MATHEMATICS
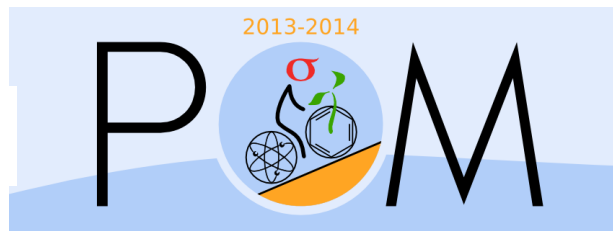
Two bricks, weighing 6 kg and 12 kg, are made of tin alloys with different percentage tin content. Someone cuts off a piece of mass m from each brick. Each piece is then melted together with the remainder of the other brick, and a new brick is then cast from the resulting material. The percentage content of tin in the new bricks is equal. Find the mass m.

PHYSICS

Using as little equipment as you can, determine the density of water ice in your freezer relative to the density of water in your tap. Please, try using only items that would be available in the 19th century (e. g. no electronic kitchen scales; freezer is OK, in the 19th century you would do that in winter time).

This is an experimental problem. You have to design the measurement, optimize the conditions for your experiment to guarantee the best accuracy possible, and perform the measurement. Describe your experiment in sufficient detail so that it can be reproduced by a person grading your work and estimate the accuracy of your measurement.

CHEMISTRY

A 250 mL conical flask (so called "Erlenmeyer flask") containing 10 grams of magnesium carbonate has been placed on the right scale of the pendulum balance scales. An identical flask, containing 10 grams of *calcium* carbonate, has been placed on the left scale. In addition to the flasks, there are two identical glass beakers with 80 grams of 30% nitric acid[1] on each scale. The scales are at equilibrium, as shown on the photograph.

Question 1. What happens to the scales after we pour the acid from each beaker into the corresponding flask, and place each beaker back to the original position? Will the scales remain at equilibrium? If not, which scale will go up?

Question 2. Will the result be different if we use only a half of the acid? Three quarters of the acid? (Of course, the rest of the acids remain in the beakers, and the beakers remain on the scales).

The SchoolNova web site contains all needed information to solve this problem
http://schoolnova.org/nova/classinfo?class_id=chemistry101&sem_id=f2013

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[1] 30 grams of nitric acid per 100 grams of the *final solution.*

BIOLOGY

We all have been taught by our parents that to stay healthy one should keep his or her body clean. Nature must have taught the same lesson to other animals as well because almost all creatures have developed some ways of cleaning and tidying themselves. Moreover, some animals continue doing it even when there is no apparent need for that; in animal life, cleaning plays a more important role than merely hygiene maintenance.

1. Man-made aids such as bathtubs, soap, plastic combs, and brushes are not available to animals, so they must manage with whatever equipment nature provides. Please list at least 5 different ways in which animals clean themselves (try to provide examples covering different animal taxa, e.g. insects, birds, mammals, etc.).

2. Please provide at least 3 reasons other than simple hygiene why different animals clean and groom themselves and each other.

COMPUTER SCIENCE

Write a Java program that reads 2 integers from the stdin (not from local variables) and returns true if only one of the integers is in the range [13,19].

For example:
onlyOneTeen(15,5) -> True
onlyOneTeen(1,19)->True
onlyOneTeen(13,14)->False

The program should reject improper input (such as strings, floats, etc) and use boolean expressions.

2 points for handling improper input
7 points for the correct onlyOneTeen function (I will be using my input for testing)
1 point for a short, easily readable program.

Some resources:
http://www.youtube.com/watch?v=PWez5mVXACc
http://www.youtube.com/watch?v=YeLkiLq14Qo
http://theoryapp.com/conditionals-in-java/
http://www.erpgreat.com/java/java-boolean-logical-operators.htm
http://www.dummies.com/how-to/content/how-to-use-boolean-expressions-in-java.html