Student Name: Points: 10 Period:

Date:

Due:

Activity 5.7

Force and Stability

INTRODUCTION

Forces are everywhere. Gravity exerts a force on every **mass**on earth. Whenever two objects touch or collide, a force is applied to each. Wind, water, snow, ice, and soil can exert a force on an object they contact. Forces also result when objects heat up and expand or cool down and shrink. Magnetic fields can exert force on metallic objects.
Engineers must take into account how forces will affect the design of nearly every physical object. Large objects, such as buildings, dams, bridges, and machines used for manufacturing, are obvious examples of engineered products that require careful consideration of forces. However, forces can affect the design of smaller objects, such as streetlights, highway signs, furniture, and toys. Engineers analyze forces, whether they are designing a building or a toy, to be sure that the design will work properly. Perhaps more importantly, engineers analyze forces to be sure every design is safe so that it will not harm people, property, or the environment.

In this activity, your team will investigate factors that affect the force required to tip an object over and will develop a mathematical model to represent the relationship among those factors.

EQUIPMENT

- 8–10 different small cardboard boxes
- Materials of different densities that can be used to fill the boxes
- Scale
- Ruler

Procedure

Part 1 - Factors That Affect Tipping Force

Perform the following experiment and document your work in your PLTW Engineering Notebook.

1. As a team, brainstorm factors that might affect the magnitude of a **horizontal** force applied at the top of the box that is required to tip over an object.

2. Make a hypothesis about the relationship between each factor (that you identified in step 1) with respect to the magnitude of the (horizontal) force required to tip a box (rectangular prism).

   For example, if you think the height of the object being tipped is related to the tipping force, your hypothesis might be:
   - *As the height of the box increases, the magnitude of the horizontal tipping force decreases.*

3. With the help of your instructor, select one factor you identified in item 1 above to investigate. Design an experiment to test your hypothesis. Perform the experiment and collect data. Record your data in a table similar to that shown. Note that you will vary ONLY the variable that you are investigating. The other variables under investigation should be the same for each trial.

Trial	Mass of box, *m* (g)	Weight of box, *W (N)*	Base dimension (in direction of force), *b (cm)*	Height of force application, *h (cm)*	Magnitude of Tipping Force, *T* (N) (dependent variable)
1					
2					
3					
4					
5					
6					
7					

4. Create a scatter plot of your data. Graph the variable that you were investigating (independent variable) with the magnitude of the tipping force (dependent variable). The other variables should be constant in each of your trials.

5. Find a mathematical model to represent the data.

6. Present your findings to your classmates.