The Notion of Motion Workshop

These workshops address each of Newton's laws but particularly reinforce the concept of "Inertia" which is totally new to most students. May also help older kids grasp the concepts of "mass" and "force" and "acceleration".

1. Table cloth pull - everyone gets to try this classic demo of Inertia
2. If I had a hammer - learn the simple way carpenters use inertia to reassemble hammers
3. Rolling Floor - as seen in the show, kids get to experiment with their own inertia and force
4. Balloons in a box - be amazed by comparing the inertia of a Helium balloon to that of an air balloon
5. Force Tug-o-War - demonstrates how action and reaction are always opposite and equal
6. Metal marble Accelerometer - kids roll marbles past a magnet and interpret the role of force, mass, and inertia in their observations.

Given time, we also generate a Distance vs. Time graph (showing the Scientific Method at work) with Zusha, the racing hippo.

Quick Facts

* 30 student maximum; 25 students ideally
* requires at least 5 parent volunteers to spend the day helping to supervise stations (only as many stations will be offered as can be supervised)
* grades 2 and up
* 3 workshop minimum
* Follows "The Notion of Motion"

Activities

Table Cloth Pull: Static Inertia.
Students will get to try pulling the shower curtain from under various objects on the table and observe which objects move the least (the ones with the most inertia). Using the mug, it can be shown experimentally that it has more inertia when it has water in it...only let the kids do this if it's OK for the floor to get a little wet. I never let a group have more than one mug of water, because if they are well-behaved they won't even spill a drop of that; if they know that's all the water they get, they will probably be careful with it. Many variations exist; let students be creative and try their ideas.

Metal Marbles: Particle Spectrometer
This demo shows thereality of inertia in motion. As marbles of various sizes roll past a magnet, they experience a magnetic force and are accelerated in the direction of the force (an acceleration is any change, even a change in direction). Objects with the least inertia (i.e. the least mass) will undergo the greatest acceleration. This is how different isotopes of an element are separated, except that atoms are used instead of marbles, and an incredibly sensitive electromagnet instead of a chunk of rare-earth magnet. After examining the station and observing a trial run, students should make hypotheses before rolling all the marbles themselves. Allow students to complete rolling all the marbles and making observations before retrieving any from the end boxes.

Zusha Races: Making a graph.
Motion is a graphic entity, and while many classes have discussed motion and movement, this will probably be most classes' first exposure to graphing. This station is designed to emphasize the importance of "observation" (collecting data) in science, and to practice the art of drawing conclusions based on observations (interpreting data). The Hippo will race the length of the track. The monitor at this station should give a data table and pencil to each kid, make sure the hippo is ON, and then say "go." Kids should record (on charts provided) the progression of Zusha at 10-second intervals; these will be announced by the monitor as the stopwatch passes "10 seconds", "20 seconds", "30 seconds....60 seconds". Then announce "90 seconds" at the proper time (70 and 80 aren't crucial, but it doesn't hurt to announce them also). Kids should then use the graph paper provided to make graphs of the first 60 seconds of Zusha's travel. Based on these first 6 points, most kids will observe that their graphs are straight lines. Now ask them to predict, i.e. hypothesize - FROM WHERE THEY EXPECT THEIR GRAPHS TO GO - where the dot should be at 90 seconds. Have them compare results.

Rolling Floor:
Students can demonstrate Newton's Third Law (Action and Reaction) by walking the length of the floor. It's a deceptive apparatus. Since experience with running this station is imperative for keeping it safe, only Dr. Quark can supervise this station. There are numerous variations for this popular activity. Some possibilities are: standing two students (of equal size) back-to-back in the middle and have them walk apart; two same-sized kids start at opposite ends and walk toward each other, then try with different sized kids (now we're into unbalanced forces and acceleration - Newton's Second Law). Once again, the crucial aspect is getting students to think about what will happen and state their own hypotheses.

Force Tug 'O War:
NOTE - THIS STATION MAY REQUIRE SOME PHYSICALITY ON THE PART OF THE PROCTOR. One student (the smallest in the group) is chosen as the standard unit of force for this activity. It's nice to introduce the idea of units and standards by posing the questions "How do we measure time? or length?" and "How was it done before anyone had a watch, or seconds? Or meters or feet - and why do you suppose "feet" were chosen?" Now the standard force (we'll call her Jane) sits on the swing on the scales (if her feet are even grazing the floor your results will be confusing) and a line is drawn on each scale to show how much force the student exerts. Now the two scales graduated to equal forces are attached to each other, and the kids are divided into even teams (it's good to assign one student the task of "scale reader"). Before starting the tug'o war, ask the kids to make a hypothesis about what the scales will read. I usually attempt to control their efforts by asking, "what will the the Blue team's scale read if the Red team pulls hard enough to make their scale read one "Jane" (or whoever is the unit of force)". LAW 3: for every action there is an equal and opposite reaction. If both teams pull evenly, both scales will read the same force simultaneously. If one team pulls harder, that makes an unbalanced force resulting in the expected acceleration.

If I Had a Hammer:
How to use static inertia to your advantage IN REAL LIFE! Students will learn how to put the head back on a hammer handle. People often use mallets to drive the head onto a hammer by placing the head on the stick and then pounding the head directly with a mallet. Let kids try this and count how many blows are required before the head is really tight. Then show them how carpenters do it: put the head on the stick and gently drop the stick onto the table top. Inertia will keep the head moving after the handle has stopped, and force it down onto the handle pretty tightly, but not nearly tight enough to use. Now hold the handle and invert the hammer (WATCH YOUR TOES FOR FALLING HAMMER HEADS - I PREFER THAT HAMMERS ALWAYS STAY OVER THE TABLE!) While still holding the handle in one hand, use a mallet in the other hand to strike the end of the handle. Because the head has more inertia (it's more massive) than the handle, the handle moves through it and gets tighter very quickly - it may only require one blow this way. To remove the heads, invert the hammers and gently drop them on the table or floor. Once again, when the handle stops moving (because the table prevents it) the inertia of the head will pull it off.

Balloon Canopy:
Have the students discuss which has least inertia: a helium balloon, an air-filled balloon, or air. Whatever has the least inertia is the lightest. Then they should make a hypothesis about what will happen if the wagon with a helium balloon fastened to the floor and an air balloon suspended from the ceiling is allowed to accelerate; make them DESCRIBE how it will look. Have a kid pull quickly on the wagon's handle for a distance of about 10

feet while the other kids in the group watch from the side. It does no good to let the kids just run around with the wagon, since once a constant speed is reached, there is no more acceleration and the balloons will return to straight position. They can also try giving a quick shove on the handle. Let every kid try accelerating the wagon. If the proctor should include, as food for thought, that this may compare to sitting in your car when Mom stomps on the gas pedal, it may get the students thinking in terms of their own experience. However, while this is exactly the same thing, one key factor is the opposite. In a car, you have more inertia than the surrounding air, so you accelerate more slowly and feel yourself getting sucked backwards (like the air-filled balloon). The helium balloon has less inertia than the air, so it accelerates more quickly and leaps forward when everything starts up. Because this demonstration is contra-intuitive, they may not believe their eyes - like the "bobber" demo done during shows when time permits.

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Students and teachers with questions, comments, or suggestions for other things you'd like to see can write Dr. Quark at the above address! He loves mail and will try to answer what he gets!