LETTER TO PARENTS

Cut here and paste onto school letterhead before making copies.

Science News

Dear Parents,

Our class is beginning a new science unit, the **FOSS Variables Module**. We will be learning how scientists use critical thinking, careful observation, and measurement to conduct experiments.

The big ideas in this module are *system* and *variable.* Any collection of objects that is working together we identify as a system. The systems your child will be using in this module are pendulums, boats, windup airplanes, and little catapult systems called flippers. In each system the interacting parts influence how the whole system behaves or performs. If the parts of the system can change, those parts are called variables. An understanding of the idea of a variable and the ability to identify and control variables are the cornerstone of scientific experimentation.

Here's an example. The pendulum students use is made from a piece of string, a paper clip, a penny, a bit of tape, and a pencil. When hung from the pencil and put into motion, the penny, held by the string and paper clip, swings back and forth. The number of swings can be counted, and that number is the outcome of our experiment. The length of the string can vary, as can the mass of the system, the point from which the penny is released, and the length of time the swings are counted. Which variables influence the number of swings? And how does the answer to that question help us get a slow grandfather clock to run on time? That's one of the challenges we will be tackling in this **Variables Module.**

Your child may bring home one or more sheets called home/school connections. On them you will find suggestions for activities you can do at home with the whole family. They will give you a glimpse into the kinds of investigations we will be undertaking in our classroom. If you have any questions or comments, call or come in and visit our class.

Comments ____

VARIABLES JOURNAL

Name ______________________________

Name ______________________________

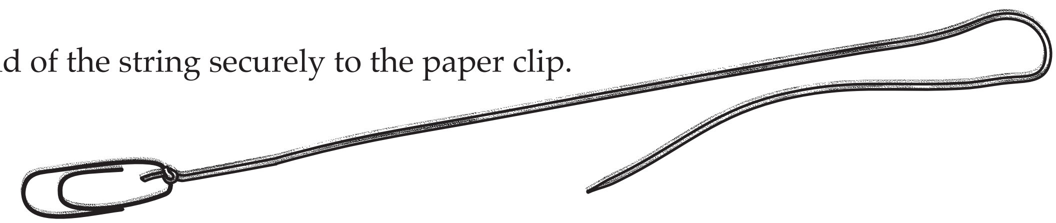
Date ______________________________

HOW TO BUILD A SWINGER

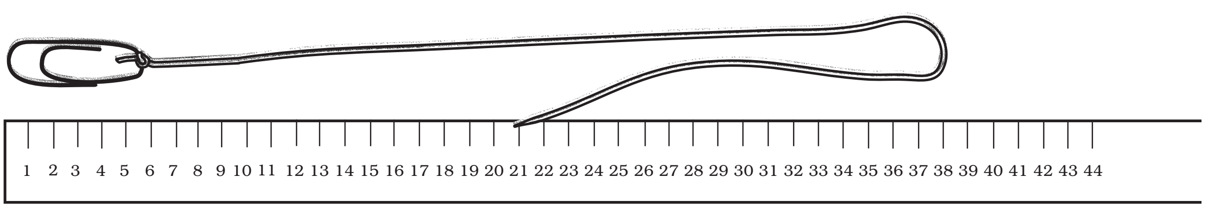
MATERIALS

- 1 String, about 50 cm long
- 1 Paper clip
- • Masking tape
- 1 Meter tape
- 1 Penny

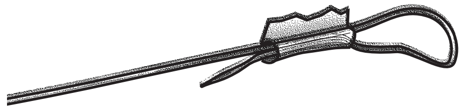
1. Tie one end of the string securely to the paper clip.



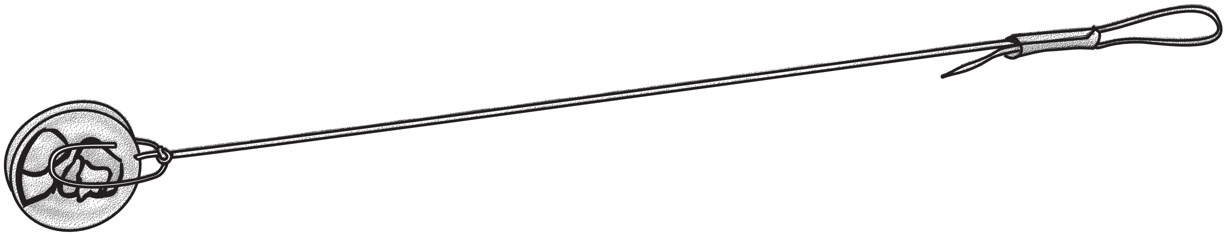
2. Measure exactly 38 cm from the tip of the paper clip along the string. Fold the string back at exactly the 38-cm mark.



3. Put a tiny piece of masking tape around the string to make a loop. The loop should be large enough to hang over a pencil. Remeasure to make sure the swinger is 38 cm from the tip of the paper clip to the top of the loop.



4. Clip a penny in the paper clip. You have made a swinger.



SWINGERS NUMBER LINE

5 6 7 8 9 10 11

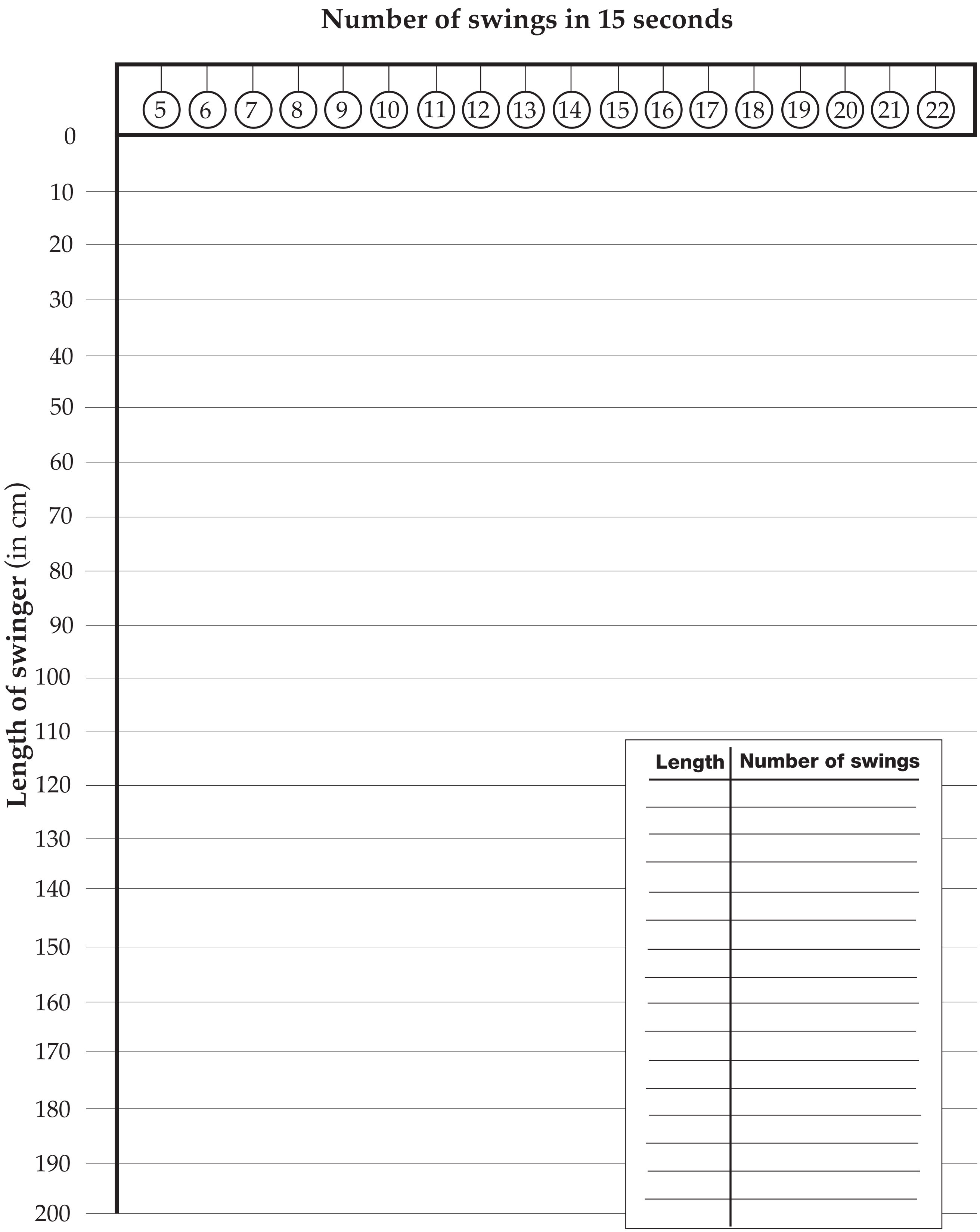
12 13 14 15 16 17 18

19 20 21 22 23 24 25

Name ______________________

Date ______________________

SWINGERS PICTURE GRAPH

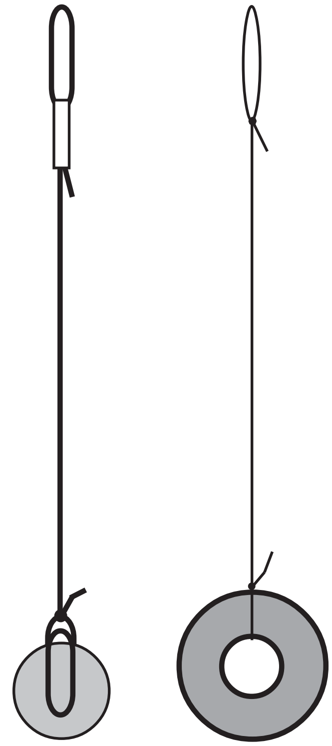


Name ____________________

Date ____________________

RESPONSE SHEET—SWINGERS

A student wanted to know what would happen in the swinger experiment if he changed the way he made the pendulum. Instead of using string he used fishing line to make his pendulum the standard 38 cm long. He used a washer at the end for the pendulum bob. Then he counted how many times his pendulum swung back and forth in 15 seconds.



Do you think he has done a good job of controlling the variables? Why or why not?

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What do you think he will find out when he swings the pendulum for 15 seconds?

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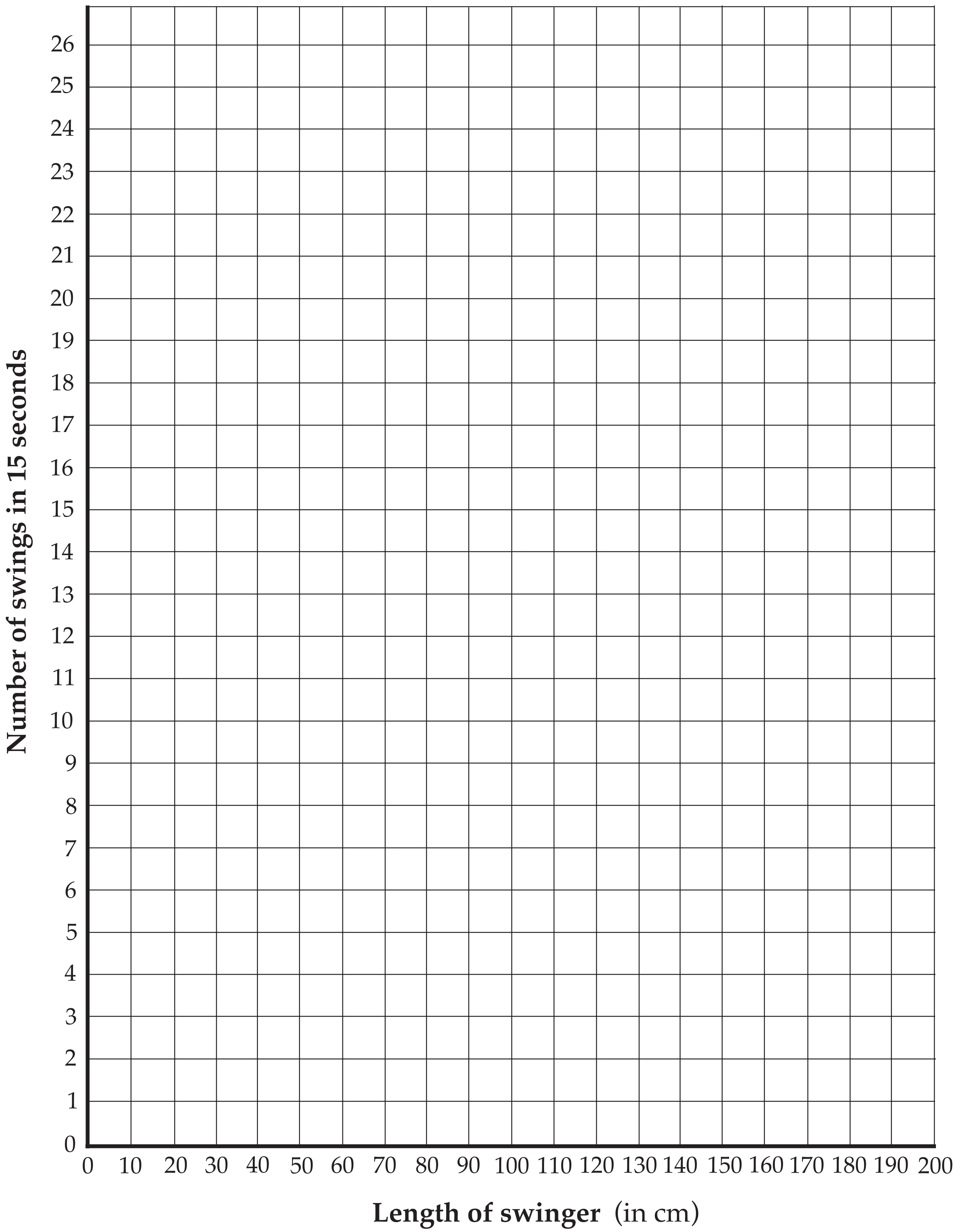
Name ____________________

Date ____________________

SWINGERS TWO-COORDINATE GRAPH



Name ____________________

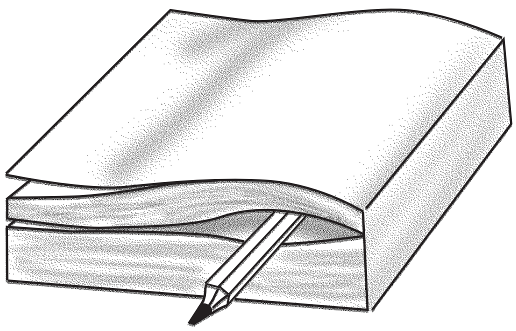
Date ____________________

BOAT BUILDING

MATERIALS

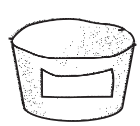
1 Cup
1 Book
1 Pencil or pen
1 Meter tape
1 Scissors

1. Place a pencil in a book so that the point sticks out. The point should be *exactly 3 cm* above the tabletop.



2. Bring a cup up to the point of the pencil. Rotate the cup to draw a line all the way around, 3 cm from the base.

3. Carefully cut the cup on the line.



Name ______________________________

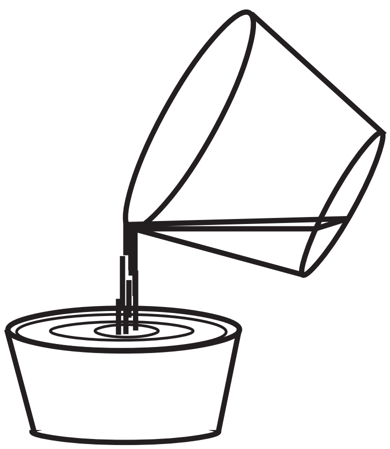
Date ______________________________

MEASURING LIFEBOAT CAPACITY

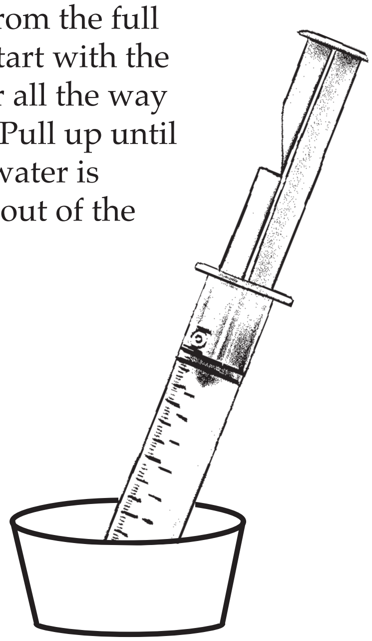
MATERIALS

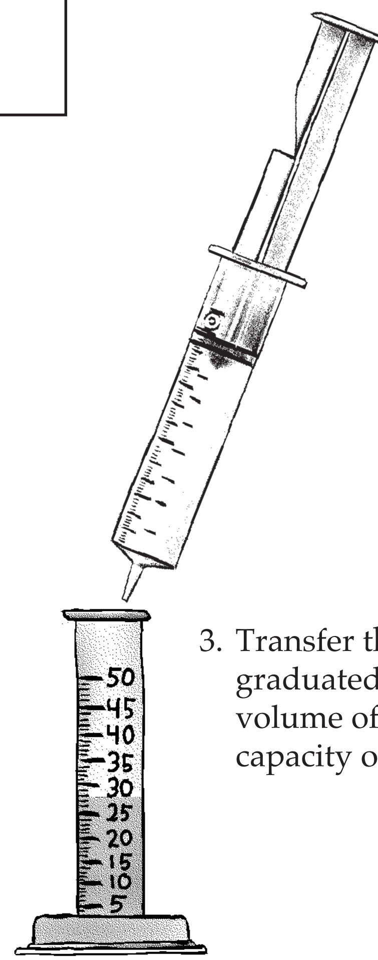
1 Plastic cup of water
1 Graduated cylinder
1 Syringe, 50-ml

1. Fill the boat to capacity with water.



2. Use the syringe to carefully withdraw water from the full boat. Start with the plunger all the way down. Pull up until all the water is sucked out of the boat.





3. Transfer the water to the graduated cylinder. The volume of water is the capacity of the boat.

4. If the boat is larger than 50 ml, suck up 50 ml of water from the boat and return it to the water supply. Then suck up the rest of the water and measure it in the graduated cylinder. The capacity of your boat is the volume of water in the cylinder plus 50 ml.

Name ____________________

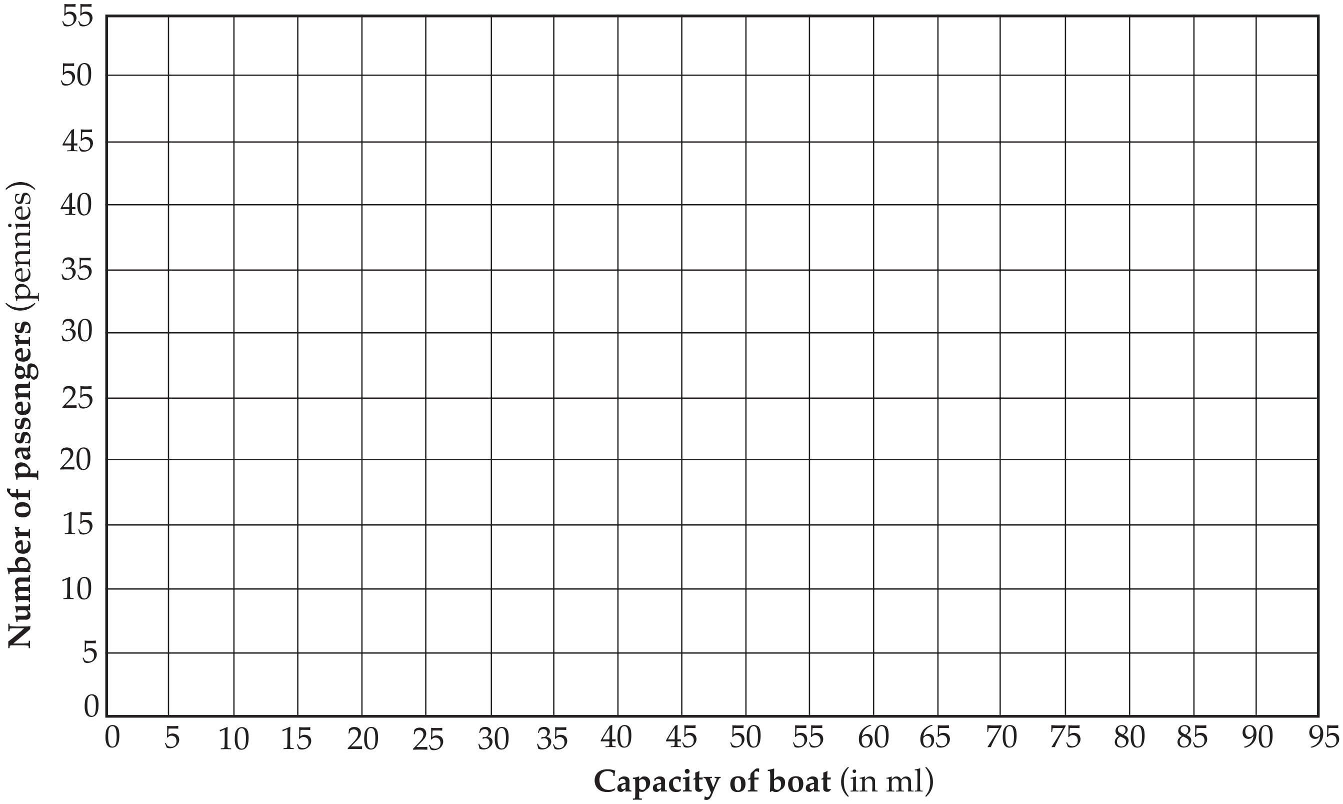
Date ____________________

LIFEBOAT INSPECTION

PART 1. Fill in the names and capacities of your fleet of boats in the chart below.

Boat	Boat name	Capacity (ml)	Passengers supported
1			
2			
3			
4			

PART 2. Graph the results of your lifeboat investigations.



PART 3. Fill in the names and capacities of the borrowed boats in the chart below.

Boat	Boat name	Capacity (ml)	Passengers supported	
			Predicted	Counted
1				
2				
3				
4				

Name ______________________________

Date ______________________________

RESPONSE SHEET—LIFEBOATS

Billy forgot to eat his ice cream while he was watching television, and it melted. He thought the ice cream melted because it was in the light. Billy decided to do an experiment to find out. Here's what he did.

As soon as it got dark, Billy put one scoop of chocolate chip ice cream into two identical bowls. He put one bowl outside where it was dark and put the other in the kitchen where a light would shine all night. Billy got up at dawn and discovered that the ice cream outside was still solid but the ice cream in the kitchen had melted.

"Aha," said Billy, "light makes ice cream melt!"

Do you think Billy's experiment was good? Explain why or why not.

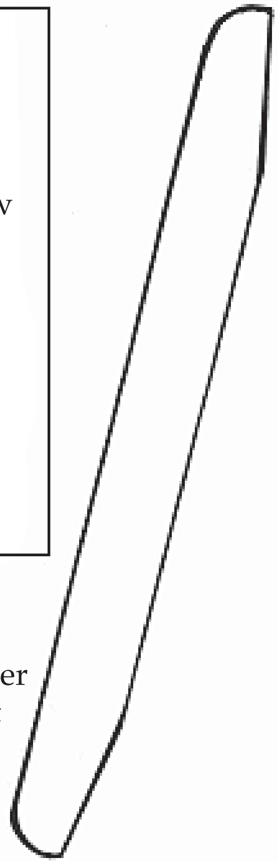
Name ______________________________

Date ______________________________

FOSS PLANE CONSTRUCTION

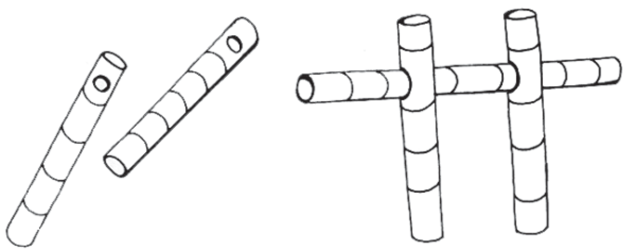
MATERIALS

- 1 Propeller
- 1 Hook
- 1 Jumbo straw
- 1 Super jumbo straw
- 1 Rubber band, #33
- 2 Craft sticks
- 1 Hole punch
- 1 Scissors
- 1 Stapler
- 1 Sandpaper piece

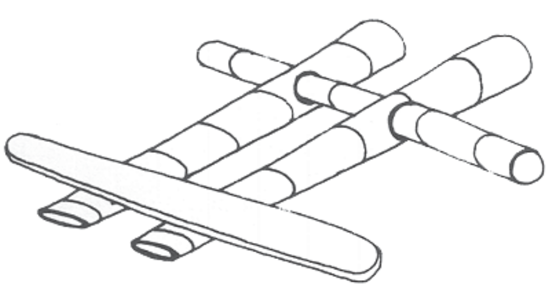


1. Use sandpaper to taper *both ends* of both craft sticks on *one side*. They should fit in this outline.

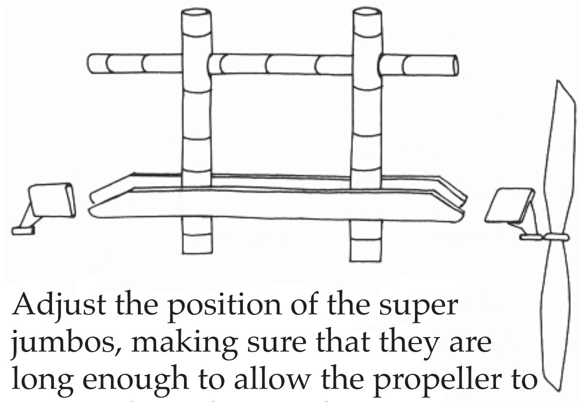
2. Cut the *super jumbo* straw in half. Punch one hole in each half near the end. Slide the *jumbo* straw through the holes.



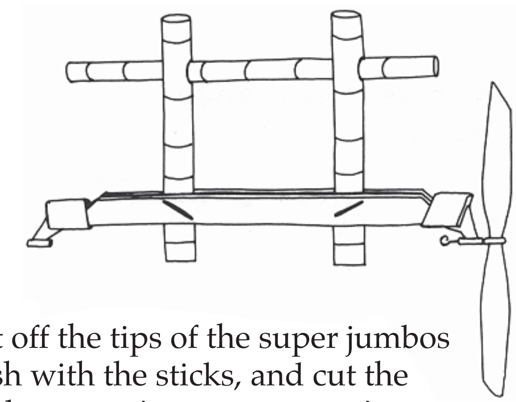
3. Flatten the free ends of both super jumbo straws. Use a craft stick.



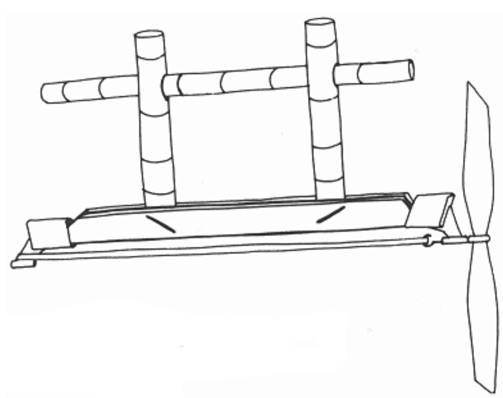
4. Trap the flattened ends of the two super jumbos between the two tapered craft sticks. Make sure the tapered edge is up. Slide the propeller on one end and the hook on the other.



5. Adjust the position of the super jumbos, making sure that they are long enough to allow the propeller to turn without hitting the jumbo-straw crosspiece. Staple through the sticks and the super jumbo straws.



6. Cut off the tips of the super jumbos flush with the sticks, and cut the jumbo crosspiece to a convenient length. Attach the rubber band between the prop and hook, and FLY!



Name ______________________

Date ______________________

FLIGHT LOG

PART 1

Our FOSS plane is called ______________________

Our flight line is ____________ centimeters long.

Our plane needs ____________ winds of the propeller to fly the length of the line.

PART 2

We guess that our plane will need __________ winds to fly halfway down the line.

We discovered that our plane needs ____________ winds to fly halfway down the line.

If your guess was different from your measured result, explain why.

____

____

PART 3

Additional variables that we think might affect the flight of our FOSS plane.

______________________ ______________________

______________________ ______________________

______________________ ______________________

PART 4. Your next task is to select one variable and test it to see how it affects the performance of your plane.

The variable we will investigate is ______________________

The standard number of winds we will use is ______________________

The outcome we will measure is ______________________

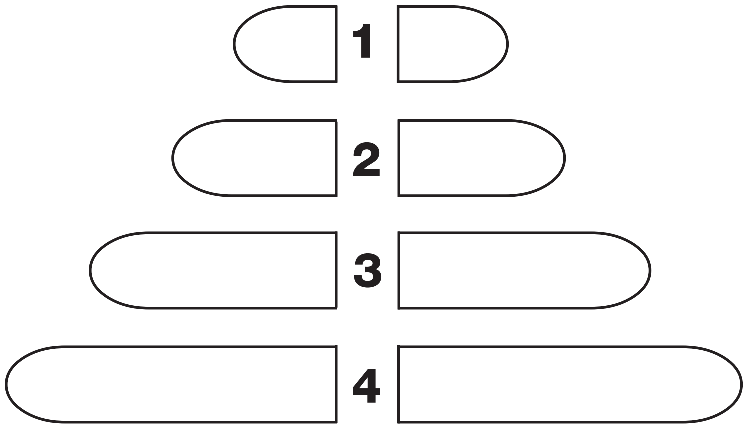
Run a few test flights to see if your plan will result in a good experiment.

Name ______________________________

Date ______________________________

RESPONSE SHEET—PLANE SENSE

A student wanted to test her FOSS plane to find out if wings would help her plane fly the length of the flight line any faster. She constructed four sets of wings. Each had the same shape, the same width, and a different length.



She started by setting up a flight line and putting 60 winds on the propeller of her plane. She got a stopwatch and timed how long it took the plane to fly from one end of the flight line to the other without any wings.

What should she do next to complete her experiment and report her findings to her class?

Name ______________________________

Date ______________________________

DESIGN AN EXPERIMENT: PLANE SENSE

Describe your standard plane system.

Slope of the flight line ______________________________

Power supply (rubber bands) ______________________________

Number of winds on the power supply ______________________________

Number of passengers (paper clips) ______________________________

Our standard plane flies __________ centimeters along the flight line.

Our experimental variable is ______________________________

The increment we will use to change the experimental variable is ______________

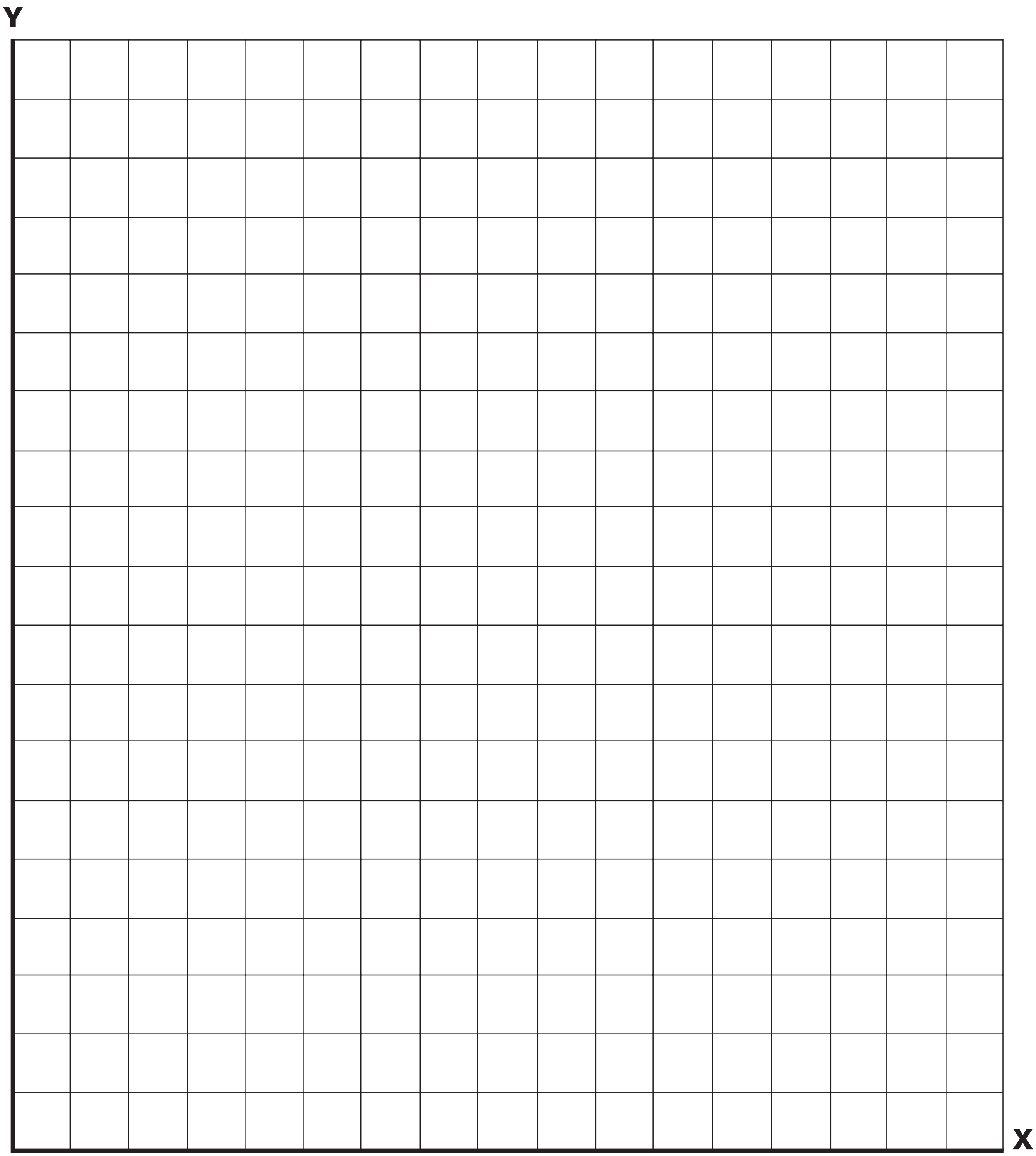
NOTE: Incremental changes are changes that are all the same size. For example, an incremental change for the experimental variable of passengers could be to add 1 passenger for each test: 0 passengers, 1 passenger, 2 passengers, 3 passengers, and so forth. Or the incremental change could be 2 passengers: 0 passengers, 2 passengers, 4 passengers, and so forth.

Experimental test	Experimental variable (list increments)	Outcome (distance)
Test 1 (standard)		
Test 2		
Test 3		
Test 4		

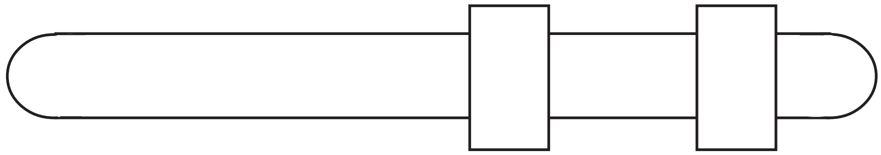
Name ____________________________________

Date_____________________________________

TWO-COORDINATE GRAPH

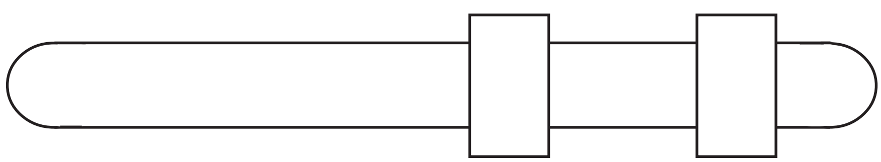


FLIP-STICK CONSTRUCTION



MATERIALS	ASSEMBLY PROCEDURE
1 Craft stick 2 Short pieces of stick • White glue	1. Lay a craft stick on the diagram above. 2. Glue two short wooden crosspieces to the craft stick in the locations indicated. 3. Use only enough glue to do the job. 4. Let the stick dry overnight.

FLIP-STICK CONSTRUCTION

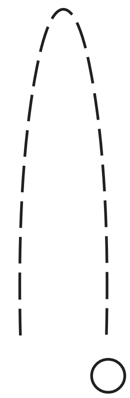


MATERIALS	ASSEMBLY PROCEDURE
1 Craft stick 2 Short pieces of stick • White glue	1. Lay a craft stick on the diagram above. 2. Glue two short wooden crosspieces to the craft stick in the locations indicated. 3. Use only enough glue to do the job. 4. Let the stick dry overnight.

Name ____________________

Date ____________________

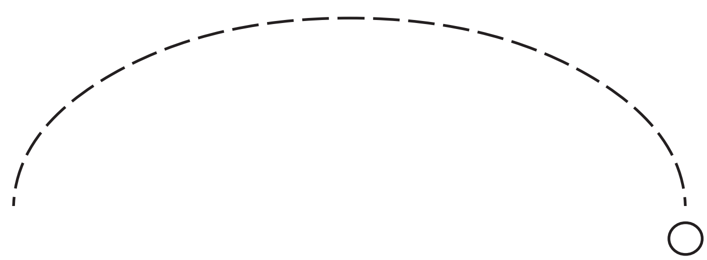
FLIPPING ALUMINUM BALLS



PART 1. How high can you flip?

Describe the flipper system that resulted in the highest flip.

Discuss all of the variables.



PART 2. How far can you flip?

Record the following information in your journal:

- Describe the flipper system that resulted in the longest flip.
- List your variables and how you plan to control them.
- Set some standards (where you will measure from, etc.)
- How will you collect and record your data?

Describe the system that resulted in the longest flip.

Name ______________________________

Date ______________________________

RESPONSE SHEET—FLIPPERS

A student was interested in studying how a lifeboat's shape affects its ability to carry passengers.

Boat	Size of aluminum foil before shaping into a boat	Shape of boat	Passengers needed to sink the boat
1	10 cm x 30 cm	rectangular	23 passengers
2	10 cm x 30 cm	oval	24 passengers
3	20 cm x 30 cm	square	32 passengers
4	20 cm x 30 cm	triangular	31 passengers

Do you think she designed a controlled experiment? Why or why not?

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What would you do the same and what would you do differently?

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Name ___________________________

Date ___________________________

DESIGN AN EXPERIMENT: FLIPPERS

PART 1. Describe the standard launch setup.

What is the angle of launch? ___________________________

What is being launched? ___________________________

Where is the object placed? ___________________________

How far out is the flip stick? ___________________________

How far is the flip stick pressed down? ___________________________

PART 2. Draw a picture of your standard launch setup.

PART 3. Set up your flipper experiment.

Our experimental variable is ___________________________

We expect to find out ___________________________

____

How the variable will change	Trial number				Result
	1	2	3	4	

Name ______________________________

Date ______________________________

PROJECT IDEAS

- Design controlled experiments to find out how a variable affects the quality of a product. Here are a few starters.
    - best size of tire for a race car
    - most-absorbent paper towel
    - longest-burning candle
    - best recipe for lemonade
    - most effective insulating material
    - best fabric for a raincoat
    - best way to heat water with solar energy
- Double pendulums provide lots of interesting variables to investigate. Find out how changing the release heights, which pendulum is released, adding masses to one pendulum and not the other, or other possibilities affect the outcome.
    - Make a double-decker pendulum by attaching a pendulum to the paper clip of another pendulum.
    - Hang two equal pendulums next to each other and link them with a soda straw that has been split at each end.
- Investigate stringless pendulums. Compare pendulums that are made from a variety of rigid materials, such as sticks, straws, paper clips, or wire. Compare these pendulums without adding masses such as pennies.
- Does the kind of liquid a boat floats in have an effect on the number of passengers it can support? Investigate the effect of heavily salted water or any other safe liquid.
- Conduct controlled experiments to investigate the variables that affect the use of any of the following toys: windup car, toy parachute, Frisbee, yo-yo, bicycle, skateboard, paper airplane, cassette player, football, and others.
- Make balloon rockets. Tape a soda straw to one edge of a plastic bag (a 1-liter zip bag is a good size) suspended from a flight line. Blow up a long balloon and put it into the bag while holding the balloon shut. When you release the balloon, the rocket will shoot down the line. Conduct controlled experiments to investigate the variables that might affect the length of flight.
- Investigate compensating variables in a flip-stick system. Set up a target, such as a cup, and launch a foil ball so that it hits the target. Then change one of the variables and hit the target again. In order to do so you will have to compensate for the changed variable by changing one or more other variables.
- Make a coin sorter, using a flipper system. Position 1/2-liter containers at strategic locations so that, when any coin is flipped, it will land in the container with the other coins of its kind.

Name ____________________

Date ____________________

PROJECT PROPOSAL

1. What is the question or the project that you are proposing?

2. What materials or references will you need to complete the project?

3. What steps will you follow to complete the project?

Name ______________________________

Date ______________________________

PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
- What materials or references did you need to do your project?
- What procedure did you follow to complete your project?
- What did you learn from doing your project?

When you begin speaking, you will see the *green card* held up for 2 1/2 minutes. When you see the *yellow card,* you have 30 seconds left. When you see the *red card,* it means you can finish your sentence, but you must stop within the next few seconds.

Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

Name ______________________________

Date ______________________________

PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
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Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

Name ____________________________________

Date ____________________________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 1: SWINGERS

Eight teams of students were experimenting with pendulums to find out how they work. Each team made a swinger of a different length. Their teacher asked them to find out how many times their pendulum would swing. What the teacher forgot to tell the students was how long to count the swings. Below is the data collected by the eight teams. From this information, can you put the pendulums in order from shortest to longest?

Team number	Number of swings	Length of time
1	9	20 s
2	11	12 s
3	9	15 s
4	36	30 s
5	10	10 s
6	10	15 s
7	8	20 s
8	10	12 s

Put the pendulums in order from shortest to longest by team number.

Shortest ____________

____

____

____

____

____

____

Longest ____________

Name ___________________________________

Date ___________________________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 2: LIFEBOATS

The bicycle club at Downhill School goes on bicycle trips that often require bicycle lights. Batteries are a constant concern, as the club does not have a lot of money in the treasury. The students decided to do some quality testing on three brands of batteries. The table shows the results of their experiments.

Battery Investigation

Brand	Cost	Length of service per battery
Brand A	$1.44 each	12 hours
Brand B	$2.40 for two	12 hours
Brand C	$3.52 for four	8 hours

Rickie's bike light uses *one battery* at a time. Using the data above, answer the following questions. (NOTE: Batteries in packages cannot be purchased separately.)

1. Rickie sometimes goes on weekend bike trips. He expects to use his light for about 8 hours each time he goes on a trip. Which brand should he buy in order to spend *the least money,* if he is buying batteries for

one weekend trip? ___________________________________

two weekend trips?___________________________________

three weekend trips?___________________________________

four weekend trips? ___________________________________

ten weekend trips? ___________________________________

2. On one of the trips, his bike club plans to visit a cave. They expect to use flashlights in the cave for about 2 hours. The flashlights each require *two batteries.* There are 22 members in the bike club, and each would like to use a flashlight. Rickie has $40.00 to buy the batteries. Does he have enough money to get batteries for all 22 flashlights? If so, how much money will he have left over? If not, how much more does he need to get the batteries?

Name ___________________________________

Date ___________________________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 3: PLANE SENSE

Reggie spills 10,000 ml of water over the course of a year. He needs a lot of paper towels. So he tested some paper towels. Here are the variables Reggie tested and the data he collected. Can you help Reggie with the questions below?

Brand	Volume of liquid absorbed by one towel	Number of towels per roll	Cost of roll
Brand P	25 ml	60	$1.50
Brand Q	16 ml	78	$0.90
Brand R	20 ml	72	$1.10

1. Which brand should he buy to use the *fewest towels?*
   a. How many towels will he need? ______________________________
   b. How many rolls will he have to buy? ______________________________
   c. How much will it cost him? ______________________________
2. Which brand should he buy to spend the *least money?*
   a. How many towels will he need? ______________________________
   b. How many rolls should he buy? ______________________________
   c. How much will it cost him? ______________________________
3. Which roll of towels soaks up the most water? ____________ How much? ________________
4. Which brand is the best bargain? In other words, which brand gives you the most soak power for your money? ________________ What is your evidence? ________________

   ____

   ____

   ____

Name ____________________

Date ____________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 4: FLIPPERS

Using the FOSS website, two teams of students decided to collaborate on a project for the **Variables Module.** They designed a controlled experiment to investigate how far a skateboard will roll across flat ground when released at the top of a 2-meter slope. The angle of the slope could be changed incrementally to conduct additional experiments. This is what the experimental setup looked like.

The two classrooms conducted the same sets of experiments and compared results. The Texas classroom conducted four trials at each angle; the Connecticut class conducted three trials. Help them analyze the results of their experiment. Here are the distances they measured.

TEXAS

Angles	10°	20°	40°	50°
Distances	105 cm	270 cm	530 cm	610 cm
	370 cm	310 cm	490 cm	550 cm
	210 cm	250 cm	540 cm	630 cm
	185 cm	340 cm	460 cm	580 cm

CONNECTICUT

Angles	10°	20°	40°	50°
Distances	75 cm	280 cm	480 cm	625 cm
	240 cm	360 cm	570 cm	710 cm
	230 cm	310 cm	490 cm	600 cm

- What is the average distance the Texas team's board traveled at each angle? Plot the results of the Texas team's experiments on a two-coordinate graph.
- Average the distances from both teams' results added together. Graph the averages. What happens to the graph?
- If your class did the same experiment but launched your skateboard at a 30° angle, how far do you predict the board would travel?

Name ____________________________________

Date ____________________________________

HOME/SCHOOL CONNECTION

INVESTIGATION 1: SWINGERS

There was a time when pendulums played an important role in everyday life as time regulators. The predictable swinging of the pendulum, when linked to the hands of a clock, kept the world on time. Now pendulum clocks are historical curiosities for the most part. Some clock fanciers still have a cuckoo clock, school clock, or grandfather clock as an interesting reminder of a time past.

MAKE A PENDULUM SECOND TIMER

You can make a second timer at home with a mass, like a fishing weight or a big washer, and some string or thread. Strive to get it as accurate as possible. Fine tune it until you can call 15 seconds at the same time another family member sees the second hand on a clock hit 15 seconds.

MAKE A MINUTE TIMER

This might be a little more demanding, as pendulums tend to lose energy (because of friction at the pivot and air resistance) as they swing. What variables can you increase to improve your chances of making the pendulum swing for a minute?

RIDE THE PENDULUM

What's a playground swing but a big pendulum you can ride? Can you guess how many cycles (complete swings back and forth) a swing will make in 30 seconds? Will longer swings complete more or fewer cycles in 30 seconds? Take a ride and find out.

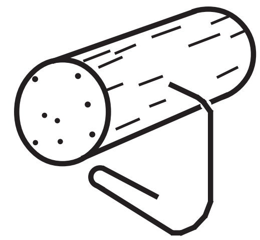
Name ______________________________

Date ______________________________

HOME/SCHOOL CONNECTION

INVESTIGATION 2: LIFEBOATS

Who can get the most passengers on a raft? Try it with a cork and a bunch of paper clips. Open one paper clip so it makes a hook and stick it into the cork. Additional paper clips can be hung on the hook as passengers. Place the raft in a basin or sink of water. Take turns loading the raft with passengers. Who can get the most passengers on before the raft turns into a submarine?



Now for something a little different. Who can get the most passengers into an aluminum-foil boat before it sinks? Each competitor gets an identical piece of aluminum foil, perhaps 10 cm square. After crafting a boat, each person should take a turn loading his or her boat with passengers. Pennies make good passengers for these boats.

Whose design supported the greatest number of passengers? Unlike corks, which have one design, boats can have lots of different designs. The variables of surface area, depth, and displacement affect the number of passengers. And to have a fair test of the various boat designs, discuss the variables that will be controlled (kept the same) for all the boats, such as everyone uses the same size of aluminum foil, passengers are the same, and so forth.

Draw a picture of the most effective design. Does it look at all like a real boat? If not, why not? What are real boats expected to do that aluminum models are not?

Name ____________________

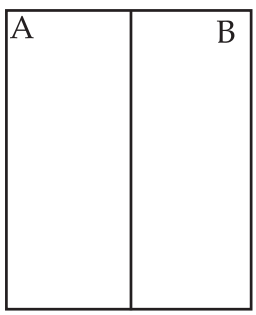
Date ____________________

HOME/SCHOOL CONNECTION

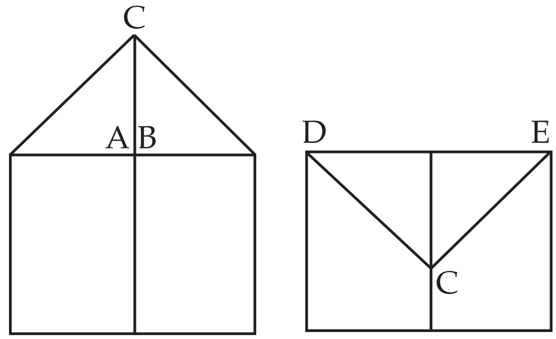
INVESTIGATION 3: PLANE SENSE

What makes a paper airplane fly straight? Do loops? Fly in a circle and come back to you? A number of variables affect the flight of a paper airplane. Here's a model that lends itself to fiddling with the variables.

Step 1

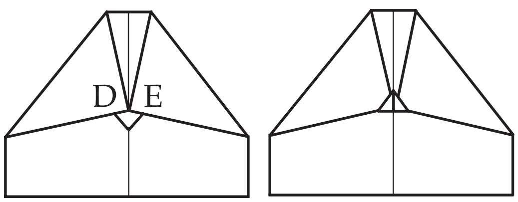


Step 2

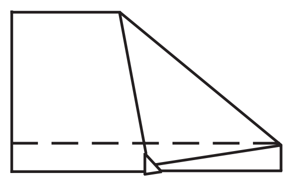


1. Fold a standard sheet of paper down the middle to create a midline.
2. Fold corners *A* and *B* to the midline, then point *C* down to the midline.

Step 3

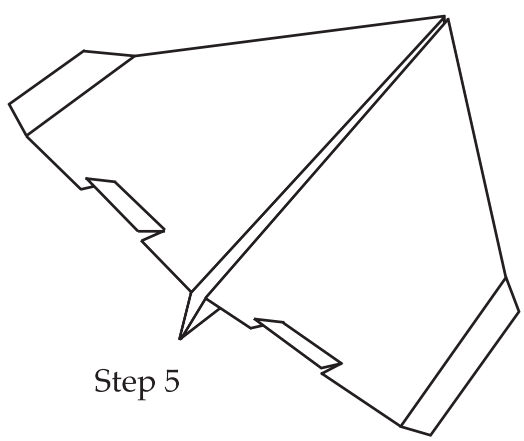


Step 4



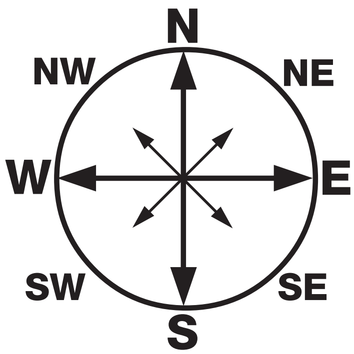
3. Fold points *D* and *E* to the midline, and then fold the little point up to hold points *D* and *E* down.
4. Fold the plane in half on the midline. Fold the wings down on the dashed line.
5. Make two primary modifications. Turn the last 1 cm of the wing up at an angle to create stabilizers, and cut a couple of flaps on the trailing edges of the wings.

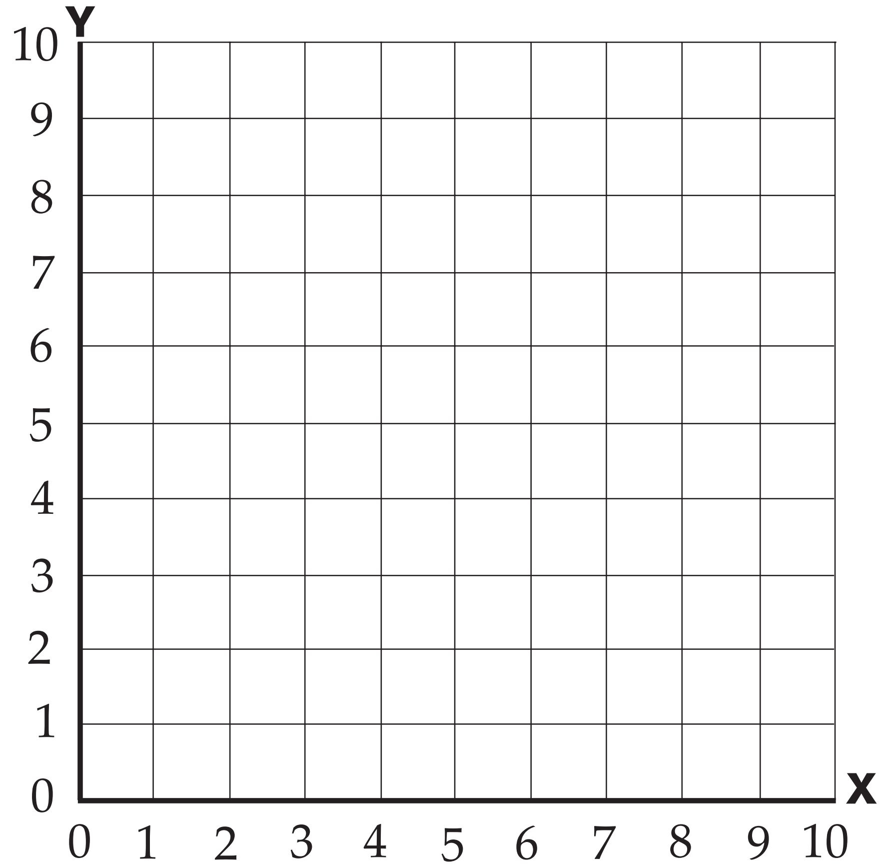
That's it. Now work with the variables to get the plane to do a number of tricks. After you master the variables, try some new ones. What happens to the plane if you make it half scale? Make it out of thinner paper, like magazine paper or newspaper? Can you make an aluminum-foil plane? Let your imagination be your guide into uncharted variable territory.

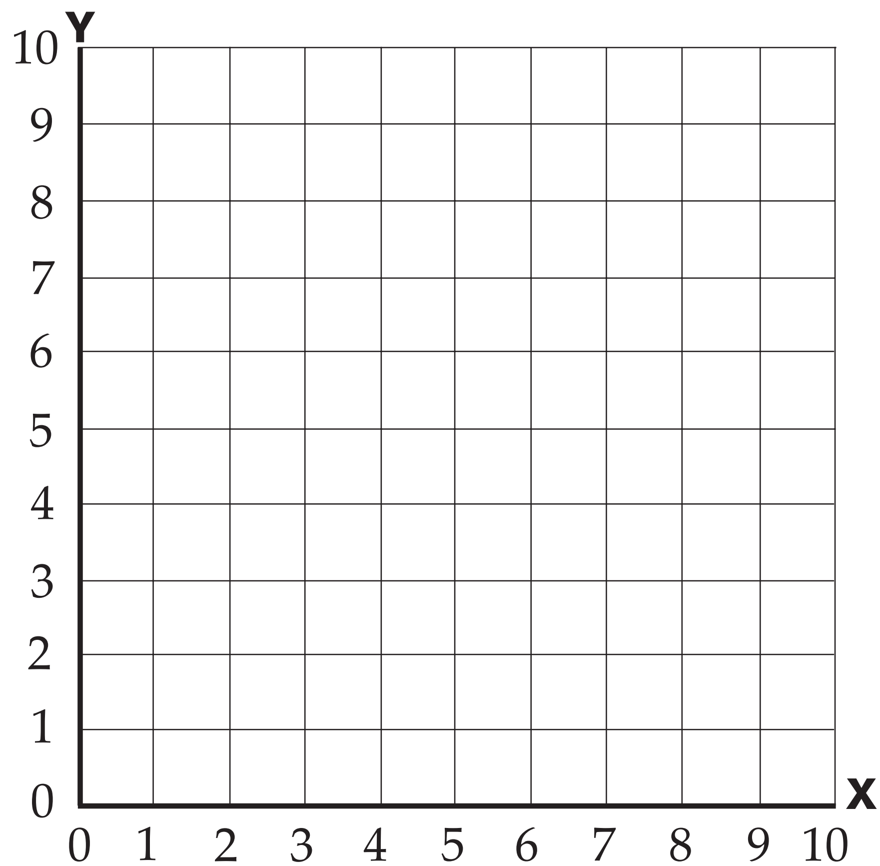


Step 5

HURKLE GRID







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