

Lesson Plan: Career Corps

Nick Wang, Pelham High School

Summer 2021

Course Title: Physics (Advanced)

Total Duration: 2 class periods, approximately 50-min each

Overview: Creating a model and applying the model to address kinematics, forces, and energy questions on the motion of the bucket on a boom truck.

Career Opportunities: Physics-related fields, e.g. engineering, teacher, researcher

Essential Question: What data and information are necessary to create a model, and how can we apply the model to answer application questions?

Background/Preparation: Knowledge of kinematics, forces, and energy

Alabama COS Physics Standards: 1, 2, 5

- **Standard 1:** Investigate and analyze, based on evidence obtained through observation or experimental design, the motion of an object using both graphical and mathematical models [...]
- **Standard 2:** Identify external forces in a system and apply Newton's laws graphically by using models such as free-body diagrams to explain how the motion of an object is affected, ranging from simple to complex [...]
- **Standard 5:** Construct models that illustrate how energy is related to work performed on or by an object and explain how different forms of energy are transformed from one form to another [...]

Learning Targets:

1. I can identify and apply strategies to accurately measure the motion of an object.
2. I can use kinematic equations to determine unknown quantities.
3. I can draw free body diagrams to describe the forces acting on an object.
4. I can apply energy calculations to determine changes in mechanical energy of an object.
5. I can create a model from experimental data.
6. I can apply a model to solve a question or design and test an experiment.

Introduction Activity:

- Watch video of a bucket truck as it travels upward, and as it moves downward.
- What are some observations that you can make about its movement?

Main Activity: Separate into groups of 3-4 (generally based on ability)

- Phase 1: Planning of experiment
 - Determine specific procedures for how you will collect the following quantities about the vertical motion of the bucket:
 - Average velocity, acceleration, mass of bucket w/ operator, relevant forces at five points along the path of the bucket, work necessary to move

- bucket from initial to final position, forms and amount of mechanical energy change as bucket moves from initial to final position
- Create a free body diagram for five positions: initial position, moving upwards, top of movement, moving downwards, and final position.
 - Identify any assumptions or shortcomings to the experimental design of the experiment.
 - Phase 2: Collection of data and creation of model.
 - Using a pre-recorded video, perform the measurements from the brainstorming process in Phase 1
 - Alternatively, travel to a location where a bucket truck can be operated by a lucky volunteer
 - 2nd alternatively, request a bucket truck to travel to our campus.
 - Calculate the quantities listed in Phase 1 above
 - Diagram a model of the bucket's behavior using all of the quantities calculated above.
 - Phase 3: Application of Model
 - Create a question or hypothesis that can be addressed by the model of the truck using the model created above. Possible examples include:
 - How long will it take for the bucket to reach its peak height if the applied force was at an angle, rather than vertical?
 - How much force is *too* much force (i.e. launches the operator?)
 - If the power of the engine is halved, what changes will occur in the motion of the bucket?
 - If there were two operators in the bucket, what changes will occur in the motion of the bucket?
 - Phase 4: Presentation of your question
 - In your format of choice (PPT, poster, whiteboards, etc.) describe your question. Then, write out a claim, evidence, and reasoning for your proposed solution. Present to the class!
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Success Criteria:

- Student uses appropriate language and techniques to collect information. (Phase 1)
 - Student clearly and appropriately applies the correct formulas and concepts using experimental data, which leads to creation of the model. (Phase 2)
 - Student creates a testable question/experiment (Phase 3)
 - Student presents their information clearly and concisely (Phase 4)
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I authorize The Shelby County Chamber and 58INC. to publicize this lesson plan on their public webpage and distribute it as they see fit.

Printed Name: Nick Wang

Signature: 