Bill van den Berg received Ph.D. generously granted in 1980 🙂

Taught physics at Penn State DuBois Campus (1980-1986) and at State College Area High School (1986—2007)

Published eight papers in *The Physics Teacher, a* peer reviewed journal.

Advanced Placement Physics C

Oscillations

Halliday, Resnick & Walker, Ch 16

Resources: Lab re damped harmonic oscillators.
See "C:\Zip_Disk_1\Gensc3\Mechanics Programs" for sim. of driven, damped harm. osc.
Oscillator.py

A. State the two necessary characteristics a system must have i
B. Define period, frequency and angular frequency.
C. State and use the fact that a restoring force whose magnitud displacement from equilibrium leads to simple harmonic mc
D. Relate simple harmonic motion (SHM) of angular frequenc angular velocity ω.
E. Write down Newton's 2nd law of motion for a simple harm differential equation for displacement as a function of time, equation, and prove the solution is a valid one.
F. Relate position, velocity, and acceleration in SHM
G. Relate kinetic, potential, or total mechanical energy of simp speed.
H. State that a simple pendulum oscillates in approximate SHN and do a similar derivation to objective E above.
I. Do the same for a physical pendulum.
J. State and use the fact that for a simple harmonic oscillator c

Work and kinetic energy: A simple demonstration

DuBois Campus, The Pennsylvania State University, DuBc

Here is a particularly simple classroom demonstration that helps make concrete the relation between the work done in accelerating a mass and the resulting velocity of the mass.

The entire demonstration, with analysis, takes no more than 20-30 minutes. The equipment I use consists only of a small hard-rubber or plastic ball, a rigid 224-cm (8 ft) length of lumber marked off in six equal sections, a chalkboard graph-chart stencil,[1] one or more electronic wristwatches with a stopwatch feature (usually several students in the class have these), and one or more hand calculators (all of our students have these).

The experiment consists of propping one end of the board on a chair and releasing the ball from rest at one of the marks along the board. Since the students have previously been introduced to the concept of gravitational potential energy, it can be pointed out that the work done by gravity in accelerating the ball ($W = mgh$) is proportional to the distance rolled along the incline; this is recorded (in arbitrary units equal to 1/6 the length of the board) in a table on the chalkboard (Table I). The speed of the ball after rolling down the incline is determined by timing its subsequent travel a fixed distance along the floor (here, 5.51 m or about 18 ft). The speed can simply be recorded in arbitrary units as the reciprocal of the time, or it can readily be calculated in meters/second if that makes the students more comfortable.

The first three columns of Table I show a typical set of raw data. Here, each time entry represents an average of six measurements, but acceptable values are obtainable with only one or two. The greater the number of people with stopwatches, the more measurements can be made per roll of the ball. Encouraging the students to help in timing and doing calculations speeds up the demonstration considerably and gives the class a sense of participation.

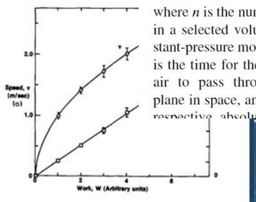


Fig. 1. Plots of v and v^2 versus W as they would appear on th chalkboard.

Initially exploring the relationship between th measured quantities as naively as possible, I first plot th speed as a function of the work (Fig. 1). Noting that thi fails to yield a straight line, I solicit guesses as to what th relationship may be. Depending on the guesses and on th mathematical sophistication of the students, there are tw options for the next plot. One is to go ahead and graph th square of the speed versus the work; this gives a very nic straight line.

The other possibility consists in assuming that W = kv^n, where k is an undetermined constant and n is a

Table I

Typical data as it might be recorded and manipulated on the chalkboard. Each time value represents the average of six measurements. The reported ranges of error are conservative, being equal to or somewhat larger than the actual ranges of measured values. The distance rolled along the floor was 5.51 m.

Work, W (arb.) units)	Time t(s)	Speed, v (m/s)	v^2 (m^2/s^2)	log W	log v
0	∞	0	0	-	-
1	5.6±0.2	0.98±0.04	0.97±0.07	0	−0.01±0.02
2	3.9±0.1	1.4±0.05	2.0±0.1	0.30	0.15±0.01
3	3.2±0.1	1.7±0.1	3.0±0.2	0.48	0.24±0.02
4	2.7±0.1	2.0±0.1	4.2±0.3	0.60	0.31±0.02

N O T E

Energy Conversion by an Electric "Space Heater"

Willem H. van den Berg, State College Area High School, 653 Westerly Parkway, State College, PA 16801-4298; whv11@scasd.k12.pa.us

Measuring the temperature of the air blown by a "space heater"[1] shows students that the air is heated at a rate approximately equal to the rated wattage of the heater. The power going into heating the air may be estimated by the relation

$$\text{power} = \frac{Q}{\Delta t} = \frac{nC_p(T_2 - T_1)}{\Delta t} \qquad (1)$$

where n is the number of moles of air in a selected volume, C_p is the constant-pressure molar heat capacity, Δt is the time for the chosen volume of air to pass through an imaginary plane in space, and T_1 and T_2 are the respective absolute temperatures of

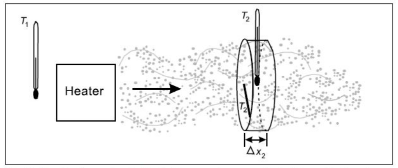
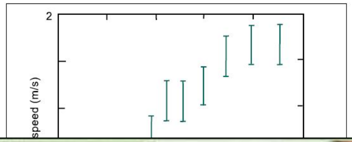


Fig. 1. Electric "space heater" with thermometers near the intake and in the stream of heated air. Imaginary cylinder's radius approximates that of airstream.



N O T E

Force Exerted by a Falling Chain

Willem H. van den Berg,[1] State College Area High School, 653 Westerly Parkway, State College, PA 16801-4298; whv11@scasd.k12.pa.us

Introductory physics textbooks for scientists and engineers pose the following problem in their chapters on momentum and impulse: "A very flexible uniform chain of length L and mass M is suspended from one end so that it hangs vertically, the lower end just touching the surface of a table. The upper end is suddenly released so that the chain falls onto the table and coils up in a small heap, each link coming to rest the instant it strikes the table."[2] The student is to calculate th

In a derivation[3] that sometimes provokes heated discussion among astute calculus students, this force is taken to be equal to the magnitude of the impulse per unit time (F_1) required to stop mass elements of the chain as they hit the table, plus the weight (F_2) of the portion of the chain lying on the table:

The chain is considered to be made up of mass elements

$dm = \frac{M}{L}\,dx$, where dx is a

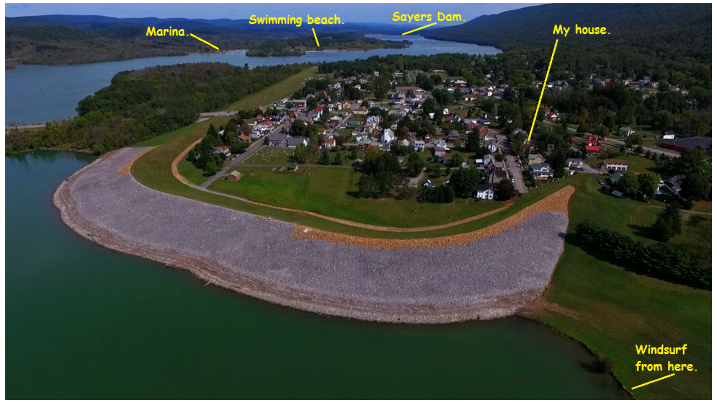
Pulling a Door Open by Pushing on It

Willem H. van den Berg, State College Area High School, State College, PA

rdinarily, opening a door by pulling on the knob or handle causes a net torque on the door, and hence an angular acceleration, *ertical* axis. However, it may be that the top of the door sticks to the door frame; this force perpendicular to the plane of the es a torque on the door about a *horizontal* latter torque is countered by an opposite used by horizontal forces exerted by the e result is that the door is deformed but readily open. The horizontal forces between and the hinges can potentially tear loose s. When the sticking is rel energy stored in the defor

Fig. 1. Scenes are illustrated by author.

Bill van den Berg retired in 2007 at age 61.



My town: Howard (Borough), PA 16841

Skiing on the Howard "glacier", spring 2017

With my sweetheart, Helen, by the flooded lake, 2018

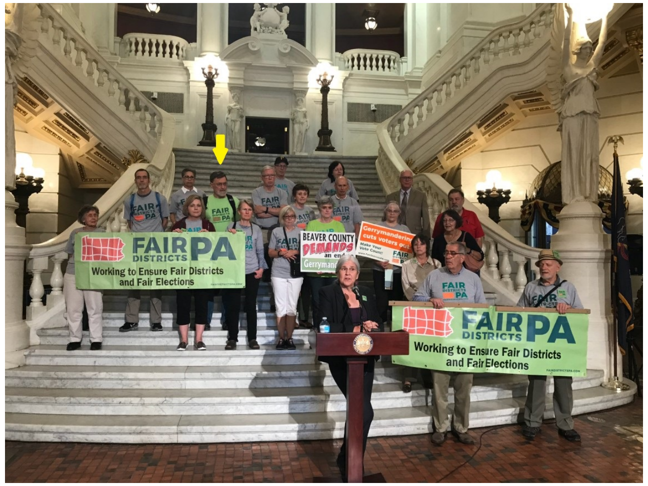
Giving 2 high school kids a windsurfing lesson, August 2018

Teaching windsurfing as a hobby, to raise money for nonprofits. www.BetterWorldWindsurfing.org

I do a lot of photography.

Windsurfing on Bonaire (Dutch Caribbean), January 2018

Discovering scuba with Helen, February 2019



In the state capitol, June 2018

My 645+ videos are at https://vimeo.com/user45119236.

Working with www.FairDistrictsPA.com to get rid of partisan gerrymandering in Pennsylvania.