MYSTERY SHADOWS

Concepts

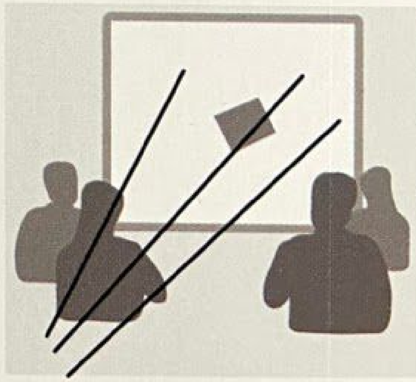
- Light and shadows
- Spatial thinking
- Geometric shapes

Materials

- Lamp without a shade, 75–100 watt bulb
- Familiar objects (e.g., D battery cell, pencil, masking tape roll, cellphone, fork, cup)
- Various geometric shapes (e.g., cube, rectangle, cone, tube, ball)

Challenge children to identify mystery objects just by looking at their shadows.

1. Prior to class, collect a variety of objects with geometric shapes.
2. Darken your classroom. Position a lamp so that it casts light on a screen or blank white wall and can make distinct shadows. Instruct children to face the screen and not turn around and look at you.
3. Hold up one of the objects so that it casts a shadow. Challenge children to identify the object based on its shadow. If no one guesses correctly, rotate the object to create a different shadow shape. (For example, a D battery cell can look like a circle or a rectangle, depending on how you hold it.)
4. Change objects and see how well children can use 3D thinking to identify them.



TIP

You can use an old slide or overhead projector instead of a lamp.

MYSTERY SHADOWS

DISCUSSION QUESTIONS

- **What is a shadow?** *A shadow is a dark area where light from a source, such as the sun, is blocked by an object.*
- **Are shadows always the same size as the object making them?** *No. If the object is near the light source, the shadow will be larger.*

FYI

Shadows can be confusing to children. Young children may try to pick up shadows or wonder if their shadows can separate (as in the Peter Pan story). Older students are often confused by the shadows on the moon that cause the different phases each month.

An important skill in science is **spatial thinking**. It is the ability to visualize objects—their shapes and relationships to each other. A common example of spatial thinking is when you give directions to someone. Another example is shopping (e.g.,"That looks big enough. It should fit."). Astronomers visualize the size and shape of the universe and objects within it from Earth's surface. Geologists have to use spatial thinking to understand the dynamics of Earth's interior that they cannot see.

In this activity, children sharpen their spatial thinking by trying to identify the actual shapes of objects based on their shadows. Doing so can be quite challenging. A cube can look like a square, but if it is held differently, it looks like a hexagon. A cylinder can look like a circle or a rectangle. Spatial thinking enables children to visualize 3-dimensional shapes when they can see only 2-dimensional shadows.

EXTRA

Look up "hand shadow puppets" online. There are many good instructional sites for creating animals and other objects and diagrams that can be printed to show hand and finger placements.

PENNY BOAT

Concepts

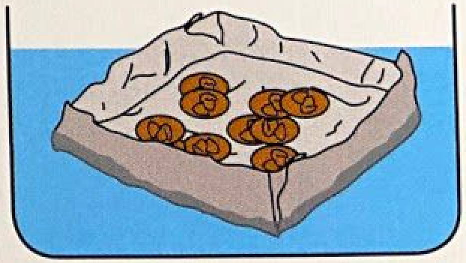
- Properties of matter (liquid)
- Buoyancy
- Density

Materials (for each group of children)

- 15 cm (6 in.) square of heavy-duty aluminum foil
- Pennies or steel washers (available at hardware stores)
- Shallow pan or bowl of water (can be shared among groups)

How many pennies can an aluminum-foil boat carry before it sinks?

1. Ask children: *Why do you think boats float?* Record their answers on the board.
2. Tell children they will investigate how things float by making boats and then testing them to see how many pennies they can hold before sinking.
3. Divide the class into small groups. Give each group a square of aluminum foil. Tell children to make a boat by folding and squeezing the foil into any shape they want, but it must be able to hold pennies. The more pennies it can hold before sinking, the better their boat design is.
4. Set up a station with one or more large pans of water where groups can bring their boat for testing.
5. Have children add one penny at a time until their boat sinks. Have groups write their results in a table on the board.
6. Discuss strategies for adding pennies (for example, all in the middle or spread out evenly) and why some boats are able to hold more pennies than others.



PENNY BOAT

DISCUSSION QUESTIONS

- **Why does a boat float?** *Water exerts an upward force (called buoyancy) that supports a boat. At the same time, the boat's weight exerts a downward force on the water. When the forces are balanced, the boat floats.*
- **What happens as you add more and more pennies to the boat?** *The weight of the boat increases, causing it to sink further into the water. With each penny added, a new balance point is reached until the boat becomes too heavy.*
- **Why does a boat sink when it has too many pennies?** *When the weight of the boat becomes greater than the upward force supporting it, the boat sinks.*

FYI

Boats float because of a property called **buoyancy**, an upward force exerted by liquids and gases. According to its weight, a boat sinks to a particular depth where a balance in forces is achieved. The upward lifting force of water balances the downward force of the boat's weight. With more weight, the boat sinks deeper. With less weight, it rises higher.

Another way to describe buoyancy is with the concept of density. **Density** is the amount of matter in an object. If the density of a boat is less than the density of water, the boat will float. If greater, it will sink. Adding pennies increases the average density of the boat until it is greater than the water's density, at which point the boat sinks.

EXTRA

If you have a spring scale or balance, you can determine the volume of a boat. When the boat sinks, remove the last penny and weigh the boat and the pennies it contains. If, for example, the total weight is 100 mg, the boat displaced a water volume of 100 ml just before it sank.

WATER SURFACE TENSION

Concepts

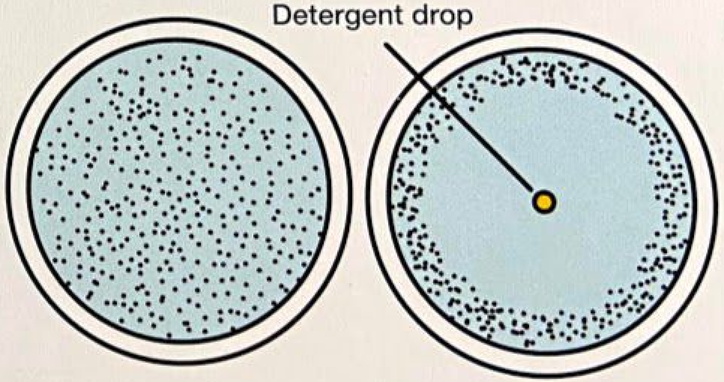
- Structure and properties of matter (liquid)
- Surface tension

Materials (for each group of children)

- Plastic dinner plate
- 5 cm (2 in.) square of wax paper
- Paper cup with water
- Ground pepper
- Dish detergent
- Paper towels (for cleanup)
- Bucket (for collecting the water after the experiment)

Find out how dish detergent gets things clean.

1. Ask children: *What does detergent do?* (It cleans things.) Tell them they will perform an experiment to see how dish detergent works to clean dishes.
2. Divide the class into small groups. Give each group a dinner plate, a square of wax paper, and a paper cup with water.
3. Have children pour just enough water in their plate to cover the bottom.
4. Explain that the experiment needs a marker so they can see what the dish detergent does. Go to each group and sprinkle pepper over the water in each plate.
5. Go around one more time and put a drop of dish detergent on each wax-paper square.
6. Have one child from each group touch the detergent drop with a fingertip and then gently touch the water in the center of the plate. Have children observe what happens.



WATER SURFACE TENSION

DISCUSSION QUESTIONS

- **What happens when the detergent touches the water?** *The water spreads outward in all directions and pushes the pepper into a ring around the plate rim.*
- **Why does the water move?** *The detergent breaks down the surface tension (or attraction of the water molecules to each other). The molecules push away from each other.*

FYI

Water (like most matter) is made up of tiny particles, called **molecules**, that attract each other. In the center of a waterdrop, molecules pull from all directions. But at the drop's surface, the pull is only inward. This inward pull is called **surface tension**, and it gives a waterdrop its shape. Surface tension is why you can fill a glass of water slightly higher than the rim.

Dish detergent has both attracting and repelling properties. For example, dish detergent makes it easier for oil and grease to mix with water. This enables water to break down oil and grease when washing dishes.

In this experiment, the detergent gets in between the water molecules at the water's surface. This reduces the molecules' attraction to one another, allowing the water molecules on the surface to spread. The pepper goes along for the ride.

EXTRA

Investigate surface tension further with an eyedropper of water and a penny. Have children count how many drops will fit on the penny. Ask: ***What shape does the water take? Does it make a difference if the penny is shiny or dirty?*** **Try using a penny coated with dish detergent.**

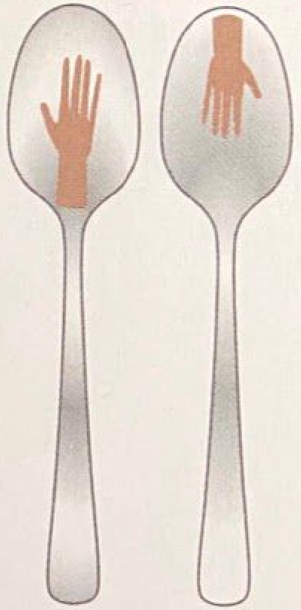
SPOON-A-VISION

Concepts
- Reflection
- Light
- Optics

Materials
- Two-sided makeup mirror—flat on one side and concave on the other
- Stainless-steel soupspoons with a shiny mirror finish (If possible, have one spoon per child.)

What can a spoon teach us about light?

1. Display the flat side of a makeup mirror. Ask children: *Where do you have to position yourself to see your reflection?* (In front of the mirror.) Show a few children their reflections. Ask: *What will happen to your reflection if the mirror is curved?* Show reflections in the curved side of the mirror and ask children to describe what they see.
2. Divide the class into small groups. Give each group a shiny soupspoon. Have children investigate the way the spoon's bowl reflects light. Let them discover that both sides of the spoon's bowl act like mirrors. One side has an inward curve and the other an outward curve.
3. Have children take turns holding the spoons upright by their handles as they hold up their other hand with fingers spread out. Tell them to look for their hand reflection on both sides of the spoon. Ask: *What's the difference between the two reflections?*



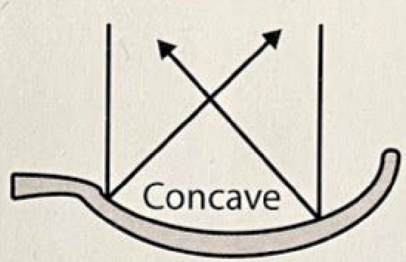
SPOON-A-VISION

DISCUSSION QUESTIONS

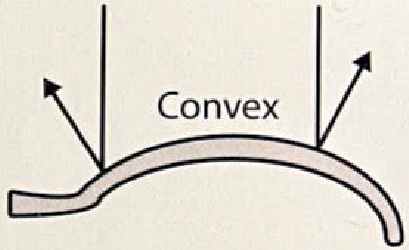
- **What do you see when you look at the reflection on the curved-in side of the spoon?** *Answers will vary.*
- **What do you see when you look at the reflection on the curved-out side of the spoon?** *Answers will vary.*
- **Is there any difference in the reflections shown on the different sides of the spoon?** *One reflection is upside down.*

FYI

Shiny spoons make excellent mirrors. One side is **convex** (outward curve) and the other side is **concave** (inward curve). Unlike flat mirrors that **reflect** an image just the way it appears in real life, curved mirrors change the image. Light rays striking a flat mirror bounce straight back. Curved mirrors also reflect light straight back but because of the curve, every point on their surface has its own straight-back direction. Convex mirrors cause light rays to spread out. Concave mirrors cause light rays to bounce toward the middle. Because light rays come together and cross each other in the middle, the image shown is upside down.



upside-down image



right-side-up image

EXTRA

Hold the curved side of the makeup mirror near a white surface, such as white paper taped to the wall. Tilt the mirror to reflect the rays from overhead lights onto the paper. By adjusting the distance and angle, the image of the light fixture will appear. You can do the same with light from the outside coming through a window to see reflections of buildings and trees.