

<p>Grade Level/Course: Grade 8 / Physical Science</p>
<p>Lesson/Unit Plan Name: Constructing a Graph from Data Table</p>
<p>Rationale/Lesson Abstract: This lesson will provide students practice in setting up a graphs from collected data. Students will receive more emphasis, practice, and support in 1) distinguishing between manipulated (independent) and responding (dependent) variables, and 2) setting up the range and scale on the y-axis of a graph. This lesson will support students as they transition further into performance assessments, where they must communicate their results through a graph, as well as on activities such as Science Fair Projects.</p>
<p>Timeframe: 1-2 class periods</p>
<p>Standard(s):</p> <p>CST standard: INVESTIGATION AND EXPERIMENTATION</p> <p>9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:</p> <ol style="list-style-type: none"> a. Plan and conduct a scientific investigation to test a hypothesis. c. Distinguish between variable and controlled parameters in a test. e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables. <p>NGSS:</p> <p>Science and Engineering Practices</p> <p>Practice 3 Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> • Grade 6-8: Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. <p>Practice 4 Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> • Grade 6-8: Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.

Instructional Resources/Materials:

- Handouts provided below.
 - Warm Up Probe
 - Assessment: Constructing a Graph from Data
 - Assessment: Modifying Design for Flight
- Blank graph individual whiteboards for practice and formative assessment or graph paper with sheet protector (1cm graph paper provided below)
- Blank paper (or template) for creating airplanes
- Miscellaneous materials for creating alternate versions of airplanes: different thicknesses or sizes of paper, scissors, paperclips, etc.

Activity/Lesson:

There are five steps in creating a graph from a data table.

*This lesson focuses on #1-3, which **set up the graph** for the points to be plotted.*

1. **Label** the x-axis and y-axis.

- The x-axis shows the manipulated variable (also known as the “independent variable”, it’s the one that you control, change, or compare).
- The y-axis shows the responding variable (also known as the “dependent variable”, it’s the result, or what you measured, from the test).

2. Determine the **range** of each axis.

- How high do the numbers go? The values on each axis of the graph must include all of the data collected.

3. Determine the **scale** that you will use for each square on the graph.

- How much is each square on the graph worth? *Each square should represent the same amount.*
- *The scale you should use depends on your range, and how much space you have on your graph.* For example, if your graph needs to go up to 50, and you only have 10 squares, then each square should represent 5 units (0, 5, 10, 15, and so on...). If your graph needs to go up to 50, and you have 25 squares, you can count by 2s (0, 2, 4, 6, etc....). If your graph needs to go up to 50, and you have 50 squares, then you can make each square worth 1 (0, 1, 2, 3...)

4. Plot the points.

5. Finally, communicate how the data is related.

- Sometimes you will **connect the dots**, for example, with change over time.
- On other graphs, you may need to **draw a “line of best fit”** which shows the trend as a line that goes smoothly through where the plotted points lie.
- And in other cases, you may just **draw a bar** that goes up to each point, comparing different categories.

Warm Up / Do Now / Pre-Assessment Probe

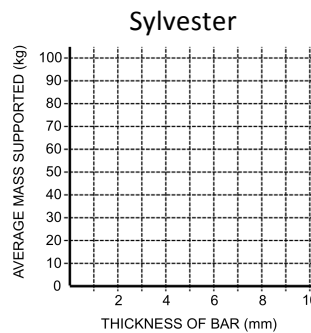
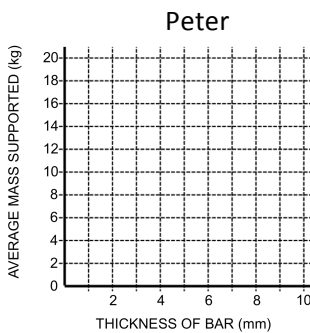
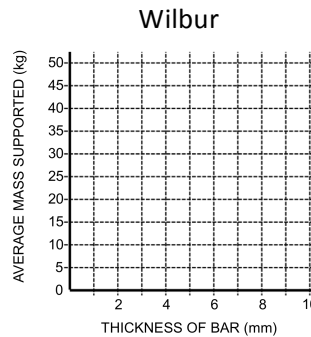
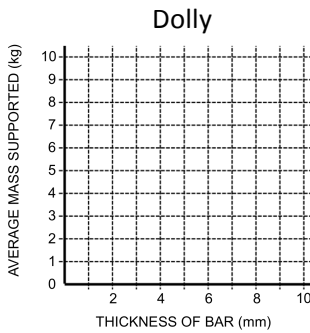
May be presented via front whiteboard, or digitally on PowerPoint, or as a handout (included below).

Mayra has just completed her experiment to see how much mass a wooden bar can support.

Here is the data she collected:

Thickness of the bar	Average amount of mass supported
2 mm	8 kg
4 mm	20 kg
6 mm	31 kg
8 mm	45 kg
10 mm	68 kg

Now she wants to make a graph for the data she's collected, but she's not sure how to set it up. Mayra asks her lab partners, and gets these suggestions:



Whose advice should she follow? _____

Explain why you chose that answer. _____

(Students should choose Sylvester, because the range of the data goes up to 68 kg. The values on the graph need to go at least that high. The only graph that does that is Sylvester's, whose graph has squares that represent 10 kg each, and goes up to 100 kg.)

Activity/Lesson continued:

Part I: Manipulated Variable vs. Responding Variable

In a scientific inquiry, we speak of “isolating variables”. This means that if you want to test *Which soil is the best for growing plants the tallest?*, then your variable would be *the type of soil*. You would be comparing *only* the different types of soil. All other parameters, or things that *could* be variable, *must* remain controlled, or the same: the same size pots, the same amount of water, the same amount of sunlight, the same type of plant, etc.

The **manipulated variable**, sometimes called the “independent variable”, is the parameter that you are comparing, or finding the effect from the difference. In the case above, *Which soil is the best...?*, the manipulated variable is the type of soil. This variable will ultimately be represented along the **x-axis** of the graph.

The **responding variable**, sometimes called the “dependent variable”, is how the test responds to the change, or what happens, or what will be measured, in the experiment. In the example above, *Which soil is the best...?*, the responding variable is the height of the plant. This variable will ultimately be represented along the **y-axis** of the graph.

Examples to do together with class:

Which soil is best for growing plants the tallest?

Manipulated variable: types of soil

Responding variable: height of the plants

In which type of liquid will a golf ball sink the fastest?

Manipulated variable: types of liquids

Responding variable: time it takes the ball to sink

Does getting more sleep help you get better grades?

Manipulated variable: amount of sleep

Responding variable: grade percentage or GPA

Examples for students to try on their own in class (Students may use whiteboards to respond.)

Under which color of light will bean plants grow the tallest?

Manipulated variable: colors of light

Responding variable: height of the bean plants

Which design of paper airplane will glide the farthest?

Manipulated variable: designs of paper airplanes

Responding variable: distance the planes fly

How does the amount of air pressure in a basketball affect how high it bounces?

Manipulated variable: amount of air pressure

Responding variable: height of the bounce

Does caffeine help you to type faster?

Manipulated variable: amount of caffeine

Responding variable: number of words typed per minute

Does the thickness of a wooden bar affect how much weight it will support?

Manipulated variable: thicknesses of wooden bars

Responding variable: amount of weight supported

Remember that the manipulated variable will go on the x-axis (horizontal, along the bottom of the graph), and the responding variable will go on the y-axis (vertical, along the left side of the graph).

Part II: Range of y-axis

Refer back to the Warm Up question. Use these data tables to ask: What is the highest value in the Responding Variable that needs to be included on the y-axis?

Use these data tables together as a class:

“How high does the y-axis need to go?”

Does the day of the week affect how many pizzas are sold?

Day of the week	Average number of pizzas sold
Sunday	58
Monday	29
Tuesday	37
Wednesday	42
Thursday	49
Friday	84
Saturday	72

Which type of barbecue reaches 400° F fastest?

Type of barbecue	Time to reach 400° F
Propane gas grill	8 minutes
Charcoal	36 minutes
Portable grill	15 minutes
Electric grill	12 minutes

Use these data tables as examples for students to try on their own. (Use the whiteboards!)

“How high does the y-axis need to go?”

Does caffeine help you to type faster?

Amount of caffeine	Average words typed per min.
none	32
35 mg (can of Coke)	39
60 mg (Snapple lemon tea)	29
160 mg (can of Rockstar)	34
260 mg (Starbucks small coffee)	31

How does the amount of air pressure in a basketball affect how high it bounces?

Air pressure in the basketball (lbs/in ²)	Average bounce height (meters)
6	1.6
6.5	1.9
7	2.2
7.5	2.6
8	2.8

Part III: Scale of the y-axis

Once students know how high the numbers need to reach on the y-axis, it's time to figure out what will be the best scale to use. Students will need support around scale, ratio, and proportion, if an appropriate scale is not intuitive to them.

- Begin by describing the y-axis as a number line. The y-axis should be drawn on top of one of the vertical lines of the graph paper, toward the left side. The horizontal lines of the graph paper represent tick marks, like on a number line.
- The point where the x- and y-axis meet is the origin, or '0'.
- Each horizontal line on the graph paper marks a point on the number line. e.g, 1, 2, 3, 4, 5, etc.
- However, counting by 1s may not reach the range necessary to represent the maximum measurements from the responding variable. That is, if the highest value is 87, and you only have 25 squares, then counting by 1s will not work for setting up this graph.
- Present options for students to choose from, starting with counting by 2s: 2, 4, 6, 8, etc. If that does not reach the maximum, suggest another option, such as counting by 5s: 5, 10, 15, 20, etc. Then, counting by 10s: 10, 20, 30, etc.
- With practice, students will develop some intuition around what types of scale to use.

Examples to try together as a class:

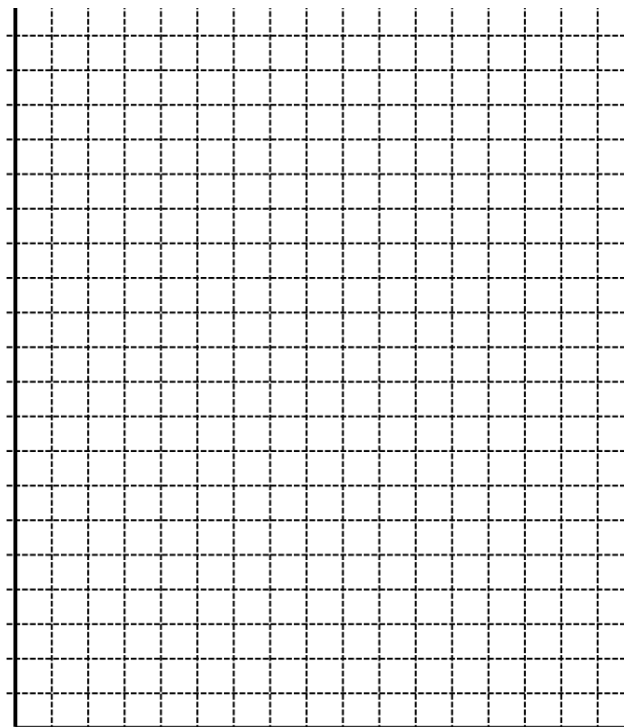
(Don't worry as much here about the manipulated variable's x-axis)

"What type of scale is most appropriate to use on the y-axis for this data?"

Is it best to count by 1s? by 2s? by 5s? 10s? 100s? by 0.5s? something else?"

Does the day of the week affect how many pizzas are sold?

Day of the week	Average number of pizzas sold
Sunday	58
Monday	29
Tuesday	37
Wednesday	42
Thursday	49
Friday	84
Saturday	72



Does caffeine help you to type faster?

Amount of caffeine	Average words typed per min.
none	32
35 mg (can of Coke)	39
60 mg (Snapple lemon tea)	29
160 mg (can of Rockstar)	34
260 mg (Starbucks small coffee)	31

Examples for students to try on their own:

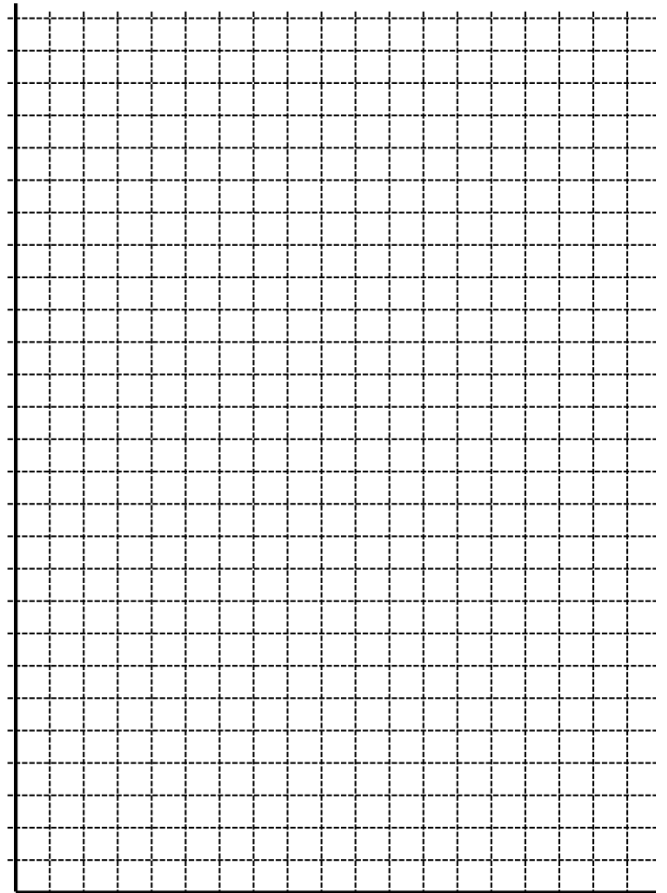
Use the graph paper whiteboards!

“What type of scale is most appropriate to use on the y-axis for this data? Draw on your whiteboard. Label the horizontal lines along the y-axis with appropriate values that reach the maximum for the responding variable. You do not need to plot the points.”

Does LeBron James’ team win championships when he scores more points?

Year	Total points scored
'03-'04	1654
'04-'05	2175
'05-'06	2478
'06-'07	2132
'07-'08	2250
'08-'09	2304
'09-'10	2258
'10-'11	2111
'11-'12*	1683
'12-'13*	2036
'13-'14	2089

*won the NBA championship



Is there a relationship to income level and admission to the UC system?

Parents’ income level	Number of students admitted
Under \$25,000	23
\$25,000 - \$50,000	48
\$50,000 - \$75,000	57
\$75,000 - \$100,000	42
\$100,000 - \$125,000	31
\$125,000 - \$150,000	52

Assessment:

Modifying Design for Flight

Part I

Use the template to fold a paper airplane with regular printer paper. Throw the airplane five times, measuring the distance in centimeters. Finally, find the average distance this plane flies.

Part II

Decide with your partner what single change you will make to your airplane. Will you use a different material to make the plane? A different size or shape of paper? Modify the way it is folded? Add weight to part of the plane? Something else?

What change did you make to the plane?

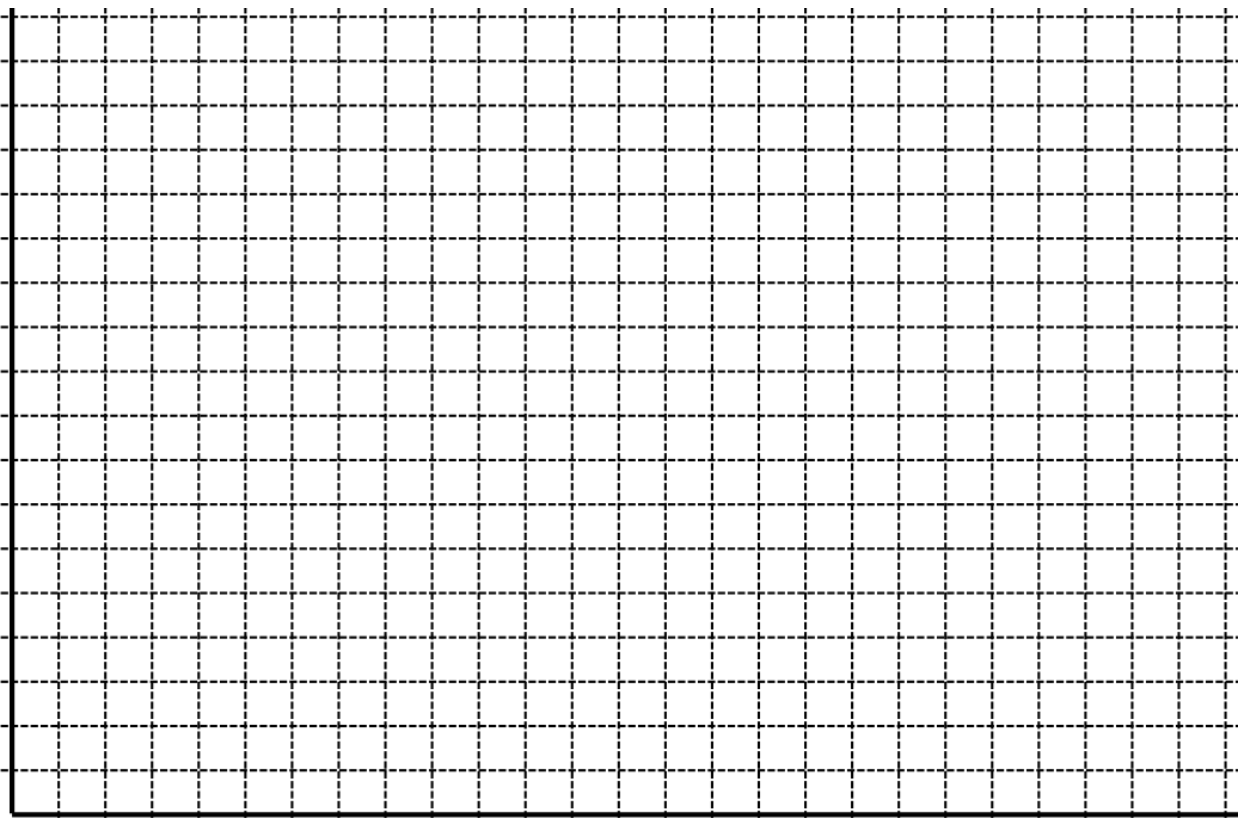
As in Part I, measure the flight of your modified plane five times, and find the average.

Trial #	Flight distance of original plane	Flight distance of modified plane
1		
2		
3		
4		
5		
average		

Part III

Now, using your data from the table above, construct a bar graph that shows your results.

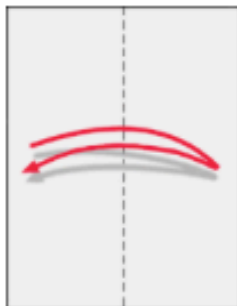
- Label the x-axis with your manipulated variable, and the y-axis with the responding variable.
- Make note of the range of your data above—How high do the numbers on your graph need to go?
- Determine the appropriate scale to use—How many centimeters will each square on your graph represent? 1 cm? 2 cm? 5 cm? more?



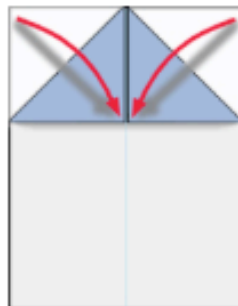
<< BACK << **Amazing Paper Airplanes**

Basic Dart

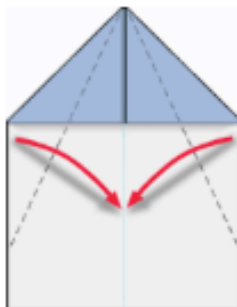
Folding Instructions



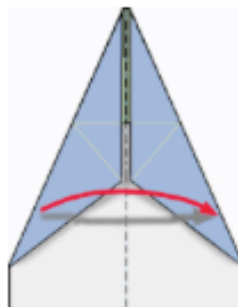
Step 1



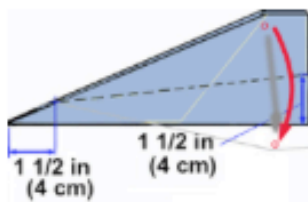
Step 2



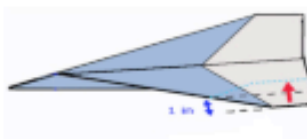
Step 3



Step 4



Step 5



Step 6

Step 1.
Use a sheet of 8 1/2-by-11 inch paper. Fold the paper in half lengthwise and run thumbnail along the fold to create it sharply. Now, unfold the paper.

Step 2
Fold down the top corners as indicated by the arrows.

Step 3
Fold the two edges toward the center line, as indicated.

Step 4.
Make a valley fold in half. Turn the plane 90 degrees as shown in figure of Step 5.

Step 5
Create a wing crease that begins at the nose as shown.

Step 6.
Form 3-dimensional shape as shown in figure. The Basic Dart is complete. Bend up the tailing edge of the wings for lift if it has a tendency to nose-dive.

Name _____

Date _____

Period ____

Constructing a Graph from Data

1. Label the x-axis and y-axis.

- The x-axis shows the manipulated variable (also known as the “independent variable”, it’s the one that you control, change, or compare).
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2. Determine the **range** of each axis.

- How high do the numbers go? The values on each axis of the graph must include all of the data collected.

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- How much is each square on the graph worth? *Each square should represent the same amount.*
- *The scale you should use depends on your range, and how much space you have on your graph.* For example, if your graph needs to go up to 50, and you only have 10 squares, then each square should represent 5 units (0, 5, 10, 15, and so on...). If your graph needs to go up to 50, and you have 25 squares, you can count by 2s (0, 2, 4, 6, etc....). If your graph needs to go up to 50, and you have 50 squares, then you can make each square worth 1 (0, 1, 2, 3...)

4. Plot the points.

5. Finally, communicate how the data is related.

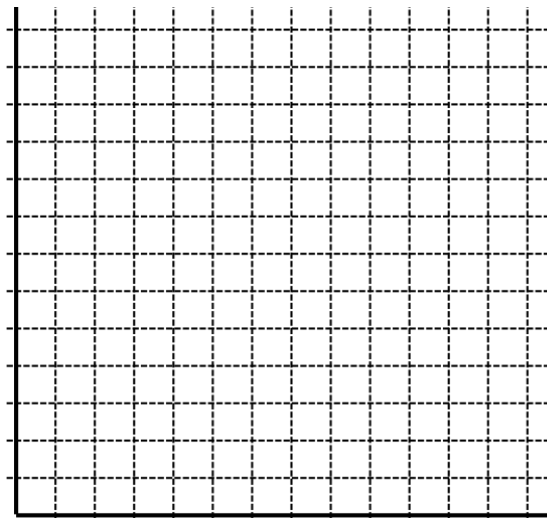
Sometimes you will **connect the dots**, for example, with change over time. On other graphs, you may need to **draw a “line of best fit”** which shows the trend as a line that goes smoothly through where the plotted points lie. And in other cases, you may just **draw a bar** that goes up to each point, comparing different categories.

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### I. Label the x-axis with the independent variable, and the y-axis with the dependent variable. You do NOT need to create the scale or plot the points.

1. What amount of water will produce the tallest bean plant?

| Amount of water per day | Height of the bean plant |
|-------------------------|--------------------------|
| 0 mL                    | 0.4 cm                   |
| 5 mL                    | 1.3 cm                   |
| 10 mL                   | 1.6 cm                   |
| 15 mL                   | 3.1 cm                   |
| 20 mL                   | 6.8 cm                   |
| 25 mL                   | 5.4 cm                   |
| 30 mL                   | 5.6 cm                   |



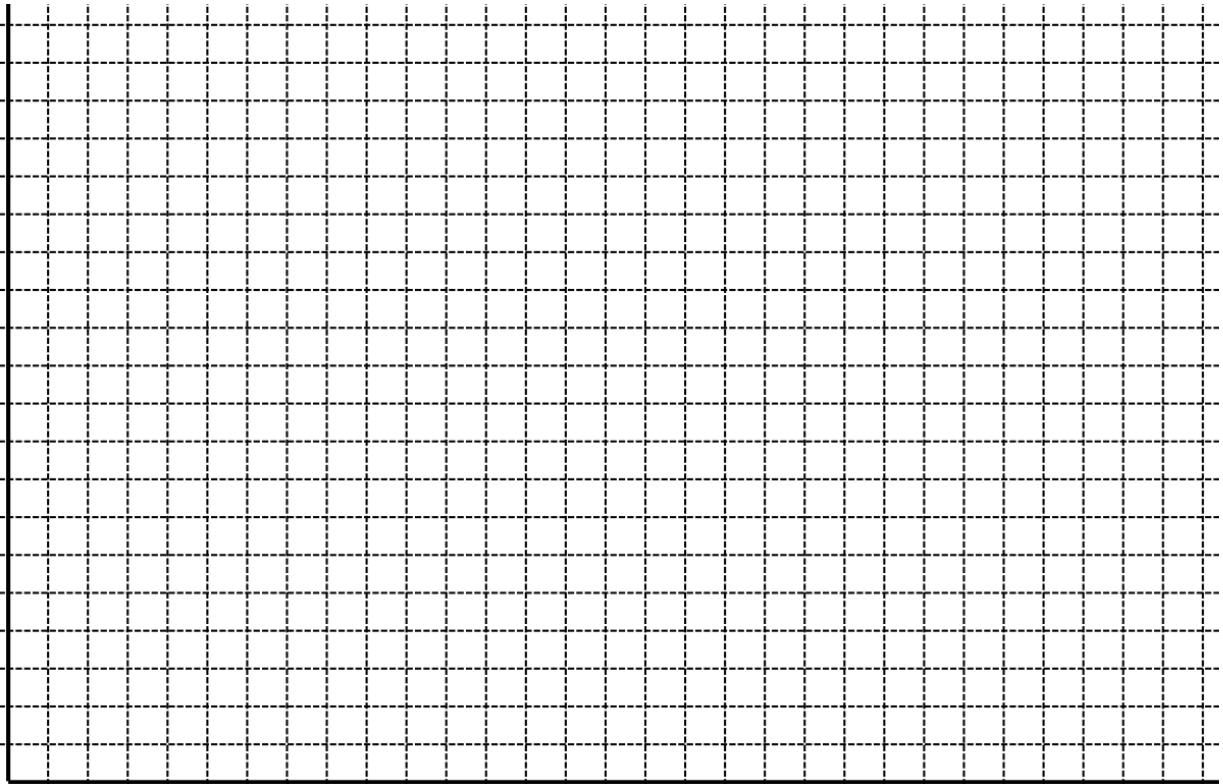
A student wanted to test how the length of a string affected how it swings. Each time, the student changed the length of the string, and counted how many times it would swing back and forth. Their data is shown in the table to the right.

| Length of string | Number of swings per minute |
|------------------|-----------------------------|
| 0.6 m            | 36                          |
| 0.8 m            | 32                          |
| 1.0 m            | 28                          |
| 1.2 m            | 26                          |
| 1.4 m            | 24                          |
| 1.6 m            | 24                          |
| 1.8 m            | 20                          |
| 2.0 m            | 20                          |

**Construct a graph from this data.**

Remember, before you can plot points, set up your graph!

1. Manipulated variable on the x-axis, responding variable on the y-axis.
2. Identify the range of your data: How high do the numbers need to go?
3. Determine the scale of your graph: How much should each square represent?



Name \_\_\_\_\_

Date \_\_\_\_\_

Period \_\_\_\_\_

## Constructing a Graph

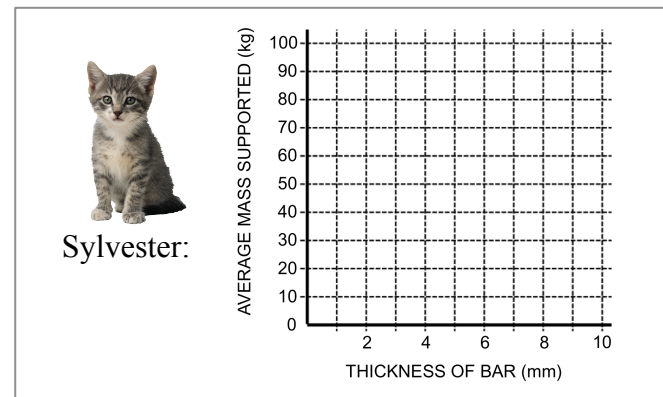
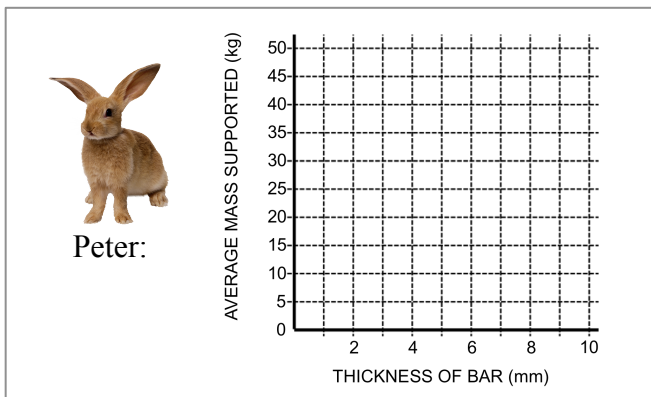
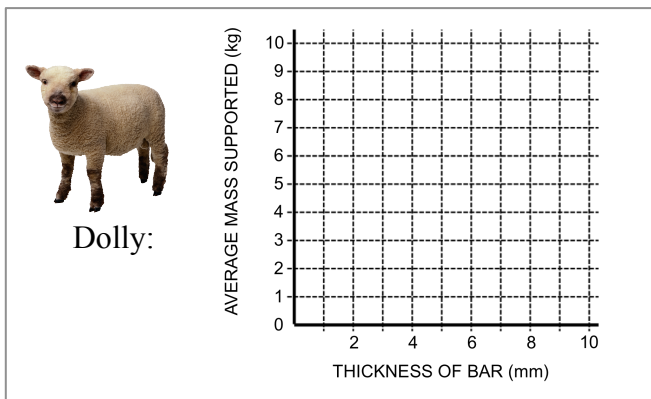
...a warm-up probe

Mayra has just completed her experiment to see how much mass a wooden bar can support. Here is the data she collected:

| Thickness of the bar | Average amount of mass supported |
|----------------------|----------------------------------|
| 2 mm                 | 8 kg                             |
| 4 mm                 | 20 kg                            |
| 6 mm                 | 31 kg                            |
| 8 mm                 | 45 kg                            |
| 10 mm                | 68 kg                            |



Now she wants to make a graph for the data she's collected, but she's not sure how to set it up. Mayra asks her lab partners, and gets these suggestions:



Whose advice should she follow? \_\_\_\_\_

Explain why you chose that answer: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

