

EQUIPMENT BUILD PLAN LIGHT & OPTICS

Classroom Wall Mirrors

Bruce frames a large concave mirror, a large convex mirror and a homemade multi-mirror made from 21 ornament balls so they can hang on the classroom wall. They work as constant points of interest and as ready-to-grab tools when the class studies flat, curved and multiple reflections.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.



<div>DIFFICULTY</div> <div>Intermediate</div>	<div>BUILD TIME</div> <div>3-5 hours</div>
<div>COST</div> <div>About \$40-80, mostly for the mirrors</div>	<div>SAFETY</div> <div>Adult build / supervision</div>
<div>GOOD FOR</div> <div>Teachers, Makers</div>	

What it shows

Three mirrors on the wall, three different versions of you: magnified, shrunk, and repeated twenty-one times.

Key ideas: concave mirrors, convex mirrors, reflection, potential and kinetic energy

Safety (Adult build / supervision).

Large glass mirrors are heavy and have sharp edges; an adult should handle them and do all sawing and drilling. Glass ornament balls shatter into sharp fragments, so use shatterproof plastic ornaments. Hang finished frames on secure wall anchors.

CONSTRUCTION

Build it

Materials

- ☐ **Large concave demonstration mirror** · 1
From a science supply company; they usually come without a holder
- ☐ **Large convex demonstration mirror** · 1
- ☐ **Plywood, 1/2 in** · enough for two octagonal backs
Each octagon slightly larger than its mirror
- ☐ **Wood blocks for the concave mirror supports** · 4
Each grooved to accept the mirror's edge
- ☐ **Wood screws** · about 12
- ☐ **Plastic mirror clips (hardware-store mirror supports)** · 4
For the convex mirror
- ☐ **Shatterproof ornament balls, all the same size** · 21
Bruce used Christmas tree balls
- ☐ **Thick sheet of plastic foam (polystyrene)** · 1
Big enough to hold all 21 balls
- ☐ **Wood strips for the multi-mirror frame** · 4 or more
- ☐ **Glue suitable for foam and plastic** · 1
Some solvent glues dissolve polystyrene; test first
- ☐ **Flat black paint** · small can

☐ **Picture-hanging hardware and wall anchors** · 3 sets

Tools

Jig saw or band saw

Table saw or router (for grooving blocks)

Drill and screwdriver

Hole saw or spade bit sized to the ornament necks

Paintbrush

1

Cut the concave mirror back

Cut an octagon from 1/2 in plywood slightly larger than the concave mirror. The octagon is easier to cut than a circle and looks neat on the wall.

2

Groove the support blocks

Cut a groove in each wood block wide enough to accept the edge of the mirror.

3

Mount the concave mirror

Set the mirror on the plywood and position the grooved blocks around its edge. Screw the blocks to the plywood with wood screws so they grip the mirror without squeezing it.

4

Mount the convex mirror

Cut a second plywood octagon for the convex mirror and hold the mirror in place with plastic mirror clips screwed around the edge.

5

Prepare the multi-mirror base

Drill 21 holes in a piece of plastic foam in a tight, evenly spaced pattern, sized to fit the neck of each ornament, where the hanging cap normally goes.

6

Set the ornament balls

Remove the hanging caps, put a little glue on each neck, and press each ball into its hole so all the balls sit at the same height.

7

Frame the multi-mirror

Build a wood frame that fits around the outside of the ball array. Paint the inside of the frame black so it does not show in the reflections.

8

Finish and hang

Attach hanging hardware to the backs and hang each mirror at a height where students can see themselves.

THE PHYSICS

How it works

A flat mirror reflects light so the image appears the same size and as far behind the mirror as the object is in front.

A concave mirror curves inward and gathers light toward a focal point. Up close it shows an enlarged, upright image; farther away than the focal point it shows a smaller, upside-down image.

A convex mirror bulges outward and spreads reflected light, so it always shows a smaller, upright image with a wide field of view, like a store security mirror.

Each ornament ball is a small convex mirror. Because the 21 balls face slightly different directions, each shows its own small reflection of the same scene from a slightly different angle.

Using it

- Have students walk slowly toward the concave mirror and find the point where their upside-down image flips upright.
- Compare how much of the room each mirror shows and connect the convex mirror to car side mirrors and store mirrors.
- Look into the multi-mirror and count how many of you appear. Ask why each image shows the room from a slightly different viewpoint.
- Lay the concave mirror flat on its back and roll a ball back and forth across it to show potential energy changing to kinetic energy and back.

GO FURTHER

Variations

- The multi-mirror can be built in any size; more, smaller balls give more images.

- Mount a flat mirror in a matching octagonal frame so all three types of mirror hang side by side.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The mirror rattles in its frame.

TRY THIS

Line the grooves with a strip of felt or rubber so the mirror is held snugly without stress.

IF THIS HAPPENS

The frame edges show up in the multi-mirror reflections.

TRY THIS

Paint the inside of the frame and any visible foam flat black.

IF THIS HAPPENS

The glue melted the foam.

TRY THIS

Use a foam-safe glue or a hot-glue gun on low temperature.