

High School IVC Unit

AP Physics

LESSON BY: Brian Hanna, Newport High School

SUBJECT AREA: Math

GRADE LEVEL: 11–12

NETS•S ADDRESSED: 3, 6

CONTENT STANDARDS ADDRESSED (OREGON):

1. Calculations and Estimations

- A. Use computation, estimation, and mathematical properties to solve problems; use estimation to check the reasonableness of results, including those obtained by technology.

2. Statistics and Probability

- A. Use experimental or theoretical probability to represent and interpret situations or problems involving uncertainty.

3. Algebraic Relationships

- A. Simplify expressions and solve equations involving advanced functions.
- B. Understand and analyze the behavior of advanced functions.
- C. Model situations and solve problems using a variety of functions.

4. Mathematical Problem Solving

- A. Understand and formulate problems; select or provide relevant information; use mathematical concepts, models, and representations.
- B. Consider and choose among various strategies, algorithms, models, and concepts to devise and carry out solutions.
- C. Represent and communicate reasoning processes, solutions, ideas, and conclusions; use correct mathematical terminology, symbols, and notation.

DURATION: Three to four class periods

VOCABULARY:

Atwood machine

Negligible mass and/or friction

Unit Goal

Students will understand and be able to use Newton's Second Law of Motion to analyze multiple-object motion.

Unit Objective

After completing this unit, students will be able to use Newton's Second Law of Motion to analyze connected objects undergoing equivalent or opposite acceleration (neglecting friction).

Prior Knowledge Required

Students should have a knowledge of Newton's Laws of Motion and the form of Newton's Second Law written as:

$$\Sigma \text{ Forces} = \text{mass} \times \text{acceleration}$$

Students should be familiar with this equation and its application in one dimension.

Students should know that the value of g used in class is 9.8 m/s^2 .

Pre-Conference Activities

Not applicable for daily class.

Preparation for Videoconference

- ✓ Students are trained in use of the videoconferencing modality at the beginning of the term, including interaction protocol, teacher expectations, and directions for accessing class materials and assignments.

Lesson Notes

DAILY QUIZ

A large, light ball falls from a rooftop. Because of air resistance, however, its acceleration due to gravity is only 7.5 m/s^2 . Determine the time required for it to reach the ground if the roof to ground distance is 1.0 m .

ANSWER

Using the previously introduced (prior lesson) equation $d = 0.5 \times a \times t^2$, students will solve for t and determine the time to be 1.6 s . The following equation for time will be used in the practical application problem:

$$t = \sqrt{\frac{2 \times d}{a}}$$

DEMONSTRATION

The setup for the demonstration of Atwood's machine consists of a single pulley system about 50 cm above a level surface and various hooked weights or weight hangers in increments of 20 g with a string between them.

The demonstration and discussion begins with equal weights on both sides of the pulley

and the analysis of the forces acting on both weights. Weights are then added to one side to initiate acceleration. An analysis of forces leads to the equation for the acceleration.

$$a = \frac{m_1 - m_2}{m_1 + m_2}$$

APPLICATION

As each part of the problem is read, I use two small dolls and a small cup of nails to illustrate. The practical application problem consists of the following:

Buzz and Woody's Construction Company is working on a building. To assist in hauling equipment, a pulley system is installed to move tools and supplies up and down. Buzz (weight = 800 Newtons) and Woody (weight = 600 N) are 10 m up on a platform when they begin hauling up a crate (weight = 700 N) of nails (weight = 200 N). Unfortunately, just as they begin pulling the crate up, Buzz finds that he has inadvertently wrapped the rope around their legs, bends down to untie them, and knocks them both over the edge. After hitting the ground, Buzz gets his legs free and rolls away from Woody. The loss of weight at the ground end sends Woody back up, still tied to the rope, and the crate of nails crashing down. When the crate of nails hits the ground, the nails spill out and Woody again plummets to the earth. Stunned, but not yet unconscious, Woody gets free and tries to roll away. Before doing so, the empty crate smacks him on the head, knocking Woody out cold. Assume the mass of the rope and pulley, as well as any friction, is negligible. Determine the minimum amount of time necessary for this tragic event to occur.

Post-Conference Activities

Not applicable for daily class.