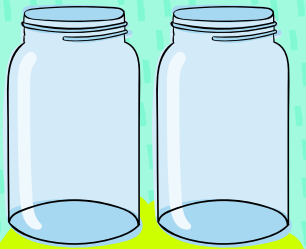
Popping Ears!

Have you ever felt that weird ear-popping sensation when you fly in an airplane or go up a hill? This uncomfortable sensation is related to pressure changes in the air space behind the eardrum (the middle ear). Why do you think this happens? You can find out by doing this experiment.

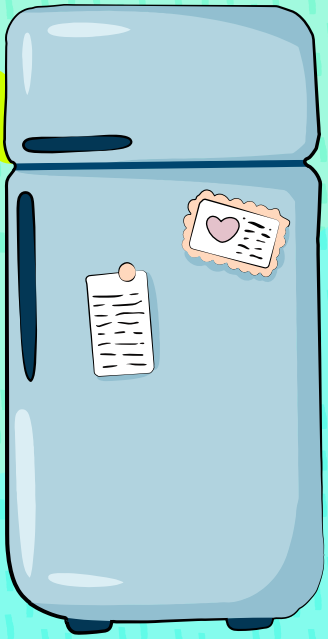
What you need



2 containers

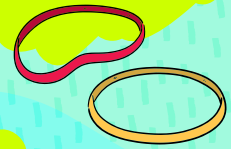
2 rubber balloons
Must be able to fit over the mouth of your containers.

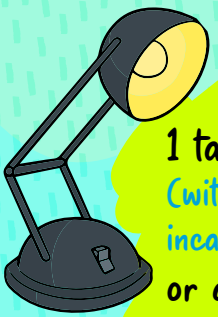
A refrigerator



1 pair of scissors

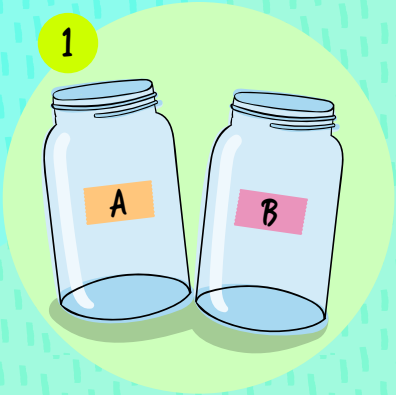
2 rubber bands





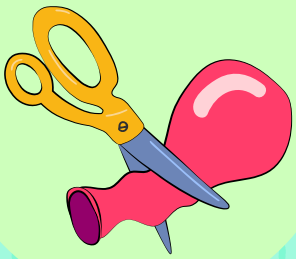
1 table lamp
(with a fluorescent/ incandescent bulb)
or direct sunlight

1



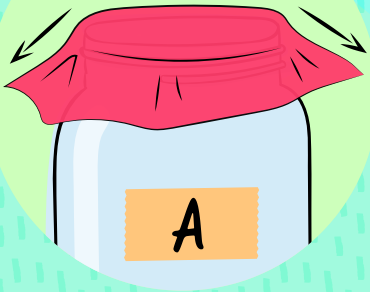
Label the two containers: A and B

2



Cut the necks of the two balloons at the expansion point.

3



Carefully stretch one balloon over the mouth of container A and pull tightly across the mouth of the jar to remove all wrinkles on the balloon surface.

4

Place a rubber band around the top of container A to hold the balloon firmly in place. Repeat this procedure for container B.

5

Record the appearance of both balloons before carrying out the next steps.

6

Place container A into a freezer for about 15 minutes.

7

Place container B near a heat source (the table lamp or sunlight) for 15 minutes.

8

Observe the appearance of the balloons and containers after 15 minutes.

Result

Container A (cold environment) has a concave balloon while container B (hot environment) has a convex balloon.

Concave vs. Convex

Concave Surface — Curves inward

Convex Surface — Bulges outward

Explanation

The air in container A, which was in the freezer, cooled and contracted. As a result, the rubber balloon was pulled into the jar. Because the molecules in cool air are more closely packed, it is denser, and take up less space.

The air in Jar B (positioned near the light source) became warmer and expanded, pushing the rubber balloon out. The number of air molecules in the jar has not changed, but they are less closely-packed, therefore the warm air takes up more space.

Think:

Can you relate the changes in the balloon shapes to what might take place inside your ears, as you climb up and down a mountain or experience the ascent or descent of an aircraft?

When we are on ground level, the air around us is held close to the ground by gravity. This means that there would be less air at higher altitudes (e.g. 1000m above ground level on a mountain). Because of the difference in the amount of air molecules in the same given volume, air pressure changes. The air molecules at higher altitudes are loosely packed, therefore the air pressure is lower; the air molecules at ground level or lower altitudes are closer packed, hence the air pressure is higher.

Anatomy of the ear

The ear can be divided into three sections: the outer ear, the middle ear, and the inner ear. The middle ear is an air-filled chamber that is connected to the nose and throat via a channel called the Eustachian tube. This is similar to the containers sealed with a balloon that you just made.

As an airplane rises in altitude, the air pressure in the cabin gradually drops, air molecules are less closely packed. This causes the eardrum to bulge slightly outward, just like container B.

After a while, the Eustachian tubes open, allowing the middle ears to equalise the pressure, and the eardrum is straight again. When the plane descends and the pressure in the cabin increases again, the middle ear pressure seems relatively low and the eardrum is pulled slightly inward.