

# Q4 - PS Motion

## Stage 1: Desired Outcome

### Established Goals:

1. **MS-PS2-1** **Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.**\*[Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]
2. **MS-PS2-2** **Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]
3. **MS-PS2-3** **Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.** [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

4. **6.RI.1** Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

<p><b>Understandings</b></p> <p><i>Students will understand...</i></p> <ul style="list-style-type: none"> <li>❖ they can <b>be aware</b> of Newton’s three Laws of Motion.</li> <li>❖ by <b>investigating</b> various means of motion, it mimics engineering practices in the real world</li> <li>❖ they can <b>provide examples</b> in the real world of how motion and energy are used (transportation, building, engineering).</li> <li>❖ a combination of forces interact to create different outcomes.</li> <li>❖ they can <b>manipulate variables</b> in Newton’s formula <math>F=m(a)^2</math> to problem solve situations.</li> <li>❖ they can <b>engineer and design</b> models to represent Newton’s Three Laws of Motion</li> </ul>	<p><b>Essential Questions:</b></p> <ol style="list-style-type: none"> <li>1. What are the relationships between forces and motion?</li> <li>2. What are the variables that affect motion and force?</li> <li>3. How does Newton’s three laws describe the motion of a moving object?</li> <li>4. How does gravity impact objects?</li> </ol>
<p><b>Students will know...</b></p> <ul style="list-style-type: none"> <li>● the relationship between speed and velocity</li> <li>● the impact of gravity and friction on motion.</li> <li>● Each of the three Newton Laws</li> <li>● The impact of the law of conservations of momentum on the movement of objects.</li> <li>● Key Vocabulary: <ul style="list-style-type: none"> <li>○ <b>acceleration</b></li> <li>○ <b>force</b> <ul style="list-style-type: none"> <li>● <b>balanced / unbalanced force</b></li> <li>● <b>gravitational force</b></li> </ul> </li> <li>○ <b>free fall</b></li> <li>○ <b>friction</b></li> <li>○ <b>gravity</b></li> <li>○ <b>inertia</b></li> <li>○ <b>kinetic energy</b></li> <li>○ <b>mass</b></li> <li>○ <b>momentum</b></li> <li>○ <b>motion</b></li> <li>○ <b>Newton’s First, Second &amp; Third Laws of Motion</b></li> <li>○ <b>potential energy</b></li> <li>○ <b>speed</b></li> <li>○ <b>velocity</b></li> </ul> </li> <li>● Law of motion formulas <ul style="list-style-type: none"> <li>○ Acceleration = final speed - initial speed / time</li> <li>○ Force = mass x acceleration or <math>F=ma</math></li> <li>○ Distance = rate x time or <math>D=rt</math></li> </ul> </li> </ul>	<p><b>Students will be able to...</b></p> <ul style="list-style-type: none"> <li>● Measure and calculate their speed and acceleration in a variety of situations.</li> <li>● Assess the impact of force, gravity and friction on objects</li> <li>● Cite examples of new force and balance forces.</li> <li>● Design and conduct investigations involving the motion of objects</li> <li>● Justify which of Newton’s Laws is evidenced in a variety of examples.</li> </ul>

## Stage 2: Assessment Evidence

### Performance Tasks:

- Through what authentic performance tasks will students demonstrate the desired understandings?
  - Expository Readings
  - Class discussions
  - Documentaries and short movie clips of investigations
  - Virtual Fieldtrips
  - Online simulations
- Work within pair or collaborative groups to investigate standards

### Other Evidence:

- Through what other evidence (e.g. quizzes, tests, academic prompts, observations, homework, journals) will students demonstrate achievement of the desired results?
  - Multiple Choice assessment on key formulas and terms.
  - Completion of math computations
  - Expository Questionnaire (Quizzes on Edmodo)
  - Design Presentation of Newton Law project with supporting evidence (GoAnimate, video)
- Students reflect upon on self-assess his or her learning?
  - Journal writing in Lab journal
  - collaborative discussion

## Stage 3: Learning Plan

### Learning Activities:

- **Week 1: Newton's 1st Law of Motion**
  - Day 1 - Intro to Unit, Key Words & Inquiry
    - **Hook / Activity:**
      - Tug-o-War (15 min.)
      - Recording Motion in Motion- In pairs or small groups, students take school gallery walk to record on iPads 3-5 visual examples of motion, solicit POV answers narrated to iPads (15 min.)
    - KWL Chart (15 min.)
    - GLAD chart- Create / discuss chart with key vocab (**force, mass, motion**) - (20 min.)
  - Day 2 - Newton's 1st Law of Motion (Law of Inertia)  
Law 1: An object at rest will stay at rest, and an object in motion will stay in motion, unless an unbalanced force acts upon it.
    - Intro Laws of Motion packet/ science folders (10 min.)
    - **EQ:** *What are the variables that affect motion and force? Are there universal rules of how motion works?*
    - **Hook / Activity:** "Pass the Water" Lab Races & Record observations in packet, partner/group share-out (30 min.)
    - GLAD chart - Create / discuss chart with key vocab (**gravity, inertia, Newton's 1st Law of Motion, unbalanced force**) (10-15 min.)
  - Day 3 - Newton's 1st Law of Motion(continued)

- Review / clarify previous inquiries & vocabulary (5 min)
- **EQ:** *What are the variables that affect motion and force? Are there universal rules of how motion works?*
- **Hook Video** of [Galileo's Thought Experiment](#) (3min)
- **Activity:** Inertia Labs - worksheet (Parts A,B,C) (40 min.)

Day 4 - Newton's 1st Law of Motion (continued)

- Review / clarify previous inquiries & vocabulary (5 min)
- **EQ:** *What are the variables that affect motion and force? Are there universal rules of how motion works?*
- **Activity:** Pendulum Experiment (30 min.)
- GLAD chart - Add to chart key vocab (*speed & formula  $Speed = Distance / Time$  velocity, acceleration*) (10 min.)
- **Guided Practice:** Speed & Velocity worksheet (10 min)
- Closure of Newton's 1st Law of Motion (5 min.)

**Week 2: Newton's 2nd Law of Motion (Law of Acceleration) & Forces**

Law 2: An object that has an unbalanced force acting on it will accelerate in the direction of that force.

● Day 1- Friction

- **Hook:** Back-to-Back Inquiry Activity - Practice & discuss (15 min)
  - Pairs stand back to back and push against each other. Who will move first?
  - What is causing one person to move? (A. unbalanced forces)
  - What is happening if no one moves? (A. balanced forces, friction of shoes against floor greater mass of one person)
  - Make a connection to the Tug-of-War activity from the first day. (A. Tug of War exerted pulls against forces, this exerts pushes, both are "applied force")
  - Predict what would happen if Tug-o-War was done on a) rainy or muddy field b) sand c) ice - ask students to justify their answers

**EQ:** *What are the relationships between forces and motion? What are the variables that affect motion and force?*

**Activity:** Conduct this in the classroom along the whiteboard or outside in the hallway, discuss and record observations. You will need at several types of balls to share & experiment (20 min.)

<http://www.brainpop.com/science/motionsforcesandtime/newtonslawsofmotion/experiment/>

- **Powerpoint:** Watch and discuss [FrictionGravityForces](#) Powerpoint -**Slides 1-30 only** (15 min)
- GLAD chart - Add to chart key vocab (*friction*) & catch up for drawing and recording observations from the day (10 min.)

● Day 2- Forces

- Review / clarify the definition of **speed**, as well as any other previous vocabulary- (5 min)
- **EQ:** *What are the relationships between forces and motion? What are the variables that affect motion and force?*
- **Hook / Activity:** Coffee Filter Races - Modeled example, procedure, modeled plotting graph, discussion of results, drawing conclusion paragraph (35 min)
  - Make connections to friction force activity. What kind of force is used here? (A. gravitational force & air resistance)
- **Powerpoint:** Watch and discuss [FrictionGravityForces](#) Powerpoint -**Slides 31-end** (15 min)
- GLAD chart - Add to chart key vocab (*freefall*) (10 min.)

- Day 3- Reducing Forces & Friction
  - Review / clarify the definition of **speed & gravity**, as well as any other previous vocabulary (5 min)
  - ***EQ:*** *What are the relationships between forces and motion? What are the variables that affect motion and force?*
  - **Activity:** Paper Airplane Lab - construction, testing and modifications, 6 trials, recording observations, answering questions on worksheet (45 min.)

#### Day 4 & 5 - Reducing Forces and Friction (continued)

- Hook: Do objects fall at the same speed? (Although students will determine from the airplane activity that they do not, this demo will prove otherwise, and give them time to evaluate/clarify what they know & see)
  - Demo: Hold a crumpled up one 8x11 piece of paper and a pen in either hand. Drop them from the same height. Ask them to observe which fell to the ground first. (A. Both should drop equally). Ask why? Although the masses may be slightly different, the only FORCE on them is gravity. However, if you dropped a pen and a flat piece of paper, they will fall separately because AIR RESISTANCE (FORCE) is pushing against the surface area of the paper.
- **Internet Research & Forces Poster:** The Back-to-Back Activity is an example of “applied force”. However, there are other kinds of forces in the universal that are not “applied” but by person or object.
  - Have student pairs/groups use the last slide of the PPT and visit this link to research what other kinds of forces there are: <http://www.physicsclassroom.com/Class/newtlaws/U2L2b.cfm#applied>
  - Student collect notes on other forces and create a poster to illustrate each of the five types.

### **Week 3: Newton’s 3rd Law of Motion (Law of Action/Reaction)**

*Law 3: For every action, there is an equal and opposite reaction.*

- Day 1- Intro Newton’s 3rd Law
  - ***EQ:*** *What are the relationships between forces and motion? What are the variables that affect motion and force?*
  - Hook Video: **Gravity (movie clips science accuracy) - (5-6 min each)**  
[http://youtu.be/46PRoR\\_t2Us](http://youtu.be/46PRoR_t2Us) OR <http://youtu.be/7jwJgYLOGW4>
  - **Activity:** [Balloon Powered Race Cars](#) - Create cars using cheaper materials from video rather than worksheet (30 min.)
    - Have students watch the video for step-by-step instructions
    - Record acceleration attempts
    - Discuss what is the FORCE making it go, action-reaction & complete worksheet
- Day 2 - Newton’s 3rd Law (continued)
  - Review Newton’s 3 Laws (6min.) <http://youtu.be/mn34mnnDnKU>
  - Activity: Balloon Powered Race Cars (40 min)
    - Goal: to modify cars to increase acceleration - make notes of materials and changes
    - Conduct races & measure for distance
- Day 3 - Closure- Newton’s 3rd Law
  - Bill Nye- Laws of Motion & Inertia (23 min) <http://youtu.be/UcLy6Fqhwsg>
  - Acceleration PPT (can skip the last 10 with formula, if too difficult)
  - Interactive game & quiz:  
<http://www.sciencechannel.com/games-and-interactives/newtons-laws-of-motion-interactive.htm>
  - Practice Questions:  
<http://www.brainpop.com/science/motionsforcesandtime/newtonslawsofmotion/fyi/>

- Day 4 - Intro PBL Motion Project (see Week 4)
- Day 5 - PBL Motion Project

### **Week 4-6 PBL Motion Project**

- Students pick **one of three projects** to plan, construct and test in class, simulating Newton's Laws of Motion. Students may use the internet to search for ideas & replicate. Students also **create a video documentary** of their progress to go with it. Rubric to be included: (1) justify understanding of Newton's concepts, (2) cost of materials (3) effectiveness. All projects will compete in a Motion Field Day at the end of the unit.
  - Land:
    - 1. Create **another balloon powered car using different materials** than were given in class. Goal: Go the farthest distance in least amount of time.
    - 2. Create a **homemade marble run** (Google keywords: *marble run, paper roller coaster, wall marble run*) using cardboard, towel paper rolls and other inexpensive materials. Goal: Design the run to last as long as possible without stopping.
  - Air: Create a **parachute that will successfully land a raw egg without cracking**. Goal: To land the egg from a two-story drop.

#### **Resources:**

**Interactives:** [http://www.learner.org/interactives/?d\[\]=SCI](http://www.learner.org/interactives/?d[]=SCI)

**Background Knowledge:** <http://www.bozemanscience.com/newtons-three-laws-of-motion>

**Websites for Activity Ideas:**

<http://www.physicsclassroom.com/class>

<http://eisforexplore.blogspot.com/2012/06/slingshots-and-catapults.html>

<http://www.resources4educators.com/forces--motion.html>

<http://teachertech.rice.edu/Participants/louviere/Newton/>

**Video Sources / Clips:**

1) Brainpop > keyword (Forces) > See categories & related topics

<http://www.brainpop.com/science/motionsforcesandtime/>

2) Newton's 3 Laws: <http://youtu.be/mn34mnnDnKU>

3) Gravity (movie clips science accuracy)

[http://youtu.be/46PRoR\\_t2Us](http://youtu.be/46PRoR_t2Us)

<http://youtu.be/7jwJgYLOGW4>

4) Bill Nye - Friction <http://youtu.be/IOAIvTwPsZQ>

5) Skateboarding Science <http://www.exploratorium.edu/skateboarding/>

**\*\*Create PPT review for each week based upon Physics Classroom link**