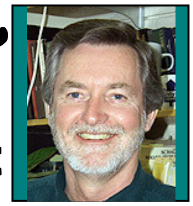
NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS (An Affiliate of the A.A.P.T., and a charitable organization) November, 2008

# The Demonstration Corner

## The Ultimate Elevator Ride: Weight and Apparent Weight



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We all know that some concepts are harder for students to comprehend than others. The concepts of *weight, apparent weight* and *weightlessness* are often stumbling blocks for many of our students. Apparently they are also somewhat confusing for the seasoned scientists and engineers. While visiting the Lyndon B. Johnson NASA Space Centre in Houston, TX, I had a unique opportunity to have lunch at the "Zero-G Diner"[1]. Apparently, the Space Centre Houston is located at a special place where Newton's Law of Universal Gravitation does not hold and should be modified.

When discussing the concepts of weight and apparent weight I like to bring a bathroom scale to class. Then I ask a volunteer to draw a Free Body Diagram for a person standing on a scale. I make sure the students label all the forces using two indices: the force of the scale on the person (aka apparent weight or normal force); the force of Earth on a person (aka weight).

Then we discuss what happens when the person has acceleration directed downwards or upwards. Notice that downward acceleration can happen either when the person is moving down while speeding up or when the person is moving upward while slowing down. This can be illustrated when a student starts squatting while standing on a scale. The scale will show a student's real weight only when the student is standing still or when she is moving with constant velocity (which is hard to achieve while on a scale). However, as soon as the student starts squatting or even jumping, the values of the normal force

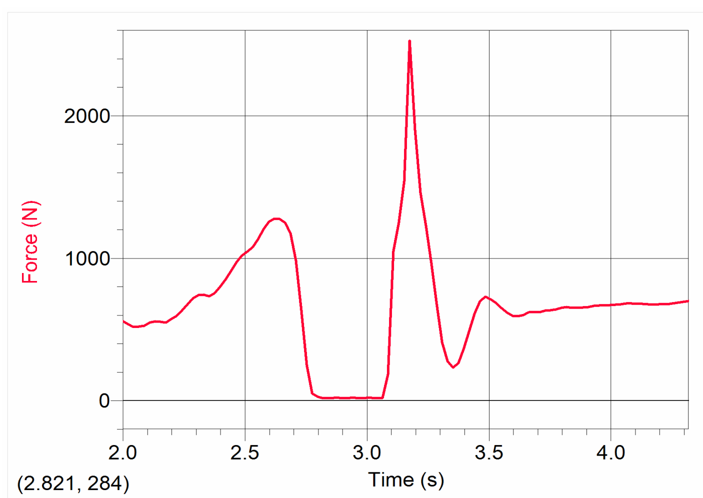


Figure 1: Recording of the normal force (apparent weight) for a student jumping off a scale.

(apparent weight) and the weight will differ.

This demonstration can be performed even more effectively if instead of a regular bathroom scale you can use an electronic scale connected to a computer, such as a Vernier Force Plate[2]. Ask a student to stand on such a scale and then jump up. The scale readings during the jump (Figure 1) will differ dramatically from the student's weight.

For even a more dramatic demo, invite your students to ride an elevator with you … while standing on the Force Plate and recording the data (Figure 2)! This ultimate elevator ride will provide your students with an opportunity to **discuss and experience** the concepts of weight, apparent weight and ultimately of weightlessness (hopefully you will discuss "weightlessness" only theoretically as nobody wants to experience weightlessness while riding in an elevator). I did it with my students and based on their feedback this was one of the most memorable experiences in the physics class.

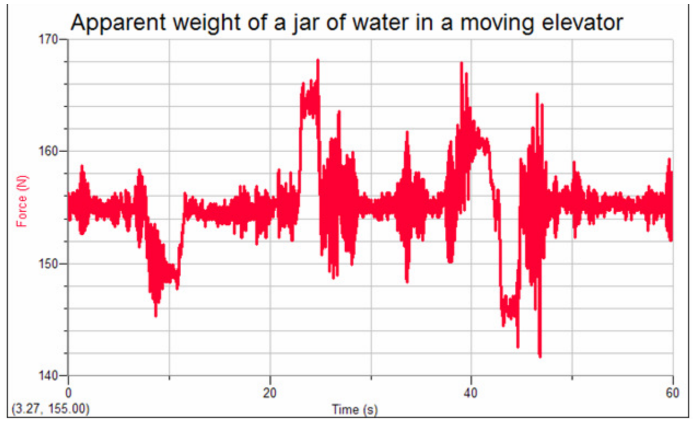


Figure 2: Recording of the apparent weight of a jar of water in a moving elevator.

***References:***

[1] Space Centre Houston, Houston, TX: http://www.spacecenter.org/

[2] Vernier Technology, 2008. www.vernier.com

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Submissions describing demonstrations will be gladly received by the column editor.

# MOdern PhYSiCS

## CERN Large Hadron Collider

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The LHC was all over the news this fall and will be again in the spring. Your students are going to be asking you lots of questions about it. To understand what the particle physicists do, you need to use lots of physics from the grade 12 curriculum: circular motion, conservation of momentum, electromagnetism, relativistic momentum and energy etc. There are many resources on the Internet but many of these are hard to follow or goofy or just a bunch of words on a computer screen. Here are the best resources that I've found so far. These will get your students actively engaged in learning about particle physics.

1) There are many particles other than protons, neutrons and electrons. Let your students be bubble chamber detectives during the EM unit. They can figure out quite a lot by applying the right hand rule for a charged particle in a constant magnetic field, conservation of momentum and charge. Two good sources of bubble chamber photos from CERN and their analysis can be found at http://education.web.cern.ch/education/Chapter2/Intro.html and http://quarknet.fnal.gov/biblio.shtml

2) Bubble chambers aren't used very much anymore because they are too slow. To get up to date you should have your students visit Fermilabyrinth at

http://ed.fnal.gov/projects/labyrinth/games/index1.html. There are 12 games there. In "Warp Speed" I recommend "Push the Particle" where they can try to build the best linear accelerator. In "Ghost Bustin'" I recommend "Particle Trappin'" and "Detector Detail" where they can learn about calorimeters which are very important for the LHC.

3) From 1989 to 2000 CERN was running the LEP in the 27 km ring that now houses the LHC. It collided electrons and positrons instead of protons and antiprotons, but was otherwise very similar. It was used to discover the W and Z particles that transfer the weak nuclear force. Your students can analyse 3-D data from these experiments at http://keyhole.web.cern.ch/keyhole/. I recommend that you avoid the two annoying animated ducks that try to teach the physics. Go to the index and then to "Projects". There are ten sets of 100 events that the students can analyse. Also in the index is "Projects, teacher's instructions" which contains answers! You can get this program on a CD ROM by emailing Antonella.Del.Rosso@cern.ch

4) In 1995 physicists at Fermilab discovered the sixth and final quark – the top quark. If you go to http://ed.fnal.gov/samplers/hsphys/activities/summary.shtml your students can use conservation of momentum in 2-D and come up with the mass of the top quark themselves.

The best books dealing with this material are "**Understanding the Universe: from Quarks to the Cosmos**" by Don Lincoln, 2004, "**The Quantum World: Quantum Physics for Everyone**" by Kenneth W. Ford, 2004 and **Quarks, Leptons and the Big Bang**" by Jonathan Allday, 1999. If you want more details of how to use these in the classroom you can visit my website http://roberta.tevlin.ca. If you know of some other great resource in this area please let me know about it! Thanks Roberta Tevlin, roberta@tevlin.ca

# Transitions

## Factors affecting the Drop Out Rate in First Year University Courses

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A recent paper [1], with an abridged and updated version [2], discuss the increase in drop-out rate from the introductory physics course at Trent University (Physics 100) from the 1980's to the present, primarily with the same instructor and the same content and rigour. Over this time, the drop-out rate rose gradually from about 8% to about 16% in 1998. This was followed by a more abrupt rise to over 25% in the last 9 years with the exception of the double-cohort year (2003-04) and the following year which included the 22% of double-cohort students who stayed in high school for an extra year. For these two years, the drop-out rate plummeted back to 9% before rebounding in 2005-06; a similar decrease in these years was seen at Brock University and the University of Guelph. The paper considers possible reasons for these changes. It also investigates ways to decrease the drop-out rate once students reach university, based on a survey of students who stayed in the course or dropped it. The main conclusions are the following.

1. The most likely cause of the dramatic decrease in the drop-out rate for the double-cohort students was their improved work habits developed in high school, driven by four years of trying to ensure a place at university when it seemed likely that the competition for these places would be extreme. This raises the question of how to ensure that students develop good work habits in the absence of the double-cohort pressures.

2. The large increase in drop-out rate, particularly over the last 9 years, is likely caused by a combination of grade inflation at the high-school level and the primary goal of many university students to gain a credential for a job rather than learning for its own sake [3]. The paper documents

grade inflation in two ways: the average grade of Ontario students applying to Ontario universities rose an average of 0.23% per year from 1998 to 2006, and the percentage of Ontario Scholars (graduating high-school students with an average of at least 80%) has risen at one (presumably typical) high school from about 5% in the 1960's to about 30% now. Since the replacement of grade 13 by the OAC system in 1990, the percentage of Ontario Scholars at that school has increased by 1% per year. As the *de facto* entrance requirement to university has remained roughly constant at about 70% since 1990, this implies that students entering university have been progressively weaker on average. This is substantiated by their performance over the years on the same test in some courses at university.

3. High-school preparation in physics and mathematics does not seem to be a major factor in the drop-out rate, as the percentage of students entering Physics 100 with calculus and physics has remained fairly steady at about 90% and 80%, respectively, from the 1980's to at least 2001. However, the percentage of students in Trent's Physics 100 with 4U/OAC physics fell to 66, 72 and 63% in 04-05, 05-06 and 06-07, respectively, which may partly explain the very high drop-out rates of 27% and above in the last three years.

4. We carried out a survey in Physics 100 in March of 2005-06, to try to determine which of a variety of potential causes might have contributed to the drop-out rate that year, including (1) hours per week students spent on paid work (to finance their education), (2) commuting times, (3) a culture of dropping courses in high school and in university, (4) years off after high school, (5) high-school physics background, (6) high-school math background, (7) whether or not a student lived in residence at university, and (8) whether or not students worked on assignments with their peers. The only three factors which were statistically correlated, at the 95% level or better, with students remaining in the course were the following: living in residence, working with other students on their physics problems assignments, and having taken the 4U/OAC physics course. The first two results are consistent with other studies that show that students who are well integrated socially and intellectually into university life are more likely to complete their degrees. The dependence on high-school training in physics (even when the university course begins by repeating all of high-school physics) is substantiated by data from the University of Calgary which show that students without the senior high-school physics course were four times more likely to drop their university physics course as were student who had taken that high-school course, even when the former group was enrolled in a course specifically designed for students without prior physics preparation.

5. Finally, the updated version of this paper in *Physics in Canada* includes new data, derived from the records of the Ontario Universities Application Centre, showing that the percentage of applicants to Ontario universities (from Ontario high schools) who took the 4U/OAC physics course has fallen from 35% in 1999 to 27% in 2007, a decrease of 23% over this time. Over the same period, the number of students attending Ontario universities has doubled, with the result that the absolute number of students taking 4U/OAC physics has remained roughly constant. However, Trent's Physics 100, like most introductory university physics courses, has grown in enrolment by about 30% over this period, implying that fewer of our students have a physics background, as verified in point 3. above. In contrast, the percentage of high-school students taking the senior physics course in British Columbia has remained roughly constant over this period, so the decrease in the percentage of Ontario students taking this course seems likely to be an Ontario phenomenon. One has to wonder if this is related to the Ministry's drive, beginning in 2000, to have more students graduate from high school, and the concomitant changes in student assessment practices.

[1] Canadian Journal of Physics **86**, 839-847 (2008).
[2] Physics in Canada, July – Sept. issue (2008).
[3] J.E. Côté and A.L. Allahar, *Ivory Tower Blues - A University System in Crisis.* (University of Toronto Press) 2007.

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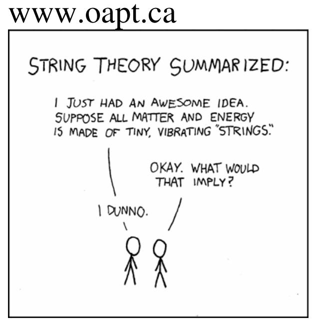


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