

PROBLEM OF THE MONTH: December 2012

MATHEMATICS

This story happened in the school of a small Scottish town. This school had exactly 1000 students. All of them had lockers that were numbered 1 to 1000. It was a very old building so probably just as you suspected there were 1000 ghosts living on premises.

Every night all students were locking their lockers and every night ghosts were playing opening them.

On one night students locked their lockers as usual and went home. The night was dark and perfect for the ghosts. At 12 am sharp they got out of the walls and started playing:

- The first ghost opened all of the lockers;

- Then the second ghost locked the ones that had even numeration;

--The third ghost didn't like it and switched it around - opened lockers (if they were locked) and locked them (if they were open) - for those that had the numbers that were divisible by 3;

- Ghost number four did the same for all lockers whose numbers were divisible by 4 (locked the ones that were open and opened the ones that were locked); and

- so on

- so on

- so on

As soon as the 1000th ghost finished his part the dawn began to break and all the ghosts had to disappear.

The students came to school in the morning as usual. How many lockers they found to be open?

PHYSICS

Two flat mirrors are joined with their sides at an angle of 17 degrees to form a wedge, with reflective surfaces on the inside. That is, looking from above, the two mirrors simply form an angle on the plane. A laser beam parallel to one of the mirrors and passing at the distance of 15cm from it, hits the other mirror, gets reflected, hits the first mirror, gets reflected again, and so on. What would be the smallest distance between the beam and the vertex of the angle, before the beam is reflected away?

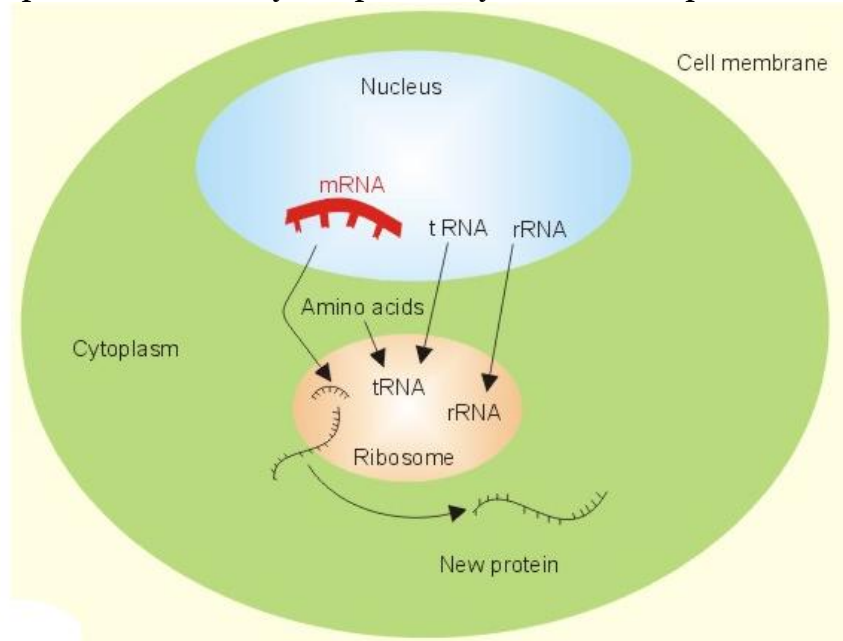
CHEMISTRY

Normal saline (sometimes referred to as *physiological saline* or *isotonic saline*) solution has many medical applications. It is a 0.9% m/v solution of sodium chloride (NaCl) in water. It can be used, for example, to clean contact lenses, as a nasal spray, etc. According to Wikipedia, "home-made" saline is made by dissolving approximately half a teaspoonful of table salt into "a glass" of clean water. However, the concentration you get according to this procedure is not too accurate.

Imagine, you need to prepare exactly 0.9% m/v saline solution, and you have no standard spoons, cups or "glasses" (or course, your kitchen scales appeared to be broken too). The only things you have are: your brain, Internet, salt, water, and some (non-standard) cups, glasses, pans. Please, propose the procedure for preparation of normal (0.9% m/v) saline with maximal possible accuracy.

BIOLOGY

It is widely accepted that in eukaryotes protein synthesis takes place in the cytoplasm.



Why do you think this is the case? (Wouldn't it be easier and faster to synthesize at least nuclear proteins "on site" without evolving elaborate mRNA- and protein-transporting mechanisms?)

Interestingly enough, almost all the components of the protein synthesis machinery can be found in eukaryotic nuclei making "nuclear translation" a plausible hypothesis. Please propose as many potential functions of nuclear translation as possible (at least two, or more for extra credits).