EXPLORATION 2

Where is the centre of gravity?

Examine the concept of the centre of gravity.

The famous Leaning Tower of Pisa has literally "leaned" for hundreds of years because the ground cannot support its weight. But have you ever wondered why the Leaning Tower of Pisa does not topple over?

The weight of an object is concentrated at a precise point which is known as its centre of gravity. The gravitational force passes through this point in a vertical line toward Earth. And no matter at which location an object is hanging from, the object will rotate itself so that its centre of gravity is along this vertical line to gain stability. For an object that is in a regular or symmetrical shape, its centre of gravity is located at the geometric centre of the object. However, for shapes that are irregular or asymmetrical, plumb lines can be used to determine their centre of gravity. A plumb line is a weight suspended from a string and it always points vertically to the centre of gravity. But different positions or orientations of an object can result in different plumb lines. So how do we determine the centre of gravity using plumb lines?

Due to its tilt, the Leaning Tower of Pisa has two heights, and they have a difference of almost a metre!

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Where is the centre of gravity?

Level of Difficulty:	moderate
Time Needed:	1 hour

In this experiment, you will see how the centre of gravity can be determined using plumb lines.

Hypothesis:

Circle the word(s) to show your hypothesis.

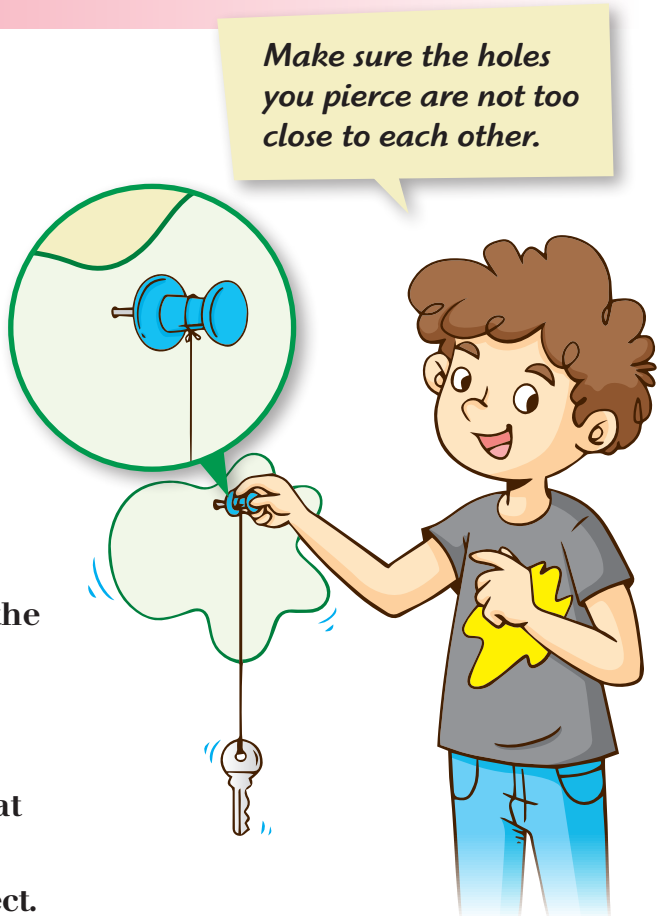
The plumb lines of a shape make **one / more than one** intersection(s).

Materials:

- construction paper
- a small weight (e.g. key, eraser)
- a push-pin
- a pin
- string
- scissors

Steps:

1. Cut the construction paper into an irregular and asymmetrical shape.
2. Tie the small weight to one end of the string.
3. Hang and secure the other end of the string on the pin to make a plumb line.
4. Use the pin to pierce a hole anywhere along the edge of the irregular shape so that the shape is free to swing.
5. Hold the pin and wait for the shape and the plumb line to stop swaying.
6. Once they stop swaying, trace the string's path on the shape.
7. Remove the pin from the shape and repeat Steps 4 to 6 four times.
8. Mark the point where all the lines intersect.



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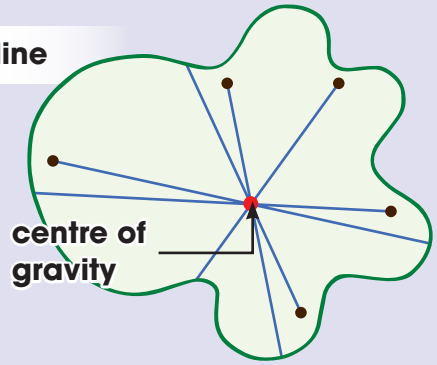
Conclusion:

Circle the correct words after conducting the experiment.

The plumb lines of the shape make **one / more than one** intersection(s).

My hypothesis was **correct / incorrect** .

Explanation:



From the experiment, you should have realized that the plumb lines intersect at only one point, and this point is where the shape's centre of gravity is.

The hanging shape rotates itself until its centre of gravity lines up directly below the hanging point, which is shown by each plumb line. These plumb lines allow you to visualize the vertical gravitational pull from Earth. The centre of gravity can lie anywhere on the plumb lines of the hanging shape. However, individually, they do not show the exact location of the centre of gravity.

There is, however, only one centre of gravity for the shape, and this centre of gravity must lie somewhere along all the plumb lines. Therefore, the centre of gravity must be the point where all the plumb lines intersect.

It is crucial for architects and engineers to determine the centre of gravity when designing buildings. They must also take into consideration the buildings' capabilities to withstand heavy winds, violent storms, and even earthquakes. So even though the Leaning Tower of Pisa is not in its most stable position, and it looks like it can topple over any time, its centre of gravity prevents the tower from collapsing.