Name _____

Newton's First Law

Newton's 1st Law states: "An object at rest remains at rest and an object in motion continues in motion unless an outside force acts upon it" (simplified).

What is inertia? _____

The more mass an object has, the more it _____ in its speed.

Experiment 1: Coin Toss

Watch demonstration by teacher.

Discuss what happened when the teacher dropped his elbow to grab the coins.

Why were the coins able to be caught? _____

Experiment 2: Rope Pull

Based on your understanding of inertia and the coin example, use an "if," "then," and "because" statement to write out a hypothesis for what you think will happen when the string attached to the object is quickly yanked away.

Hypothesis:

IF...the string is yanked quickly,

THEN..._____

BECAUSE..._____

_____

Experiment 3: Tablecloth

Since an object's inertia increases with greater mass, write out a hypothesis based on what will happen to the heaviest bottle when the tablecloth is rapidly pulled off the table.

Hypothesis:

IF…the tablecloth is rapidly pulled off the table,

THEN…_____

BECAUSE…_____

_____

Discuss what happened to the bottle *without* water and then explain why it happened.

_____

_____

What is the mathematical formula for force?_____

Review:

- ✓ What is Newton's first law of motion?
- ✓ What is inertia?
- ✓ What increases an object's resistance?
- ✓ What is the formula for force?

Newton's First Law

Teacher Notes

Newton's 1st Law states, *"An object at rest remains at rest and an object in motion continues in motion unless an outside force acts upon it" (simplified).*

Ask the students about Isaac Newton; if they know who he is and what his three laws are. Isaac Newton was a scientist who lived in the 17th century and is known for several original scientific hypotheses, the three laws of motion included.

What is inertia? "Inertia" is defined as: An object's resistance to a change in its speed (simplified). This "resistance" is called "inertia."

And secondly, the more mass an object has, the more it resists a change in its speed, or we could say, the more "inertia" it has.

Teach

Newton's first law is really about "inertia." Inertia is an attribute of all objects that have mass. In other words, if it is made of atoms, it has mass—so everything we think of in normal life. Basically, the law is stating that the more mass an object has, the more the object "wants to resist being moved (changing its speed)." Think about kicking a balloon and then kicking a bowling ball. If you kick the balloon, the balloon does not really "resist" being moved because it has fewer atoms (less mass). But the bowling ball does 'resist' moving (you know this because your foot hurts!). So, when you kick it, it sort of says to your foot, "No, I'm not budging!"

So, inertia is just the tendency of objects to resist changing their speed (whether zero or some other actual speed), and secondly, the more mass, the more they resist this change.

Because Newton's First Law has lots of components to it, the focus will only be on inertia and will not try to explain all the other forces that are acting on the objects. Although inertia is a relatively simple concept, there is so much else going on with friction and gravity, that it can get very complex very quickly! One thing at a time!

Experiment 1: Coin Toss

Place 3 coins of the same size on the end of your upturned elbow (as in video). Rapidly bring the hand down to catch the coins in mid-air (again, as in video).

Discuss what happened when the teacher dropped his elbow to grab the coins.

Why were the coins able to be caught?

Teach

When the arm was rapidly dropped, the speed of the coins changed rapidly (because gravity, although always present, began to pull the coins to the ground). This caused the coins to resist moving (because of their inertia), at least for a split second. Of course, eventually, gravity wins, but it is that split second that allows your hand to move around and catch the coins mid-air.

Experiment 2: Rope Pull

Tie a piece of yarn or thin cord around an object that is not too light but not too heavy. About 100-200 grams. Twirl the object around on the string a few times (not whirling around your head!) just to show the students that the object's weight is not enough to break the cord (as in video). Now place the object on the ground, wind some of the cord around some of your fingers so that it does not slip and then yank the object really fast (as in video). (WARNING: Only adults should demonstrate this experiment. Young children just don't have the force available, and so end up flinging the object up into the air where it might hurt someone!).

Based on your understanding of inertia and the coin example, use an "if," "then," and "because" statement to write out a hypothesis for what you think will happen when the string attached to the object is quickly yanked away.

Hypothesis:

***IF*…the string is yanked quickly**

THEN…the string will break

BECAUSE…the object's inertia caused it to resist changing its speed (zero in this case). This resistance broke the string.

Teach

As with the first experiment, the object's inertia causes the object to resist moving. Now, a very low change in speed, as when you picked up the object and twirled it around, was not enough to get the inertia to 'kick in.' You will want to point this out to the students. An object will resist all changes in its speed (even small changes), but demonstrating inertia requires a rapid change in the object's speed, enabling us to see the results.

Experiment 3: Tablecloth

Set up three, same-sized water bottles in a row on a table covered with a table cloth. Fill one to the brim, one half full, and keep one empty. Now pull the table cloth off the table rapidly!

Since an object's inertia increases with greater mass, write out a hypothesis based on what will happen to the *heaviest* bottle when the tablecloth is rapidly pulled off the table.

Hypothesis:

***IF*…the tablecloth is rapidly pulled off the table,**

THEN…the heaviest bottle will stay in place

BECAUSE…the object's inertia caused it to resist changing its speed (zero in this case).

Discuss what happened to the bottle *without* water and then explain why it happened.

This bottle did not have as much mass as the full container. So, although its inertia did cause the object to resist moving (it did not fly off the table with the tablecloth) it still fell over.

Teach

Slowly moving the objects meant virtually no change in speed. Although all three objects resisted moving, the slow change in speed did not allow us to visually detect this resistance. But, when the table cloth was yanked, the speed of the table cloth changed rapidly. This rapid change in speed was transferred to the objects. As soon as the objects "felt this change" they said, "No way, we're not moving," and so their inertia kicked-in.

All going well, only the empty container will fall over. This is because it has the least amount of mass and thus the least inertia.The full container should stay upright, and barely move at all because it has the greatest mass and thus the greatest inertia. The half-full container should also stay upright, but in a slow-motion video, it should move around a bit more than the full container.

What is the mathematical formula for force? F = ma

Teach

It's also at this point that you will want to make the connection between a change in speed and a force. If an object has mass, and if it experiences a change in speed over a period of time, then we call this—a force.

Now introduce the students to F = ma. The 'm' is for mass and the 'a' is for acceleration, but a change in speed that occurs over a period of time is the same thing as acceleration. Since all objects have mass then, *and sacrificing precision for the sake of clarity*, you can say that changing the speed of an object with mass is the same thing as the object "feeling" a force.

Now you can *connect* inertia to Newton's first law which once again states, "An object at rest remains at rest and an object in motion continues in motion unless an outside force acts upon it" (simplified).

All objects do not like to change their speed, whether that is zero or some actual speed. Think of a large ship approaching a small sail boat. Unless the small sail boat is spotted early, there is no way for the captain of the ship to avoid hitting the sailboat. That's because the ship is travelling at a certain speed and the ship's inertia does not allow the ship to change that speed very easily. The ship is essentially resisting a change in its speed. That's inertia, but it's also the key to Newton's first law!

Review:

- ✓ What is Newton's first law of motion?
- ✓ What is inertia?
- ✓ What increases an object's resistance?
- ✓ What is the formula for force?