NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS (An Affiliate of the A.A.P.T., and a charitable organization) September, 2009

The Demonstration Corner

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An Inexpensive Magnetometer

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Several years ago I was in need of a cheap, easily assembled, sensitive magnetometer. The intent was to design a tool for students to palpably observe the magnetic field around a current carrying conductor. Deflection of a compass needle lacked the 'wow factor' I sought. The solution turned out to be beautiful in its simplicity.

A plastic petri dish is the central component, consisting of a circular bottom dish with a slightly wider dish acting as the lid. Begin by taking the top dish and sitting it flat, like a tiny swimming pool. Fill it nearly to the brim with water (place the dish on a paper towel for spillage). The bottom dish is then floated on top of the water-filled top plate. A small wooden stick, with a wafer magnet hot-glued on each end, is set across the centre of the top dish so that it balances easily. Give this a tiny torque and it should spin freely without the edges grinding. Adjust the amount of water and the position of the wooden stick until friction is essentially eliminated. You now have a sensitive (qualitative) magnetometer (Fig. 1). Any standard magnet can be used to gauge the sensitivity.

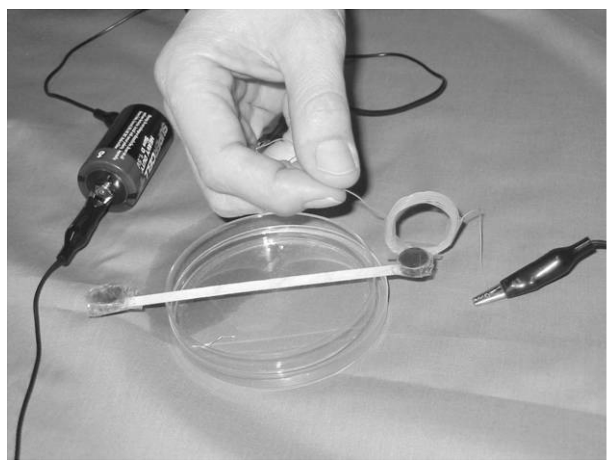

Figure 1: A coil of wire (10 windings) is held near one of the wafer magnets glued to the wooden stick. This causes the dish/stick assembly to rotate, depending on the position of the coil, direction of current, and wafer polarity.

Students first test a disconnected wire for magnetism — this gives a null result. Then they attach the wire leads to the terminals of a 1.5-V battery. The wire should be stretched flat and held directly overtop one of the wafer magnets. The orientation of the wire is critical. When placed parallel to the wooden stick, and directly over one wafer magnet, the resulting rotation of the dish/stick apparatus is maximized.[1] The rotation is reversed by switching the leads. The alligator clip ends of the wire need to be kept away from the wafer magnets, as the steel leads are magnetic.

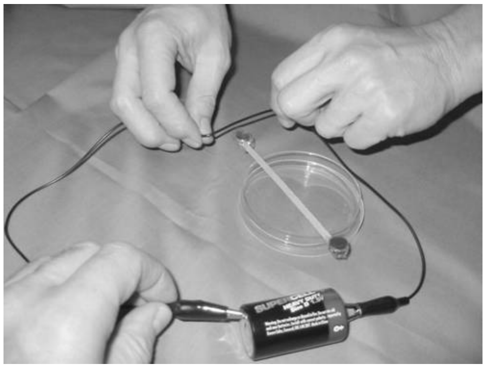

Figure 2: The conducting wire, when perpendicular to the wooden stick, produces zero torque but causes the stick/magnet assembly to accelerate linearly. This halts quickly as the petri dishes make contact.

When the wire is perpendicular to the stick (Fig. 2), but still directly above a wafer magnet, the rotation is zero. In this case the magnetic force is directed along the long axis of the stick, and careful observation will reveal the entire assembly to accelerate linearly for a brief time, halting when the floating dish butts against the bottom dish. Students can coil up the wire to see the notable increase in attraction or repulsion. By "flipping" the coil, they begin to visualize the coil's N-S magnetic polarity, mimicking the magnetic field about the wafer magnet. A ceramic magnet can be substituted for the coil to underscore this similarity.

Teachers can scaffold this activity into the SPH3U *electromagnetism* unit. The new curriculum emphasis on inquiry learning would support a minimal introduction, if any, and an opportunity for students to present whiteboard observations and explanations to their peers. It would be a simple matter for class groups to try wires and coils and list a series of observations. Each group could then select a different observation to explain. As discussions ensue, groups should be free to modify their explanations. This mirrors the fluid, provisional nature of science modeling and reinforces the student-centered instructional approach recommended on page 31 in the **2008 11/12 Ontario Science Curriculum**: "*A much more effective way to learn is for students to be actively involved in thinking and discussing during both class and investigation activities, with the goal of having the students develop a deep understanding of scientific concepts*."[2]

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Email: elm@physics.uoguelph.ca Submissions describing demonstrations will be gladly received by the column editor.

[1] The force on a charge q moving with velocity $\vec{v}$ in the wire in the magnetic field $\vec{B}$ above the wafer magnet is given by the vector cross product $\vec{F} = q\vec{v} \times \vec{B}$. The magnetic field above the magnet is essentially vertical, and since $\vec{v}$ is along the direction of the horizontal wire, the direction of the force on the wire will also be horizontal but perpendicular to the wire. Therefore, when the wire is parallel to the stick, this force will be perpendicular to both the wire and the stick. By Newton's third law of motion, the force on the magnet (and attached stick) will be in the opposite direction to the force on the wire. Thus, the force on the magnet is also perpendicular to the stick and this force provides a torque that rotates the stick/magnet assembly.

[2] Kathleen Falconer et al., *Effect of Reformed Courses in Physics and Physical Science on Student Conceptual Understanding* (American Educational Research Association, April 2001, p1).

Ontario Association of Physics Teachers

American Association of Physics Teachers

FREE - AAPT/PTRA Workshop for Physics Teachers

The OAPT and AAPT are offering a 6-hour Physics Teaching Resource Agent (PTRA) workshop on Laboratory Activities for Physics Teachers in Ontario.

When: Saturday, November 21, 2009, 9:00 – 4:00pm
Where: Victoria Park Collegiate Institute, 15 Wallingford Rd, North York

Presenters: Diana Hall, PTRA (OCDSB) and Sarah Torrie (TDSB)

Please visit **www.OAPT.ca** - home page under "What's New" for more information.

MODERN PHYSICS

The Safety of Laser Pointers

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Lasers are fabulous tools that clearly show many key properties of light from basic optics to interference and quantum erasers[1]. However, the safety of laser pointers is in need of clarification. Lasers of Classes I and II have beam powers of less than 1 mW and are generally considered safe for supervised classroom use. Lasers that are Class III or IV are considered to pose unacceptable potential danger. Now, check the labels on your laser pointers. You will find that they are all Class IIIA – even the cheap dollar store versions!

This is because there is a problem with the classification system. Class IIIA lasers are restricted to 5 mW while Class IIIB can put out up to 500 mW. That's two orders of magnitude greater! So, should we be concerned about using these lasers? Dennis M. Robertson, an opthamologist at the Mayo clinic, has done some very clear studies on laser pointers and eye safety. In 2000 he pointed a 5 mW laser pointer at a human eye for 15 minutes (it was due to be removed for medical reasons) and he couldn't find any effect[2]. In 2005 he repeated the experiment with a green laser pointer. In this case, after 60 seconds, the patient reported no change in vision, but Dr. Robertson was able to detect changes to the retina. This makes lots of sense. Your retina is red, which means it absorbs green and reflects red. If it absorbs the light, it heats up. This is something that the classification system doesn't address. I found a website selling a Class II green laser pointer. It stated "This pointer is visually the brightest laser one can find

[1] If you visit my website http://roberta.tevlin.ca you can find out how to use a laser pointer to make a quantum eraser.

[2] You can find the articles at the website of the Archives of Opthamology - http://archopht.ama-assn.org/ - Dec. 2000; 118: 1686-1691 and 2005; 123: 629-633.

with a CDRH Class II rating … the highest class rating that many school systems permit."[3]

So, it appears that the red laser pointers are safe to use in the classroom and the green laser pointers are questionable. It is really easy for students to purchase a dangerous laser over the Internet.[4], so when we use a laser pointer we should take the opportunity to point out the real hazards of other lasers and model clearly how to use a laser so that the beam is never pointed or reflected near anyone's eyes

Roberta Tevlin

[3] http://www.i-fiberoptics.com/laser_detail.php?id=115

[4] www.dealextreme.com - This site has many Class IIIB green lasers that put out 100's of mW as well as some very cheap Class II red.

Spring Meeting

Highlights from Kingston May 2009

James Ball
J.F. Ross, Guelph

This past May The Royal Military College of Canada hosted our annual meeting. Our hosts Jean-Marc Noel and Mark Labrecque put together a terrific three day event. It began in style with a barbeque at the officer's mess. The evening kicked off with Rolly Meisel myself and Glenn Wagner sharing some of our favourite demonstrations. The evening finished with a excellent talk on remote sensing (an RMC specialty) by Dr Joseph Buckley.

Friday morning began with our keynote address by Randy Knight author of "Five Easy Lessons: Strategies for Successful Physics Teaching". Randy showed us that in order to transform student learning we must transform physics teaching. Randy's session was followed up by the first of three workshop sessions (one of which he also gave). These sessions covered such topics as electrostatics, hands on quantum mechanics and practical Newtonian physics labs. Tom Russell and Eric Finn took us through some excellent examples of POEs (Predict Observe Explain). Sarah Torrie shared with us the wonderful teaching and learning opportunity available to us (and our students) at the Canadian Light Source in Winnipeg. Jim Hunt amazed us with another investigation into Anamorphic art. The day ended with a tour of old Fort Henry where, after an excellent dinner, Terrence Dickinson shared his passion for Astronomy with us.

Figure 1: Jim Hunt and a Refractive Anamorphic Viewer

Saturday began with our final set of workshops. John Berrigan took us for a ride with his session "Rockets for Dummies". The day concluded with Jean-Marc Noel sharing his research with us helping us to understand how Auroras influence satellites.

Please come and join us next year at U of T as we see how they have transformed undergraduate physics teaching using lab practicals.

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