Students will explore forces. Students will design ways to push and pull objects. Students will record and analyze data to decide if design solutions work.

Student Science Performance

Grade or course: 2nd Grade	**Title:**
Topic: Forces	Forces at Work

Performance Expectation for GSE:

S2P2. Obtain, evaluate, and communicate information to explain the effect of a force (a push or a pull) in the movement of an object (changes in speed and direction).

a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object.
b. Design a device to change the speed or direction of an object.
c. Record and analyze data to decide if a design solution works as intended to change the speed or direction of an object with a force (a push or a pull).

Performance Expectations for Instruction:

- Students will plan and carry out an investigation to demonstrate how pushing and pulling an object affects the motion of the object.
- Students will design a device to change the speed or direction of an object.
- Students will record and analyze data about their design solution

Additional notes on student supports

Materials

Sports- sticky notes, sports pictures
Blindfolded Directions- large balls (one for each team of 3-4 students)
Moving Balls- ping pong ball, rubber ball, tape, meter stick/tape (for measuring)
Traveling Beth- meter stick or meter tape, various construction materials (recyclable materials), tape, Beth cutout (see template)
Pig Pen Push- ping pong ball, rubber ball, paper towel roll, paper/plastic cup, tape, ruler, pig and fence cutouts (see handout)
Straws and Surfaces- straws, cotton ball, ping pong ball, soda bottle cap
Cars and Ramps- cars, ramps (commercial or homemade- pool noodles, insulation tubing, paper towel rolls), tape
Marble Paths- clay or soft dough, marbles, paper plates or shoe box lids

Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners	**Phenomenon** Athletes use pushes and pulls during sports games.
	Obtaining **Sports-** The teacher will show pictures of athletes playing various sports. See handout, Sports Photos. Guiding Questions: ● How are the athletes moving the ball or equipment? ● How do the players use various speeds to move the ball or equipment in certain directions? ● What causes the ball to speed up, slow down, or change direction? ● When may a hard push or a soft push be more useful?

	Evaluating **Sports-** Students will discuss in their table groups what forces were at work in each photograph. In small groups, students will label sports pictures as push or pull using sticky notes.
	Communicating **Sports-** In their journals, students will choose a picture to write about. Students will describe how forces work in that sport.
Exploring	*Obtaining* **Blindfolded Directions-** This activity should take place in a large open area such as a gym, or outside field area. Divide students into teams of 3-4. Teams are given a ball and asked to get a ball from a starting point to an ending point by kicking the ball. The first time, students should just focus on moving the ball from the start to the end. After teams have completed this task once, have the teams complete the task again with one team member blindfolded and the other team members giving directions about which way to move the ball. Teams should give accurate directions to their team member to get the ball to the ending point. Students will have to vary the direction of the ball and speed to make it successfully to the ending point. **Moving Balls-** In small groups, students are given two balls of varying weights such as a ping pong ball and a rubber ball. Students should use tape on a table or flat surface to design a straight path that they will move each ball. Paths should be 1 meter in length. Students should test out each ball on the path by pushing the ball. Which ball required a harder push to get to the end? What happens when two balls collide? **Straws and Surfaces-** In groups students will use straws to move objects on different surfaces. Students will record how many blows through the straw it took to get the object to move a meter on each surface. Objects will include a cotton ball, ping pong ball, and water bottle cap. Surfaces include a smooth tabletop, rug/carpet, and grass. Students will chart results on a table (see handout, Straws and Surfaces). **Cars and Ramps-** In groups, students will design a way for a toy car to travel from point A to point B (a length determined by available space 2-4 meters) the fastest. The teacher should use tape to mark off desired points. A and B should flow one direction and C and D should flow the opposite direction. Students will record their results in a chart (see handout- Cars and Ramps). Students will use ramps to move a toy car. Ramps can be made from insulation tubing, pool noodles, paper towel tubing, or commercial toy ramps. Students should record the amount of time in seconds it took for the car to travel from each point. After students have moved the toy car successfully from point A to B, students will design a way to have their car change direction. Students should design a new way for the car to travel from point B to point C. Students should record their results in a chart (see handout- Cars and Ramps).

	Marble Mazes- Students will design a path for a marble to travel. Using paper plates or shoebox lids, students will map out a path with turns to vary the direction of the marble. Students will use clay or soft dough to plan the path. Students will test out their paths by placing their marble and moving the plate back and forth to move the marble through the maze. Students can also push the marble through the path with their fingers and/or hands.
	Communicating **Blindfolded Directions-** Students will communicate accurate directions in the activity to successfully guide the ball to the ending point. **Moving Balls-** Students will discuss with their table groups which ball needed more force to move. Students will discuss the result of two balls colliding. **Straws and Surfaces-** Students will answer guiding questions on their handout or their journals. ● Which object moved the easiest? ● Which surface did the objects move the easiest? ● Which surface was the most difficult to move your objects? ● Why do you think that surface was the most difficult? ● Did the amount of force you applied affect how far the object traveled? ● How did pushing the air through the straw affect the motion of the object? **Cars and Ramps-** Students will communicate their design for their ramps. Students will communicate the amount of time in seconds it took for their car to travel from each point. Students will discuss how they can change the direction of the car. Students will problem solve to change their ramps to change the direction of the cars. **Marble Mazes-** Students will write in their journals about the paths the marble took. How did the marble change direction? Was a new force needed to move the marble when it hit a wall?
	Evaluating **Blindfolded Directions-** Students will evaluate their team's directions. In their journals, students will draw out one of the paths the ball took from the starting point to the ending point. **Moving Balls-** Students will draw a model in their journals of the balls colliding. Students should draw arrows to detail the direction the balls took. Students should fill in the sentence frame. When two balls collide _____. **Straws and Surfaces-** Students will answer the following prompt in their journals. When more force is applied the object _____. The surface the object moved on was important because _____. **Cars and Ramps-** In student journals, students reflect on the different ramps the other groups made and determine what ramp was the most effective at getting the car from each point. Students should then draw the ramp in their journals with any changes they would make to the design.

	Marble Mazes- Students will swap their marble maze with a partner. Students will try their partner's maze and write about the movement of the marble. Students will critique the marble's movements and make suggestions for changing the path.
	Formative Assessment of Student Learning
Explaining Finalizing Model	*Obtaining* **Pig Pen Push-** Students will explore forces as they attempt to get a paper pig to move into a paper fence/pen. Use the template to cut out the pig and assemble by folding on the lines and taping into place. An adult should cut a paper towel tube in half to assemble a ramp. Students should then set up the ramp on top of a paper/plastic cup making sure to tape all materials in place on the table. Students should then tape the fence in place 30cm from the end of the ramp. Have students place the pig at the bottom of the ramp. Students should use tape to mark off starting positions at the top of the ramp and the middle of the ramp. After assembly students should use a ping pong ball and a rubber ball to attempt to get the pig into the pen. Variations of this activity can include changing the surface of the table by placing something that will provide friction. Students can also explore how moving the pig and the fence changes the result. Would changing the height of the ramp make a difference? See handout (Pigs and Fences and Pig Pen Push- student response sheet). For more detailed teacher directions, see the **Pig Pen Push Setup Video**, located in the Teacher Resource Link.
	Communicating **Pig Pen Push-** As students complete the challenge they will communicate with their table about their results. When were you able to successfully get the pig in the pen? How would moving the pig pen affect your results? What caused the pig to move? Students will discuss the distance (amount of cm) the pig traveled. Students may write on the recording sheet (Pig Pen Push) or in their journals.
	Evaluating **Pig Pen Push-** In student journals students will fill in the following sentence frame: The pig successfully entered the pen when we _____. The weight of the balls made a difference in the distance the pig traveled because _____. The force that was applied to the pig was _____.
Elaborating Applying Model to Solve a Problems	**Phenomenon** People use forces to get from place to place.
	Obtaining **Traveling Beth-** Students will receive the following prompt (see Traveling Beth handout). Hi, my name is Beth. I want to take a trip. Can you design a way for me to travel 1 meter? Use the materials at your table to design a vehicle for me. Choose your materials carefully. Draw your design in the box below. What forces will be used to get me from the start to the finish? Write up a plan to get Beth to the finish line. Describe the steps you will take using words.
	Communicating **Traveling Beth-** In their journals or on the handout (forces) students will write their plan to get Beth to the finish line, describing the steps they will take.
	Evaluating **Traveling Beth-** Students will observe each team as they push or pull Beth to the finish line. In the student's journals, students will write the force that each team applied and write the success or failure of each group.

	Sentence starter example: Team _____ used a _____ (push/pull) to move Beth. They were _____(successful/unsuccessful) in moving Beth one meter without falling out. Their plan to move Beth was to _____. Their vehicle looked like this:
Evaluation	***Assessment of Student Learning***
	In student journals, students should give examples of the different kinds of forces. In student journals, students should draw how objects can change direction after an initial force was applied.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	• Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information
Crosscutting Concepts	• Cause and Effect • Structure and Function • Scale, Proportion and Quantity
Disciplinary Core Ideas	From A Framework for K-12 Science Education: • PS2A: Forces and Motions • PS2B: Types of Interactions • PS2C: Stability and Instability in Physical Systems • PS3C: Relationship between Energy and Forces

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. The teacher can have students match letters prior to reading to remind them of the alphabet. 2. The teacher can have students identify words that they know in the text as the class reads. 3. The teacher should remind students to use strategies when they are reading.	1. The teacher can provide practice for students in the area of writing both in context and practicing just letters. 2. The teacher can provide a sentence starter for the students. 3. The teacher should continually give encouragement to the students. 4. The teacher can provide constructive positive feedback during the writing process to help students understand the expectations.	1. Provide students with opportunities to interact with numbers. 2. The teacher can provide manipulatives to allow the students to count and interact with materials.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should consider showing a video of a sport to have students make observations.
2. Then the teacher can ask students to talk about personal experiences with sports.
3. The teacher should use intentional and flexible grouping to group students. Best practice it to use data to drive student groupings.

4. The teacher should be prepared to repeat directions as needed.
5. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
6. Students may need additional time to complete their assignment.

Exploring:

1. The teacher should have clear and consistent guidelines for the activity to move the ball across the field and then a set of guidelines for the blind folded activity.
2. The teacher should consider helping students identify what might be a good direction to give prior to having a student blind folded and attempting to use directions that are given by another student.
3. The teacher should have clear and consistent guidelines for class discussion. These guidelines should make students feel more comfortable and be more likely to participate in the discussion.
4. The teacher should consider providing students with a table to record their results.
5. The teacher should consider providing students with an organizer to help them with the design process.
6. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student groupings.
7. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
8. Students may need additional time to complete their assignment.
9. The teacher should consider providing students with sentence frames to give students a starting point for any arguments or explanations.

Explaining:

1. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to group students.
2. The teacher should be prepared to repeat directions as needed.
3. The teacher may need to assist students with set up of the activity.
4. The teacher may need to use guiding questions to help students gathering data.
5. The teacher should have clear and consistent guidelines for sharing student work. These guidelines should help students feel more comfortable and be more likely to share their work and ideas.
6. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
7. Students may need additional time to complete their assignment.

Elaborating:

1. The teacher should consider asking students how they normally travel and how they have traveled in the past.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
3. Students may need additional time to complete their assignment.

Evaluating:

1. Students may need additional time to complete their assignment.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.

Sports Photos


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Return to Instructional Segment

Name _____ **Date** _____

Straws and Surfaces

Directions: With your group explore how an object moves on different surfaces. Record how many blows through the straw it took to get your object to move a meter on each surface.

	tabletop	carpet or rug	grass
cotton ball			
ping pong ball			
soda bottle cap			

Which object moved the easiest? _____

Which surface did the objects move the easiest? _____

Which surface was the most difficult to move your objects? _____

Why do you think that surface was the most difficult? _____

_____

Did the amount of force you applied affect how far the object traveled? _____

_____

How did pushing the air through the straw affect the motion of the object? _____

_____

Return to Instructional Segment

Name _____ **Date** _____

Cars and Ramps

Directions: With your group design a way for the car to travel from point A to point B the fastest. Use a stopwatch to record the amount of time in seconds the car took to travel. Record your results in the chart below.

Attempt	Length of track	Amount of time in seconds
1		
2		
3		

Which attempt was the fastest? _____

Which attempt used the least amount of track? _____

Now your car must change direction. Design a new way for the car to travel from point B to point C. Use a stopwatch to record the amount of time in seconds the car took to travel. Record your results in the chart below.

Attempt	Length of track	Amount of time in seconds
1		
2		
3		

Which attempt was the fastest? _____

Which attempt used the least amount of track? _____

Return to Instructional Segment

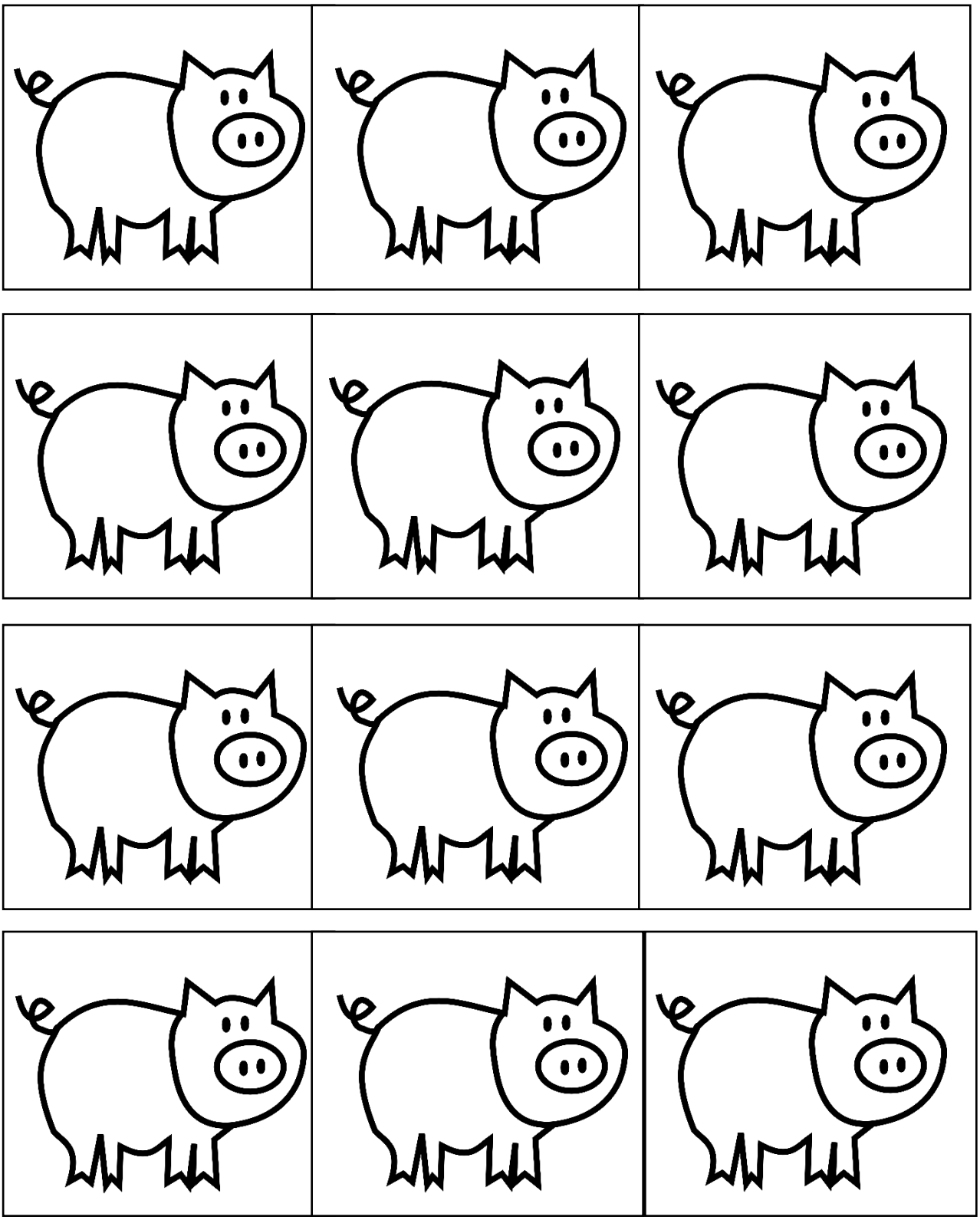
Pig Pen Push (Pigs and Fences)

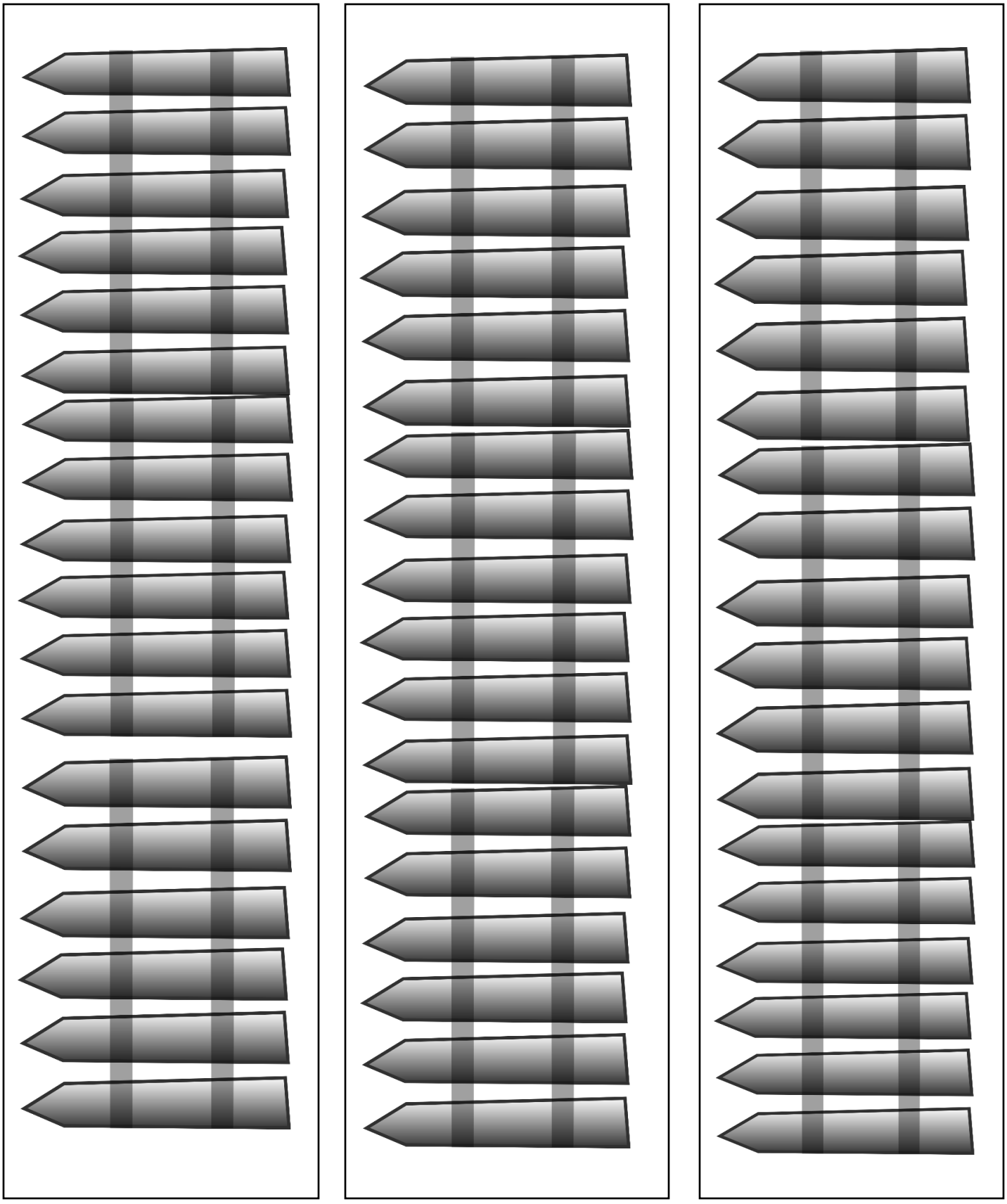
Each Group will need one row of pigs and 3 rows of fences.

Materials:

- Pigs and fences
- Golf ball, ping pong ball, or marble
- Paper cup
- Paper towel roll
- Scissors
- Tape

1. Cut out the rows of cards on the next two pages.
2. Fold each line of the three pigs to make a triangle and tape closed. That would make 4 separate triangles of pigs for the rolling ball to move.
3. Tape each row of fences to make a three-sided fence open toward the ramp.
4. Cut a paper towel roll in half to make the ramp for the golf ball, ping pong ball, or marble.
5. Tape one side of the half of a paper towel roll ramp to the top of an upturned cup to give an angle to the ramp.





Return to Instructional Segment

Name _____ Date _____

Pig Pen Push

Directions: Assemble your pig and fence. Arrange your fence on your table and tape in place. Place your cardboard ramp on top of your paper cup and tape in place. The bottom of your ramp and the end of your gate should be 30 centimeters.

1. Roll your ping pong ball down the ramp starting at the middle of the ramp. Use a centimeter ruler to record your results. Fill in your chart.
2. Roll your ping pong ball down the ramp starting at the top of the ramp. Use a centimeter ruler to record your results. Fill in your chart.
3. Roll your rubber ball down the ramp starting at the middle of the ramp. Use a centimeter ruler to record your results. Fill in your chart.
4. Roll your rubber ball down the ramp starting at the top of the ramp. Use a centimeter ruler to record your results. Fill in your chart.

Roll #	Position of ramp	Distance pig traveled	Did the pig make it in the pen?
1-ping pong ball	Middle/Top	_____cm	Yes/No
2-ping pong ball	Middle/Top	_____cm	Yes/No
3-rubber ball	Middle/Top	_____cm	Yes/No
4-rubber ball	Middle/Top	_____cm	Yes/No

Which attempt did the pig get in the fence? _____

Why did it make it in the fence? _____

_____

_____

What would happen if you moved the fence back? _____

_____

_____

What made the pig move?

_____

_____

_____

Why did the pig travel different distances?

_____

_____

_____

_____

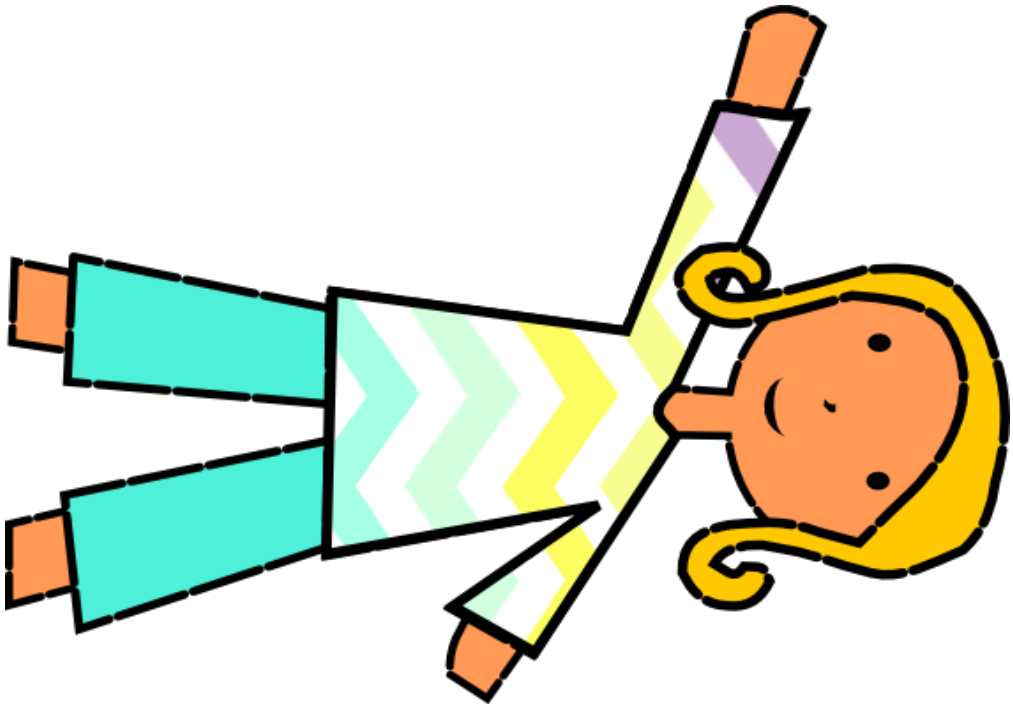
Return to Instructional Segment

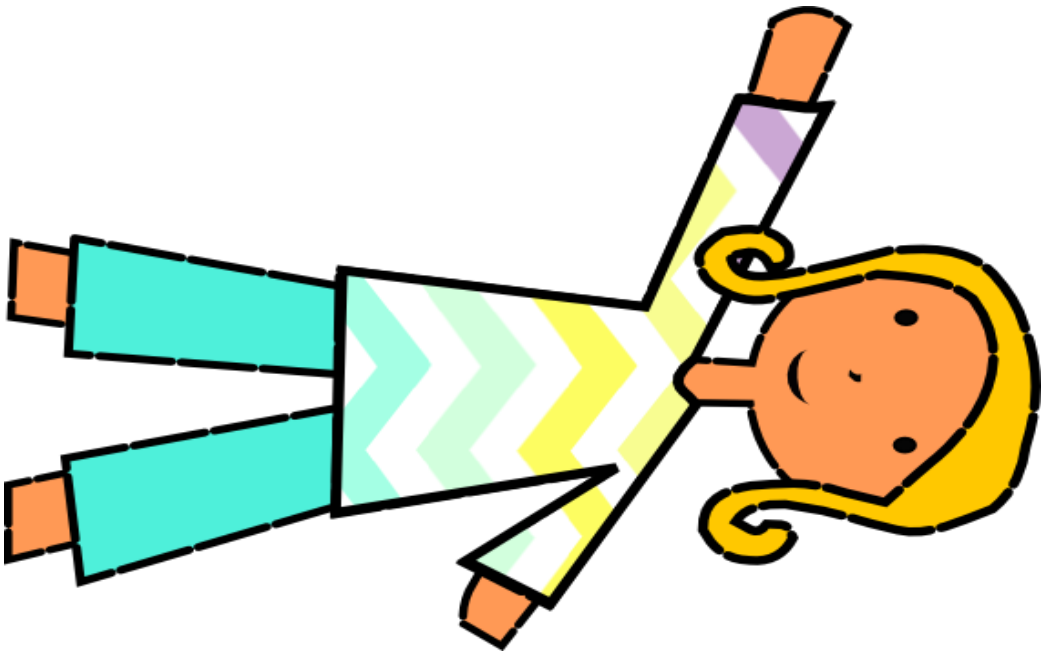
Name _____Date _____

Hi, my name is Beth. I want to take a trip. Can you design a way for me to travel 1 meter? Use the materials at your table to design a vehicle for me. Choose your materials carefully. Draw your design in the box below. What forces will be used to get me from the start to the finish? Write up a plan to get Beth to the finish line. Describe the steps you will take using words.

My Sketch	Written Plan
	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Teacher- Cut out one for each group.





Return to Instructional Segment