Title
CHEAP, ACCURATE, CONSERVATION OF MECHANICAL ENERGY EXPERIMENT

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CHEAP, ACCURATE, CONSERVATION OF MECHANICAL ENERGY EXPERIMENT

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Cheap, Accurate, Conservation of Mechanical Energy Experiment

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For some years the conservation of mechanical energy experiment in the introductory physics laboratory at Berkeley left much to be desired. The experiment involves rolling a ball bearing down a track, and measuring its velocity at the bottom. The experiment doesn't give accurate or reproducible results, nor does it allow students to verify the relation $mgh = 1/2\ mv^2$ since a substantial proportion of the kinetic energy of the bearing is rotational. In the absence of knowledge of rotational motion, the student can only conclude that $mgh = Cmv^2$ --not a very satisfying result.

Both of these objections are overcome by the experiment described here (see figure 1). A ball bearing is used as a pendulum bob: the bearing is magnetically released at some height h above its rest position. As the pendulum passes through the vertical, a Bunsen burner flame melts a Saran-wrap link in the pendulum line, releasing the bearing with maximum horizontal, but zero vertical component of velocity. The bearing follows a parabolic trajectory to the floor, where its point of impact

is recorded by carbon paper laid face down on a strip of computer printout. Knowing the height of the point at which the bearing is released, and the horizontal distance it traveled before impact, one can calculate its release velocity.

Two points deserve mention. In order to reliably melt the Saran-wrap link, a flare tip must be used on the Bunsen burner. This increases the uncertainly of the location at which the bearing is released, but does not seriously impair the experiment. The Saran-wrap links are most easily prepared on computer cards (see figure 2). Double-sided Scotch tape is laid down near each edge of the card; a precut band of Saran-wrap is affixed to the tape; next, thicker plastic is wrapped around the edge and taped down to serve as a sturdy connection to the fine wire hooks that join the links to the pendulum string and to the bearing. Links 1/16 to 1/8 in in width are cut from the card with a paper cutter. For convenience in handling, the links are left on the card-backing until ready for use.

The accuracy obtained in this experiment compares favorably with that of the other mechanical experiments performed in this course; most students are able to confirm that energy is conserved to within at least 5%. If a fine-tipped torch is used instead of the Bunsen burner, the error can be reduced to about 1%.

The cost of the experiment is minimal. The laboratory stand, rods, Bunsen burner, and lattice clamps necessary to rig the pendulum and its release are standard equipment in most undergraduate labs. The magnetic release mechanisms used here are just the solenoids from discarded relays. A pre-formed strip of .010 m tantalum foil spot-welded to the bearing provides a loop attachment; a string loop attached with masking tape works almost as well.

Many students have remarked how much they enjoyed this experiment; in a laboratory course in which most of the work is done with air tracks and electric timers, an experiment put together from commonplace objects holds a certain fascination.

Figure Captions

Fig. 1. Conservation of mechanical energy experiment based upon a parted pendulum.

Fig. 2. A satisfactory method of mass producing the Saran-wrap links is shown here. One starts with a 2 in. wide section of computer card (a). Double sided cellophane tape (b) is then put down on both sides of each edge. Precut Saran-wrap (c) is affixed to one side of the card, and widths of plastic bag material (d) are wrapped around the edges to form the attachment loops. Finally, single-sided cellophane tape (e) is used to reinforce all joints. Individual links are cut from the card with a papercutter; the center section of the card-backing is removed with scissors just before use.

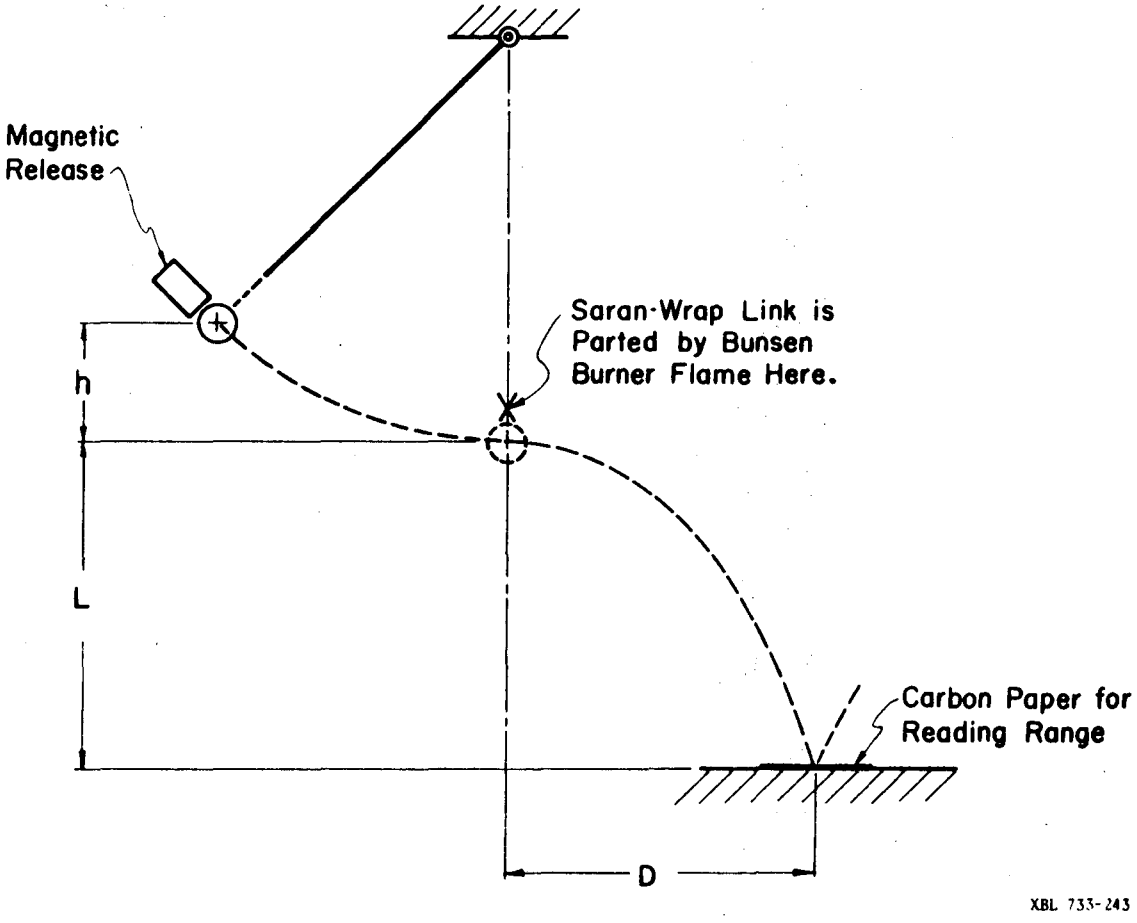
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Fig. 1

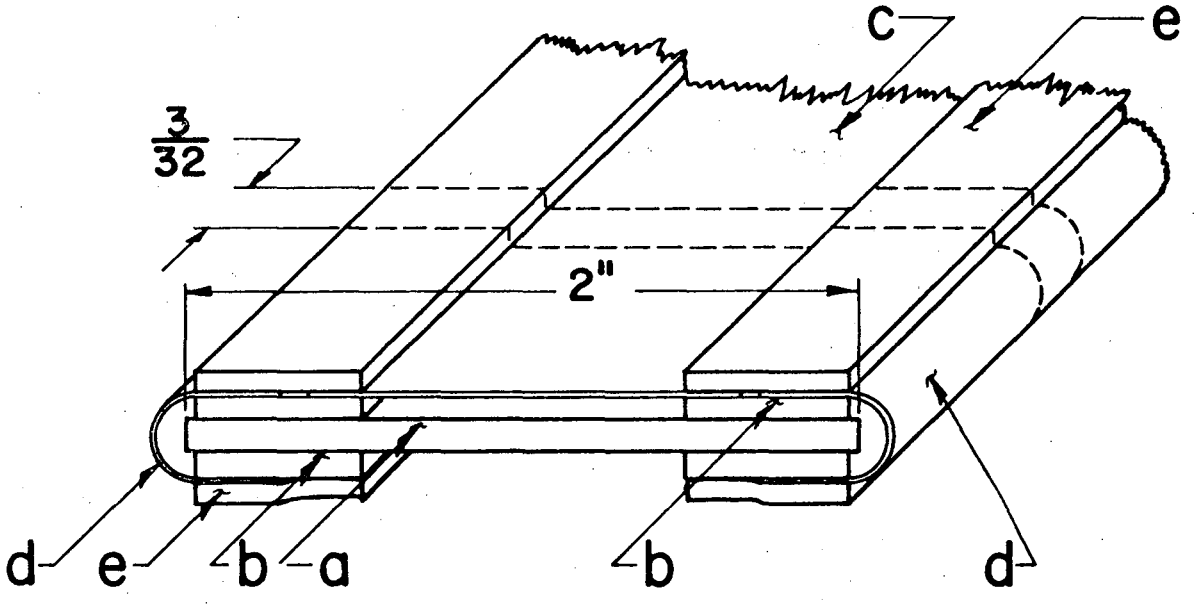

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Fig. 2

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