COMPILATION: MBL probes, equipment for 2nd semester Modeling Instruction

Date: Mon, 14 Apr 2003
From: Jane Jackson <Jane.jackson@ASU.EDU>

A modeler wrote me: "We are in the process of ordering equipment for next year. Do you have a recommended equipment list for teaching waves and light using modeling?"

Yes. Visit our high school web page for equipment ideas. Here's an list of MBL probes (old - from a query several years ago) that some Phase 1 (1995-97) modelers use for 2nd semester.

1) "I spend nearly the entire semester on electricity using the CASTLE materials. I don't use any probes." (Merv Koehlinger, Fort Wayne, IN. Also, Lou Turner, formerly near Akron, OH)

2) "I use the microphone (to measure the speed of sound) and the temperature probe (to determine the relationship between heat and electric work). I don't get to do much on light in the Modeling course. I do use the light sensor in the AP course to determine light absorption produced by a stack of glass plates (each of approximately equal thickness)." (Ellis Noll, Knoxville, TN)

3) " I use the temperature probe and the microphone. They are really essential probes. I try to have the students actually use the probes if at all possible. " (Nina Morley, near Raleigh, NC)

4) "The microphone sensor is very useful in modeling sound waves which we can't see. I don't use the other sensors in physics." (Hugh Ross, near Indianapolis)

5) "Light sensor for sure, but only need one or two. Temp probe, perhaps one. They don't seem to respond fast enough for much gas work." (Don Yost, near Sacramento)

6) Larry Dukerich (Mesa, AZ) said about the second semester, "Probes aren't used as heavily, but there's more room for simulation software. I use the microphone and Sound program by Vernier. It's superb! The light sensor is also useful, and, if you do a standard E&M treatment, the voltage/current probes would also be helpful."

Larry uses the current/voltage probe in his honors class. He said, "I would use it along with multimeters. I think kids should learn to use a multimeter. I think this probe is better than multimeters, because you can measure voltage and current simultaneously, watching how these values vary as a function of time. If you wanted to do anything with decay curves, for instance, these would be the things to have. You also have the option of running two current probes (great for checking current in parallel branches) or two voltage probes (fine for seeing potential differences at various places in the circuit) at the same time. You would need two multimeters and 6 hands to do the same thing the regular way."

7) Jim Stankevitz of Wheaton Warrenville South HS uses a class set of the light sensors and the current/voltage probes.

Date: Mon, 14 Apr 2003
From: Jane Jackson <Jane.jackson@ASU.EDU>

In 1999, I asked expert modelers what lab equipment they use for 2nd semester Modeling Instruction. Here are their replies.

1) Jeff Hengesbach, formerly of Mountain Pointe High School, Tempe, AZ, said: "Jane, I had a look through my materials list for second semester units. If I had to prioritize I would include the following in order of importance.

8-10 CASTLE Kits
Digital frequency generator
Van der Graaf generator
Mechanical wave generator
8-10 mini-mag flashlights
8-10 light sensors
Strobe light

Though there are a few other items, these are the main ones I would consider invaluable for the study of electricity, waves, and light."

Other equipment used for second semester content:

2) The Pasco optics system is expensive. Don Yost, who taught in a disadvantaged area, told me that he used instead a "convex lens, refraction tank, flat mirror, concave mirror, small lamp."

3) Jim Stankevitz uses: Ripple tank kits [various manufacturers] (one for each group), set of magnets - various sizes/types.

Date: Tue, 15 Apr 2003
From: James Vesenka <jvesenka@UNE.EDU>

We use a variety of Vernier probes for second semester physics:
* Fluid Model: Hydrostatic pressure and Bernoulli relationship, gas pressure sensor (barometer works better for Bernoulli, but the gas pressure sensor works in a pinch).
* Electric and Magnet Field Model: Circuits with the current and voltage probes, magnet field sensor to measure magnetic field dependence on radial separation from a long straight wire or center of a wire loop. We measure electric field relative strengths with a charged pith ball on a string at an angle to the vertical. The electrostatic force = weight x tan(theta) = charge x electric field. A quantitative electric field measurement can be obtained if you secure the charge on the pithball with an electrometer (Pasco). Trying to develop an electrometer for Vernier's equipment.
* Wave model: standing waves on string with a function generator (new Vernier LabPros will have this built in) an oscillator (speaker with a pin in the center that connects to a string.) Measure wave speed as a function of tension on the string or mass/length of the string - great model for mechanical waves in 3D. Sound sensor for speed of sound, sound wave analysis.
* Particle model revisited: Temperature probe to measure blackbody radiation cooling.

Date: Tue, 15 Apr 2003
From: Jean OOSTENS <joostens@CAMPBELLSVILLE.EDU>

Light probes are useful to plot diffraction and interference pattern. Also to determine the attenuation of light with distance (1/r^2 law).

One can show the coexistence of three modes in the cavity of a He/Ne laser using a polarizer and a light detector. As the tube warms up, it expands, and the polarization shifts causing the polarized component to oscillate between 1/3 and 2/3 of the total. One has a situation where the two extreme mode are parallel to the filter polarization to the case where the middle one is parallel and then back. It takes up to 20 - 30 minutes for the length of the cavity to stabilize.

I use Hall probes to check the dipole model: (a) the variation of the field of a permanent magnet along its axis (1/r^3 law). (b) The angular dependence of the radial and tangential components as a function of the angle. I use two probes, and show that the radial component follows

B-Rad = 2 p muzero Cos (Theta) / r^3

B-Tan = p muzero Sin (Theta) / r^3

This is done by spinning the magnet using music box, or by turning it by hand by steps of 10 degree at the time.

I use the pressure sensor and a syringe to study the gas law: PV = constant. Combined with a light sensor, I count the fringes of a Michelson interferometer as the gas cell in one of the branches is being filled (or pumped out).

The current probe is used to monitor the current of a permanent magnet motor driving a disk, this shows that the angular acceleration is proportional to the current. See the current issue of *The Physics Teacher* p. 303.

Covering capacitors, I compare the integral over time of the current used to charge a capacitor (0.05 to 3.5 Farad), with the integral of the current the capacitor provides to a load used to discharge it. Both should be equal to the product Q = CV, the charge stored on the capacitor. The charge and the discharge current go through various devices: resistor, light bulb, motor (free running or being loaded). Even though the graph of the current versus time varies widely, there is good agreement with the charge calculated from the formula. (I can send attachments of the presentation I made with 2 of my current students on request).