

Explain:

1. Teacher leads class discussion as to the cause of motion “What caused the vehicle to move? How can you describe the movement of your vehicle? What caused your vehicle to move faster or slower?”
2. Teacher explains that all movement requires an energy, or force, to start and end movement.
 - a. Teacher note: This lesson may be adjusted to various levels in the unit, it may be used to introduce motion, graphing, measuring motion, or unbalanced forces.
3. Introduce students to the idea of balanced and unbalanced forces.
4. “As scientists and engineers we need to be able to quantify and communicate how much force is being applied to objects, how do you think we can communicate how much force is being applied.”
5. Introduce students to free body diagrams/ force diagrams.

Elaborate:

1. Students draw a free body diagram for their zip-line, both at rest and moving.
2. Students also will graph their data from the three trials. (Optional depending on pacing of class and order of progression)

Evaluate:

1. Students free body diagrams and speed calculations serve as their evaluations.
2. Students will also have a follow up worksheet to diagram several objects in motion and at rest.

Additional Resources:

PhET online simulation of unbalanced and balanced forces

<http://phet.colorado.edu/en/simulation/forces-and-motion-basics>

PhET online simulation of forces and motion in 1 dimension

<http://phet.colorado.edu/en/simulation/forces-1d>

Lesson 2: Car Design (Add forces and the cause of motion)

Objective: Students will design and construct a self-propelled car to examine how forces are used to move objects.

Learning Goal: Students will investigate alternative ways to propel cars. What is the source of motion and the basic engineering cycle.

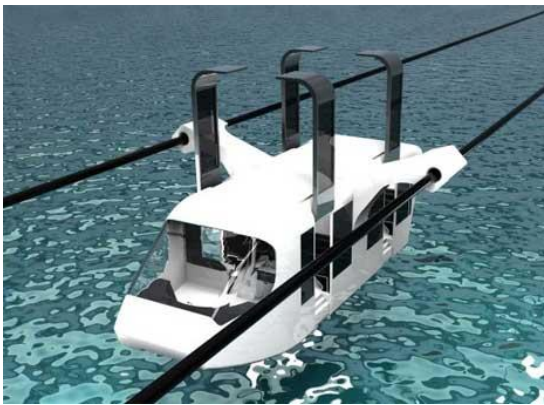
Vocabulary: Friction, Chassis, Force

Introduce students to automotive engineering: “Automotive engineering is a billion dollar industry that directly impacts the lives of almost everyone living in Los Angeles. For the next several weeks we will be following the engineering design cycle to build cars and test them.

Engage:

“The city of Los Angeles has decided that the zip-line design may be too expensive to implement city wide and has hired our engineering firm to design and build several transit cars in place of the zip-line. The first step in designing and building a car is designing”

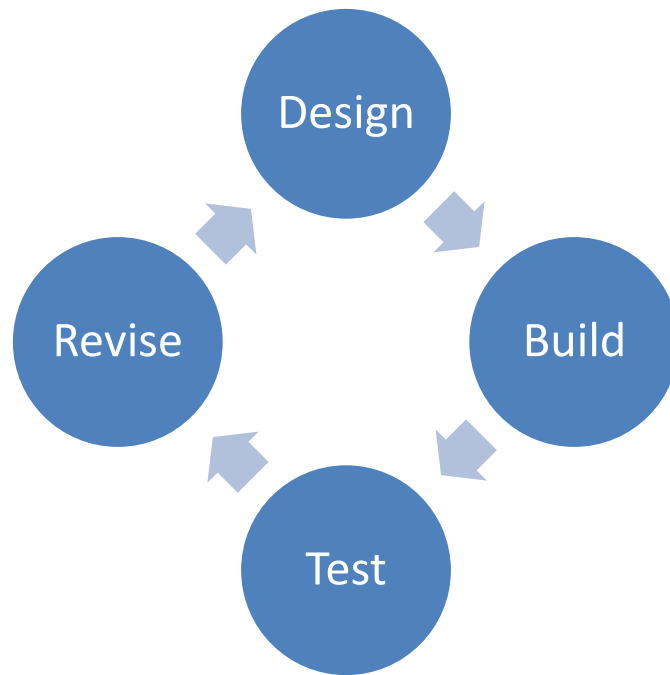
1. Show students pictures of concept cars and buses.
 - Examples of concept public transit: (add more realistic concepts, taxi/ bus)



2. Have students ,individually, design a concept bus
 - Students may focus on several different types of designs to maximize for speed, passenger load, or safety

Explore:

1. Introduce the Engineering Cycle



2. “The concept car is just the beginning of the planning and designing phase of automotive engineering, in order to truly start planning the design of your car you must know what materials you are going to be using for your car.”
3. Show students the materials that they will be using to build their “stock car”
 - Students will first begin building their cars using all the same materials, the stock car. They will have an opportunity to “buy” and bring in materials from home to customize and change their vehicle after it has met the travel criteria.
 - Students will be given different size car bodies/chassis in order to compare data in later investigations.
4. In pairs, students being to design and build their car which must be able to travel 3 meters on a flat surface.

Explain:

1. Once students have begun to make adequate progress towards building their vehicles, students will share out the norms of building, “What are you noticing about the balloon placement on the chassis? How are you connecting the wheels? Etc”
2. Teacher leads a classroom discussion as to how the vehicle is being propelled, and the source of the force. “How can we communicate this idea to other people, how can we quantify or illustrate force?”
3. Transitions into free body diagrams.
4. Teacher leads a conversation as to how we can measure the speed or rate.

Elaborate:

1. Using Newton's Third Law students will create a free body diagram showing the force being generated by the balloon and how it is propelling the vehicle forward and where friction may occur.
2. Students will also use this time to make changes to their car following the share out of the norms of building.
 - All of the changes that are being made to the cars should be kept track of in the car changes log along with an explanation.

Evaluate:

1. Students will be evaluated by the demonstration of Newton's Third Law with free body diagrams and completing several other examples provided in a follow up worksheet. Followed with practice speed calculations.