Microscope in a Cup

Explore the unseen with a drop of water!

Topics: Refraction, Magnification

Materials List

- ✓ Portion cup, 2 oz or equal, with a groove around the base
- ✓ Portion cup, 3/4 oz or equal, with a rim that will fit into the groove of the larger portion cup
- ✓ Craft stick or equal
- ✓ Clear plastic, firm, such as from clear plastic packaging
- ✓ Tape
- ✓ Thin straw or dropper
- ✓ Water (distilled is best)
- ✓ Items to examine (penny, fabric, colored printed picture)
- ✓ Optional - flashlight

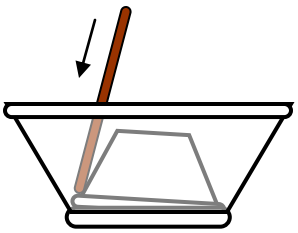
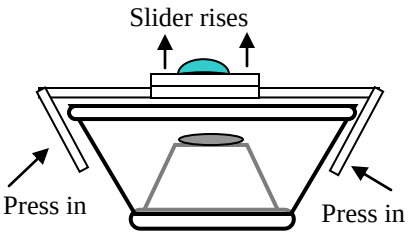


Figure 1

Press in with thumb and pointer finger



Combine portion cups and clear plastic strips, in a unique way, to create a portable microscope that uses a drop of water for a lens.

Assembly

1. Invert a smaller portion cup and put into a larger portion cup. Push on the bottom of the smaller portion cup to force the rim into the base groove of the larger portion cup. Push in with the end of a craft stick, if needed, see figure 1. (Only certain brands of portion cups will easily fit together in this manner.)
2. Cut a clear plastic strip 1.5 cm to 2 cm (1/2" to ¾") wide and 10 cm (4") long, and another strip 5 cm (2") long from firm clear plastic.
3. Lay a craft stick crosswise over the shorter strip about 1.5 cm (3/4") from an end. Hang the end of the strip over the edge of a table or desk. Bend up the end of the strip, see figure 2.
4. Remove the craft stick and use the craft stick to press the fold down, see figure 3.
5. Lay the longer strip crossways against the bend made in step 4. Fold up the other end of the short strip over the edge of the longer strip. Remove the longer strip and press down on the fold with the craft stick, see figure 4.
6. Trim the ends, creating a slider and slip back onto the longer strip, see figure 5.

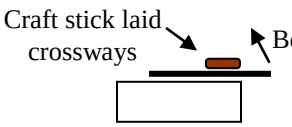


Figure 2

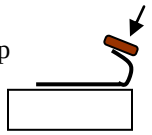


Figure 3

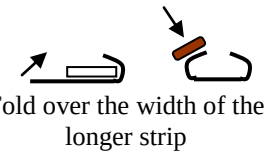


Figure 4

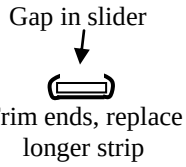


Figure 5

7. Bend the longer strip upright starting 2 cm (3/4") from an end, see figure 6.
8. Invert the larger portion cup and position the rim against the upright bend with the cup going across the longer strip, see figure 7. Insert a craft stick, crossways to the strip under the edge of the portion cup, see figure 7.
9. Press the craft stick downward to hold in place; bend up the unbent end of the long strip, and then remove the craft stick. See figures 7 and 8.
10. Invert the cups and strips and slightly press or pinch down at the points indicated in figure 9. Doing so will slightly bow the strip into the cup.

This activity can be used to teach:

- Waves are reflected, absorbed, or transmitted (Next Generation Science Standards: Middle School, Physical Science 4-2)

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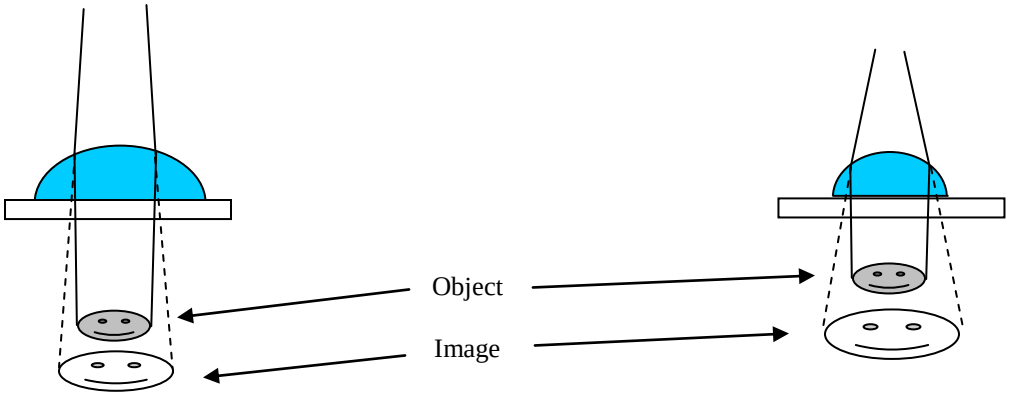
To Do and Notice

1. Cut a 4 to 5 cm (1½" to 2") strip of tape and form into a loop with the sticky side on the outside of the loop.
2. Place the loop on the inverted bottom of the smaller portion cup. Place the item to be examined on the tape loop and press down to secure the item to the bottom of the portion cup.
3. Use a thin straw or a dropper to place a 5 mm (3/8") diameter drop of water on the center of the slider.
4. Slide the slider and/or move the longer strip side to side until the water drop is over the area to be magnified.
5. While looking down through the water drop gently press on the short bent sections of the long strip, using the thumb and pointer/middle fingers as shown at the top of the first page. Pressing will cause the slider, and water drop, to rise upward. Stop when a focused image of the area to be examined is created.
6. Move the portion cup, as needed, to provide better viewing given the available lighting.
7. Create a smaller diameter water drop by absorbing some water with a paper towel or by starting with a smaller drop. Repeat steps 4 and 5. What changes when a smaller diameter drop is used?
8. Examine other items. Note the portion cup will fit into the lighted end of some flashlights when the flashlight is held upright. The additional light may make certain features of thin items more visible.

The Science Behind the Activity

Light travels in straight lines in a transparent material if the material (air, water, plastic) does not change. Light can bend (refract) when crossing the boundary between such materials, except for light rays that cross perpendicular to the boundary. Convex curved boundaries, thicker in the middle than the edges, can make light rays come together (converge). Clear convex surfaces can create magnified images when held near an object. The greater the degree of curvature the shorter will be the focal length and the greater will be the magnification. As the size of a water drop decreases, the diameter decreases and the surface curvature will increase. The increased surface curvature will require that the drop be held closer to the object in order for the light rays to converge to create a focused image for the eye.

Simplified light ray diagrams (not to scale)



A larger drop has gentler curvature than a smaller drop, which causes less bending of the light rays

A small drop has a sharper curvature, which bends the light rays more, creating a more magnified focused image when the drop is nearer the object

Taking it Further

What can be done to improve the optical image created by using a drop of water?

Web Resources (Visit www.raft.net/raft-idea?isid=527 for more resources!)

- Optical microscopy - http://www.asu.edu/courses/phs208/patternsbb/PiN/act/microscopy/optical.shtml
- Glass sphere microscope - http://www.funsci.com/fun3_en/usph/usph.htm