Iowa Science Teachers Journal

Volume 27 | Number 2 Article 7

1990

Astronomy Resources

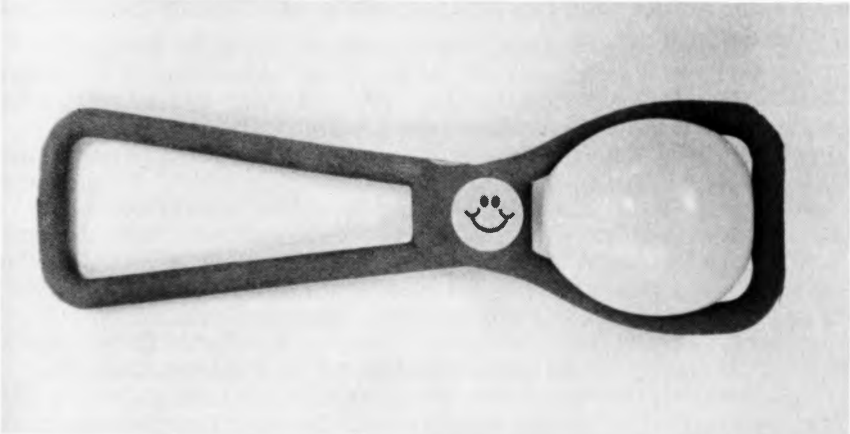
Thomas Hockey
University of Northern Iowa

The concept of orbiting bodies is complicated by the fact that no real system exists--be it satellite and planet, planet and sun, of binary stars--in which one object revolves around the center of the other. Rather, both bodies revolve about a common center of mass. The idea of center of mass enters into discussions of dynamics throughout an astronomy course or unit, beginning with the motions of the Solar System and recurring in analyses of stellar systems and of galaxies.

In order to demonstrate, from a reference frame outside of the system, the complicated motion of two bodies revolving about their center of mass, the author uses the following model based on a model first suggested by P. Steven Leiker.

Two rubber or plastic balls, of similar volume but unequal mass, are attached to an elongated rubber pet toy. The "double loop" design of the particular toy used by the author holds the balls in place without fasteners. When tossed, this device turns end-over-end; the two balls revolve around a point on the toy--the center of mass of the system.

In the model, gravity is represented by the structural forces inside the toy. Students can be asked to estimate where on the model the center of mass is located. They can then determine experimentally where this center is by placing the model on a finger. The center of mass occurs where the model balances. Students may be surprised that



M. De Foe

Figure 1
The device is shown with only the phosphorescent ball present. The "empty" end of the pet toy acts as the second mass.

this point is not situated half way between the balls but rather at a point closer to the more-massive ball. More advanced students can calculate the torques acting on the balls while in equilibrium with the model resting on the finger.

Now the model can be thrown again, this time with the center of mass marked by a bright sticker. The balls will revolve around an axis beneath the sticker. If one of the balls is exchanged with a more or less massive one, the sticker will no longer remain "steady" in flight but will itself revolve around the new center of mass.

As a specific demonstration of astrometric binary stars, replace one of the two standard balls with a phosphorescent ball. Turn off the classroom lights. Toss the ball first by itself, and ask the students to observe the relatively simple curve of its path. If your classroom comes equipped with gravity, completely linear motion will be difficult to accomplish! Then place the ball in the model without the students knowing it. Toss the model, once again in darkness, and note the more complicated path of the glowing ball. Ask the students to hypothesize why the difference in apparent motion between the two tosses occurred. Then show them the model with the lights on, and discuss the "dark" ball's role as an unseen binary companion. A final variation involves throwing an identical model in the dark, this time with an "X" of phosphorescent paint or a phosphorescent sticker applied to the center of mass.

The plastic balls and rubber pet toy were chosen for practical considerations. No one is likely to be hurt if hit by them flying in the dark. While various similar objects could be used to assemble this simple model, the author would be glad to provide, upon request, a parts list for the device.

Dr. Thomas Hockey
Department of Earth Science
University of Northern Iowa
Cedar Falls, IA 50614-0506