

Division B Environmental Chemistry:

This event will focus on the environmental aspects of soil. The following information is intended to help teams prepare for what could appear at the national event. The lab portion will be a significant portion of this event. Teams are encouraged to understand the following procedures before the tournament, as understanding the procedures may enable the team to work more efficiently. Procedural instruction at the tournament will be very limited. (14 April)

A. Main content areas that might be covered:

1. **Nutrient content of soils.** “Absolutely necessary” chemicals are compounds containing N, P, K. Vital are compounds of Ca, Mg, and S. Trace minerals necessary for plant growth are compounds of Fe, Mn, Zn, B, Cu, Mo, Cl, Si, Ni, and Co. The Division B event will emphasize the six primary nutrients while there may be a small number of questions involving the trace nutrients.
2. **Type and composition of soil**
3. **Porosity of soil**
4. **Permeability of soil**
5. **pH and buffering (neutralizing) capacity of soil. Students should understand what pH measures.**
6. **Water retention of soil.**
7. **Movement of environmental contaminants through soil.** Students should be able to determine from data whether a pollutant is from a point or non-point source.
8. **Environmental contaminants that might be harmful to plants or people eating the plants.**

B. The following lab skills and procedures may be needed. Students could actually perform these tests or perform calculations or interpret data obtained from any of the experiments.

1. General understanding of the processes and vocabulary of experimental design. For example, controls, variables, etc.
2. Determining water as a percent of the soil samples. Two methods can be used.
 - A. *Drying out wet soil*
 1. Take a saturated soil sample with no dripping water.
 2. Mass this sample, and then heat the sample at a low temperature until dry.
 3. Determine the dry mass.
 4. The wet mass - dry mass = mass of water;
mass of water/ by wet mass x 100 = %

B. Dry soil to wet soil

1. Mass dry soil, saturate the soil with water.
2. Wait until most dripping has stopped. Mass wet soil.
3. Use calculation method in "A" to determine water as percentage.

3. Determine pH of soil sample. This procedure requires measuring the pH of water that has been in contact with the soil. It might be a soil suspension or it might involve pouring water over the soil. To determine pH, use pH paper, acid/ base indicator solutions, pH meter, or pH probe from a Texas instrument device. To use the pH probe, the device needs to be inserted into the water sample. The pH is then read on the screen.

4. Determining soil porosity. Pores are the spaces between soil particles. A known volume of water is poured over a known volume of soil until the water covers all the particles. The porosity is the amount of water divided by the volume of the soil expressed as a percent.

5. Percolation rates. This test tells how fast water moves through soil. The standard science lab approach to percolation is to take a coffee can with both ends removed. It is then pushed into the soil until the can is half underground. Water is poured into the can until it fills the can above the water. The percolation rate is the time necessary for the all the water to drop below the surface of the soil.

6. Buffering (or neutralizing) capacity. This property can be measured by taking a reference acidic solution and letting it drip through the soil. The volume of the filtrate is measured, along with its pH value. Relative ranking of buffering capacity can be determined by how much the pH changes, with greater changes in pH meaning more buffering (actually neutralizing).

To numerically determine the amount, use a known acid solution and slowly add to the filtrate until it matches the original pH value. A simple way of reporting the quantity is number of drops of acid per volume of filtrate.

7. Soil particle size. Soils can be ranked by size of particles. If sample is dry, it can be passed through sieves of progressively smaller openings. If the sieve is massed before using, the change in mass is the mass of the particular sized particle in this container. Answers can be expressed as percentage by mass or the sorted dry soil can be poured into a volume measuring tool to determine percentage by volume.

8. Amount of sand, silt, and clay can be determined by measuring density of the soil suspension in water.

Procedure:

- A. Mass the dry sample.
- B. Pour the soil sample into a known volume of water in a tall graduated cylinder.
- C. Cover the graduated cylinder and shake for a few minutes.
- D. Let the sample settle for 40 seconds; all the sand should settle to the bottom in this time.

E. Use a hydrometer to measure density of the liquid. (Note: the height of the water needs to be enough that the hydrometer floats. To read a hydrometer, read the number of the line at the top of the liquid in which it floats.)

Hydrometer measures density, so if you know density and volume, you can determine the mass of silt and clay still suspended in the water. If mass of silt and clay are subtracted from dry mass, this equals dry sand. If the column is left for 2 hours, the silt should fall to the bottom. Repeat the same procedure and now calculate mass of clay. Combining this with mass of sand from earlier, gives mass of silt.

9. Determining N, P, K levels in soil. These compounds can be determined accurately with sophisticated tests conducted by state agricultural extension services. Simple tests can be done with RapidTest kits that will be used at the national tournament. For procedures of how to use each of these kits, please see

<http://www.biconet.com/testing/infosheets/rapitestSoilTestKit.pdf>

10. Determination of pollution contamination source in the field. This test requires measuring pollution levels at different locations and comparing the concentration. Detecting the pollution source relies on the dilution of the pollution as it spreads away from its original source. To trace the pollutant to its source, the concentration of the pollution is plotted on a graph of the area. Lines of equal pollution concentration, like contour lines on a topographic map or isotherms on a weather map, are drawn connecting similar data points. The more concentrated areas of pollution are the likely source regions. If the most concentrated area is small, this is probably a point source of pollution, like say an illegal dumping. If the greatest area of concentration is large, the pollution is more likely to be non-point, like you might find if an entire field was sprayed with a pesticide. Pollution in soil usually moves from higher elevation to lower elevation as the pollutants are carried by the water in the soil.