23 May, 2013

University of Louisville's Marsh White Award Project

The University of Louisville chapter of the Society of Physics Students is grateful to SPS National for the Marsh White Award for 2013. The award was used to update our display case, which is passed by hundreds of students daily. Prior to its makeover, the case had featured the same items for the past five years, all set atop the same faded black cloth. The new items make the case interactive, teach a variety of physics concepts, and can also be removed when needed for demonstration days.

Laser Pointer Communication

This fascinating device demonstrates conservation of energy and photovoltaics. Wiring a laser with a transformer, a diode, and a headphone plug, we modulate the signal from the headphone jack of the radio back into an electrical pulse which impacts the current running to the laser. Connecting a piezoelectric earphone to a photovoltaic cell allows us to capture the laser light and transform it back into sound. As the input from the radio jack changes with the beat of the music, the laser light pulses due to changes in the current powering the laser. These changes are also captured by the photovoltaic cell and converted to sound by the earphone. The music is converted from radio waves, to an electrical signal, to a light signal, back to an electrical signal, and finally to a sound. Though quiet, the music is easily recognizable in the earphone.

Homemade Spectroscope

Spectroscopy could not be made easier than ordering a diffraction grating and heading to the plumbing section of your local hardware store. We used a piece of PVC pipe, an angled pipe piece, and a rubber cap to make our tube. Cutting a thin slit in the rubber cap and propping it open with a few thin pieces of cardboard allow just enough light through to let the spectroscope function. While in the display case, we use a mirror to shine light from a fluorescent ceiling light into the tube, allowing students to see the

spectral lines. We chose a 1000 line-per-millimeter holographic grating which produces decent spacing of emission lines.

Radiometer

Many misconceptions exist regarding this simple device. Neither the result of light pressure nor the release of heat explain why light makes the vanes spin. The pressure difference between the two sides of each vane caused by the uneven absorption of light allows air molecules (the few that are in the near-vacuum of the bulb) to transfer from one side of the vane to the other. The movement causes the vanes to spin, despite the lack of motors.

Roller Coaster

A roller coaster car plummeting down a steep incline, maximizing its speed at the bottom and accelerating upwards again toward the next hill is an easy visual representation of kinetic and potential energy. This K'Nex set is wired to a push button in the front, allowing students to turn on the roller coaster to watch it work. We measured the mass of the car and the relative height of the track to determine its speed at various points along the track.

Wilberforce Pendulum

The Wilberforce pendulum represents coupled modes of oscillation, both translational (bobbing vertically) and rotational (spinning on the spring's central axis). The spring is stretched and released, going up and down as expected. Not long after, the bob on the bottom of the spring begins to oscillate back and forth, rotating around the bottom of the spring as it continues to go up and down. Eventually the vertical motion stops completely and the bob spins back and forth while sitting at a constant height. The bob gradually regains its vertical motion, returning to a completely translational mode before beginning the process again. This is caused by the spring uncoiling slightly as it stretches with the vertical bobbing. This stretching adds an additional rotational component, allowing the mode to dominate for a time. Made of PVC

pipe, a spring, a dowel rod, and binder clips, this was another easy-to-make, inexpensive project.

Optics Demo

Though being saved for next semester, the optics demo includes lasers, prisms, diffraction gratings, and mirrors. Using a light bulb versus a green laser pointer, we will trace the path of light through a series of prisms and extra virgin olive oil, which fluoresces orange when exposed to green laser light. Along similar lines to the olive oil, a black light and glow-in-the-dark stars will also demonstrate fluorescence.

Additional Items

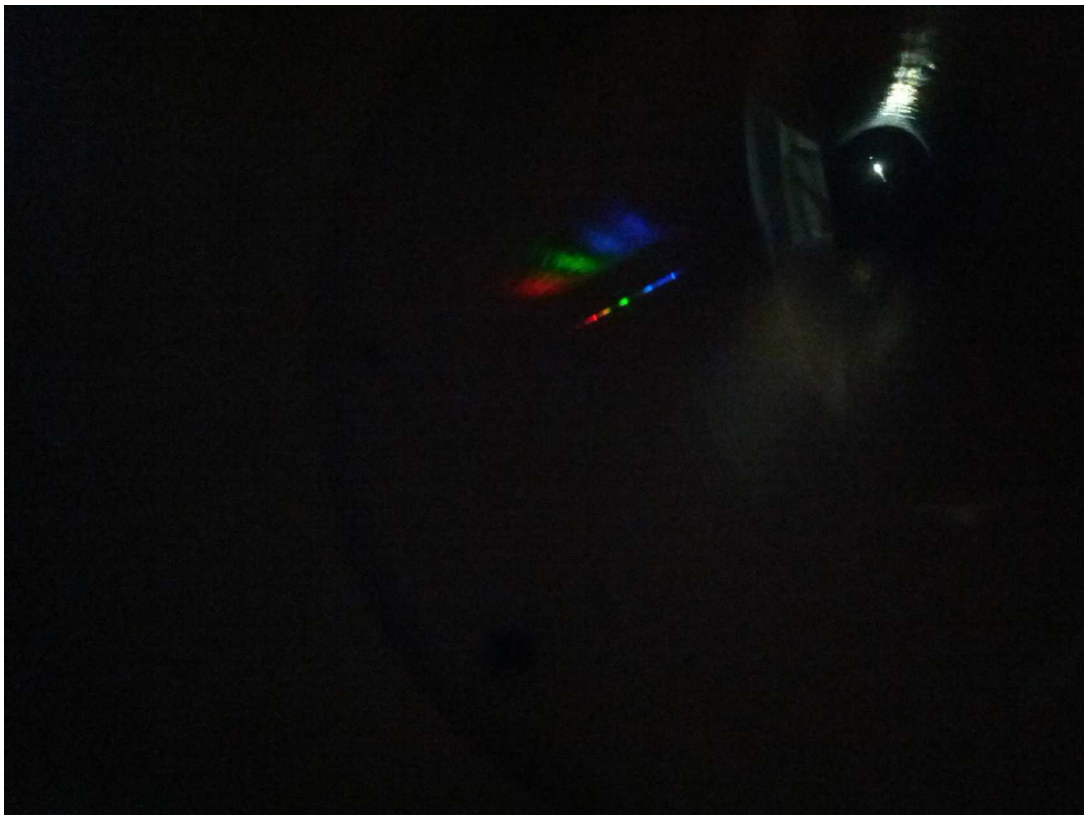
Other items in the display case include a computer which displays a PowerPoint from AIP, a Galileo thermometer, a Galileo-scope, and a center of mass demonstration. Though not funded by the Marsh White Award, these items offer additional content to the case, allowing us to rotate more new items in the future.

We found a few of the items at discount prices, and also saved money when a member offered cleaning services for the backdrop cloth, leaving a little money left over to go towards the case during the fall 2013 semester.

Creating an interactive display took a little imagination and some handy work from those involved. The initial proposal to implement motorized gadgets proved too much for some of the ideas, but the resulting demonstrations are far more interesting than what was originally planned. A good scrubbing and some new equipment certainly got the attention of everyone who passes. These items also came in handy outside of the case during the school of engineering's E-Expo event in April, in which we interacted with hundreds of grade school and high school kids. A few math professors have already stopped by to ask for suggestions for their department's display case.

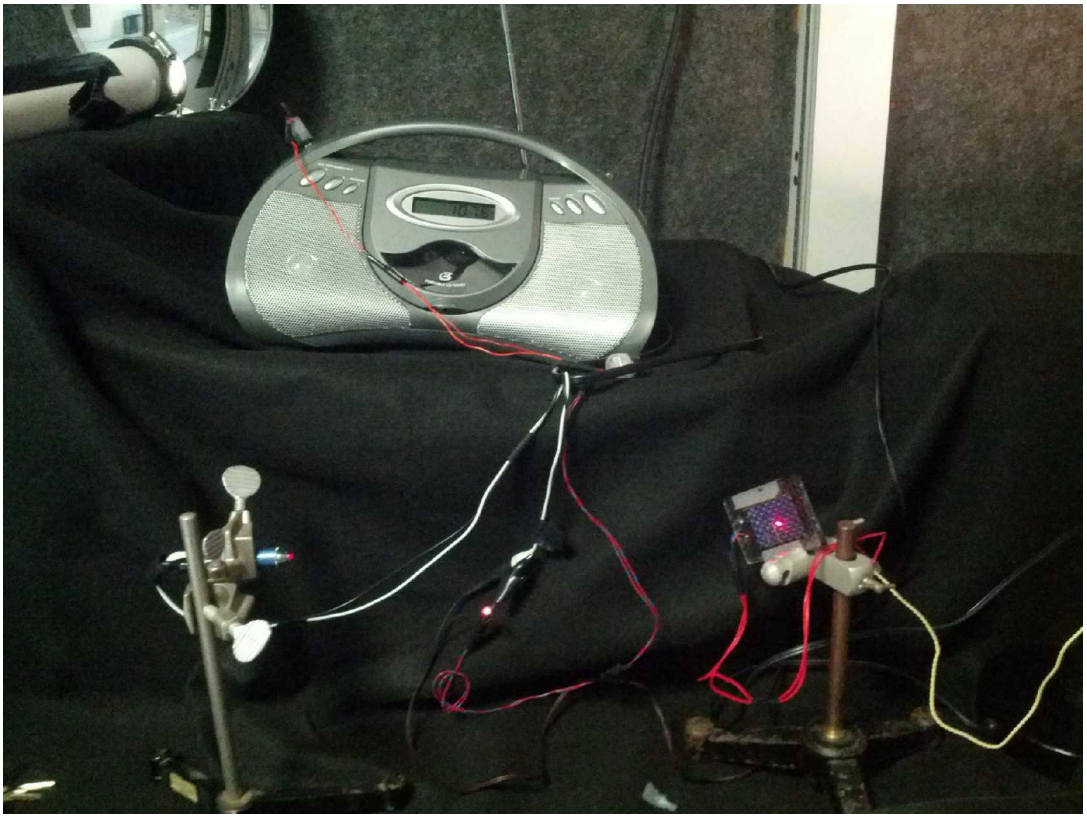
We'd like to thank the Society of Physics Students for their funding and support, as well as the volunteers who helped clean and stage the case.

Expenditure	Amount
Laser pointers	$60.27
Wiring and transformer	$12.96
Solar cell and earphone	$15.27
Radio	$26.49
Diffraction gratings	$8.52
PVC pipe materials (pendulum and spectroscope)	$8.00
Pack of metal springs	$10.95
Radiometer	$19.93
K’Nex roller coaster	$31.48
Prism set	$25.88
Fluorescent paint	$7.67
Extra virgin olive oil	$7.50
Security locks	$22.23
Power adapters	$20.97
Additional Materials (binder clips, rod, tape, poster board, etc.)	$9.77
TOTAL	**$287.89**



Above: View inside the spectroscope of a fluorescent ceiling light.

Below: Using laser light to transmit the music to the solar cell with an earphone.



Above: Radiometer in motion.

Below: SPS Officers for Spring, 2013.