Document ID: 03_08_97_1
Date Received: 1997-03-08 **Date Revised**: 05/05/97 **Date Accepted**: 05/05/97
Curriculum Topic Benchmarks: S15.2.3, S12.2.2, S12.3.2, S12.4.1, S15.1.1
Grade Level: [3-5] Upper Elementary
Subject Keywords: observing, mirror, spoon, lighthouse, spotlight, searchlight, telescope
Rating: moderate

Spoon Mirror

By: Ralph Kahn, Jet Propulsion Lab., 4800 Oak Grove Dr., Pasadena CA 91104
e-mail: ralph.kahn@jpl.nasa.gov

From: The PUMAS Collection http://pumas.jpl.nasa.gov

My parents, for reasons I never understood, occasionally held "formal" dinners. The table would be set with the best dishes we owned, cloth napkins, and silverware -- the kind that had to be polished to look good. My brother and I usually had the job of polishing.

As these affairs unfolded, we were expected to sit quietly among the adult dinner guests and look interested. My mind had the habit of wandering.

On one occasion, it landed on a large, shining soup spoon. My intimate familiarity with the nicks and dents in the metal may have drawn my attention to it, or perhaps I was just proud of my own polishing efforts, but I found myself studying the inside of that spoon. I noticed the image of my face, reflected in it, was upside down. I leaned to the left; the image shifted to the right. Whichever way I moved, it kept staring at me. Upside down. I reached out as unobtrusively as possible, and flipped the spoon over.

But I had polished the back too, and there was another image -- only now my forehead was grotesquely distorted, and my face was right side up! And again the image altered as I changed position.

...a nice story, but of what ‘practical use’ is this?

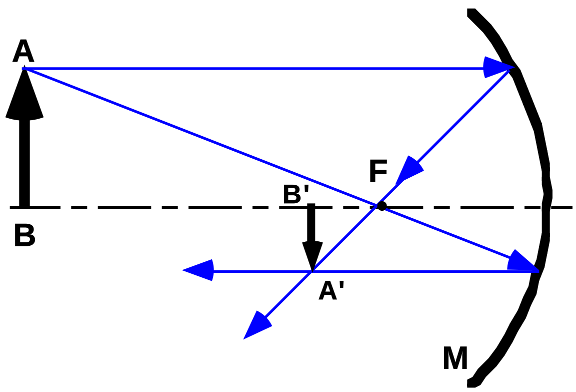
It was years before I learned about "concave" and "convex" mirrors, about their role in telescopes, cameras, searchlights, spotlights, and solar cookers. I did not know that "objects behind the car are closer than they appear" because of a convex mirror. And I would not even have thought to try to burn paper by taking the spoon out into the sun.

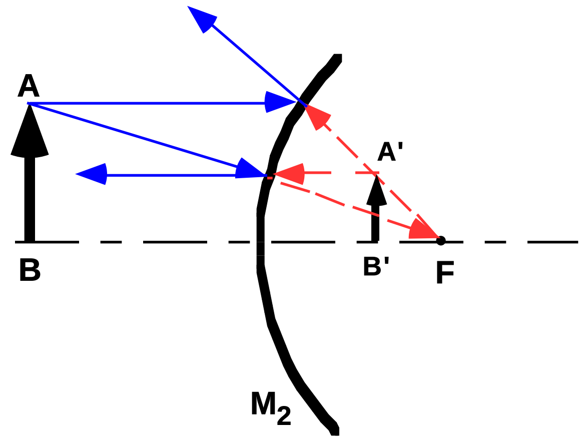
But that night, it got me through dinner.

****

Author's Note: The main point of this example is about "observing," one of the most valued skills in science. Observation is usually emphasized beginning in the Upper Elementary grades. But it is often easier to *observe* than to *explain*. "How curved mirrors actually work" is sometimes covered in High School physics. The principles are also discussed in most encyclopedias, under "Mirrors" or "Optics," and are mentioned with respect to lighthouses, telescopes, and amusement park activities. (One benefit of making observations, or even memorizing “facts,” for which you have no deeper understanding at the time, is that sometimes, perhaps many years later, you may suddenly realize what they mean or why they are important.)

The easiest way to visualize how curved mirrors work is to trace the paths of several rays of light as they travel from the light source past the object to the mirror, and then bounce toward the observer's eye. Here are two of the simplest cases:





The original object is AB, the mirror is M, the image produced by the mirror is A'B'. For the concave mirror (M), all light rays hitting the mirror are re-directed so they pass through the focus, F. (The light rays are blue.) For the convex mirror (M_2), the red and dashed arrows are called "virtual rays." The actual rays of light are all on the left side; they bounce off M_2 in a way that makes them *appear* to emanate from F.

These figures also show how curved mirrors re-direct light, and can change both the size and orientation of an object's image. A "shrinking" mirror (like M_2) is sometimes used to see the wide view into an elevator, around a blind corner, or across many aisles in a large retail store.

Things get more complicated as the object is moved from a position at the center of the mirror, and as the shape of the mirror is altered. For those familiar with "conic sections," which are typically introduced in High School geometry, a parabolic mirror will focus parallel rays from a distant source to a single point. So telescope mirrors and satellite TV dishes are often this shape.

And if a light source or transmitter is placed at the focus, a parabolic reflector will emit a parallel beam. (Just think of reversing the direction of all the rays in the concave mirror diagram.) This makes parabolic mirrors popular in applications ranging from searchlights to radar antennas. If the source is shaped more like a line than a point, a cylindrical reflector, perhaps with a parabolic cross-section, can be used... which brings to mind the shapes of other radar antennas, and the dreaded dentist's mirror-lamp. Well, maybe we'd better just stick with spoons.