Gravity Board

Description:
Does this defy gravity?

Materials:
10" square (or round) piece of wood
Drill
Adhesive-backed rubber (found at the home improvement stores)
Thin rope
Plastic cup
Water
Large ring washer
Scissors/knife
Adult Supervision

Procedure:
1) Drill equidistant holes on the board (in the corners for a square, or three to four holes around the edge of a circle board) so that the rope can slide through the hole openings
2) Cut lengths of rope so that each corner can be threaded and knotted under the board and attach on the ring washer 18 inches above the board (make the line lengths as even as possible)
3) Cut a piece of the adhesive backed rubber and stick it to the top board
4) Fill up a plastic cup half full with water
5) Place the cup on the rubber
6) Pick up the assembly by the washer and begin to slowly swing it like a pendulum
7) If there is ample room (best done outside) you can swing it in an entire circle
8) Observe that the water in the glass holds still even when upside down
9) Hypothesize as to how this may work
10) Note: This can also be done using a pail of water with a very good handle.

(Part 2)

Gravity Board

My Results:

Explanation:
This demonstration begins with Newton's First Law of Motion that an object in motion stays in motion and an object at rest will stay at rest unless it is acted on by another force. The water, cup and board all want to continue on their straight path, but they are being pulled in by the string (a simulation of gravity) and ending up in a controlled curved path, centripetal force.
Gravity is responsible for the planetary and satellite orbits as well, as they fall in a circular path referred to as centripetal force. For example, if the moon were closer and traveling more slowly it would fall into the surface of the Earth, and if it were further away with greater speed, it would slingshot away from the Earth in a straight line because of inertia. However, objects traveling at the correct speed will fall in a circular path around the more massive object. For things to orbit Earth, they must be outside of the atmosphere, as the particles in the air would cause enough friction to slow it down causing it to crash, and centripetal force is in play. Centripetal force is most easily described as an inward force toward a center (in this case resulting from gravity) and its straight linear motion (inertia). The combination of the two forces results in a curved path. The speed is critical as well as the satellite must travel about five miles each second to remain in Earth's orbit and if it were to accelerate to seven miles per second, the satellite would pull away from the Earth traveling in a straight line.

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Falling Book and Paper

Description:
Do different objects fall at different speeds? Why?

Materials:
Book
Several sheets of paper

Procedure:
1) Hold both items up and predict which item will hit the floor first when dropped
2) Drop the items and notice that the paper floated down whereas the book did not
3) Think of a way that the two items will fall at the same speed
4) Fold the paper in half and place it on top of the book and drop them together to notice that they fall at the same speed
5) One of the papers can also be placed underneath the book or crumpled up

My Results:

Explanation:
When objects fall on the surface of the Earth, they continue to accelerate at 9.8 meters per second, slowed down of course by air resistance and friction, but for argument sake, this means that the object's speed quickly rises with each passing second: 9.8, 19.6, 29.4, etc. It is also possible to demonstrate that objects with very different masses (and weights) will fall at the same speed. The rate of falling speed is also directly related to the mass of the planet or moon. In this case the paper was slowed down air resistance, more so than the book. By changing the paper's shape or placement in relation to the book (where friction by the air can be reduced or eliminated) they will fall at the same speed due to the constant gravitational pull on every object.
There are good video clips online demonstrating objects of different masses (a hammer and a feather) being dropped by astronaut David Scott of the Apollo 15 moon mission to show that in the vacuum of space there is no air resistance to alter the constant rate of objects falling.

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Water Fall

Description:
The water falls. The cup falls. At the same speed?

Materials:
Styrofoam cup
Pencil
Water
Bucket

Procedure:
1) Poke a hole in the side of the cup 1/3 of the way up from the bottom
2) Cover the hole with your finger
3) Fill the cup so that it is nearly full
4) Demonstrate that the cup will leak when you remove your finger
5) Predict what will happen when the cup and water are both dropped
6) Hold the cup over the bucket (or do the demonstration outdoors if possible) and drop it
7) Observe that the water does not flow out of the hole but falls with the cup

My Results:

Explanation:
Gravity was acting on both the cup and the water, however because the cup was held in place only the water was free to fall. So when the hole was exposed, gravity was able to pull on the water allowing it to leak out of the cup. When the cup is dropped, gravity pulls on both the cup and the water equally so they fall together. This can be related to astronauts who appear to "float" in space when in reality both they and the ship are falling at the same speed. Many people can relate to free fall rides at amusement parks in which they ascend a vertical tower and are dropped. By holding a penny in front of them at the beginning of the ride and letting it go during the fall, the penny will appear to float weightlessly as both the penny and ride momentarily free fall at the same rate.

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Accelerating Washers

Description:
Things may sound different than you think they will.

Materials:
String
Washers (all the same size)
Chair

Procedure:
1) Cut two pieces of string that are each 2.5 meters long
2) On the first string tie a washer on the end of the string and tie five more washes on the string so that they are each spaced 50 cm apart
3) On the second string tie on a single washer and then, the next one 10 cm away, then 30 cm from the second washer, then 50 cm, 70 cm, and 90 cm away so that each span is further than the preceding
4) Predict the sound that the first string will make when it hits the floor
5) Hold the string so the first washer is 50 cm above the ground and release the string
6) Repeat several times to capture the sound
7) Predict what the second string will sound like on impact while holding it only a couple of centimeters over the floor
8) Repeat several times and compare the two

My Results:

Explanation:
The string that has the washers equally placed does not make sounds in an even rhythm, whereas the ones that are not evenly spaced do. This is because of the acceleration of objects when they fall. When objects fall on the surface of the Earth, they continue to accelerate at 9.8 meters per second, slowed down of course by air resistance and friction, but for argument sake, this means that the object's speed quickly rises with each passing second: 9.8, 19.6, 29.4, etc. Therefore the washers need to be spread further apart as they move up from the floor because that distance will be covered faster and faster as the washers have more time to accelerate.

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Spacey Soda Cans

Description:
How much would you weigh on Jupiter?

Materials:
Soft drink cans
Pennies (836) (another 4,139 if representing the sun)

Procedure:
1) Have you ever considered what a soft drink can would weigh on other planets?
2) Pick up a full can for comparison sake and make a prediction on which planets the full can would feel heavier or lighter
3) Remember that the mass of the can is the same, but the gravitational pull is different depending on the mass and diameter of the planet
4) Fill 9 additional empty cans with pennies according to the following equivalencies
   a. Mercury = 38 pennies (gravitational factor of .38)
   b. Venus = 101 pennies (gravitational factor of .91)
   c. Mars = 38 pennies (gravitational factor of .38)
   d. Jupiter = 293 pennies (gravitational factor of 2.54)
   e. Saturn = 119 pennies (gravitational factor of 1.08)
   f. Uranus = 102 pennies (gravitational factor of .91)
   g. Neptune = 133 pennies (gravitational factor of 1.19)
   h. Pluto = 0 pennies (gravitational factor of .06)
   i. Moon = 12 pennies (gravitational factor of .17)
5) If you are ambitious, you can prepare a larger container holding 4,139 pennies to simulate the weight of the can on the sun (gravitational factor of 27.9)
6) Graph the number of pennies used to see the impact of the mass and planet diameter to determine weight
7) By multiplying your own weight by the gravitational factor, you can also determine your weight on each of those planets, moon, or sun

(Part 2)

Spacey Soda Cans

My Results:

Explanation:
When comparing planets and moons in our solar system, it is possible to demonstrate the varying gravitational forces and their relationship to their masses. Jupiter is much more massive than Earth and therefore we would weigh much more there than here. It is important to make a distinction between mass and weight, as people have many misconceptions. Weight is measured by how hard your mass is being pulled down, so if it were possible to stand on the surface of other planets (bearing in mind that some are liquefied gas), your weight would change even though your mass would not. Interestingly, Jupiter is 318 times more massive than Earth yet the force from its surface to its center is only 2.5 times greater than Earth's. That is because the further the surface is from the center, the weaker the pull. If on the other hand Jupiter kept its same mass but was the size of Earth we would weigh 318 times more on the small dense Jupiter than we do on Earth. Here the cans of "soda" would still have the same mass but would be pulled down to the surface with different forces altering their measured weight.

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The Curiosity Guide

Subject: Gravity

STEM Challenge

Season 1 Ep. 8 (#108)

Making a Protective Device for a Dropped Egg

Materials:
Fresh large grade-A eggs
Small paper cups
Toilet paper rolls
Straws
Toothpicks
Cotton balls
Sandwich bag
String
Masking tape
Rubber bands
Paper clips
Bubble wrap
Plastic jars
Packing peanuts
Pipe cleaners
Infant socks
Puffed wheat cereal
Small containers
Plastic drop cloth
Ladder
Plastic (practice) eggs that split in half

Procedure:
1) Consider what will happen to an egg that falls on a hard surface (the Humpty Dumpty story is a poignant opening)
2) Design a protective device to ensure that an egg withstands a fall on to pavement from a specified height
3) Limits include: there can be no parachute system to slow descent but that the system must be intended to transfer the kinetic energy into a shock absorbing system
4) Review available materials before drafting blueprint designs
5) Build and test along the way using the plastic breakable eggs, redesigning as necessary
6) During actual testing, lay out a large plastic drop cloth, set up an eight foot ladder (or drop from the roof if it is an option)
7) Reflect on what designs were most effective and why

The Curiosity Guide

Subject: Gravity

STEM Challenge

Season 1 Ep. 8 (#108)

(Part 2)

Making a Protective Device for a Dropped Egg

My Results:

Explanation:

Because gravity will have accelerated the egg during the fall, an egg dropped from a height of eight feet will be traveling at roughly 22 ▯ feet per second requiring a significant protection system that can absorb the kinetic energy into the structure without damaging the egg.

Newton's first law of motion states that the object in motion will stay in motion, so the egg within the structure will continue to move toward the ground with minimal time to slow the descent and absorb the energy.

This is an introduction to: the rate of acceleration of 9.8 meters per second for an object in free fall due to Earth's gravity, the transfer of energy when objects collide, and gaining experience designing and evaluating original prototypes. These concepts can be related to structural shock absorbing automobile chassis, football helmets, or dropping rovers in airbags on the surface of Mars.

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