

EQUIPMENT BUILD PLAN LIGHT & OPTICS

Adjustable Angle Mirrors

Two mirrors glued to wooden blocks, one fixed to a base and one movable, let students set exact angles with cut-out angle cards and count the images that appear. The number of images follows a simple rule, which makes this a satisfying measure-predict-check activity on reflection.

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



DIFFICULTY Beginner	BUILD TIME 1-2 hours
COST About \$10-15	SAFETY Adult build / supervision
GOOD FOR Teachers, Families, Makers	

What it shows

Close the angle between two mirrors and one line on a card becomes three, five, seven, even eleven copies.

Key ideas: plane mirror reflection, multiple images, angles, kaleidoscopes

Safety (Adult build / supervision). An adult should handle the cutting of the wood and any glass mirrors. Choose blocks slightly larger than the mirrors so no glass edge is exposed, or use acrylic mirror tiles. Wear safety glasses when cutting.

CONSTRUCTION

Build it

Materials

- ☐ **Small flat mirrors, the same size** · 2
Glass or acrylic mirror tiles; acrylic is safer for students
- ☐ **Wood blocks, slightly larger than the mirrors** · 2
- ☐ **Large wooden base board** · 1
- ☐ **Wood screws** · 2-3
To fasten the fixed block from underneath
- ☐ **Mirror adhesive or construction adhesive** · 1 tube
Use an adhesive labeled safe for mirror backing
- ☐ **3 × 5 index cards** · 7 or more
For the angle cards
- ☐ **Thick marker** · 1

Tools

Saw
Drill and screwdriver
Protractor
Scissors
Sandpaper

1

Cut the blocks

Cut two identical wood blocks a little larger than your mirrors, so that once a mirror is attached no glass edge sticks out.

2

Attach the fixed block

Screw one block to the large base from underneath so it is held firmly and cannot shift.

3

Glue the mirrors

Glue a mirror to the face of each block, centered, and let the adhesive cure fully. The second block stays loose so it can be moved.

4

Make the angle cards

With a protractor, draw these angles on 3×5 cards: 30, 40, 45, 51, 60, 72 and 90 degrees. Cut each card along its angle lines to make a wedge-shaped corner.

5

Draw the target line

Draw a thick line across each card along the middle of the angle (the line that splits it in half). This is the object whose images you will count.

6

Set an angle

Place a card on the base with its corner at the hinge where the two mirror faces meet, then swing the movable mirror until both mirror faces touch the card's edges.

7

Count the images

Look into the mirrors and count the images of the line, not counting the real line itself. Repeat for each card and record the results.

THE PHYSICS**How it works**

Each mirror forms an image of the object. Light can also bounce from one mirror to the other and back again before reaching your eye, and each extra bounce creates another image.

The images lie on a circle around the hinge. When 360 degrees divided by the mirror angle is a whole number, the number of images you see is that number minus one. At 90 degrees, $360/90 = 4$, so you see 3 images; at 60 degrees you see 5; at 45 degrees you see 7.

The smaller the angle, the more bounces fit before the light escapes, so the number of images grows quickly as the mirrors close. A kaleidoscope uses the same idea with mirrors at 60 degrees.

Using it

- Give students the angle cards and have them build a table of angle versus number of images, then look for the rule.
- Expected results: 90 degrees gives 3 images; 72 gives 4; 60 gives 5; 51 gives 6; 45 gives 7; 40 gives 8; 30 gives 11.
- Ask students to predict the count for an angle they have not tested, such as 36 degrees (9 images), then check.
- Put a small colored object or a drawn pattern between the mirrors instead of a line and watch the

pattern repeat into a kaleidoscope design.

- Bring the mirrors to parallel and discuss why the number of images seems to become endless.

GO FURTHER

Variations

- Hinge the two blocks together with tape or a small hinge for a quick tabletop version.
- Use the 60-degree setting as the starting point for a student-built kaleidoscope.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The count is off by one or two at small angles.

TRY THIS

The last images form after many bounces and may be dim or hidden by the mirror edges. Look straight down the center of the wedge and use larger mirrors.

IF THIS HAPPENS

The images look doubled or fuzzy.

TRY THIS

Back-silvered glass mirrors make faint secondary reflections. Front-surface or acrylic mirrors give cleaner images.

IF THIS HAPPENS

The movable mirror will not stay at the angle.

TRY THIS

Weight the movable block or add a strip of non-slip shelf liner underneath it.