23. ročník, úloha II . 1 ... *calamity* *!!! chybí statistiky !!!*

One of FYKOS organizers was travelling home by train. The train was trapped in a snow storm. He was bravely counting snow flakes behind the window and was thinking: "How many snow flakes are there in 1 kg of snow?" Are you able to make a "qualified" guess to answer this question?

This problem has many solutions and many outcomes as everybody makes a different "qualified" guess. We can say that there is no solution which would be "the most correct one". Below, you can see two possibilities of dealing with this problem. One is experimental, the other is theoretical. The latter uses the pieces of information found on the internet.

Experimental version

With a good portion of luck, it is snowing outside and one can catch a few snowflakes. Let them melt (snow is a type of precipitation and we know a lot about water) and then determine the mass of a single snowflake. We can presume that an average snowflake becomes an average drop of water. We measure the amount of water (the number of snowflakes is known). It is easy to calculate the mass of a single snowflake. If we are not lucky enough and it is not snowing, we can do the same experiment using water drops from faucet. Still we assume that one drop of water equals one snowflake.

Is there any problem with the measurement? The problem is that the measurement is subject to error. Moreover, falling snowflakes can be tricky (two or more snowflakes can stick together and be counted as one snowflake). Equally, we should realise that the mass of a snowflake depends on the temperature of the air.

Theoretical version

An average snowflake consists of 10^{18} molecules of water. That is a piece of information found on the internet. Let N be this amount, M stand for the molar mass of water and N_A be the Avogadro constant. We use the following equation

$$n = \frac{N}{N_A}\,, \quad n = \frac{m}{M}\,, \quad m = \frac{N \cdot M}{N_\mathrm{A}}\,.$$

The molar mass of water can be computed using the periodic table of the chemical elements, $M_{\mathrm{H_20}} = 18\,\mathrm{g{\cdot}mol^{-1}}$. Hence, all the quantities are known and can be inserted into the equation. The mass of a single snowflake is approximately $10^{-8}\,\mathrm{kg}$. The number of snowflakes in one kilogram of snow is then its multiplicative inverse. It implies that there are about tens million snowflakes.

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Fyzikální korespondenční seminář je organizován studenty UK MFF. Je zastřešen Oddělením pro vnější vztahy a propagaci UK MFF a podporován Ústavem teoretické fyziky UK MFF, jeho zaměstnanci a Jednotou českých matematiků a fyziků.