

Inquiry Lesson: Newton's Second Law

by Carl Wenning

Guiding Questions: What is the expected relationship between force, mass, and acceleration? How can one experimentally verify this expected relationship?

Overview: This 50-minute inquiry lesson is designed to have students to predict nature of the relationship between force, mass and acceleration, and then prepare to use an experimental approach to check this expected form of the relationship.

Performance Objectives: The student will:

- Determine the relationship between arbitrary combinations of mass, force and accelerations using dimensional analysis.
- Develop, with the assistance of the instructor, an experimental approach for finding the relationship between mass, force, and acceleration using a controlled experimental approach.

Anticipatory Set: Open up class by having the students discuss the prelab before starting. There are vocabulary terms as well as questions regarding units of measure. Also, discuss Newton's First law to transition into discovering Newton's second law.

Process:

- Students will observe a number of demonstrations and will be asked to find the relationship between acceleration of an object and the applied force (a proportional relationship).
- Students will observe a number of demonstration and will be asked to find the relationship between the mass of an object and the applied force (an inverse relationship).
- Students will conduct an dimensional analysis of $F = f(m, a)$.
- Ask students how to design an experiment using the materials provided. Write process on board and have students write it in their notebooks as well.

Closure: At the end of the inquiry lesson, students will describe the predicted relationships they found and describe their process for confirming the relationship.

Assessment: The students will be assessed by participation (mainly; through questions, explanations, and conclusions of observations), through a prelab write-up and through a lab packet which contains questions that correspond to their 4 graphs.

Preconceptions:

- There is no connection between Newton's Laws and kinematics.
- The product of mass and acceleration, ma , is a force.

Materials:

- Low friction carts and tracks
- Spring scales
- Set of metric masses
- Heavy string