



PROBLEM OF THE MONTH: November 2012

MATHEMATICS

- i) Show that there are 2 people in Sigma Camp that have the same number of friends in Sigma Camp.
- ii) An Island with an area of 1 km^2 is covered by trees – one tree per 1 m^2 . Each tree has at most 70000 leaves. Prove that there are at least 15 trees with the same number of leaves.

PHYSICS

A cockroach is dropped on a straight horizontal tree branch, which is one meter long. The roach can run to the right or left with a constant speed of 1 meter per minute. When the roach reaches an end of the branch, it falls off. It is clear that no matter what point of the branch the roach lands at initially, the time it takes it to reach the end of the branch is at most 1 minute: 1 minute corresponds to the case when the roach lands at one end of the branch and starts running towards the other end.

- i) Imagine that you drop two roaches at the same time. Each of those roaches can travel to the right or to the left, depending on the initial orientation, and the speed is 1 meter per minute. When the roaches meet, they bounce off each other *elastically* and keeping the same speed run in the opposite directions. When the roach reaches the end of the branch, it falls off. Assuming that two roaches are dropped simultaneously on the tree branch, what is the maximum time one needs to wait to guarantee that both roaches are off the branch?
- ii) If you start with 2012 roaches what is the longest time you need to wait to guarantee that the branch has no more roaches?

CHEMISTRY

To understand the phenomenon of combustion Alex conducted the following experiment: he measured the weight of a sealed glass flask containing some quantity of iron powder, which he then proceeded to heat, and then cool to the initial temperature. He then opened the flask and measured its weight again. Based on the results of his experiment, Alex made a conclusion, that during heating, fire elements enter through the walls of the flask and that these elements can become stable and acquire substance-like properties, such as weight. Later, Mark repeated Alex's experiment with some changes and concluded that Alex's hypothesis (opinion) was false, since...

- i) What mistake did Alex commit?
- ii) How did Mark change Alex's experiment?
- iii) What conclusions did Mark come to as a result of his own experiments?
- iv) Calculate the mass of fire-substance, which, according to Alex, entered the flask during heating, given that the flask had a volume of 5L (sealed) and contained 4g of iron powder.

BIOLOGY

It is known that some animals live in families. Some live in big groups. Others live mostly by themselves. Animals have to find the right way of living together so they can stay safe, take care of their babies, and find food.

Groups of animals (these are called "aggregates") may be either temporary (animals group only for specific purposes) or permanent. For example, many wild and domestic animals live in herds.



Please provide other examples of permanent groupings of different animal species and explain why these groupings might be important for survival.

Give examples of temporary groups. Why do you think such temporary grouping exists? Feel free to illustrate your answer with images.