MIND TREKKERS
Kinematic Carts Lesson Plan

Amount of time Demo takes: 3-5 min

Materials:
1. 2 physics kinematic carts
2. Medicine ball (heavy ball)
3. Basketball

Set up instructions:
1. Find a flat, smooth surface to roll carts on.

SAFETY!
1. Physics gliders may only be used while participant is seated, not as a skateboard!
2. Watch for fingers and toes to make sure no one gets run over.
3. Keep the speed of the gliders to a minimum to ensure the safety of the participants.

Instructional procedure:
1. Have participants sit on the carts and have them predict what will happen when they push off each other. What will happen if just one person pushes off the other? Then let them try each to see if they were correct.
2. Have participants predict what will happen when they throw each of the balls to each other, then have them do so.
3. Explain the concepts behind the physics gliders.

Lesson’s big idea:
- Newton's Laws: 1st Law, A body in motion stays in motion unless something else acts on it. A body at rest stays at rest.
- 2nd Law, Force is equal to mass times acceleration
- 3rd Law, For every action there is an equal and opposite reaction.

Background Information:
- Newton's laws of motion are three physical laws that form the basis for classical mechanics. They describe the relationship between the forces acting on a body and its motion due to those forces. They have been expressed in several different ways over nearly three centuries, and can be summarized as follows:
  1. First law: The velocity of a body remains constant unless the body is acted upon by an external force
  2. Second law: The acceleration \( a \) of a body is parallel and directly proportional to the net force \( F \) and inversely proportional to the mass \( m \), i.e., \( F = ma \).
  3. Third law: The mutual forces of action and reaction between two bodies are equal, opposite and collinear.
- The law of conservation of linear momentum is a fundamental law of nature, and it states that if no external force acts on a closed system of objects, the momentum of
the closed system remains constant. Momentum is a property of mass and velocity -- so larger objects moving quickly have much more momentum than small ones moving slowly. In collisions (such as when one person pushes on the other) the sum of the momenta before the collision must equal the sum of the momenta after the collision:

\[ m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \]

where \( u_1 \) and \( u_2 \) are the velocities before collision, and \( v_1 \) and \( v_2 \) are the velocities after collision.

- **Science of hockey**: Collisions and hitting in hockey. Due to reduced friction from the hockey skate on the ice, you are able to witness Newton’s laws in action easier. Sometimes players hit each other and both continue sliding in one direction. You can also see this during shoving matches/fights - both players move backwards during contact, not just the one receiving the hit. This is due to the conservation of momentum and the type of collision (inelastic vs elastic).

**Sample questions you can ask:**
1. Whose laws are at work?
2. What would be different if two people sat on one cart, and only one on the other?

**Clean Up**
Pack up the carts, make sure the medicine ball and the basketball are back in place.

**References:**
http://www.youtube.com/watch?feature=player_embedded&v=hU-P-WZ5IYU#!
http://en.wikipedia.org/wiki/Momentum#Conservation_of_linear_momentum
http://en.wikipedia.org/wiki/Newton%27s_laws

**National Standards:**
K-4 Content Standard B: Physical Science, Position and motion of objects
5-8 Content Standard B: Physical Science, Transfer of energy, Motions and forces
9-12 Content Standard B: Physical Science, Motions and forces, Interactions of energy and matter