<u>Lesson 3</u> Fabricate an Actual Rocket and PVC Launcher

SCENARIO: Fabricate a paper rocket and PVC launcher.

CHALLENGE: To produce a rocket within constraints given by teacher and then design a launcher using materials provided. Launch a projectile at a target. In lesson 4, you will conduct an experiment to collect data, then use math to calculate the required angle to reach the target

TIME ALLOWED FOR PREPARATION: four class blocks if both the rockets and launcher require fabrication, otherwise one block for rocket only.

MATERIALS: Paper, glue stick, tape, graph paper, ruler

EQUIPMENT: Provided in class (Previously used launcher)

DESIGN CRITERIA: The teacher will present: Make Magazine Compressed Air Rocket to provide the overall concepts.

EVALUATION: Sketch the final design using graph paper (worksheet 3). Be sure to draw the design to scale. Is your "Rocket" a projectile or a missile?
NOTE: Projectile Motion Tutorial Power Point link on at the bottom of Unit Plan page 1.

Lesson 3 Fabricate an Actual Rocket and PVC Launcher
Worksheet 3

<u>Lesson 4</u> Launch Day

SCENARIO: Test fire your rocket to obtain data, then launch rockets at targets

CHALLENGE: To get your rocket to hit targets on a sports field at a known distance

TIME ALLOWED FOR PREPARATION: 2 class block

MATERIALS: Rockets and Launcher, Lesson 4 Launch Day Worksheet, Calculator, Pencil/pen, and Rocket repair material.

EQUIPMENT: Provided in class (Previously used launcher)

EVALUATION: Team with highest percent of targets hit will win.

Going Further:

- Tracker software, allows video analysis of a projectile during flight and imports data into Tracker software for analysis. The Regression Simulation (requires JAVA) tutorial is attached after Lesson 4 worksheet, **SCATTERPLOTS AND LINEAR REGRESSION**

- Class trip or virtual visit to Submarine Force Museum and Historic Ship *Nautilus* in Groton, CT (www.ussnautilus.org)

Lesson 4 Launch Day Worksheet 4

Procedure

Determine the average range of your projectile

Launch the rocket 10 times at a fixed firing angle of 30 degrees. Measure the range of the rocket each time and record the results in the table provided as feet/inch. Calculate the mean range.

Trial Number	Measured Range
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Mean Average =	

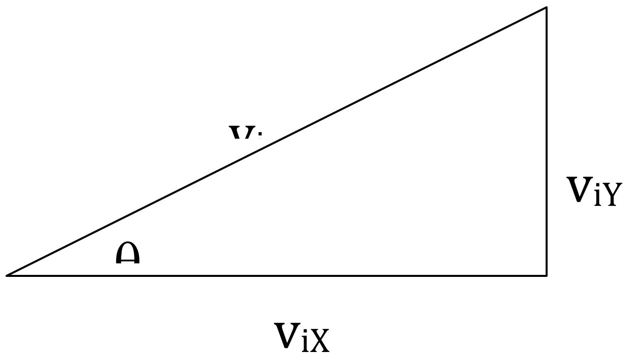
Calculate the initial velocity (V_i) of the projectile

Use the calculated value for the average range in step 1 to calculate the initial velocity (Vi) of the rocket. Substitute the value of the average range for (x), the firing angle for (θ), and 32.2 ft/sec2 for (g).

Initial Velocity (V_i): $V_i = \sqrt{\frac{-gx}{\sin 2\theta}}$

Calculate the X and Y components

Now that you have the initial velocity use trigonometry functions to determine the initial horizontal and vertical velocity of the rocket at the angle you just tested.



Calculate the ideal range of the projectile at various firing angles

Use the calculated value for initial velocity, and specified firing angles to calculate the ideal range of the rocket at each angle. Record the values in the table provided as decimal feet.

Range (x): $x = \frac{V_i^2 \sin 2\theta}{-g}$

Angle	Range
0°	
10°	
20°	
30°	
40°	
45°	
50°	
60°	
70°	
80°	
90°	

Determine the actual range of the rocket at various firing angles

Launch the rocket from the launcher three times for every angle setting, record the range in feet/inch, and calculate mean average range in the table provided.

Angle	Range 1	Range 2	Range 3	Average Range
10°				
20°				
30°				
40°				
45°				
50°				
60°				
70°				
80°				

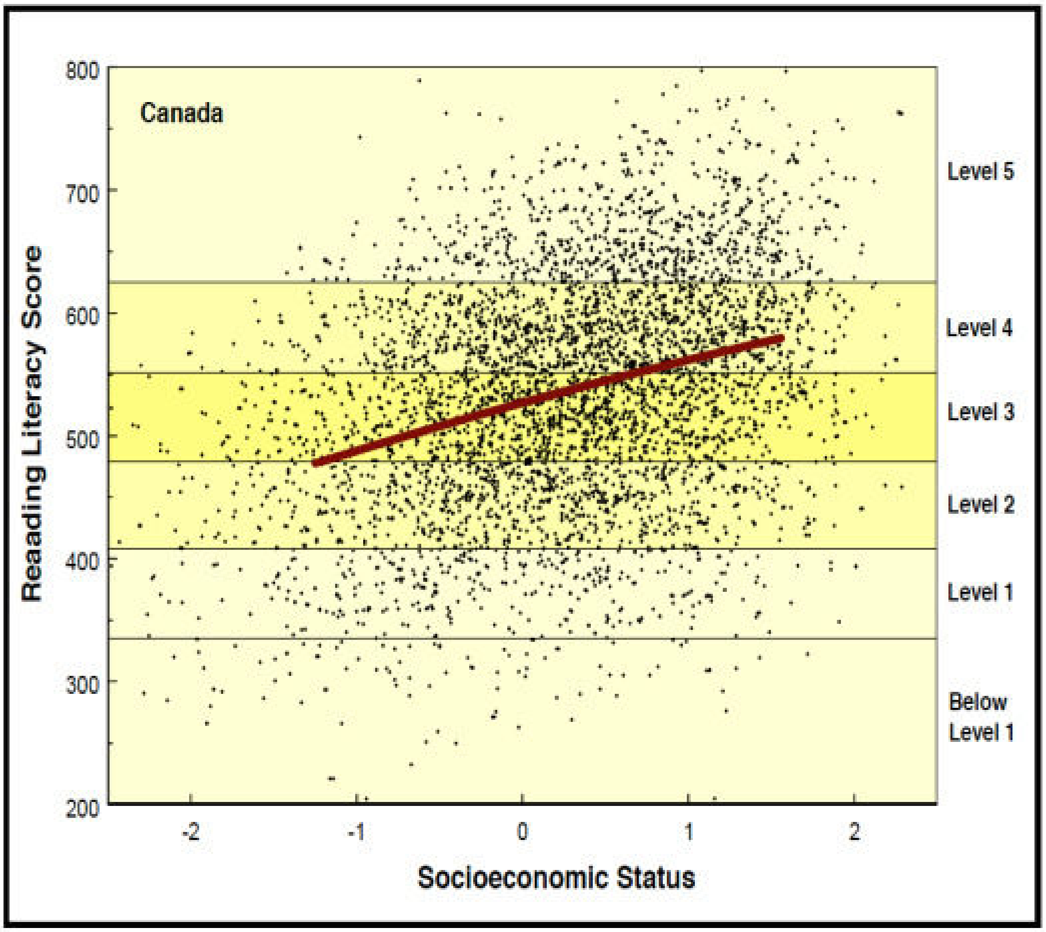
Compare the ideal range and actual range of the device

Input the values gathered into the Excel spreadsheet to create a graph that illustrates the contrast between the calculated (ideal) range of the rocket and the actual range of the rocket at the selected firing angles.

NOTE: Projectile Motion Tutorial Power Point

(link on at the bottom of Unit Plan page 1)

TUTORIAL: SCATTERPLOTS AND LINEAR REGRESSION

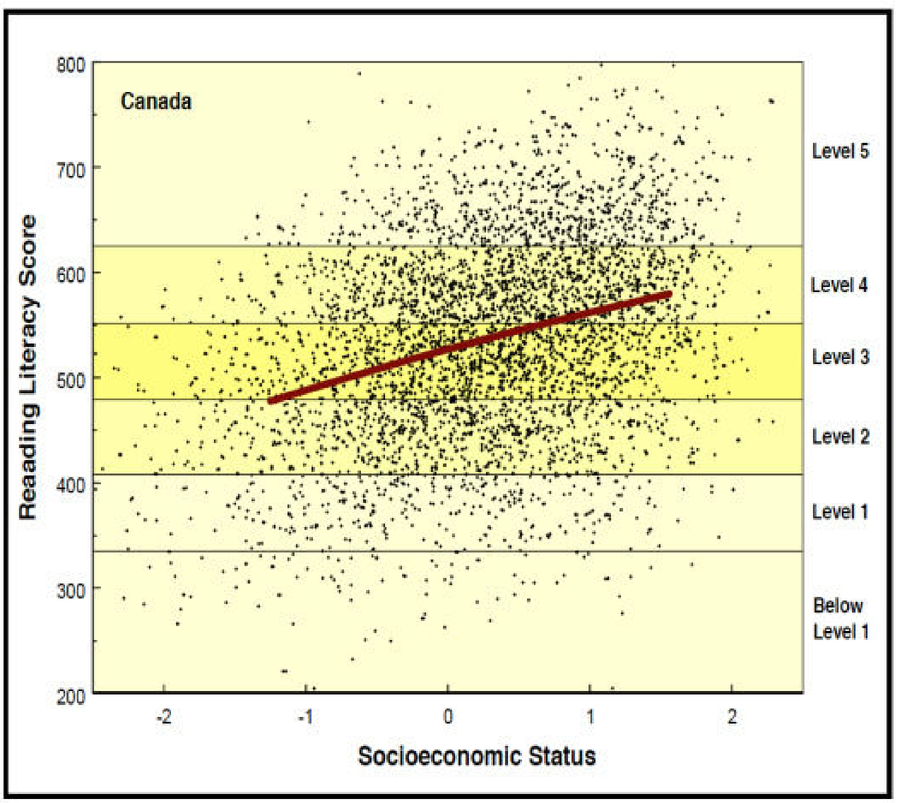


Scatterplots and Lines of Best Fit

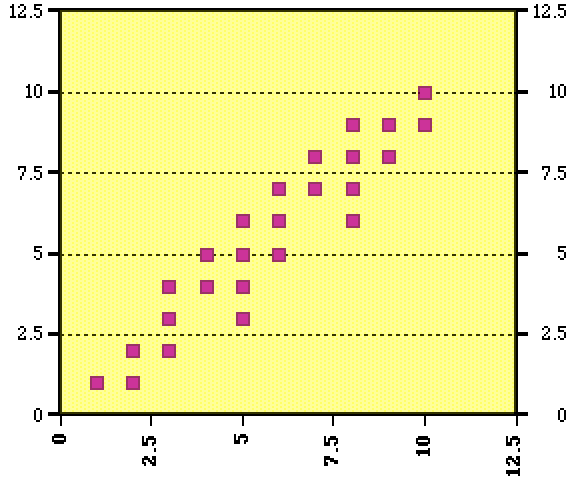
A scatterplot is a graph that represents how two quantitative variables change together

A line of best fit is drawn through a scatterplot to find direction of the association between two variables.

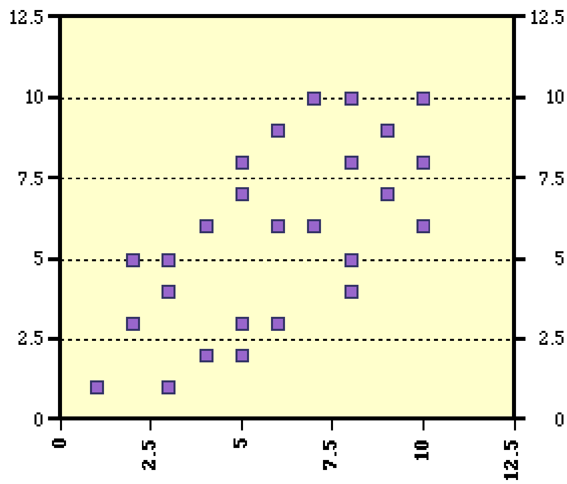
This line can then be used to make predictions

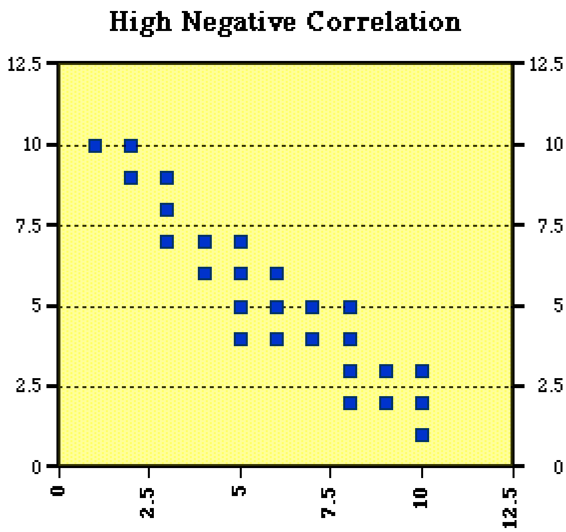


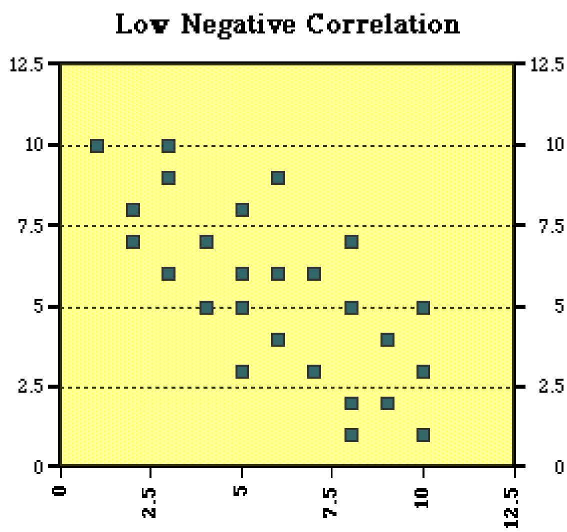
High Positive Correlation



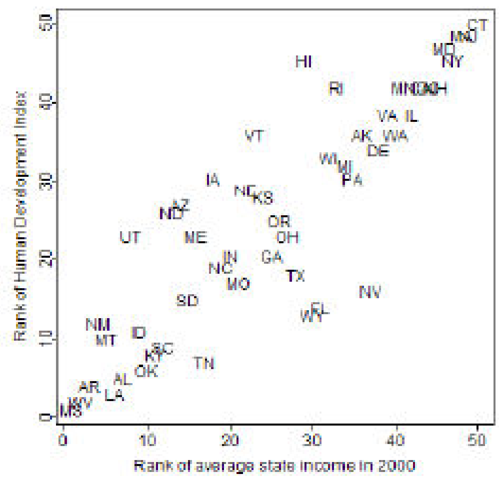
Low Postive Correlation

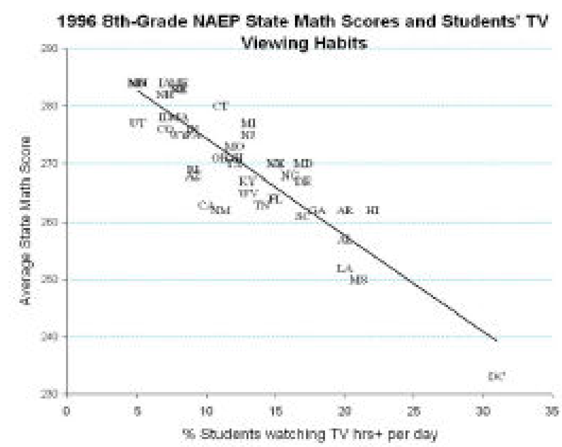



High Negative Correlation
12.5
10
7.5
5
2.5
0
0
2.5
5
7.5
10
12.5


Low Negative Correlation
12.5
10
7.5
5
2.5
0
0
2.5
5
7.5
10
12.5

Positive and Negative Linear Relationships





Positive relationship: As rank of average state income *increases* the rank of Human Development Index *increases*.

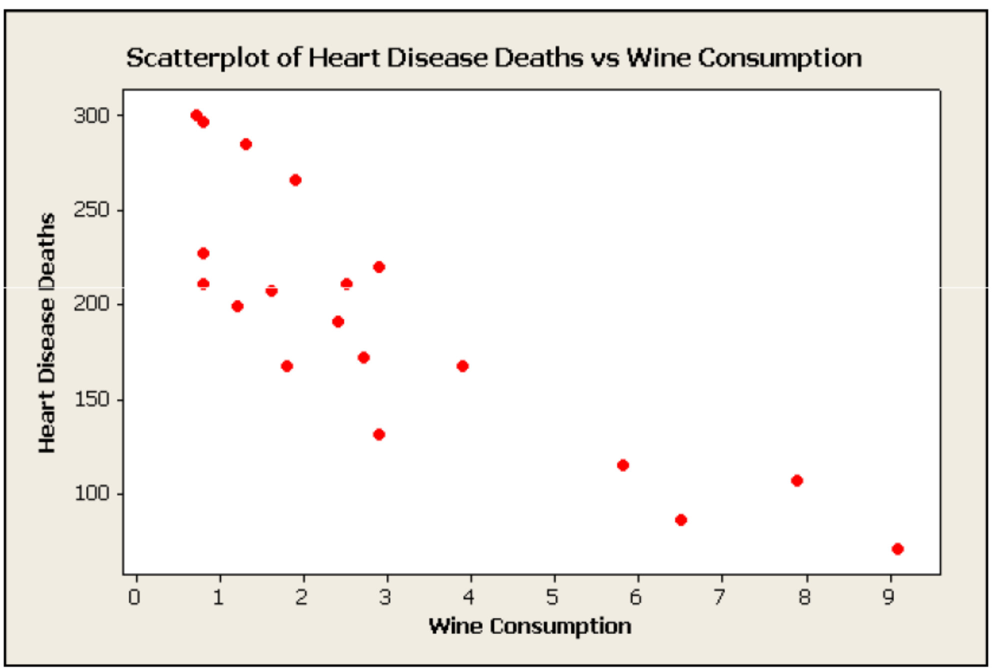
Negative relationship: As percentage of students watching 6+hr tv per day *increases* NAEP State Math scores *decrease*

Linear Regression

• The goal of collecting data and creating a scatterplot of values is usually to find a formula that can be used to model the relationship between the variables if, in fact, a relationship exists.

• This process of finding an equation to fit your data points is called **regression**.

Example:



Liters of wine per year, per person vs. deaths from heart disease per 100,000 people

Correlation Coefficient

- The **correlation coefficient**, ***r***, tells us how good of a fit the line is.

- ***r*** varies between -1 and 1

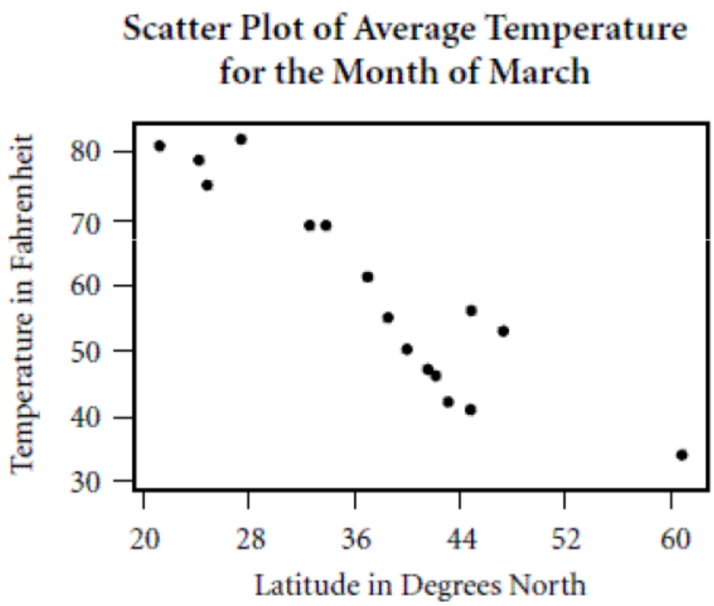
- When r= +1 is a perfect positive linear relationship.

- When r= -1 there is a perfect negative linear relationship.

- When r is 0, there is no relationship between the variables.

- As r gets closer to 0 there is a weaker relationship between the variables. As r gets closer to ±1, we say there is a stronger relationship between the variables.

Power of Prediction



$y = -0.6054x + 73.21$
$r = -.92$

What is the meaning of slope?

What is the meaning of the y-intercept?

Use the model to predict the average temperature in March in CT.