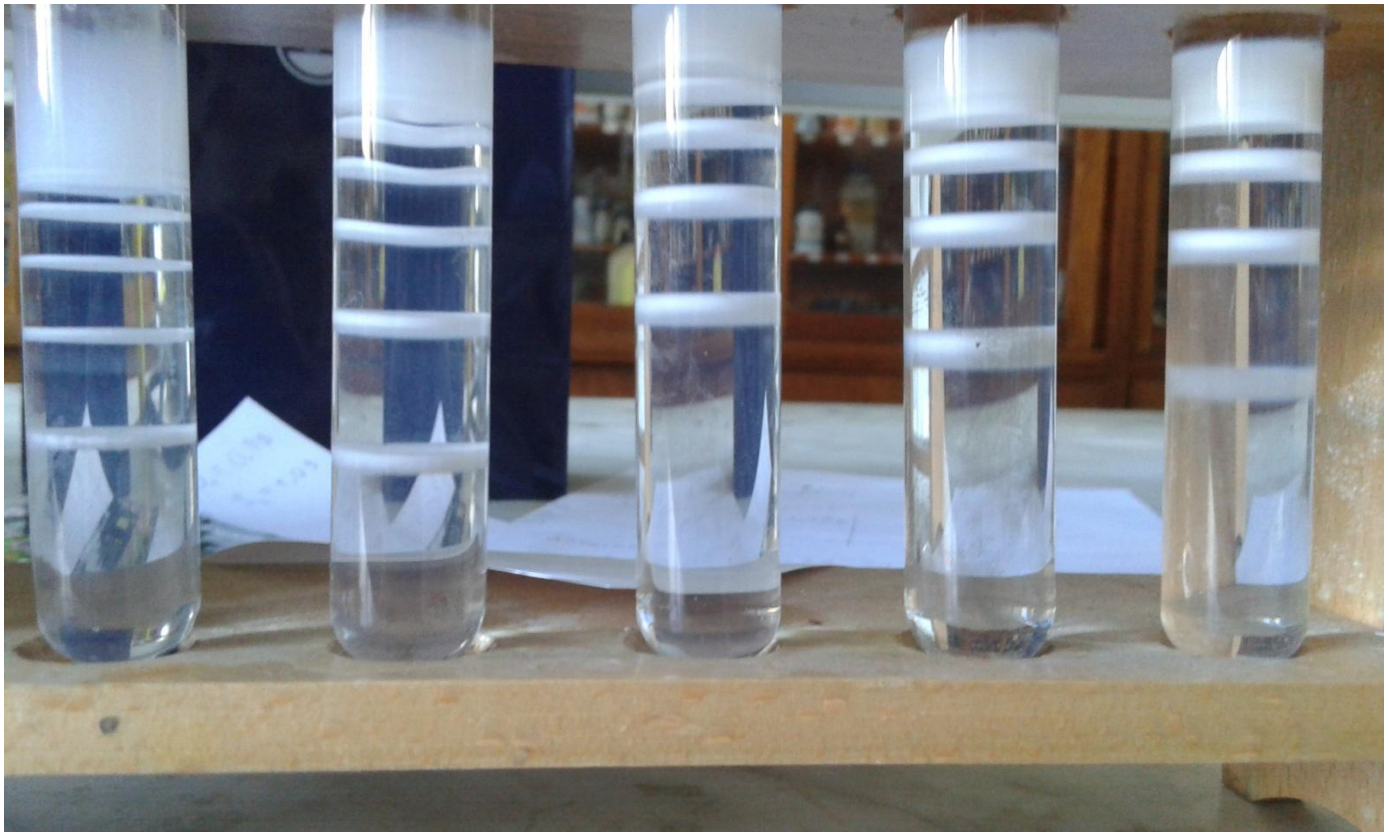
1mol/L

3.

Ring number in the measuring beakers

Beaker number	Concentration [mol/L]	Ring number
1	0,1	4
2	0,5	3
3	1	2 irregular

2. part: expanding the experiment



1. 2. 3. 4. 5.

Ring number in the measuring beakers

Vial number	Concentration [mol/L]	Ring number
1	0,1	7
2	0,25	7
3	0,5	5
4	0,75	4
5	1	4

3. Part of the experiment: temperature influence on the ring making

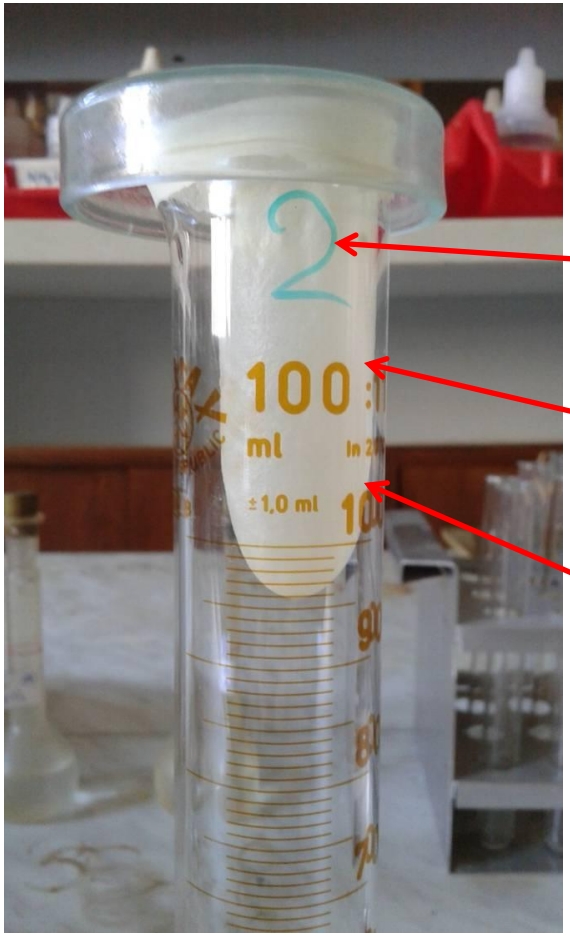
16 ° C

1.

40° C

2.

4. Part of the experiment: determinating the gel density in different rows



Beaker row	Gel density [g/mL]
1	0,98
2	1,04
3	1,09

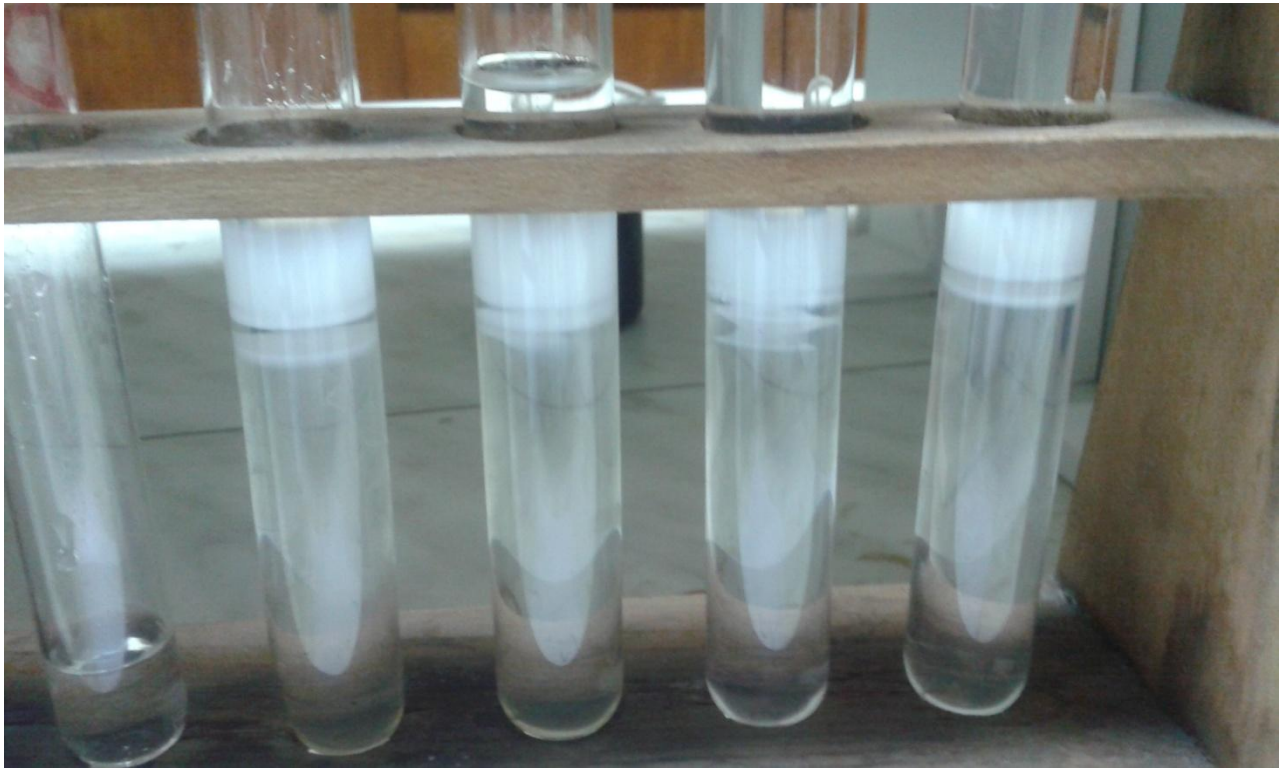
Expanding the experiment

- Determinating the effect of the ammonia alkaline on the ring number
- Proof of the ammonia ions importance in the system
- Proof that gelo is important for formation of rings

New hypothesis

- The biggest number of rings will appear in the beaker with the biggest volume of ammonia
- Ammonia ions are important for the appearing of the periodic rows of residue

1. Effect of various volumes of ammonia



Importance proof of amonium ions

Instead of using ammonium alkaline, sodium alkaline is used
Magnesium hydroxid is still produced but not in shape of rings

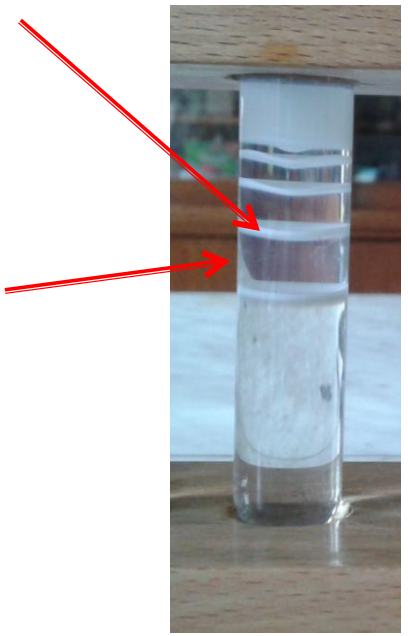
Theory of the liesagang rings

$MgSO_4(aq) + 2NH_3(aq) + 2H_2O(l) \rightarrow Mg(OH)_2(s) + (NH_4)_2SO_4(aq)$

$(NH_4)_2SO_4(aq) \rightarrow 2NH_4^+(aq) + SO_4^{2-}(aq)$

$NH_4^+(aq) + H_2O(l) \rightarrow NH_3(g) + H_3O^+(aq)$

$Mg(OH)_2(s) + 2\,H_3O^+(aq) \rightarrow 4\,H_2O(l) + 2\,Mg^{2+}(aq)$



Expiriment in water

Conclusion

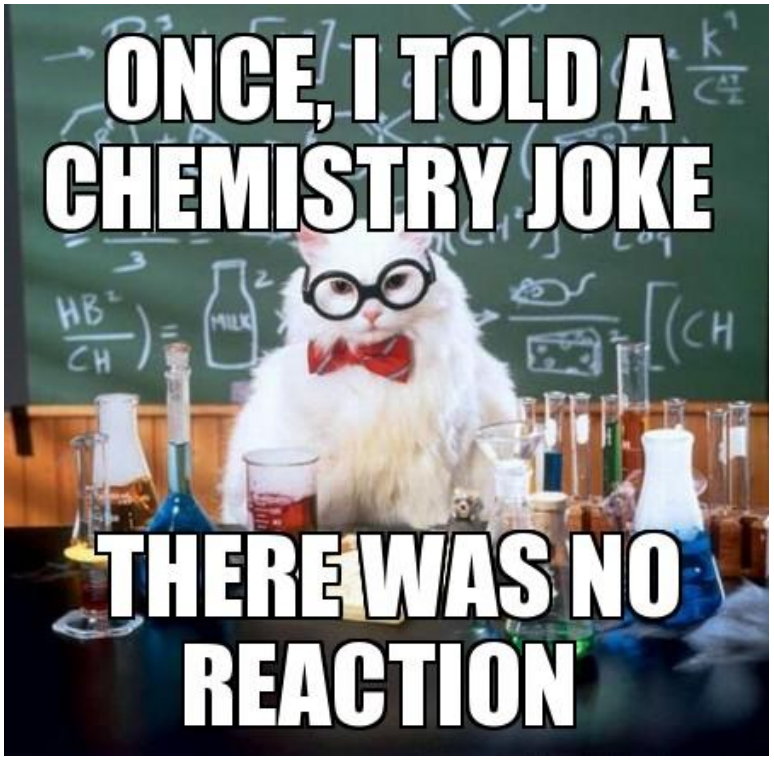
- Bigger friction of gelo in solution is better for forming rings
- Smaller concentrations of magnesium sulfate is better for forming rings (in this case 0,1mol/L)
- Temperatures lower than room temperture are better for forming rings (3-6° C lower)
- At higer temperatures, in which gel from gel state transforms into sol state rings will not form
- Different volume of ammonium alkali does not effect forming rings until there is not enaugh ammonium for reaction
- If ammonia is poured fastly it can effect on different shapes of rings

Cobalt chloride and ammonia

Literature

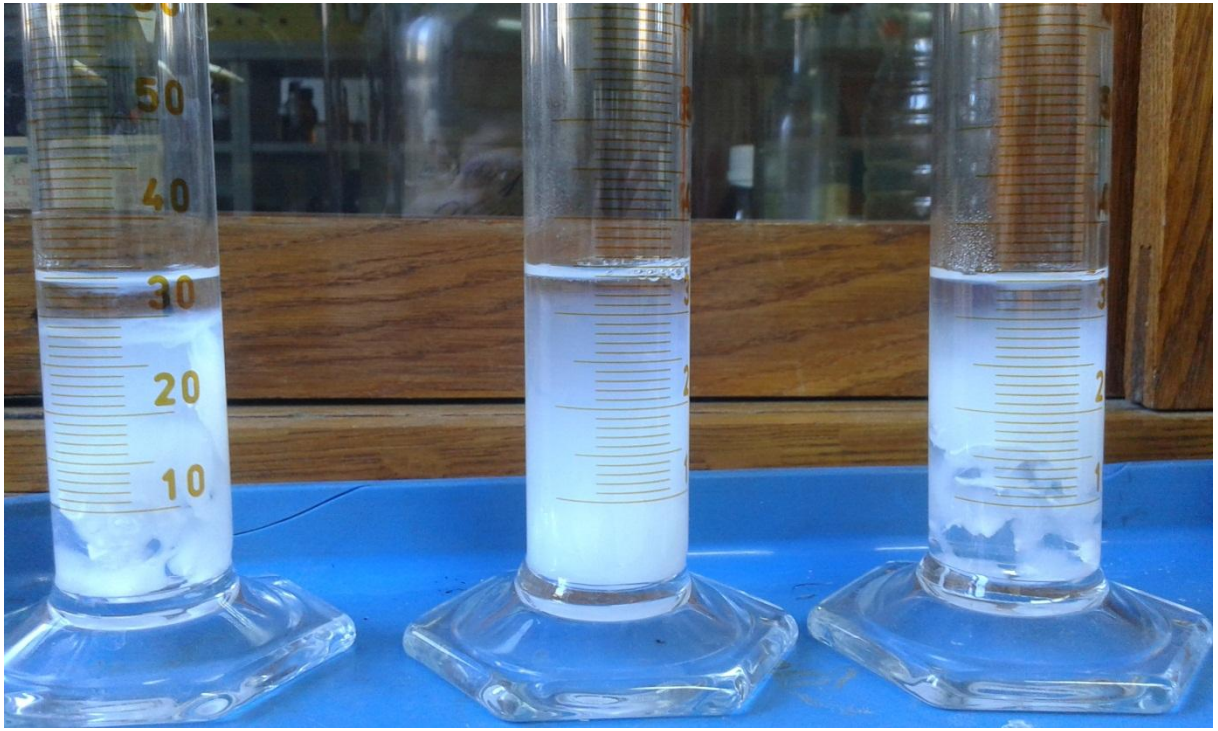
- www.insilico.hu/liesegang/experiment/experiment.html – 17.3.2015.
- www.rsc.org/learn-chemistry/content/filerepository/CMP/000/000/717/isms-39.pdf – 19.3.2015.
- link.springer.com/article/10.1023/A%3A1026489416640#page-1 – 17.6.2015

Thank you for your attention!



- $x_n Q(1+p)$
- $p = F(b_0) + G(b_0)\frac{p_0}{a_0}$

1. Part of the experiment



1. 2. 3.

Determinating the effect of different gel area on the ring number