<table>
<tr><td>Title:

Straw Missile Launch</td><td>Grade(s): 7th
Authors:
Jean Fuller and Laurel Bennett</td><td>BIG Idea:
Direct Variation/ Linear Relationships</td></tr>
<tr><td colspan="3">Real-World Connection:
After watching a video of a NASA rocket test flight, students will explore the factors that influence the flight path of a missile. The investigation will help students identify the key features of linear and non-linear relationships in tables and graphs as they conduct test flights of their “missiles.”

How Students will Experience the Connection:

Video Clip   Photo   Podcast

Print Media (article, ad, etc.)   Vodcast   Other</td></tr>
<tr><td>GPS Standards:

M7A3. Students will understand relationships between two variables.
a. Plot points on a coordinate plane.
c. Describe how change in one variable affects the other variable.
d. Describe patterns in the graphs of proportional relationships, both direct ($y = kx$) and inverse ($y = k/x$).
M7D1. Students will pose questions, collect data, represent and analyze the data, and interpret results.
f. Analyze data using appropriate graphs, including line graphs.
g. Analyze and draw conclusions about data, including describing the relationship between two variables.
M7P3. Students will communicate mathematically.
a. Organize and consolidate their mathematical thinking through communication.
b. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
c. Analyze and evaluate the mathematical thinking and strategies of others.
M7P4. Students will make connections among mathematical ideas and to other disciplines.
c. Recognize and apply mathematics in contexts outside of mathematics.
M7P5. Students will represent mathematics in multiple ways.
a. Create and use representations to organize, record, and communicate mathematical ideas.</td><td colspan="2">Objectives:

Students will be able to:

1. Plot their data on a coordinate plane.

2. Describe direct variation using a table or graph (Data from Group B shows that as the force increases, the distance increases).

3. Communicate verbally their data findings to the class for their assigned data collection group. (The A groups will correctly identify their graphs as NOT linear and the B groups will correctly identify their graphs as linear).

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Materials:

- ☑ Computer with projector
- ☑ Video of rocket test flight (approx. 2 minutes)
http://news.nationalgeographic.com/news/2009/10/091028-nasa-ares-video.html
- ☑ Video of projectile motion
http://www.youtube.com/watch?v=N0H-rv9XFHk&NR=1&feature=fvwp

Per Group:

- ☑ Missile Launchers - Purchase from PITSCO [**http://shop.pitsco.com/store/detail.aspx?ID=2547&bhcp=1**]
- ☑ Stiff plastic straws (3 per launcher)
- ☑ Putty weight for launched straw
- ☑ Measuring Tape (60 ft.) or Trundle Wheel
- ☑ Hula Hoop (Optional Target Area)
- ☑ Data Collection Sheets
- ☑ Oversized Graph Paper/chart paper with grid lines

Per Person:

- ☑ Calculators
- ☑ Pencils

Related Task:

Watch video of test flight (http://news.nationalgeographic.com/news/2009/10/091028-nasa-ares-video.html).

Ask: Can anyone think of what might affect the flight path (called the trajectory) of a missile?

Answer: Students should be led to a discussion of the amount of power used (force) and the launch position used (trajectory angle). **How would you "aim" a rocket? Could you make it fly in a certain direction? How would you accomplish this? If force and trajectory are our independent variables, what do you think would be our dependent variable? What will change? (Students should identify *distance* as the answer to both questions.)**

Group students in order to have at least 6 different groups (2-3 in each group). Rotate students through the activities if more than 6 groups are used. Group Roles Needed: spotter; measurer; and recorder.

Explain that students will collect distance travelled for their assigned force and trajectory, and then make large graphs to share with the class. Some graphs will be straight lines, but others will be different. Show the projectile motion video at http://www.youtube.com/watch?v=N0H-rv9XFHk&NR=1&feature=fvwp so students will know what to look for.

The ***A* groups** will maintain a constant force but vary their launch angles. Each station collects data for angles of 10, 20, 30, 40, 50, 60, 70, and 80 degrees (similar to the video). Assign one force to each *A* group (10, 20 or 30). Each of these three groups will produce a graph for their force level with *angle* on the x-axis and *distance* on the y-axis.

The **B groups** will maintain a constant angle but vary their launch forces. Each station will collect data for forces of 10, 15, 20, 25, 30, 35 and 40 (or maximum). Each of these three groups will produce a graph for their launch angles with *force level* on the x-axis and *distance* on the y-axis.

Ask: What do you notice about the graphs? Do they all look the same? Which do not? Why are they different? Do you see any patterns? What made you decide that? How can you know? What do you think about what (student's name) said?

Answer: Students should notice the ***B*** **group graphs (that change forces) are roughly a straight line**. This result shows that as force is varied, distance varies directly (when the launch angle stays the same).

Ask: Are the *A* group graphs straight lines? What are they like?
Answer: The *A* group graphs will look like the projectile curves shown in the video (parabolas). It will be natural for students to say that the graphs represent the path of the missile because both are parabolic. However, be sure to point out that the *A* graphs are really showing the distance that each rocket travelled when launched at a certain angle. Each graph increases to about 40° and then decrease s. Discuss what this means for launching. More advanced students may be able to discuss optimum angles and symmetry. Mention that as they progress to higher grade levels they will graph curves like this.

Extensions – Have students come up with an equation for one of the lines shown in the *B* group graphs.

Or

Give the students a distance to shoot the missile. Allow them to use all of the data to determine the best angle and force to use. Place a hula hoop with the center at the desired distance and have them try to launch their straws into it.

Learn More:

NASA Rocketry for Educators
http://www.nasa.gov/audience/foreducators/rocketry/multimedia/index.html

LAUNCH PAD 1

Group A

Using a Force of 10

Angle	Distance in feet
10°	
20°	
30°	
40°	
50°	
60°	
70°	
80°	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the angle of elevation and distance travelled related?

3) What is the best angle to shoot a missile? Why?

LAUNCH PAD 2

Group A

Using a Force of 20

Angle	Distance in feet
10°	
20°	
30°	
40°	
50°	
60°	
70°	
80°	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the angle of elevation and distance travelled related?

3) What is the best angle to shoot a missile? Why?

LAUNCH PAD 3

Group A

Using a Force of 30

Angle	Distance in feet
10°	
20°	
30°	
40°	
50°	
60°	
70°	
80°	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the angle of elevation and distance travelled related?

3) What is the best angle to shoot a missile? Why?

LAUNCH PAD 1

Group B

Using an Angle of 20°

Force	Distance in feet
10	
15	
20	
25	
30	
35	
40	
45	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the force and distance related?

3) What is the best force to shoot a missile? Why?

LAUNCH PAD 2

Group B

Using an Angle of 40°

Force	Distance in feet
10	
15	
20	
25	
30	
35	
40	
45	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the force and distance related?

3) What is the best force to shoot a missile? Why?

LAUNCH PAD 3

Group B

Using an Angle of 60°

Force	Distance in feet
10	
15	
20	
25	
30	
35	
40	
45	

Plot your data onto the graph paper provided. Be ready to answer the following questions:

1) Does the data look linear?

2) How are the force and distance related?

3) What is the best force to shoot a missile? Why?