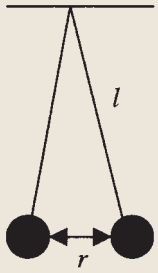
Physics Challenges for Teachers and Students

A Slow Approach

Two small balls of mass m each are suspended by light strings of length l as shown. Initially, each ball carries a positive charge q. The initial separation of the balls is r ($r << l$). The charge of each ball slowly drains into surroundings; the charge on each ball changes with time as $q_t = q(1 - bt)^{1.5}$, where b is a given constant. As a result, the balls get closer. Find the speed at which the balls approach each other.



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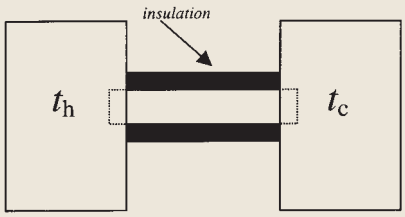
Fire and Ice

An insulated container is filled with a mixture of water and ice at $t_c = 0°C$. Another container is filled with water that is continuously boiling at $t_h = 100°C$. In a series of experiments, the containers are connected by various thick rods that pass through the walls of the containers (see diagram). The rod is insulated in such a way that there is no heat loss to surroundings. In experiment 1, a copper rod is used, and the ice melts in $T_1 = 20$ min.



In experiment 2, a steel rod of the same cross section is used, and the ice melts in $T_2 = 60$ min. How long would it take to melt the ice if the two rods are used "in series"?

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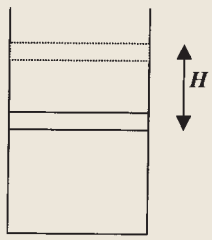
Giving in to Pressure



A portion of helium gas in a vertical cylindrical container is in thermodynamic equilibrium with the surroundings. The gas is confined by a movable heavy piston. The piston is slowly elevated a distance H from its equilibrium position and then kept in the elevated position long enough for the thermodynamic equilibrium to be reestablished. After that, the container is insulated and then the piston is released. After the piston comes to rest, what is the new equilibrium position of the piston?

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Below are the names of the readers who were first to submit the correct solutions to our November *Challenges*.

John F. Goehl Jr. (Barry University, Miami Shores, FL)
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The solutions, as well as the more complete list of their contributors, can be found on our website: http://aapt.org/tpt. We look forward to your future contributions.

•**Note to contributors:** As the number of submissions grows, we request that certain guidelines be observed, in order to facilitate the process more efficiently:

–please email the solutions as Word files;

– please name the file as "Feb04LSimpson" if — for instance — your name is Lisa Simpson, and you are sending the solutions to February 2004 *Challenges*;

– please state your name, hometown and professional affiliation in the file, not only in the email message.

Many thanks!

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