Physics contests for high school students

Sponsored by AAPT sections

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For two years the Ontario Section of AAPT has sponsored a "Grade Eleven Prize Physics Contest." The purposes of this contest are to generate interest in physics, and to give recognition to outstanding high school physics students.

This article describes how the contest began in the Ontario Section, the adaptation of the contest by the Southeastern Pennsylvania Section, the outcomes of the contests, and suggestions for other Sections interested in beginning a similar contest.

Ontario provides five years of high school with two full years of physics in grades eleven and thirteen, the latter being a PSSC-based course. There are three physics contests[1-3] available to grade-thirteen students with prizes ranging from books and subscriptions to $8000.00 scholarships. Mathematics contests are available for students at all levels.

During 1979-1980 Barbara Ure was a grade-eleven student in a physics class taught by Doug Fox. Barbara was preparing for the mathematics contest and knew of the grade-thirteen contests in physics. She asked why there was not a contest for grade-eleven physics students. Barbara asked the right question of the right person. Doug Fox was vice-president of the then fledgling Ontario Section of AAPT.

To gain experience Doug Fox organized a dry run of a contest for the spring of 1980. Questions for the contest were solicited from the University of Guelph, the University of Windsor, and the University of Western Ontario. These questions formed a pool that was used in the development of the contests. Doug asked the then tiny Ontario Section membership for volunteers to administer the contest and received 42 responses. The dry run was limited to ten students per school but the interest was so great that difficulty was experienced by the teachers in limiting the number of entries in their school. This was the first concrete evidence of the potential and value of the contest idea. Armed with this experience the Ontario Section tackled the province as a whole in 1981.

Four sets of mailing labels for all the schools in the province were provided by the University of Waterloo and were used as follows:

1. master record set,
2. mailing publicity and order form,
3. mailing the contest, and
4. mailing the contest results.

The University of Guelph provided computer response cards, computer time and some clerical help with the analysis of the contest results.

In February each school was sent a package containing a letter announcing and explaining the contest, posters for classroom display, and an order form. Also included was a copy of a recent Section Newsletter. Although the Ontario Section now charges a dollar per copy of the contest, in 1981 it was fifty cents. The major cause of the increase was a large leap in postal rates. On the order form there was a checkoff box for enrolling or renewing membership in the Section. This checkoff box substantially increased the Ontario Section membership. There is no doubt that the contest project contributed to the fast growth of the Ontario Section. Although Ontario is the newest section of AAPT it is now the second largest with 580 members.

Doug Fox *earned his B.S. and M.S. in astronomy at the University of Western Ontario and an M.Ed. at the University of Windsor. He has been teaching physics at Belle River District High School for 12 years. He is a past president of the Ontario Section of AAPT. (Belle River District High School, Belle River, Ontario, Canada N0R 1A0)*

James H. Nelson *received a B.S. in physics from Lebanon Valley College, an M.S. in physics from Clarkson and an M.Ed. from Temple University. He has taught physics and other sciences at Harriton High School for 22 years. He relaxes with classical music, sings in a church choir and gets his exercise playing tennis. (Harriton High School, Rosemont, Pennsylvania 19010)*

AAPT-Ontario Section Contest

1. Nowhere in Physics is the watt per pascal used. (If it were it would be called the nerd (Nd) after an obscure Physics teacher named Julius T. Nerd.) That should not stop you from figuring out the nerd as expressed in base SI units.

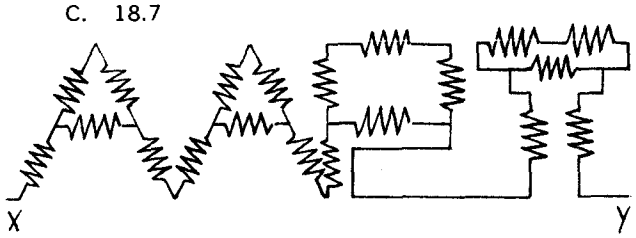
A. m^3/s
B. m^2/s
C. m^2/s^2
D. m/s^2
E. s/m^3

2. Galileo lived

A. at the time of Aristotle.
B. about the time of Leonardo da Vinci.
C. near the time of Isaac Newton.
D. until the early 1800s,
E. until just after the Second World War.

3. Below is pictured an arrangement of 20 resistors each of which has a value of two ohms. The total resistance between points X and Y, in ohms, is

A. 12.7
B. 13.5
C. 18.7
D. 19.5
E. 40.0



4. The 1980 Nobel Prize for Physics was won by

A. Fitch and Cronin
B. Richter and Ting
C. Cassidy, Davis and Smith
D. Glashow, Weinberg and Salam
E. Maxwell and Hertz

5. The term tokamak is drawing a great deal of public attention. This term refers to

A. the bombardment of North America by microwave radiation.
B. a Canadian project to accelerate electrons to high energy in a ring accelerator.
C. a nuclear reactor where the products are fuel for another reactor.
D. confining hot gases in a magnetic field for fusion purposes.
E. an experiment planned for a future voyage of the space shuttle Columbia.

Examples of questions used in the Ontario Section contest

In April the following materials were sent to participating schools:

1. copies of the contest based on orders,
2. computer cards for identification and recording of answers, and
3. instructions for administering the contest.

The contest was administered in participating schools in a one-hour period in the morning of a designated day early in May. Completed computer cards were mailed directly to the University of Guelph for processing. In late May the results were sent to participating schools. Enclosed with the results were first and second place certificates for individual schools. Each school has the responsibility for purchasing a prize for its top student. Jearl Walker's *The Flying Circus of Physics with Answers* was the recommended award but other awards such as calculators, books, magazines, or gift certificates were deemed appropriate.

Contributions from physics departments of Ontario universities support the provincial level prizes. A modest contribution in units of $35.00 covered the costs of a calculator and a special gold certificate for 17 provincial awards in 1982.

The 1981 contest contained 20 multiple-choice questions based on the provincial curriculum plus some questions on general knowledge, current events in physics, history, trivia, and "Nobelia." See the questions in the margins for examples. The questions are written and proofread by section members. Although several individuals may write and review questions only one person sets the style of the questions. This is done so that the "flavor" of the questions can be maintained throughout the contest as well as from year to year.

For May, 1981, 2862 contests were ordered and 2105 were returned for scoring. In Ontario about 184 schools participated with an average of 12 students per school. A small profit in 1981 helped to finance the start-up costs in operating the 1982 contest.

Comments from Ontario teachers and students lead to the conclusion that the contest has been successful in generating student interest in physics and in recognizing the achievement of many students in the province. Also the idea of such a contest is beginning to spread. In 1982 one school in Manitoba and another in British Columbia participated but the biggest news is the adoption of the idea by the Southeastern Pennsylvania Section of AAPT.

During the Summer Meeting of AAPT at Steven's Point, Wisconsin Jim Nelson met Doug Fox and learned of the Ontario Contest. Jim carried a copy of Doug's material to Pennsylvania and began making plans to run a physics contest using the Ontario contest as a model. The Southeastern Pennsylvania Section (SEPS) sponsored its first contest in May, 1982 with the participation of 398 students from 15 schools. The SEPS contest consisted of 30 multiple-choice items covering most of the major topics taught in introductory high school physics. (Again see the sample questions in the margin.) With the exception of the handling of the answer sheet similar procedures were used. In the SEPS contest an answer sheet on colored paper was supplied with each contest order. Using an answer key teachers corrected the papers written by their students. After the teachers had discussed the results with their students all answer sheets were returned to the Section for review and tabulation.

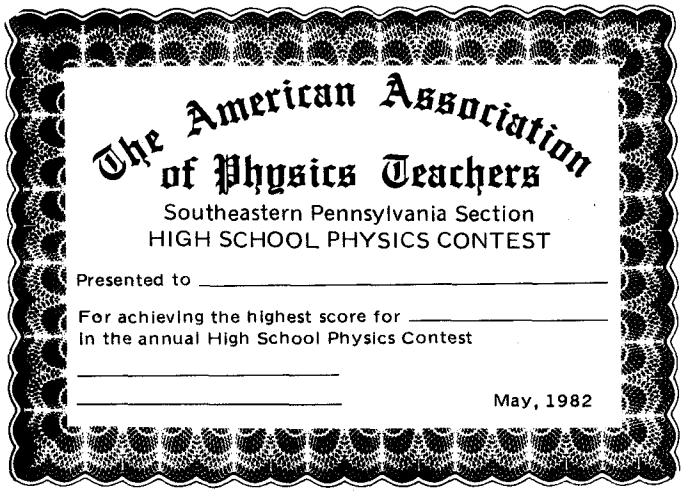


Fig. 1. The award certificate

Students were permitted to use calculators, however, the questions were designed to minimize complex calculations. The time limit was 45 minutes for 30 multiple-choice questions and the score was equal to the number of correct answers with no deduction for incorrect responses.

Very attractive certificates were made using blank gold-edge certificates from a stationery store for about ten cents each. A master copy of the certificate is then photocopied onto the blanks (Fig. 1). The certificate is then signed by the school principal, the physics teacher, and the president of the Section.

To encourage schools to publicize the achievement of their students as well as AAPT, a sample news release is included with the mailing of the results. Some teachers might also use the scores of this contest to select the recipient of the AAPT "Outstanding Physics Student of the Year Award." The contest could also be used in conjunction with a Physics Olympics.

As in the Ontario Section the response by teachers and students has been most encouraging. The 1982 charge per contest copy in SEPS was fifty cents and, although not a goal of the contest, the addition of about $100.00 to the treasury and 13 members was most welcome.

An information package and a time schedule is available to help other sections of AAPT interested in beginning a high school or introductory college physics contest. This package contains all the materials needed to start a contest, ten items in all, as well as a copy of the previous contests. If you would like a set of these materials please send to **Doug Fox**, *Belle River District High School, Belle River, Ontario, Canada N0R 1A0* or **Jim Nelson**, *Harriton High School, 600 N. Ithan Avenue, Rosemont, PA 19010.*

And a special thanks to Barbara Ure for the idea – that was the key!

References

1. Sir Isaac Newton Physics Test
Phil Eastman, Physics Department, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1
2. Canadian Association of Physics
High School Prize Exam
Faculty of Science, York University, 4700 Keele Street, Downsview, Ontario, Canada, M3J 1P3
3. McMaster Physics Contest
Department of Physics, McMaster University, 1280 Mani Street, Hamilton, Ontario, Canada, L8S 4M1

AAPT-SEPS Contest

1. The mass of a normal family car is approximately

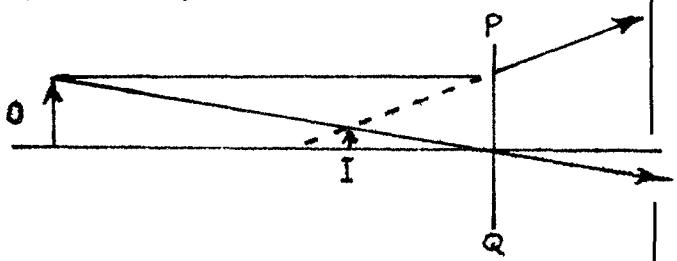
A. 10^2 kilograms
B. 10^3 kilograms
C. 10^4 kilograms
D. 10^5 kilograms
E. 10^6 kilograms

2. Two boxes of different mass rest on a horizontal frictionless surface and are joined by an inelastic string. A spring then exerts a force F on the object with the larger mass.

Which of the expressions gives the net force acting on the other object?

A. $\frac{Fm}{M+m}$
B. $\frac{FM}{M+m}$
C. F
D. $\frac{Fm}{M}$
E. $\frac{FM}{m}$

3. The diagram shows an Object O, an Image I and two rays from the object.



What device when placed on the line PQ, will produce the image shown.

A. plane mirror
B. converging (concave) mirror
C. diverging (convex) mirror
D. converging lens
E. diverging lens

4. A moving charged particle experiences a force due to a magnetic field. The force exerted on the particle

A. will not change the particle's speed.
B. depends on the mass of the particle.
C. is independent of the charge of the particle.
D. is an inverse square law force.
E. is independent of the speed of the particle.

Examples of questions used in the Southeastern Pennsylvania Section contest.