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Notebook

Engineering Design

Fall 2019
STEM

The E in

Phase I – Research and Planning
Date: Midterm

Due

In order to implement in my classroom in time for the end of the semester, this must be a topic I will cover in the first two months of the year. The two first units are Forces and Motion and Astronomy phases of the moon, seasons, Earth, Sun and Moon systems. The design challenge Launch It from NASA PBS Design Squad On the Moon would fit well with forces and motion and laws of motion.

1. Identify the “Big” concept to be covered by the engineering design challenge.

The big concepts being covered in this challenge are Newton’s laws of motion as well as forces including fluid friction (air resistance/drag), thrust and gravity’s affect on the flight path.

The main concepts are reinforced through engineering design in this activity.

Students will need to use learned forces and motion concepts to create a balloon powered straw rocket to hit a target.

2. Research appropriate learning standards associated with the topic.

NYS Science Standards

5.1c An object’s motion is the result of the combined effect of all forces acting on the object. A moving object that is not subjected to a force will continue to move at a constant speed in a straight line. An object at rest will remain at rest.

5.1d Force is directly related to an object’s mass and acceleration. The greater the force, the greater the change in motion.

5.1e For every action there is an equal and opposite reaction.

Cross Cutting Concepts

Cause and Effect relationships may be used to predict phenomena in natural or designed systems.

NGSS:

MS-PS2-2. Plan and conduct 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 (including simple machines), 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.]

PS2.A: Forces and Motion

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)

The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)

All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

NGSS Engineering Design

MS-ETS 1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS 1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS 1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS 1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

3. Identify and discuss the different types of problem solving and declarative/procedure knowledge needed.

Launch It is a moderately structured problem in that it gives students a clear goal but requires them to modify their models to reach a desired solution (hitting a target). The constraints are that the launcher is the same and the materials of straw and balloon are the same. However students can modify fins, nosecones, the amount of air in the balloon, the angle of launch, etc.

The declarative knowledge required is that of forces and motion:

Forces is a push or pull.

The forces that would be acting on the rocket (gravity, drag, thrust).

Newtons laws of motion and how they would affect the rocket:

1st law - inertia

2nd law - $F=ma$

3rd law - reciprocal actions

The procedural knowledge required for this task would be around creating and launching the rocket:

How do you launch a rocket?

How do you create the rocket? (nosecone, fins) How to determine the size of these.

How to attach the nosecone and fins - optimal materials.

How to aim at the target - get the rocket to go straight.

4. Explore objectives and ancillary concepts/content covered by the project.

The objectives of this task would be:

- Following the design process to create a solution to a problem (a rocket that hits a target).
- Apply knowledge learned about forces and motion to complete the task.
- Work collaboratively to complete the task.

The ancillary concepts/content/skills covered by the project would include:

- Researching a problem
- Working in groups, collaboration, brainstorming, compromise
- Sketching and building accurate models
- Following a procedure
- Testing a model
- Collecting and analyzing data
- Sharing information

5. Identify possible activities.

Launch It - NASA and Design Squad On the Moon activity

https://pbskids.org/designsquad/parentseducators/guides/activity_guide_moon.html

6. Select the best activity for your classroom.

Launch It - NASA and Design Squad On the Moon activity

https://pbskids.org/designsquad/parentseducators/guides/activity_guide_moon.html

Possible modification to use Pitsco rocket launcher

<https://www.pitsco.com/Straw-Rocket-Launcher>