PHS 531: Methods of Teaching Physics II

I. Workshop objectives.

The main objective of the mechanics modeling workshop was to acquaint teachers with all aspects of the modeling method and develop some skill in implementing it. To that end, you were provided with a fairly complete set of written curriculum materials to support instruction organized into coherent modeling cycles (as described in Wells et. al. (1995)). The physical materials and experiments in the curriculum are simple and quite standard, already available in any reasonably equipped physics classroom.

In PHS 531 teachers will use the same process but will develop skills in materials usually covered after mechanics. You will be covering either Mechanical Waves or Models of Light using materials developed by modeling teachers from around the country. Their work has been arranged into units with a coherent story line and field tested in PHS 531 at ASU in previous summers.

II. Preparation and plans for PHS 531.

On the first day of the workshop, we will have a morning session with both groups combined that will include a discussion of the experiences of those participants who have taught mechanics by the modeling method. This "post-use analysis" will have the purpose of allowing novice modeling teachers a chance to discuss any concerns that have arisen as they taught.

The short duration of the summer workshop and the quantity of material to be covered in each of the content areas requires that you *make a choice* as to which of the content areas you wish to investigate during the workshop (Models of Light or Mechanical Waves). We believe that to develop the familiarity with the materials necessary to fully implement them in your classroom, you must work through the activities, discussions and worksheets, alternating between student and teacher modes, much as you did in the 1st Modeling Workshop in Mechanics.

If you are not sure which class to choose, review the 2nd semester materials so that you can make an informed choice of the unit on which you wish to work. To do so, you should go to the Modeling Instruction in High School Physics page, click on the [Curriculum materials] link, then on [Participant resources]. ... Scroll down to 2nd semester materials, then [Read Me First] link to get an overview of how the materials are organized, then on any of the links to 2nd semester topics. There you will find stuffed (Mac) or zipped (PC) archives of the materials to expedite download. If you are unable to obtain the materials this way, please e-mail Jane.Jackson@asu.edu and give her your full mailing address so that she can mail you a CD-ROM.

Special attention has been paid to the development of coherent teacher's notes. Review of these should give you the best idea of what the development team has decided was a logical development of the key features of the underlying models.

III. Description of the units in the 2nd semester materials.

1. Mechanical Waves & Sound

Unit 1 is called "The Oscillating Particle." In this unit we develop the model of an oscillating particle, its causal force model, the restoring force, along with its kinematical model, simple harmonic motion. We will develop graphical and mathematical representations by experimentally studying the motion of masses oscillating vertically on springs. Energy considerations are also studied.

Unit 2 is called "Mechanical Waves in 1-Dimension." In this unit we connect a string of particles together with springs to help develop the model of a wave being a disturbance propagated through the connected particles as they oscillate. We move on to study the behavior of transverse and longitudinal pulses as they move and reflect. After establishing pulse behavior we use standing waves on a string to experimentally develop the wave velocity equation relating frequency and wavelength. We finish by experimentally developing the relationship of the velocity of waves on a string and the linear density of the string along with the relationship of the velocity and the tension in the string.

Unit 3 is called "Sound." In this unit the model of sound being a pressure wave caused by longitudinally oscillating particles is developed. We study the concept of resonance and factors necessary for it in tubes, on strings and on rods. We use MBL microphones to study beats, harmonics, pitch and loudness. We finish the unit with the Doppler effect.

Unit 4 is called "Mechanical Waves in 2-Dimensions." In this unit we study reflection, refraction, diffraction and two-slit interference. This unit makes use of ripple tanks to develop two dimensional behaviors. To be honest, the oscillating particle model is not taught as a factor in these behaviors. Due to the difficulty of studying these behaviors fully using coupled particles, we will use light.

Each unit will make use of Java applets, practicums, MBL probes, many demonstrations and deployment activities. All participants will leave with a set of singing rods with rosin, and a Chladi plate.

2. Models of Light

Unit 1 starts by modeling light as stream of tiny particles (rays), treating a variety of light behaviors including aspects of geometric optics. The second unit is introduced with experiments that reveal the inadequacy of light as a particle and explains light behavior as a wave. Finally the wave model of light is discounted and a model of light as a photon is developed. The Light units end with a brief introduction of how light can be used to explain the structure of the atom.

Unit 1 is called "The Particle Model of Light." In this unit we develop the model of light as stream of particles to explain a variety of light behaviors including shadows, intensity, reflection and refraction. A variety of experiences in light are pursued including simple low cost activities, high-tech activities and computer simulations.

Unit 2 is called "The Wave Model of Light." This unit starts with activities involving diffraction and interference. The unit activities and labs effectively transition the student from a model of light as a particle to a model of light as a wave. A section on mechanical waves (one and two dimensional waves) is provided to support student practical comprehension of waves.

Unit 3 is called "The Photon Model of Light". This unit uses the photoelectric effect to support both the model of light as a wave and light as a particle. The interaction of light with matter is emphasized. The photoelectric effect is examined to establish the model of light as a photon. The photon model is then used to explain spectra of light emitted by gasses. Teachers use both interactive computer simulations and specialized equipment in this unit.

Each participant will receive a CD-R containing the resources for both the 1st semester (mechanics) and the 2nd semester instructional materials.