III IYNT 2015

Problem № 10
«Ice hole»

Team *«MG 12»*

10. Ice hole

You have drilled two ice holes in a frozen lake on a frosty winter day. One ice hole is close to the shore, while the other ice hole is far from the shore. Surprisingly, the height difference between the ice surface and the liquid water is different for each hole. How can you explain this? How can one use this height difference to determine the local ice thickness?

Hypothesis: if the uprise height in the ice-holes located in different places of lake is various, it is possible to explain it the especial properties of water.

Research objective: to explain the phenomenon of formation of ice in reservoirs with fresh water.

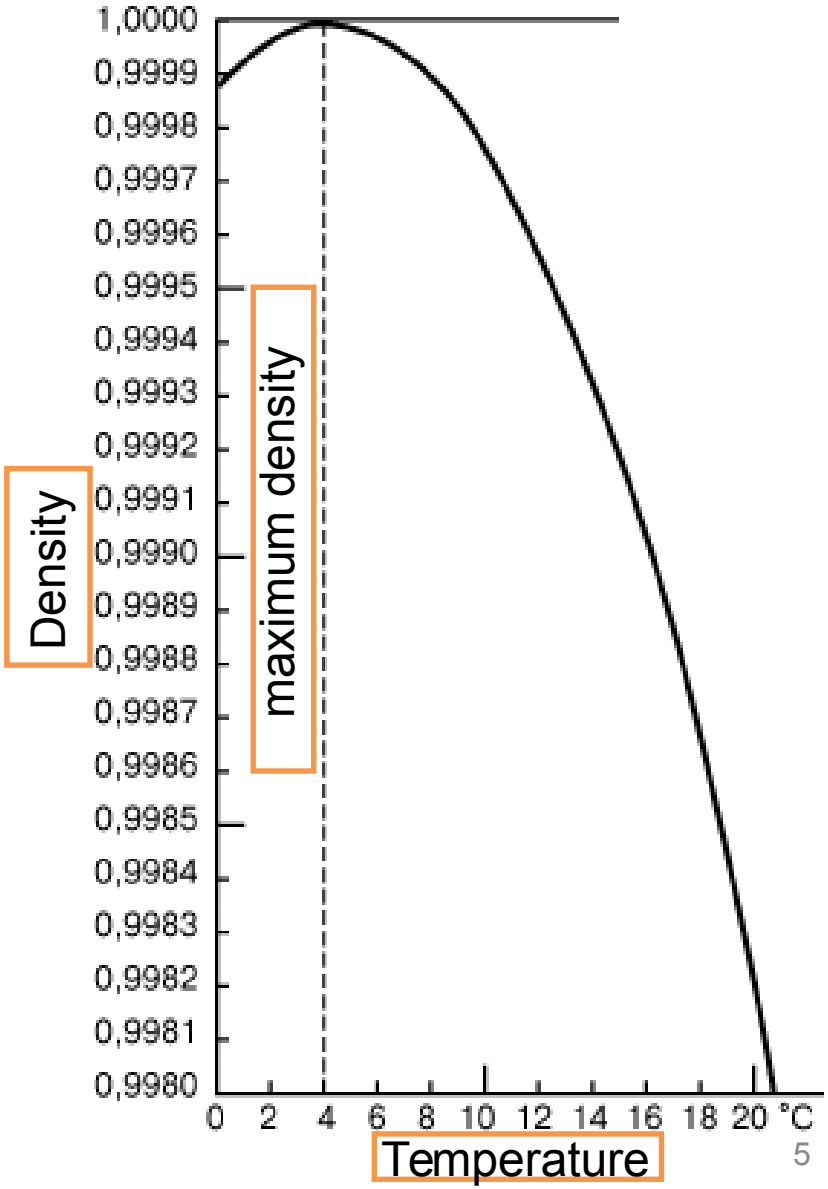
Problems :

- To consider features of formation of ice in reservoirs with fresh water.
- To define the parameters influencing process of formation of ice on lakes.
- To explain the phenomenon of rising of water in an ice-hole.
- To deduce the formula of connection of height of rising of water in an ice-hole from a thickness of ice.

Explanation of the process

At temperatures above 4°C water at cooling is compressed, reaching the greatest density at 4°C.

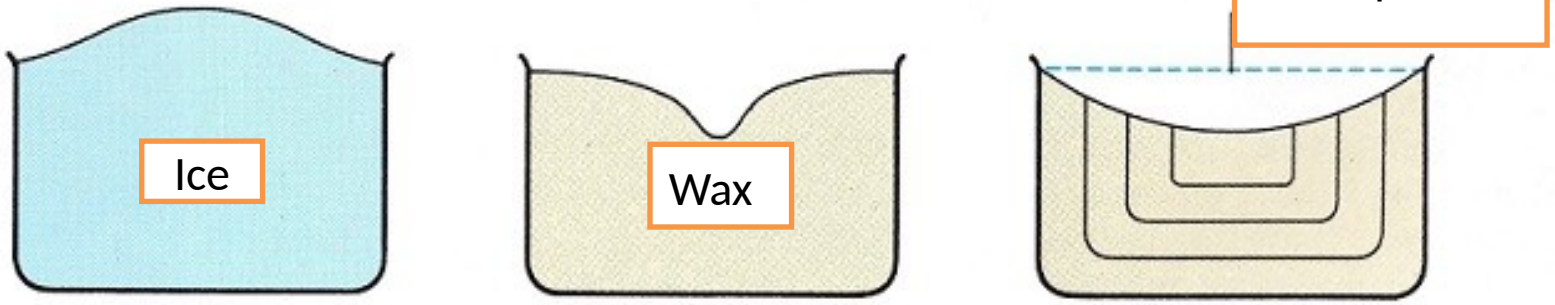
However, if cooling proceeds also temperature falls more low 4°C, water starts to expand and its density decreases.

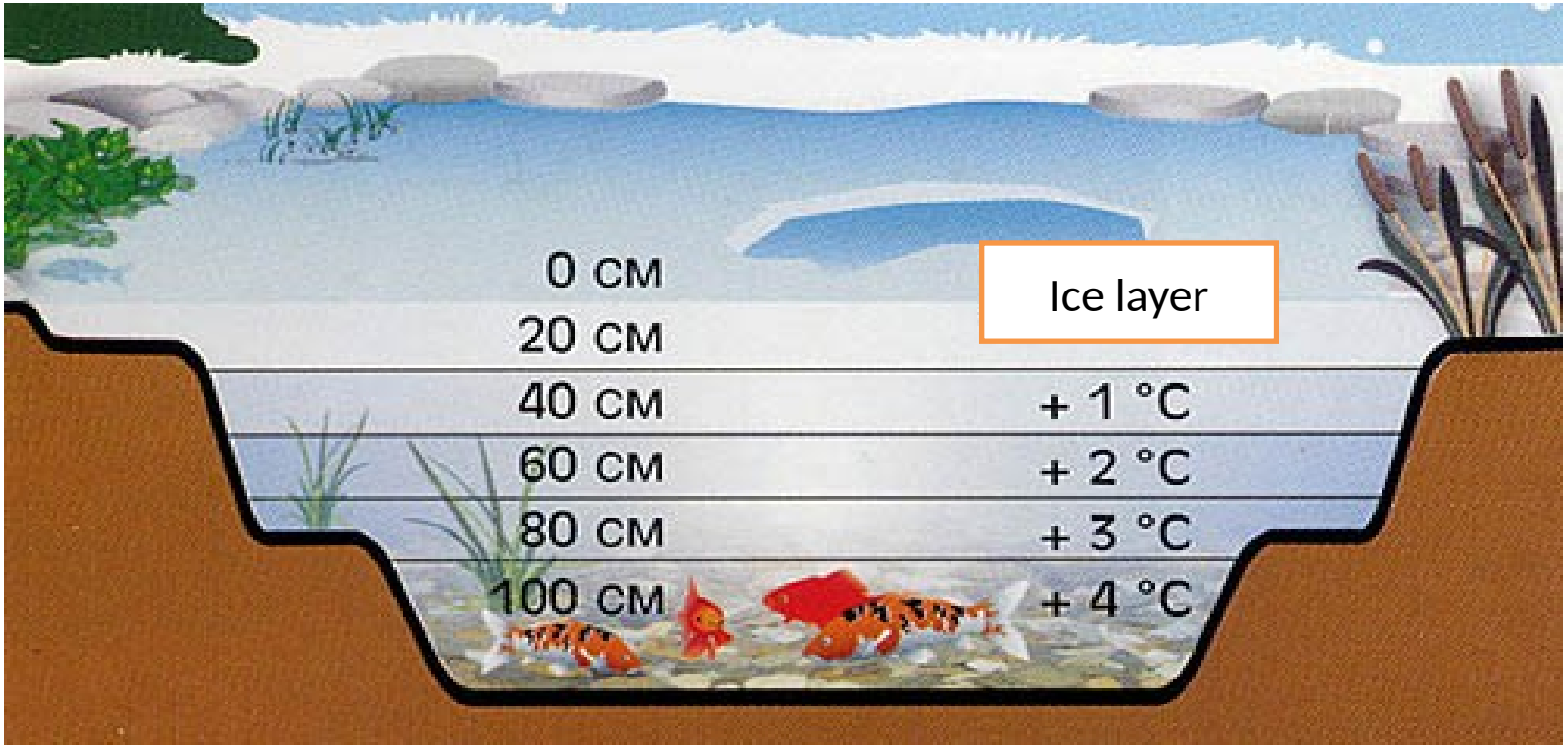


Explanation of the process

1. Water in the lake, cooled to 4°C, becomes more dense and falls on a bottom. Warmer and consequently lighter water rises to a surface, cooled and also falls downwards.
2. When last portion of water will be cooled to 4°C, convection under which action cold water falls downwards, and warmer water rises upwards, stops. In this case all water has identical temperature. The water density also is identical.
3. When water in a blanket will be cooled lower 4°C, it extends and becomes less dense. As water at 3°C is lighter, than at 4°C, colder water remains above.
4. The water blanket continues to be cooled with the further reduction of density. At last, at 0°C the water blanket turns to ice.

The solution



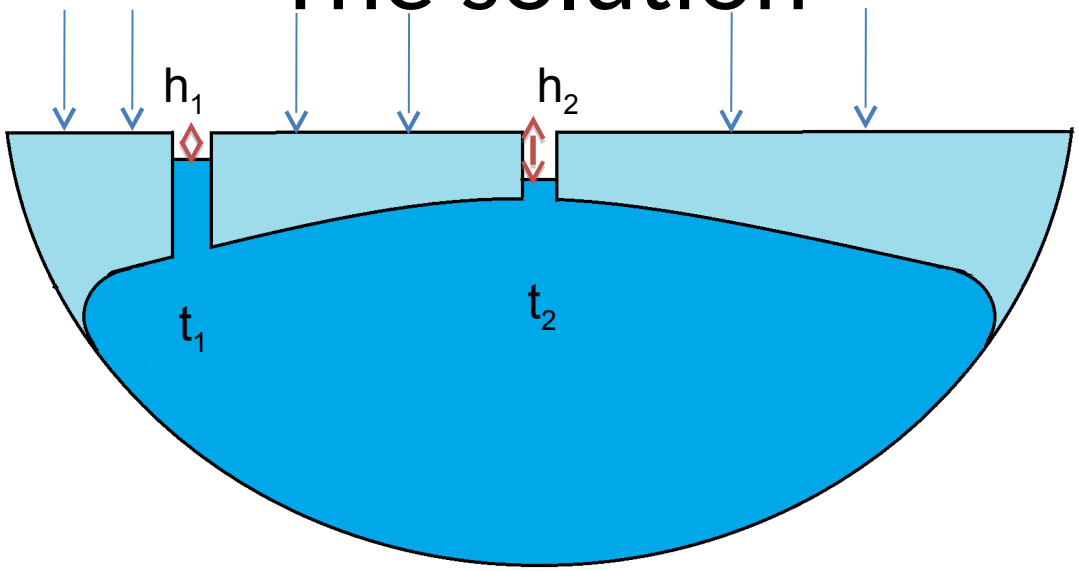


Experiment №1

Purpose: to prove that the thickness of ice at coast has the greatest value, than in the middle.

Conclusion: By means of model of a reservoir we managed to prove that at coast thickness of ice is more.

The solution



$t_1 < t_2$

$\rho_1 < \rho_2$

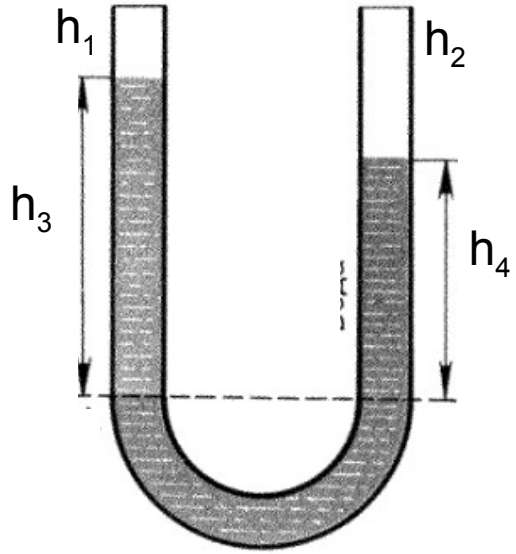
According to the rule of communicating vessels :

$$\rho_1 h_3 g = \rho_2 h_4 g$$

$$\rho_1 h_3 = \rho_2 h_4$$

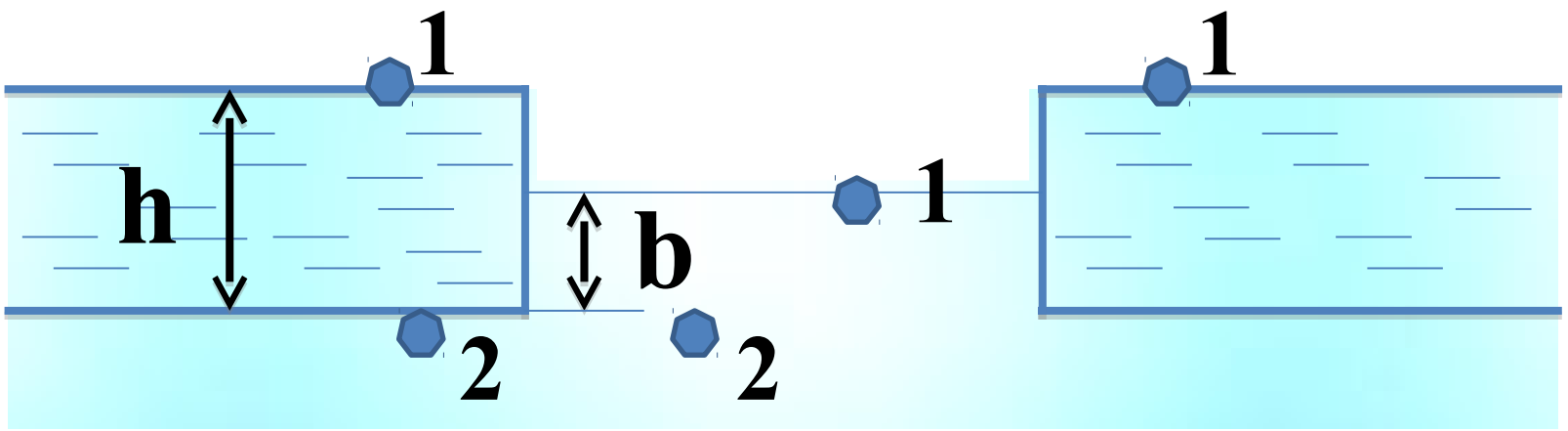
Let's take into account that $\rho_1 < \rho_2$,then. $h_3 > h_4$

It is obvious that **$h_1 < h_2$**



h – thickness of ice, m

b – rising height of water in an ice-hole, m



$$h = \frac{\rho_{Water}(h-b)}{\rho_{Ice}}$$

Conclusion:

- During the solution of the given problem we theoretically have explained the phenomenon of formation of ice on a lake surface.
- The distance from a surface of ice to a water surface at coast has appeared less, than on depth. It is explained by features of change of density of water at freezing.

Resources

- http://www.o8ode.ru/article/answer/ice/voda_pri_4degc.htm
- http://www.xumuk.ru/bse/1483.html
- Physics student's book for 7th grade, edited by A.A.Pinskiy, V.G. Razumovskiy