Newton's First Law

Let's move on to Newton's First Law. Newton has a famous quote that goes "If I have seen farther then others, it is because I have stood on the shoulders of giants." One of the giants he was referring to was Gallileo. Thanks to the discoveries of Gallileo and others, Newton was able to make many of his own discoveries. The most famous of which are Newton's Laws of Motion. Newton's Three Laws of Motion are: 1. An object at rest tends to stay at rest, an object in motion tends to stay in motion unless a force acts against it. 2. Force equals mass times acceleration. 3. Every action has an equal and opposite reaction.

At first glance Newton's first law seems rather obvious. Especially the first part, "An object at rest tends to stay at rest" Well….of course. When was the last time you saw your table move across the room for no reason! Last time you were eating your potatoes did they float off your plate and into the lamp…no! It's really the second part that is an amazing statement. Especially if you consider when the statement was made. "An object in motion tends to stay in motion." Think about that. When was the last time you saw an object keep moving on its own? If you push a toy car, does it just go and go until it hits the wall? Last time you threw a ball, if your buddy missed it did it just keep sailing down the street? No! Both objects stopped. All object stop right? Well, yes but only on a planet.

The reason things stop is because of our two buddies that we talked about last month, the forces of gravity and friction. Without them, things would just keep going. This is why planets, comets, space shuttles, meteors and more, never stop moving. They have no air resistance (in space there's no air and as such no friction from air) and they may or may not have much gravity pulling on them. Things in orbit (the moon, satellites, etc.) do feel the pull of Earth's gravity but they are moving fast enough to keep falling around the Earth and not into the Earth.

Now imagine Newton sitting there in 1666, he has never seen a frictionless place or a place with no gravity. He's never seen the pictures from the space shuttle of things floating around. No one's been to the moon yet. For him to "see" the reality that in such places things would never stop moving is pure genius. Aristotle said the natural state for most objects was to be at rest. Newton, without ever seeing

any evidence to the contrary, said the natural state for a moving object was to continue moving. When you can see through what everybody has believed to be true for centuries you are a true genius (or out of your head!).

Inertia

There is a term in physics that really kind of encompasses Newton's first law, and that is inertia. Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving, or to change directions. Generally, the heavier an object is, the more inertia it has. I like to think of inertia as a mule. It is often very hard to get a mule to move, and once you do get him moving it is very difficult to get him to stop or to change directions! Quick quiz, what has more inertia, a ping-pong ball or a train? If you said "train" you're right. It is very easy to get a ping-pong ball to move and it is very easy to get it to stop. A train, on the other hand, is quite difficult to move or stop! Let's play with inertia a bit.

Experiment 1
Why Seat Belts Are Your Best Friend

You Need:
A car
A ball

1. Next time you go for a ride bring a tennis ball with you in the car.

2. Sit in the back seat and put the tennis ball in the seat next to you.

3. Now watch the ball carefully as the car moves. See how it moves around the seat? (Try not to let it get on the floor and roll around. It might roll under the pedals and that would be bad).

4. Pretty easy huh?

As the car moves forward at 20 mph, everything in the car is moving forward at 20 mph. Everything in the car has the same inertia. If the car were to stop suddenly, everything in the car that's not bolted down, still moves forward at 20 mph until it

hits something. An object at rest tends to stay at rest, an object in motion tends to stay in motion. Right? So, if the car stops quickly, the tennis ball continues to move forward until it hits something. If the car turns, the ball continues to go in the direction it was going a second ago, so it rolls around the seat. What would happen if the car stopped suddenly and you weren't wearing a seat belt? Yup, you'd fly forward at whatever speed the car was going until you crashed into something in the car. See now why seat belts are your best friend?!

Experiment 2
Little Red Inertia

You Need:
A wagon
Friends

1. Pull the wagon down the sidewalk.

2. Try to stop as quickly as you can. Be careful. You could get run over by the wagon if you're not careful.

3. Put a friend in the wagon and repeat steps 1 and 2.

4. Put another friend in the wagon and repeat steps 1 and 2.

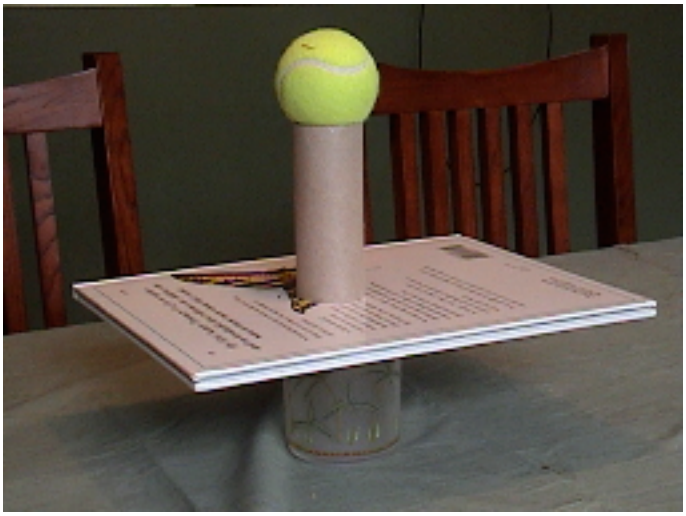
5. Again...pretty easy huh?!

You may have noticed that the more friends (the more weight) you had in the wagon the harder it was to get moving and the harder it was to stop. This is inertia. The more weight something has the more inertia it has and the harder it is to get it to go and to stop!

Experiment 3
Taa Daaaa!!!

(A movie of this is available at http://www.bitesizephysics.com/physicsmovies.html)

You Need:
Plastic cup
Book
Toilet paper tube
A ball that's a bit smaller then the opening of the cup



1. Put the cup on a table.

2. Put the book on top of the cup.

3. This is the tricky part. Put the toilet paper tube upright on the book, exactly over the cup.

4. Now put the ball on top of the toilet paper tube.

5. Check again to make sure the tube and the ball are exactly over the top of the cup.

6. Now, hit the book on the side so that it moves parallel to the table. You want the book to slide quickly between the cup and the tube.

7. If it works right, the book and the tube fly in the direction you hit the book. The ball however falls straight down and into the cup.

8. If it works say TAAA DAAA!

Again, this is inertia. The force of your hand got the book moving. The friction between the book and the tube (since the tube is light it has little inertia and moves easily) causes the tube to move. The ball, which has a decent amount of weight, and as such a decent amount of inertia, is not effected much by the moving tube. The ball, thanks to gravity, falls straight down and, hopefully, into the cup. Remember the old magician's trick of pulling the table cloth and leaving everything on the table? Now you know how it's done. "Abra Inertia"!

So inertia is how hard it is to get an object to change its motion, and Newton's First Law basically states that things don't want to change their motion. Get the connection?

In a Nutshell

Newton's First Law is an object at rest tends to stay at rest and an object in motion tends to stay in motion unless a force acts against it.

Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving or to change directions.

An object will probably have more inertia the more mass and/or friction it has.

Did You Get It

1. Gravity pulls equally on a man with a closed parachute and the same man with an open parachute. Why does the man fall more slowly with an open parachute?

2. Newton's first law says "An object at rest stays _____?"

3. And it says "an object in motion stays _____?

4. What is inertia?

5. What does inertia have to do with the last time you spilled a drink in the car?

6. Which has more inertia a taco or a tow truck?

7. Math Question. I drop a feather and it takes the feather 4 seconds to fall 8 feet. What is the velocity of that feather? (Velocity is v=d/t)

8. So how long would it take that same feather to drop 12 feet? (t=d/v)

9. Which drops with more acceleration; a bowling ball or a golf ball?

Answers

1. Gravity pulls the same on both (they weigh the same) but air resistance is much greater with an open parachute. The force of air resistance equals the force of gravity much more quickly with an open parachute so the fall is slower.

2. Rest

3. Motion

4. Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving, or to change directions. Generally, the heavier an object is, the more inertia it has.

5. When the car is moving, everything in the car is moving at the same rate of speed as the car. If the car changes its speed or direction, the drink's inertia keeps it moving the way it was moving. So if the car changes direction or speed, and the drink is not restrained, nothing will stop the drink from moving in the same direction it was already moving in and spill all over the seat.

6. A tow truck has more mass so it has more inertia. It is harder to stop, change its direction, or get it moving.

7. 2 feet/second downward. Divide 8 feet by 4 seconds to get 2 ft/s. Add the downward to make it a velocity and not just a speed.

8. 6 seconds. Divide 12 feet by 2 ft/s and you get 6.

9. Neither. Remember last lesson? All things drop with the same acceleration. It's air resistance that effects the top velocity things can reach. On the Moon, feathers fall as fast as bricks.