NEWTON'S FIRST LAW
Lesson Plan 1

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:
1 Pre-Assessment test per student **Egg Drop handout (1 per group of 4)** 1 cardboard toilet tissue tube per class 1 Aluminum pie pan per class 1 Raw egg per class (maybe bring some back-ups) 1 Large drinking glass filled ¾ full of water per class **Coin Drop handout (1 per group of 4)** 1 Small glass cup per group of 4 1 quarter, 1 dime, 1 penny, 1 nickel per group of 4 One playing card or index card per group of 4 Other small objects (example: 1 paperclip, 1 button, 1 bead) per group of 4 **Paper Pull handout (1 per group of 4)** 1 piece of printer paper per group of 4 1 piece of Kleenex per group of 4 1 paper towel (the rougher the better) per group of 4 1 piece of felt or fabric (around 8.5" x 11") per group of 4 1 piece of sandpaper (3.5" x 9" piece is fine) per group of 4 1 box of playing cards per group of 4 1 button, quarter, or paperclip per group 1 pink eraser Poster with the definition of inertia (make these on easel pad paper if you can) Poster with definition of force Poster with definition of gravity

Activity Name:	Rotation or Session #
Egg Drop, Card and Coin Trick, Paper Pull	1 of 8

Goal/Objective of Activity:
Goal: The purpose of today's lesson is to introduce students to several physics terms, including inertia, force, and gravity. **Objective:** Students will be able to give basic definitions for inertia, force, and gravity. Students will

be able to explain how each term applies to one basic experiment. Students will be able to name one variable that can be changed in an experiment.

Background Information for the Teacher:

Who was Isaac Newton? Isaac Newton was an English philosopher who lived from 1642 – 1727. He was the single most important contributor to the development of modern science. Most consider him the greatest scientist of his era who happened to discover gravity. Amazingly, Newton didn't know how gravity actually worked. He just knew that it existed. Newton added knowledge to the study of physics, optics, calculus and astronomy.

In this series of lessons we will learn about Newton's First Law.

Newton's First Law - An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. Newton's First Law is also referred to as the Law of Inertia.

The word inertia is from the Latin word *iners* meaning *idle*. Inertia is the resistance of any physical object to any change in its motion or change of direction. It is the tendency of objects to keep moving in a straight line. Inertia either keeps an object sitting still or moving at a constant speed.

Vocabulary:

Inertia - the tendency of objects to resist changes in their state of motion

Force - a push or pull upon an object resulting from the object's interaction with another object; when there is an interaction between two objects, there is a force on each of the objects

Gravity - a force that pulls things down toward the center of the earth

State of motion - on object's velocity (or speed with a direction). For the purposes of this unit, do not go into the equations. Just describe the state of motion as movement or motion in general.

Variable - one factor in an experiment. In order to make a demonstration into a true experiment, you need to change one variable and retest, keeping all other variables the same. In any given experiment, there are always multiple variables involved, for example, speed, mass, angles, surface area, etc.

Activity Instructions:

Pre-Assessment Test: Distribute the **Pre-Assessment handout**. Tell students that it is okay if they do not know an answer and that they should take an educated guess. Allow 5 minutes for the assessment. Collect for future grading and data collection. If your students have access to a computer lab, the assessment can be taken on Survey Monkey.

Opening/I DO:

1. *Hang up poster for entire class to see:*

INERTIA - The tendency of objects to resist changes in their state of motion.

2*. Say the following narrative, pausing for questions and pointing at demos when appropriate:*

Today we're going to learn about physics, which is a type of science that deals with matter, energy, motion, and force. You usually don't even take physics class until your senior year in high school, so we're starting early. Today, specifically, we're going to learn about this word. Can someone pronounce this word for me? It's a hard word to say, but we're going to say it a lot so let's get used to it. It's pronounced IN-ER-SHUH. When I was your age, the first time I saw it, I thought it was pronounced IN-ER-TEE-UH. I had no idea what it was! And you know what, I'm still learning more about inertia every single day. So during this unit, we're going to learn about **inertia** and physics together. Let's read this definition. What does that mean, "The tendency of objects to resist changes in their state of motion?" Can someone try to put it in their own words for me? Let's demonstrate, okay?

I need a volunteer to come up here and sit in this chair. Imagine it's Sunday, and you're sitting on the couch watching football, and you have a bowl of chips over here and a can of soda over here. You have your sweats on and some warm slippers. And then your mom comes in and says, "Honey, take out the trash." What do you want to do? Do you want to get up from the couch and take out that trash? Nope. No, you're comfortable and you want to stay right where you are. That's right, you're going to resist changes in your state of motion. And you might think, well he's just sitting there, that's not motion. Well no motion is still a state of motion, just an absence of motion or very little motion, and he's going to resist a change to it.

So, let's see this in action! Or should I say *inaction*? HA!

3. *Perform the egg drop experiment. It's explained in detail in the accompanying handout. As you perform the experiment, say this:*

So what do you see here? That's right, an egg on top of a paper tube, on top of a pie tin, on top of a cup of water. Guess what? I'm going to apply a force and hit that pie tin like this *(demo the motion, but don't hit it yet)*. What do you think is going to happen? Wait! Don't say anything! We're going to try something new called Numbered Hands. I'm going to ask a question, and you're going to answer it by holding up a number. So here's my question: "What do you think is going to happen to the egg when I hit the side of the pie tin? Is it going to (1) fly straight out horizontally and hit Sasha in the face? (2) Drop into the cup of water? or (3) Roll off the tin and crack open on the table? Don't say it, just hold up your numbered hands. Again. What do you think is going to happen when I hit the side of the pie tin? Hold up one finger if you think it's going to fly straight out horizontally. Hold up two fingers if you think it's going to drop into the cup of water. Hold up three fingers if you think it's going to roll off the tin and crack open on the table. Numbered Hands UP! Now look around. Find a partner. Try to find a partner with a different number than you, but if you can't, it's fine if you both have the same answer. Explain to your partner why you chose your answer. Okay, after talking to your partner, what do you think? Numbered Hands UP? Interesting. We have some changes in numbers. Let's see what will happen. Back up, please!

Perform the magic!

4. *Say this:* Thank you! Thank you! No applause necessary. Now let's break this down, and explain what happened using our new science vocabulary. Someone set up the egg for me again.

Okay, so the object I'm focusing on here is the egg. So what's the egg doing? That's right, it's resting in its little tube nest. So what does it want to do? That's right, it wants to stay resting. So what's it going to resist? What does it not want to do? That's right, it's going to resist a change in its state of motion. It is not moving, so it wants to keep on doing that - not move. So I'm going to apply a force to the pan, but not to the egg. Tell me what's going to happen. *(let them explain)*

That's right. After I applied the force to the tin, the egg wanted to stay in the same position, so you could almost see it pause in the air for a bit. But because of gravity, it eventually fell into the cup. What stopped it from moving even more? The water in the cup. Now, I just used two words in that explanation that are not on our poster. I used the word **FORCE** and the word **GRAVITY**.

Can anyone tell me what force means? Just your best guess…try to put it into a simple definition. That's right, it's like when you push or pull on something. *(reveal poster)*
A **force** is a push or pull upon an object resulting from the object's *interaction* with another object. Whenever there is an *interaction* between two objects, there is a force upon each of the objects.

How about **gravity**?
That's right, it's the force that attracts a body toward the center of the earth. *(reveal poster)*

Hang up those posters as well. All the posters need to stay up as the lessons progress.

5. Now, if I wanted to turn this egg demonstration into an experiment, what is one **variable (or factor)** I could change? (You could change the object, so something lighter or smaller than an egg, you could change the angle at which you hit the pie tin; you could change

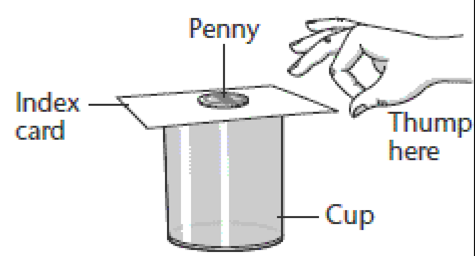
6. Great. Now let's see if you can keep all those words in your head and apply them to 3 more demonstrations. Get into groups of 4. At each station, you're going to see the materials you'll need to set up each demonstration. Follow the instructions on the handouts, step by step. Make sure you make a prediction on the page before you perform the demonstration. After the demonstration, answer the questions at the bottom of the page. I'll come around and help. At the end, we'll go over

what we found out.

WE DO/YOU DO:

Coin Drop and Paper Pull Experiments

1. Put students into groups of 4. Have tables set up with materials for the experiments, including the handouts. They will be asked to do the Coin Drop and the Paper Pull. **Optional:** You can include the Egg Drop handout at the top of the packet, and walk them through the prediction and questions as a "we do" step. Or you can say that the egg drop handout is at the top, and while they do not need to do the experiment again, they should write the prediction they had at the beginning of the lesson and then answer the questions based on what they observed.
2. The handouts are self-explanatory. Circulate as the students work to see if they need any help with the procedures or with new vocabulary.
3. As you circulate, ask these kinds of questions:
    - How does inertia apply to this experiment?
    - What variable could you change in the demonstration if you wanted to turn it into an experiment?
    - What do you think is going to happen when you do it again with the paperclip/button/coin?
    - Why do you think it works better when you do it that way?
    - What kind of force is acting on the object right now?
    - Why do you think that happens when you use the sandpaper/fabric/paper towel?



4. Give the students enough time to perform all activities.
5. Debrief.

Debrief:

Have students stay in their groups. Ask them to discuss the activities with you. You will be asking the same questions that are on their handouts, edited down a bit.

Coin Drop

1. Did the size of the coin play a part in the results?

    No. All the coins did the same thing

2. How does the law of inertia apply to what happens with the coin?

    The coin is at rest and wants to stay at rest. Even when a force is applied to the card, the coin still wants to stay at rest.

3. What force or forces are acting upon the coin during the experiment?

    While it's at rest, the force of gravity is acting on the coin. The card is also exerting a force on the coin. However, the force of gravity pushing down combined with the force of the card *pushing up is **balanced**, which is why the coin can remain at rest. When you flick the card straight out, the forces are **unbalanced**. There is nothing holding up the coin, which is why it falls due to the force of gravity. But notice how it falls straight down. It's still trying to resist a change in its state of motion.*

4. What do you think will happen if you flick the card from underneath rather than from the side? Why do you think this will happen?

5. If you have time, test the other objects. Does the law of inertia still apply if you use lighter objects (paper, paperclip) or objects of different shapes (bead, button)? Explain what you observed.

   The law of inertia still applies.

Paper Pull

Note: While the Paper Pull activity is definitely about inertia, it's also about friction.
Ask them general questions about the experiment. What did they observe? What were their conclusions? See if they start talking about the surface texture of the paper or the weight of the various objects. Validate their answers, but don't explain anything. See if they make the connection during the next lesson when they learn about friction.

Tips/Things that work well/Additional Resources:

Note: This is a very long lesson. The opening and the debrief set up most of the background knowledge for the rest of the unit, so there is a lot of explanation and questioning happening. Plan accordingly.

You can find descriptions of the egg drop demonstration here:
http://www.stevespanglerscience.com/lab/experiments/egg-drop-inertia-trick#sthash.tQt4fKNB.dpuf

An ambitious trick!: Combine each group's materials, replacing the 5 pie tins with 1 plastic cafeteria tray. Set up the demo again with 5 eggs (all on the same tray) over 5 cups. Have a brave soul hit the tray and see if it still works. Maybe at the end of the unit, you can have a magic show and do all the physics tricks you've learned!

Another trick that's related to Newton's First Law is the classic tablecloth trick. If you do this, you can wow the kids. It would also be cool opening for any of the following lessons. I would watch a video of how to do it online and practice first. Hint: Use a tablecloth with NO HEMS. Use cheap, unbreakable tableware.

Newton's First Law
Lesson Plan 2

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:
The posters from yesterday for **inertia, force, and gravity.** An apple (or any object that can be dropped and pushed for the opening demo) New posters for friction, inertia & mass, and unbalanced/balanced forces. 2-3 textbooks (or things you can stack and push with one finger) for whole class Pinky Push demo 1 **Make it Slide handout** per group 1 wooden or plastic ruler per group 1 pink eraser (don't substitute this one; they need to see that rubber creates more friction) per group 1 toy car per group 1 dice (or quarter or button or paperclip…have extra items available for extra testing) per group 1 piece of felt or textured fabric (about 10" x1.5", you can cut up the piece you used in Lesson 1) per group 1 strip of sand paper (about 9" x 1.5", you can cut up the piece you used for in Lesson 1) per group **Optional:** The Effects of Friction handout. You would need one CD, one large rubber band, and measuring tape per group for this activity. See info in tips section.

Activity Name:	Rotation or Session #
Pinky Push Demo, Make It Slide Experiment	2 of 8

Goal/Objective of Activity:
Goal: The purpose of today's lesson is to introduce students to friction and the relationship between mass and inertia. **Objectives:** Students will be able to give a brief definition of friction. Students will be able to identify two factors that affect friction. Students will be able to explain the relationship between mass and inertia.

Background Information for the Teacher:
Newton's First Law - An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. Newton's First Law is also referred to as the Law of Inertia. **Mass -** the amount of matter an object has. Even though mass is different from weight, it's okay if you use them interchangeably for this unit since we're not going into the calculations or units of measurement. You can play it safe by referring to mass as how heavy something is.

Force: A **force** is a push or pull upon an object resulting from the object's interaction with another object.

Balanced forces: Balanced forces <u>do not</u> cause a change in motion. They are equal in size and opposite in direction.

Unbalanced force: Unlike balanced forces, **unbalanced forces** always cause a change in motion. They are not equal and opposite.

Friction - a resistance to motion that occurs when two surfaces are in contact with each other

static friction: the resistance to motion that must be overcome in order to allow one surface to begin sliding against another surface (students don't need to know this)

kinetic friction: the resistance to motion that occurs once one surface is in motion, sliding against another surface (students don't need to know this)

Activity Instructions:

Opening:

Hang up all the posters from yesterday. Have the new ones for friction, inertia & mass, and unbalanced forces ready to go. Start out the lesson by doing a little review and activating prior knowledge.

1. Okay, someone tell me what we learned last time! What is inertia, and what does it tell us about objects?
   They're lazy! They resist changes to their state of motion.

2. Gravity! What is it? Here's an apple. Show me how gravity works…SAFELY, PLEASE.
   (The student could drop it.)

3. Force! What is it? Here's the same apple. Show me how force works….SAFELY, PLEASE.
   (The student could just push it.)

4. Okay, those are both really simple understandings of gravity and force, but it's good enough for now. We're going to do this slowly. Now I need a volunteer. You guys are going to figure out one more rule about inertia for me.

Get one volunteer to come up and do the Pinky Push Demo for the class. Walk the student through the following steps. Ask the other students questions during the demo.

1. Here's a book. Push it across the table with your pinky. Is it hard to do?

2. Return the book to the starting point and place a second book on top of the first book. What do you think class, will it be harder to push? Push the two books across the table with the same

pinky. What are your observations? How would you compare this to the first test of when you pushed the single book across the table? Repeat with a third book. Again, what are your observations?

The volunteer should observe that the more books you pile on, the harder it is to push.

3. You can almost say that the heavier something is, the more it resists a change to its state of motion. What's it called when something resists a change to its state of motion?

   Inertia.

4. So the heavier an object is, the more…what? Finish the sentence.

5. Yes, the heavier the object, the more inertia it has. Instead of heavier, we're going to use the word mass. So the more mass an object has, the more inertia it has. The more it will resist a change to its state of motion.

   Reveal the poster that says: ***The more mass an object has, the more inertia it has. The more it will resist a change to its state of motion.***

6. Now there is one more thing I need you to know today before I send you off to do experiments. So far, we've been talking about inertia and things that stay at rest. But the inertia actually applies to things that are in motion, too. If something is in motion, it wants to stay in motion, and it will stay in motion unless acted upon by an unbalanced force. Sometimes, that unbalanced force can be something called friction. Does anyone know what friction is? Can you give me an example?

   Students might say they feel friction when they rub their hands together. They might say there's friction when a car brakes, and you can feel the friction between your shoes and the ground.

   Hang up the poster that says: ***Friction - A resistance to motion that occurs when two surfaces are in contact with each other***

7. When we were pushing the book with our pinky, was there friction involved?

   Yes, there was friction between the surface of the book and the surface of the table.

8. Okay, so we learned two new things today. It's time for you to do your experiments on friction!

YOU DO:

Make it Slide Activity

1. Put students into groups of 4. Have tables set up with materials for the **Make It Slide** experiment, including the handout.

2. The handout is self-explanatory. Circulate as the students work to see if they need any help with the procedures or with new vocabulary.
3. As you circulate, ask these kinds of questions:
    - How does inertia apply to this experiment?
    - What variable could you change in the demonstration if you wanted to turn it into an experiment?
    - How does friction work? What kinds of surfaces create more friction?
    - What do you think is going to happen when you do it again on a different surface?
    - Why do you think that happens when you use the sandpaper/fabric?
    - Does the weight of an object affect friction?
    - Does the size and shape of an object affect friction?
4. Give the students enough time to perform the experiment and any extra "tests" they want to run.
5. Debrief.

Debrief:

1. Question: What has more mass? Me or a car? (A car) Yeah, you *better* say car!
   Question: What has more inertia? Me or a car? (A car) That was a little tricky, right? Whatever has more mass will always have more inertia. They are directly related.

   Question: What has more mass? A school bus or a dog? (school bus)
   Question: What has more inertia? A school bus or a dog? (school bus)

2. What factors affect friction? What conclusions did you draw from the experiment? *(the condition of the surfaces in contact and the weight of an object)*

3. What kinds of surfaces create more friction? Less friction? What conclusions did you draw from your experiment? (*Smooth surfaces create less friction. Rough surfaces like sandpaper create more friction. Sticky surfaces like rubber create more friction - think of shoes, tires, the eraser, the rubber band!)*

Tips/Things that work well/Additional Resources:

The Effects of Friction activity requires access to 3 surfaces, which might be hard to do depending on your site. The CDs can also travel long distances on carpet and tile (easily over 30 feet), so it is not a practical experiment unless you have wide open spaces like an empty hallway or multi-purpose room. It is fun, though, and it very clearly demonstrates the effects of friction. It also follows the science fair format perfectly. Do it instead of Make It Slide if you have the space and time. Don't worry about it if you don't. The Make It Slide experiment is enough.

Newton's First Law
Lesson Plan 3

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:
For the whole class demo (you only need one of each item for the whole group demo): **Dropping Things handout** (for the teacher to use) 1 sheet of flat printer paper 1 sheet of printer paper rolled into a ball 1 book 1 single flat bottom paper coffee filter 1 crumpled coffee filter **For the Parachute Activity (Each pair needs the items below. Each set must be identical.):** 1 flat bottom paper coffee filter 36" piece of string Scotch tape Pencil 2 washers 1 small paper cup 1 plastic grocery bag scissors binder clips small screws nuts and/or bolts **Parachute Activity handout**

Activity Name:	**Rotation or Session #**
Dropping Things Demo and Parachute Competition	3 of 8

Goal/Objective of Activity:
Goal: The purpose of today's lesson is to encourage teamwork and critical thinking skills. Students will apply knowledge of forces and friction to create a parachute. **Objectives:** Students will be able to explain the relationship between surface area and air resistance.

Background Information for the Teacher:
All objects fall at the same speed - regardless of mass - when the only force at work is gravity. However, sometimes you will see objects fall more slowly than others due to air resistance.

When things move through air, they slow down and produce heat. Air resistance is also called fluid friction. The size and shape of an object affect air resistance. The more surface area, the more resistance. There is more air resistance when an object goes faster.

Activity Instructions:

Opening:

Tell the students that you are going to ask them to make some predictions while a volunteer drops things. Use the Dropping Things handout as your guide/script. This is the perfect opportunity to use the Numbered Hands tool. For example, ask: "What do you think will fall faster? Hold up one finger if you think the crumpled paper will fall faster. Hold up two fingers if you think the flat paper will fall faster."

After you do the Dropping Things demo, tell the students that they are going to compete to see who can make the best parachute.

YOU DO:

Parachute Hang Time Activity

1. Put students into teams of 2. Have tables set up with materials for Parachute Hang-Time competition, including the handout.
2. The handout is self-explanatory. Circulate as the students work to see if they need any help with the procedures or with new vocabulary.
3. As you circulate, ask these kinds of questions:
   - How does inertia apply to this experiment?
   - What factors affect an object's hang time?
   - How can you make an object stay in the air longer?
   - What objects do you want to use? Why?
4. Give the students enough time to create and test out their parachutes. Stop the class with at least 20 minutes left for the competition. Start the competition, following the rules on the handout. Carry out the parachute in a safe manner. If you have two stable chairs the students can stand on in order to drop the balloon, use them. But make sure students get on and off the chairs safely. Have a prize for the winners (maybe some THINK swag).
5. Clean up. Debrief.

Debrief:

Ask teams to share out the thought process behind their parachute designs. Did their plans work out? What were some unexpected results? What did they think would work but didn't? What might be the explanation for those results.

Have the students analyze the "winning" parachute. What was it about the design that made it so successful?
Encourage the students to use physics terms in their responses.

Newton's First Law
Lesson Plan 4

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:
Paper Pencils Basketball 2 smaller balls like a tennis ball and golf ball Basketball Court Someone with sweet basketball skills

Activity Name:	Rotation or Session #
Basketball Activities	4 of 8

Goal/Objective of Activity:

Goal: The purpose of this lesson is to help students make connections between physics and their everyday lives.

Objectives: Students will be able to diagram how friction, unbalanced and balanced forces, gravity, inertia, and motion apply to a basketball game.

Background Information for the Teacher:

The game of basketball is an example of Newton's 1st Law of Motion. You can apply the physics terms we learned so far to most sports, from the friction of the shoes athletes wear to the unbalanced force of a tackle in football.

Activity Instructions:

Opening:

Ask students if they play any sports. Have them raise hands and share out what they play. Then ask some brave souls to apply the terms they've learned so far to their sport. How does the law of inertia work in a game of football? How does friction work for or against a skateboarder? What unbalanced force might you see in a baseball game?

Explain that today, you're all going to go outside and see how physics applies to the game of basketball. Woohoo!

We DO/YOU DO:

Basketball and Newton's Law

1. Divide students into partner/pairs.
2. Restate Newton's First Law of Motion: **An object at rest stays at rest and an object with the same speed and motion stays in motion unless acted upon by an unbalanced force.**
3. Provide students with drawing paper and pencils and/or crayons.
4. Locate students at the basketball court.
5. Have a basketball player prepare to roll a basketball across the court.
6. Students observe the ball first at rest (Think of inertia as laziness) and then acted upon by an unbalanced force (The basketball player rolls the ball).
7. Ask, "What causes the basketball eventually to stop?" (The ball will eventually stop because of resistance or friction between it and the surface on which it is rolling.)
8. Ask students to illustrate these phenomena labeling the components: ball at rest, unbalanced force, resistance, friction.
9. Next, have the basketball player shoot the ball toward the hoop. He must toss the ball high and hard enough for the ball to reach the inside of the basketball hoop, Ask, "What does the player need to be able to judge before shooting? What caused the ball to slow down and eventually stop?"
10. Have students draw these phenomena labeling the components: ball at rest, unbalanced force, resistance, friction.
11. Next, have the player dribble the ball. When dribbling the ball, it will rest in his hand for a moment until he pushes the ball back down to the ground. Ask students, "What does the ground do?" (The ball rests on the ground for a moment and then pushes the ball back until it bounces back up into your hand.)
12. Have students illustrate what happens and label the parts.
13. Finally, have the basketball player make a slam dunk. Ask students, "What part of Newton's 1st Law is in effect during a slam dunk?"
14. Students illustrate the slam dunk.
15. Students share illustrations with classmates.
16. **Basketball Variation:** Try the experiment again using a basketball and a smaller ball like a tennis ball, golf ball, or other smaller bouncy balls.
17. First bounce the basketball and tennis ball side by side to compare their bounces. Start them off around chest height.

18. Make a hypothesis (a guess) about what will happen when you stack the small ball on top of the bigger one and then drop it. (Explanation – The energy of motion from the bigger ball is transferred into the smaller one. Most of your attention is on the sky-rocketing small ball, but if you look at the basketball, it doesn't have much bounce at all.
19. Try it! It may take a couple tries to line them up just right but the results are pretty awesome.
20. Experiment further. What if you switched the two balls and dropped the smaller one on the bottom? What if you used two of the same=sized ball? A golf ball on top? Have students think of other things.

Debrief:

Ask these questions to help students **make connections**:

1. We discussed how physics relates to sports. Think of other areas in your life where you see physics in action. (dance, car rides, amusement parks, walking and slipping)

2. Do you think understanding physics would make you a better athlete or dancer? Why or why not?

3. Now that you understand a little more about physics, what's something you could invent that has to do with inertia, forces, friction, resistance, etc.? Think of it this way: What's a problem you see in everyday life that has to do with physics, and how would you solve it? You don't have to answer now, just think about it.

   They don't have to answer now, but hopefully they'll want to share out next time. Maybe they'll come up with designs for faster cars, more comfortable shoes, etc. Maybe you have some future engineers in your class!

Tips/Things that work well/Additional Resources:

There is a fun video showing the physics of football:

http://science360.gov/obj/video/70fadaa8-c3d4-4132-ba1f-c98be5caeb14/science-nfl-football-newtons-first-law-motion

There are probably educational videos showing the physics of most sports. Search around. You can show 1-2 to the students if you have access to the Internet at your site.

Newton's First Law
Lesson Plan 5

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:

A poster with the full Newton's First Law statement written on it

2 cones for the Running Stop Demo

Each group of 3 will need the following items for the Water Walk:

- 1 **Water Walk handout**
- 1 Pie tin
- Water
- 1 Cup
- Tape or chalk or 2 cones
- Clipboard, paper, pencil (for recording observations)
- Measuring tape

Activity Name:	Rotation or Session #
Running Stop Demo and Water Walk Lab	5 of 8

Goal/Objective of Activity:

Goal: Students will have a deeper understanding of Newton's First Law as it applies to objects in motion.

Objectives: Students will be able to identify inertia, force, gravity, and motion as they apply to a simple demonstration.

Background Information for the Teacher:

Who was Isaac Newton? Isaac Newton was an English philosopher who lived from 1642 – 1727. He was the single most important contributor to the development of modern science. Most consider him the greatest scientist of his era who happened to discover gravity. Amazingly, Newton didn't know how gravity actually worked. He just knew that it existed. Newton added knowledge to the study of physics, optics, calculus and astronomy.

Newton's First Law - An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. Newton's First Law is also referred to as the Law of Inertia.

Activity Instructions:

Opening:

Before going outside, gather students in whole group setting and show them the new poster with Newton's First Law on it. Have a student read it. Explain that Isaac Newton is considered the father of modern science, and that everything they've been learning about so far is Newton's First Law (also known as the Law of Inertia). Point out that so far, they've been focusing on **objects at rest**. Today, they're going to start observing how inertia affects **objects in motion**.

Take them outside for the first demo. Review outside safety rules. **Safety First! Because this activity involves spilled water, do these activities on grass or rough asphalt. Do not attempt these activities on tile or smooth concrete.**

Opening Activity: Running Stop Demo

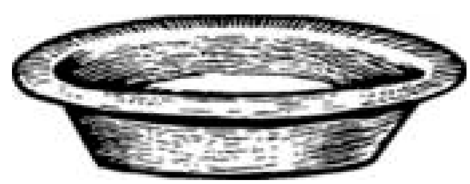
What you will need:

- Clearly-market targets (cones)

What you will do:

1. Take the students outside.
2. Have a student recite Newton's First Law.
3. Place a cone 10-15 yards or meters away from a starting line. Mark the starting line with a cone.
4. Ask a student to run and then stop on the first target (10 yards).
5. Ask students, "What happened to the runner's upper body when he stopped abruptly on the first target?" (His feet stopped, but his body learned forward as if it still wanted to keep moving.)
6. Ask students, "What unbalanced force caused his upper body to stop?" (Since the upper body is connected to the lower body, his feet wouldn't allow him to proceed further.)
7. Tell students that they will now get into groups of 3 and see what happens when we apply Newton's Law to water.

YOU DO:



Water Walk Activity:

1. Group students into 3. Go over safety rules. Pass out materials and Water Walk handout. The handout is self-explanatory.
2. Watch students closely and make sure they are being safe. Help them if they need any clarification. You can save questioning for when you're back inside.
3. Clean up.

Debrief:

Ask students to share their observations. This is what they should have observed:

The water would have a tendency to spill from the container during specific locations on the track. In general the water spilled when:

- the container was at rest and you attempted to move it
- the container was in motion and you attempted to stop it
- the container was moving in one direction and you attempted to change its direction.

The water spills whenever the **state of motion** of the container is changed. The water resisted this change in its own state of motion. The water tended to "keep on doing what it was doing." The container was moved from rest to a high speed at the starting line; the water remained at rest and spilled onto the ground. The container was stopped near the finish line; the water kept moving and spilled over container's leading edge. The container was forced to move in a different direction to make it around a curve; the water kept moving in the same direction and spilled over its edge.
The behavior of the water when the Walker reversed direction can be explained by Newton's first law of motion.

Tips/Things that work well/Additional Resources:

Newton’s First Law
Lesson Plan 6

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:

You will need one set of these items for each group of 3-4

- Toy car (Hotwheels)
- Cardboard ramp (2 feet long is fine, at least 10” wide)
- Protractor to measure angles (if not, a ruler to measure height of ramp is fine)
- Measuring tape (cm.)
- Books they can use to raise the ramp/support its height
- calculator

Activity Name:	Rotation or Session #
Car Ramp Experiment	6 of 8

Goal/Objective of Activity:

Goal: The purpose of this experiment is for students to work in teams to perform an experiment.

Objectives: Students will be able to perform a controlled test with multiple variables. Students will be able to accurately record data. Students will be able to draw conclusions from their data set.

Background Information for the Teacher:

Gravity is a force that acts on all objects trying to pull them towards the center of the earth. It is the force that is moving the car down the ramp. Friction is a force that can oppose motion. The greater the frictional force, the slower the car travels. Air molecules can also slow down the movement of the car down the ramp and across the floor’s surface. The wheels on the car come into direct contact with the ramp, and other surfaces, which cause friction that, can affect the motion and direction of the car.

Activity Instructions:

Opening:
Tell students that they are going to test out how far a car can go on a ramp today. Remind them that they will be working on making predictions and recording data.

YOU DO:
Car Ramp Activity

1. Put students into teams of 3-4. Have areas cleared for ramps.

2. The handout is self-explanatory. Circulate as the students work to see if they need any help with the procedures or with new vocabulary. Leave them on their own for the most part. It's time for them to ask their own questions.
3. Give the students enough time do their measurements.
4. Clean up. Debrief.

Debrief:

Have groups share out their conclusions.

Tips/Things that work well/Additional Resources:

The experiment is modeled for you in the OC Stem Science Fair Webinar!
http://www.youtube.com/watch?v=XCA164laWOo

Search for a picture of the ramp; I believe it's at 24 min.

Newton's First Law
Lesson Plan 7

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:

You'll need a set of the following items for each team of 3-4.

- **Build a Track handout**
- Scotch or masking Tape
- Perfectly round objects (different sizes and weights, i.e., marbles, ball bearings, beads)
- 2 Sturdy Paper Plates
- 4 Paper Cups
- 5 Pipe Cleaners
- 5 Popsicle Sticks
- Calculator
- Stop watch or clock with second hand

Activity Name:	Rotation or Session #
Build a Race Track Day 1	7 of 8

Goal/Objective of Activity:

Goal: The purpose of this lesson is to encourage teamwork and critical thinking. Students will have to re-evaluate their track design and predict how it will affect the outcome.

Objectives: Students will be able to apply their understanding of Newton's First Law to the design of a racetrack. Students will be able to perform tests and collect data.

Background Information for the Teacher:

FACT: Once an object is in motion, no additional force is needed to keep it in motion. Instead, an additional force is required to make it stop.

The statement above pretty much restates the second half of Newton's First Law: An object in motion stays in motion unless acted upon by an unbalanced force. However, most people incorrectly think that an additional force is necessary to keep an object in motion. They are, perhaps, incorrectly blending both parts of Newton's First Law (thinking that an object in motion wants to come to rest - *which is wrong* and completely goes against the Law of Inertia).

A great way to truly test your students' understanding of Newton's First Law is to show them the bolded statement, and ask them if it's true or false. You can use Numbered Hands for this.Don't be discouraged if the students get it wrong. Again, most adults get the question wrong. But, if you even get one student who can get it right and explain why, that is amazing! That's pretty high level thinking going on there!

Activity Instructions:

Opening:

Tell students that they will become engineers today and design a racetrack.

YOU DO:

Build a Track Day 1

1. Put students into groups of 3-4. Have tables set up with materials, including the handout.
2. They will continue the activity from last time, changing one variable to their track and retesting.
3. As you circulate, ask these kinds of questions:
   - What information from the Car Ramp activity can you apply to your design?
   - Are you experiencing any difficulty building your design? How are you going to solve the problem?
   - Is the object rolling off the side? Why is that? What forces are at play?
   - What could you do to make your objects go faster?
4. Give the students enough time to play with their tracks. At the end, have groups share out their fastest times again. Have students observe the fastest tracks and analyze the design.
5. Clean up. Make sure you have a place to store the tracks. Students should put all extra supplies and anything unattached to their track into their bag. Label it so you can return the bag to the group for the next lesson.

Debrief:

Ask students to reflect on the process of building a track.

- Did they have any problems turning their drawing/design into an actual track?
- Did they use the materials in innovative ways?
- How did they come up with their designs? Was it trial and error? Were they basing their designs on their understanding of roads and race tracks?
- What other questions could they ask for future research? They can test out these questions next time.

Tips/Things that work well/Additional Resources:

Do not over-explain the activity and do not model anything for them. Just tell them they're going to build a track, give them the handout, and go over safety rules. The goal is for them to truly struggle and learn from the process. Let's see how creative and innovative they can be. As you circulate, your questions should ask them to apply their physics knowledge. But just listen to their responses. DO not correct them and DO NOT offer advice on how to build the track.

THINK Together

Newton's First Law
Lesson Plan 8

Group		Grade(s)	7 & 8	Week		Day	

Materials/Equipment:

Post-Assessment

Race tracks from Day 7
Each group's extra supplies from Day 7 in their marked bags

- Scotch or masking Tape
- Perfectly round objects (different sizes and weights, i.e., marbles, ball bearings, beads)
- 2 Sturdy Paper Plates
- 4 Paper Cups
- 5 Pipe Cleaners
- 5 Popsicle Sticks
- Calculator
- Stop watch or clock with second hand

Activity Name:	Rotation or Session #
Build a Race Track Day 2 and Post Assessment	8 of 8

Goal/Objective of Activity:

Goal: The purpose of this lesson is to encourage teamwork and critical thinking. Students will have to re-evaluate their track design and predict how it will affect the outcome.

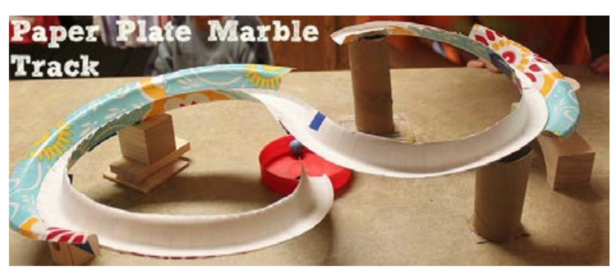
Objectives: Students will be able to apply their understanding of Newton's First Law to the design of a racetrack. Students will be able to perform tests and collect data.

Background Information for the Teacher:

None.

Activity Instructions:

Opening:



Tell students they will continue to work on their tacks today. Yay!

YOU DO:
Build a Track Day 2

1. Put students into same groups from the last lesson. Have tables set up with materials and

tracks from the last lesson, including the handout.

2. They will continue the activity from last time, changing one variable to their track and retesting.
3. As you circulate, ask these kinds of questions:
    - What change are you going to make to your track? Why?
    - Which object travels slowest on your track? Why do you think that is? What factors are at play in its speed? How can you make it go faster?
    - Are you experiencing any problems with your track? Is the object rolling off the side? Why is that? What forces are at play?
    - IF you wanted to make your object travel more slowly, what could you do?
4. Give the students enough time to play with their tracks. At the end, have groups share out their fastest times again. Have students observe the fastest tracks and analyze the design.
5. Clean up.

Debrief:

1. Do a mini-review of the unit. You can use the unit overview chart as a question guide.

2. Have student reflect on their learning. You can have them write their responses in paragraph form on an index card:

    - Do you feel comfortable using physics vocabulary now? Why or why not? Do you want to learn more about science in school? If yes, what topics would do you want to study?
    - What was one AHA moment you had during the unit?
    - What concept still confuses you a little bit?

3. Administer the **Post Assessment**. If you have Internet access, assessments can be taken on Survey Monkey.

Tips/Things that work well/Additional Resources:

The second day of Build a Track should not take very long. Remember to administer the Post Assessment. If you do not want to do a mini-review of main concepts, materials out for students to practice ”magic tricks.” The kids would probably love a finale demonstration of the tablecloth trick or the egg drop trick with 5 eggs at a time.