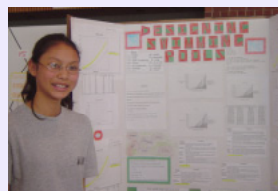


FOCUS ON MATHEMATICS

MATH FAIRS!

WWW.FOCUSONMATH.ORG

The *Focus on Mathematics* partnership is sponsoring school-wide Math Fairs of student research projects on topics in mathematics. The Math Fairs, held throughout April and May, encourage and support student research in each of the *FoM* school districts. This is a yearly event in which students develop projects that are mentored by teachers and mathematicians from Boston University, UMass Lowell, Worcester Polytechnic Institute, and EDC. Students then present their results to peers, educators, and panels of mathematicians and visiting scientists at poster sessions in the districts.



REMEMBER THESE DATES!

- **FEBRUARY/MARCH** – Students work on projects.
- **APRIL/MAY** – Math Fairs are held in schools.
- **JUNE 9, 2007** – Selected projects will be presented at the Museum of Science, Math Expo.

This effort is being coordinated by mathematicians

Art Heinricher (Worcester Polytechnic Institute) and Glen R. Hall (Boston University).

Students are encouraged to come up with their own ideas, but other project ideas are available. A preliminary list is available now at <http://www.focusonmath.org/FOM/resources/math/mathexpo/>
All project ideas are welcome!

For mathematical mentoring or help with project ideas, email: HardMathCafe@focusonmath.org

SOME PROJECT SUGGESTIONS:

THE SIMPLEX LOCK

The Simplex Company makes a combination lock that is used in many public buildings. It comes in several versions, but it always has 5 buttons. These locks are purely mechanical (no electronics). You can set the combination using the following rules:

1. A combination is a sequence of 0 or more pushes, each push involving at least one button.
2. Each button may be used at most once (once you press it, it stays in).
3. Each push may include any number of "open" buttons, from one to five.
4. When two or more buttons are pushed at the same time, order doesn't matter.

Getting Started

The company advertises thousands of combinations, but the question is, how many combinations are there? Is the company telling the truth? How many combinations would there be if the lock had only 3 buttons? 4 buttons?

Going Deeper

How many combinations would there be if the lock had 6 buttons? 7 buttons?

Submitted by A. Cuoco

AVERAGE RAINFALL IN THE STATE

Suppose you want to compute the average rainfall in Massachusetts, but the only data you have is from official rain gauges in Boston, Lawrence, Worcester and Pittsfield. How could you figure out the average rainfall for the state?

Getting Started

The gauges in Boston, Lawrence and Worcester are all in the Eastern half of the state while the gauge in Pittsfield is the only one in the west, so the gauge in Pittsfield represents the rainfall in more of the state than any of the other three. So each of the readings has to be "weighted" depending on what fraction of the state it represents.

Going Deeper

Where would you locate two rain gauges in Idaho in order to determine the average rainfall in that state? Justify your choice.

Submitted by A. Heinricher

WHY ARE THERE LEAP YEARS?

Everyone knows there are 365 days in a year—except in a leap year, when there are 366. The reason an extra day is added every four years is because the number of days in the year is actually 365.2422. Without a leap year, Boston's summer would eventually start in January!

Getting Started

Adding one day every four years makes the average year $365 + (1/4)$ days long, which is just longer than the actual length of 365.2422 days. To compensate, leap year is skipped in years ending with 00 (every hundred years). How close is the new average to 365.2422?

You'll see that this correction is pretty good, but still not perfect. One way to improve it is to, every so often, have a year ending in 00 actually be a leap year. How often should this be done? How close is this new average to the actual year?

Can this process be continued to make the average year even closer to the actual length? Could you come up with a more accurate calendar using the same idea (skipping or not skipping leap years in a regular pattern)?

Going Deeper

Can a decimal number (like 0.2422) be approximated by a sum and difference of fractions with numerator 1 and denominators forming a regular sequence? Are there other ways of representing a decimal as a sum of fractions that could be used to make a reasonable calendar?

Submitted by Chelsea High School Math Department