Teacher Toolkit - Newton's First Law of Motion

Objectives:

1. To state Newton's first law of motion and to describe several examples of the law in operation.
2. To define inertia and to identify the variables that affect and do not affect the amount of inertia an object possesses.
3. To understand that force is an interaction between objects and to be able to recognize the presence and absence of specific force types.
4. To refute the misconceptions that (a) forces are required to sustain the motion of an object, (b) an object moving in a given direction must be experiencing a force in that direction, and (c) that contact forces persist even after the contact ceases.
5. To analyze representations of physical situations (dot diagrams, motion graphs, force diagrams) and to predict whether or not the forces are balanced or unbalanced.

Readings:

The Physics Classroom Tutorial, Newton's Laws of Motion Chapter, Lesson 1

Historical Perspective: The Genius of Isaac Newton

1. The Mind of Isaac Newton http://cll.mcmaster.ca/multimedia_projects/sample/newton/
   A beautifully-organized glimpse into Isaac Newton's work through three strands: mathematics, physics, and philosophy.
2. The Newton Project http://www.newtonproject.sussex.ac.uk/prism.php?id=1
   This resources includes translations of his famous Latin texts, all of his scientific and mathematical writings, and podcast interviews with historians. A glimpse at his notebooks and correspondence will give anyone a better perspective of the genius of a man whose influence was much broader than we may realize.

Interactive Simulations:

1. Two Dimensional Air Drop Model http://www.thephysicsfront.org/items/detail.cfm?ID=9972
   This simulation shows an airplane flying at constant horizontal velocity, preparing to drop relief supplies to a small island. Activate the release button to drop the package and watch as the trajectory of the falling package is traced onscreen. If you were too far off, the package drops into the ocean.

Video and Animation:

1. NBC Learn: The Science of NFL Football http://www.nsf.gov/news/special_reports/football/lawofmotion.jsp
   This 4-minute video explores inertia from the context of a running back resisting the force of a defender.
2. Physlet Physics: Circular Motion and Inertia http://webphysics.davidson.edu/physletprob/ch7_in_class/in_class7_1/mechanics7_1_2.html
   Good warm-up to spark discussion about uniform circular motion and the Law of Inertia.
3. UCLA Demoweb: Partial Pie Plate http://www.physics.ucla.edu/demoweb/demomanual/mechanics/first_law_inertia/partial_pie_plate.html
   What would happen if an object in circular motion suddenly loses its net centripetal force? Teachers can easily set up this demo to show students that Newton's Law of Inertia will govern the situation, and the object will fly off in a straight line tangential to the circular path.

Applications of Newton's First Law: Inertia and the Human Body

1. eLearnIn: Spinning Eggs Inertia Demo https://www.youtube.com/watch?v=Avj7Z0CXIFE
   Try using this video to introduce inertia in the context of traumatic brain injury. Think of our brain as the raw egg. In traumatic head injuries, extensive damage can happen because inertia causes the softer brain tissue to bang around inside the hard skull (like the yolk in the raw egg).
2. MediVisuals: Traumatic Brain Injury Animation https://www.youtube.com/watch?v=AmAML1-F2LE
   So why would a neurosurgeon need to know about Newton's First Law? This 6-minute animated video shows what happens inside the brain during collisions. The video shows how inertial movement can cause axonal shearing and blood vessel rupture, resulting in the death of neurons and permanent brain injury.
3. NASA: Law of Inertia Video http://www.nasa.gov/mov/192447main_017_law_of_inertia.mov
   This 3-minute video from NASA's Dryden Flight Research Center explores Newton's First Law from the context of both low and high speeds. Kids will sit up and pay attention at the footage of the very-high-acceleration rocket sled showing the effects of rapid stopping on a crash dummy and on NASA's human volunteer, Col. Paul Stapps (photo above).

Labs and Investigations: **(See the complete toolkit at TPC's Teacher Toolkit website for details.)**

1. The Physics Classroom, The Laboratory, Pass the Water
2. The Physics Classroom, The Laboratory, Galileo for a Day
   Link: http://www.physicsclassroom.com/lab#nl

Other Lab Investigations: **(See the complete toolkit at TPC's Teacher Toolkit website for details.)**

1. NASA: Inertial Balance Lab http://www.nasa.gov/pdf/315957main_Microgravity_Inertial_Balance.pdf

Demonstration Ideas: **(See the complete toolkit at TPC's Teacher Toolkit website for details.)**

1. Inertia Hoop Demonstration https://www.youtube.com/watch?v=--MDILG7Znk
2. Hero Engine https://www.youtube.com/watch?v=pxWHWOYVov4
3. Inertia Ball https://www.youtube.com/watch?v=jgEt5kBjnTA
4. Sick Science: Inertia Beads https://www.youtube.com/watch?v=1_EV2KEnqoQ
5. Self-Siphoning Metal Beads http://blogs.scientificamerican.com/observations/2013/07/03/gravity-defying-self-siphoning-metal-beads-explained-video/

Minds On Physics Internet Modules: http://www.physicsclassroom.com/mop

The Minds On Physics Internet Modules are a collection of interactive questioning modules that target a student's conceptual understanding. Each question is accompanied by detailed help.

1. Newton's Laws, Ass't NL1 - Inertia, Mass, and Newton's First Law
2. Newton's Laws, Ass't NL2 - Balanced Forces and the State of Motion
3. Newton's Laws, Ass't NL3 - Unbalanced Forces and Acceleration

Concept Building Exercises: http://www.physicsclassroom.com/lab#newtlaws

The Curriculum Corner, Newton's Laws:
1. Inertia and Mass 2. Preconceptions 3. Balanced vs. Unbalanced Forces

Flipped Lesson

1. PBS Learning Media: Newton's First and Second Laws
   http://www.pbslearningmedia.org/resource/ae18595e-60fc-47d5-9c6f-11f582fe175a/physics-401-newtons-1st-and-2nd-laws/
   This 27-minute video could be used in a flipped lesson or to provide extra support for struggling readers or students with disabilities. It includes 4 demonstrations performed by kids to show everyday examples of inertia.

Real Life Connections:

1. Problem-Based Learning: First Day on the Job
   http://pbl.ccdmd.qc.ca/resultat.php?action=clicFiche&he=1050&afficheRecherche=99&IDFiche=138&endroitRetour=99&lesMotsCles=first%20day
   Problem-Based learning activity ideal for your seniors or AP physics students. Using physics, students will determine who is at fault in a car collision.

Common Misconceptions **(See the complete toolkit at TPC's Teacher Toolkit website for details.)**

1. Forces are Required to Sustain a Motion 2. Forces Persist after the Interaction Ceases

Elsewhere on the Web:

1. Recognizing Forces http://www.physicsclassroom.com/morehelp/recforce
   This activity describes 11 physical situations and asks students to identify whether specific forces are present or absent. Instant feedback with explanations are given to student answers.

Standards:

A. Next Generation Science Standards (NGSS) – Grades 9-12
Standards coming soon.

B. Common Core Standards for Mathematics (CC) – Grades 9-12
Standards coming soon.

C. Common Core Standards for English/Language Arts (ELA) – Grades 9-12
Standards coming soon.

D. College Ready Physics Standards (Heller and Stewart)
(See the complete toolkit at TPC's Teacher Toolkit website for details.)