Teacher's Guide
Kindergarten Unit
Forces and Interaction:

Pushes & Pulls

Physical Science: Forces and Interactions- Pushes and Pulls

Teacher Background Information

In helping students be successful in the performance expectations, activities are geared to build on the inherent knowledge and experience that five year olds have already acquired and use their knowledge in a wider range of tasks. Students are given the opportunity to examine, measure, reflect upon, describe, and discuss how pushes and pulls of various objects are used to produce and control motion. Students are asked to

analyze what they have already observed, internalized, and made sense of through experience and observation. Students begin to form a clear sense of what cause and effect is. Within the content of motion, students are also given the opportunity to begin to recognize and apply the nature of science. The unit gives students a series of experiences that challenge their thinking about motion. By exploring motion in a variety of settings, students are better able to think about their understanding so they can analyze and interpret observations and data, synthesize ideas, build new knowledge, and clarify their understanding.

Retrieved from: Developed for the Introduction to the Next Generation Science Standards CREATE for STEM Institute, Michigan State University, May 28, 2013 Nancy Karre/BCAMSC and Paul Drummond/Wayne County

Prior Knowledge

Students entering kindergarten have considerable knowledge regarding motion of toys and how to apply a push or pull to get the toy moving. Students have observed the motion of toy cars, balls, wagons, etc. They think of forces as active pushes and pulls that are needed to explain an object's motion. Students know that different strengths of pushes on a toy car will give them different results. The prior experience of motion of toys serves as a background to investigate strengths of pushes and pulls on a variety of objects in terms of distance, speed, and direction. They can understand that when a ball has rolled out of sight, it still exists.

Part Retrieved from: Developed for the Introduction to the Next Generation Science Standards CREATE for STEM Institute, Michigan State University, May 28, 2013 Nancy Karre/BCAMSC and Paul Drummond/Wayne County AND TCAPS Pushes and Pulls Kindergarten Science Unit

Possible Student Misconceptions:

- All things fall down, but heavy things fall faster. (we are not assessing gravity, but could be a common misconception.)
- The speed of an object is directly related to the force currently applied.
- If an object is moving, there is a force acting on it in the direction of motion.
- Constant motion requires a constant force.
- Everyday experience suggests that objects set into motion eventually come to a stop when no obvious external force acts on them.

At the end of the Unit, Kindergarteners will need to understand:

- a push and/or a pull as a force that affects motion.
- that an object moves in the direction of the push or pull.
- that pushes and pulls can speed up, slow down, or change the direction of an object.
- that size, weight, and shape of an object affects its motion.

And be able to:

- describe motion in terms of objects around it
- make observations of motion and generate questions about motion
- plan and conduct simple investigations about motion
- construct simple charts from motion data and observations
- share ideas about motion and communicate findings orally and through drawings and writings
- recognize patterns in the effect of pushes and pulls on objects
- gather information from books and one another
- demonstrate concepts of motion through illustrations and performances
- analyze a design in terms of its ability to change direction or speed of a moving object

Above Retrieved from: Developed for the Introduction to the Next Generation Science Standards CREATE for STEM Institute, Michigan State University, May 28, 2013 Nancy Karre/BCAMSC and Paul Drummond/Wayne County

Helpful Next Generation Science Standard Materials on the Web:

http://www.nextgenscience.org/

* Click Next Generation Science Standards tab on top
* Appendices E, F, and G (on the left side of webpage) are extremely helpful
    - Appendix E: **Disciplinary Core Idea Progressions**
    - Appendix F: **Science and Engineering Practices**
    - Appendix G: **Crosscutting Concepts**

See next page for Next Generation Science Standards

Unit Plan

Forces and Interactions Kindergarten Unit :
Push and Pull

Lesson	Pacing/page #	Materials
Important Notes to Teachers		Camera - need to be taking pictures throughout this unit (see Lesson 7)
Book List		PUSH AND PULL BOOKS: Motion, by Darlene R. Stille How Things Move, by Don L. Curry Give it a Push! Give it a Pull!, by Jennifer Boothroyd And Everyone Shouted, "PULL!", by Claire Llewellyn Push and Pull, by Lola M. Schaefer Push and Pull, by Patricia Murphy Push and Pull, by Charlotte Guillain Move it!: Motion, Forces and You, by Adrienne Mason SCIENTIFIC METHOD BOOKS: Scientists Ask Questions, by Ginger Garrett Everyone is a scientist, by Lisa Trumbauer

		It's a Date, Let's Investigate!, by Kelly Doudna It's an Event When We Experiment, by Kelly Doudna I'll Use Information For My Explanation by Kelly Doudna Where is it? Is it Moving? by Delta Education
Lesson 1 Let's Get Movin', Movin'	2 days	· Materials for charting · Hokey Pokey Song · Plain White Paper · Pencils · Motion, by Darlene R. Stille
Lesson 2 Pushes and Pulls Treasure Hunt	Possible 2 days	· Give it a Push! Give it a Pull!, by Jennifer Boothroyd
Lesson 3 Round and Round we go! Where we stop nobody knows? Introduce Investigations, Experiments, Data	2 days	· Masking tape · Slide or merry-go-round · Stopwatch · Sticky notes · Scientific Method sheet in (not in student journal) · Chart (teacher created, sample found in lesson) · Extra adults (optional) · Scientists Ask Questions, by Ginger Garrett
Lesson 4 Down the Ramp	3 days	· Rope (jump rope) · Round objects (golf balls, ping pong balls, cotton balls, Styrofoam balls, marbles, wooden spheres) · Cylinder objects (wooden cylinders, toilet paper rolls, soup cans, water bottles, pop cans) · Toy cars · Ramps · Objects to add weight · String/Yarn

		· Books or objects to use to change ramp · Stopwatches · Rulers · Introduce I wonder...sheets in Student Journals · Scientific Method sheet in Student Journals · Pencils
Lesson 5 Changing direction, starting, stopping	2 days	· Kick balls/soccer balls · A way to take pictures or video
Lesson 6 Science Centers	2 days	· Push and Pull books (see book list) · Venn Diagram Worksheet · Push, Pull, Push and Pull Sort Worksheet · Sticky notes · Magazines · Objects to sort · Pencils · Computers · Hula Hoops (or materials to make circles for big Venn Diagram) · Cotton balls · Masking tape · Measuring tape · Straws · Exploration Materials from Lesson 4 · Tempera-paint · White paper · Smock and drop cloth · Pipettes · Paper · Scissors · Dominos
Lesson 7 Writing a book	2 days	· Digital Photos of class taken throughout the Unit · Paper

		· Pencils · Vocabulary Cards · Book references · Book-binding tools
Extra handouts and assessments		Various handouts for homework, morning work, assessment or extra time use.
Student Journal Pages	Throughout Lessons	page 1- Changes in Motion: Push & Pull page 2- Pushes and Pulls Chart page 3- Scientific Method I-Chart page 4- I wonder... pages page 12- Scientific Method Student page page 22- Push and Pull Venn Diagram

NGSS Lesson Planning Template

Grade: Kindergarten	**Topic:** Forces and Interactions: Pushes and Pulls	**Lesson (number/title):** 1

Brief Lesson Description: ***Introduction/Foundational Lesson***

Students will be expected to identify objects/things that can be moved and how they are put into motion.

Performance Expectation(s):

CORE IDEA PS2: MOTION AND STABILITY: FORCES AND INTERACTIONS

How can one explain and predict interactions between objects and within systems?

Interactions between any two objects can cause changes in one or both of them.

Specific Learning Outcomes:

- I can identify/brainstorm objects that can be moved
- I can identify and problem solve how to move objects

Narrative / Background Information

Prior Student Knowledge:

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	**N/A- Introduction/foundational Lesson**	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Primary- Highlighted yellow** **Secondary- Highlighted green**

Possible Preconceptions/Misconceptions

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

- Play a movement activity or sing a movement song, such as the Hokey Pokey.
- Not only can we move our bodies, but have students brainstorm a list (pictures and words) of other objects we can move, either on them, at school, at home, or in their community (i.e. Legs, cars, ball, chair, door, desk, book, toy, clothes, etc.).
- Leave the brainstormed list up where students can view it and refer back to it.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

- Pose different questions such as, “Can objects move on their own?” (Can use example using a chair and needing to move it), and then, “I wonder the different ways we can make objects move?” (Write this question on chart paper/board).
- Tell them they are going to investigate this question using different objects around the room.
- Send them off to a designated area (classroom, gym, playground, etc.) to investigate this question.
- Remind them they need to be safe and can work with others.

- During this time observe and guide the students by asking questions that will further their learning (i.e. I see you are trying to pull that tub of crayons, what other motion can you use to make it move?).

EXPLAIN: Concepts Explained and Vocabulary Defined

- Gather students back up after a few minutes.
- Again pose the question, "I wonder the different ways we can make objects move?"
- Have students share/explain some of the ways they were able to move objects, or how objects move.
- Write down key words they say such as walk, run, drop, lift, push, pull, drag, kick, bump, roll, slide, bounce, etc. on another chart labeled- How Objects Are Moved.
- Read the book (if time) Motion, by Darlene R. Stille

Closing if done for the day:

- Bring students back together to review the concepts learned today (Charts- what objects can be moved, how we move objects).
- Tell students to keep their eyes open for moving objects and objects being moved throughout the rest of their day.

ELABORATE: Applications and Extensions

Day 2 (optional)

- If this is done on another day review the brainstormed lists you created previously and possibly sing the Hokey Pokey again.
- Give the students a blank white piece of paper and a pencil.
- Have them go back out into the space (classroom, gym, playground) you are using and have them draw an object and the way that it moves.
- Encourage them to label with words on the charts.
- Bring them back together and have an author's chair to let the students share their findings with their peers.

Closing:

- Discuss their findings and add any new discovered words to the How Objects Are Moved list
- *If you didn't tell the students to keep their eyes open for moving objects and objects being moved throughout the rest of their day…tell them today.*

EVALUATE:

Formative Monitoring (Questioning / Discussion):

- Assess through classroom discussions, exploration observations, and author's chair activity.

Summative Assessment (Quiz / Project / Report):

- **N/A**

Elaborate Further / Reflect:

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
	Materials to make eye charts		
	Hokey Pokey song		
	Plain White paper		
	Pencils		
	Motion, by Darlene R. Stille		

NGSS Lesson Planning Template

Grade: Kindergarten	Topic: Physical Science – Pushes & Pulls	Lesson (number/title): 2 Pushes and Pulls

Brief Lesson Description:
Introduction of push and pull and discovering these in our world.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Specific Learning Outcomes:

- **Students will know the difference between a push and a pull.**
- **Students will know that pushes and pulls can have different strengths and directions.**

Narrative / Background Information

Prior Student Knowledge:
Position understanding

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	**PS2.A: Forces and Motion** ▪ Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Highlights indicate the primary practice(s) & crosscutting concept(s) uilized; Highlights indicate the secondary practice(s) & crosscutting concept(s) utilized**

Possible Preconceptions/Misconceptions

- With things that move (example: car, bike, skateboard, tractor, 4-wheeler, lawnmower)

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

- Review movement chart from lesson #1
- Identify opposite actions (walk/run, open/close or shut, **push/pull**); identify the opposite pair that starts with the same sound

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

- Find things in the classroom that push or pull or need to be pushed and pulled
- Come back together & create a push/pull T-chart (T-chart included)

EXPLAIN: Concepts Explained and Vocabulary Defined

- Create a class definition of push
- Create a class definition of pull
- Read the book: Give it a Push! Give it a Pull! By Jennifer Boothroyd
- Compare our definitions with the definitions in the book.

ELABORATE: Applications and Extensions

- Take children out to the playground; practice pushing doing push-ups; practice pulling by doing pull-ups (on the monkey bars)
- Ask the children to find other ways they push and pull on the playground

EVALUATE:
Formative Monitoring (Questioning / Discussion):

- Through activity observations and questioning

Summative Assessment (Quiz / Project / Report):

- Not during this lesson

Elaborate Further / Reflect: Close our lesson by having each student explain how they pushed or pulled something in the classroom or on

the playground and what that action created (cause & effect).

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
1 sheet	Chart paper (to make a T-chart)		**X**
1	Give it a Push! Give it a Pull! By Jennifer Boothroyd		**29.95**

Pushes & Pulls T-chart

Push	Push & Pull	Pull

NGSS Lesson Planning Template

Grade: Kindergarten	Topic: Physical Science – Pushes & Pulls	Lesson (number/title): 3 Investigations, Experiments, Data

Brief Lesson Description:
Introduction of developing investigations, experiments and recording data.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Specific Learning Outcomes:

- **Students will know a bigger push or pull will increase an objects speed.**
- I can slide three ways, no push, self push, and partner push.
- I can help time each trial.
- I can help construct a chart.
- I can discuss and describe data on charts.

Narrative / Background Information

Prior Student Knowledge:
Pushes and pulls

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	**PS2.A: Forces and Motion** ▪ Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2) ▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) **PS3.C: Relationship Between Energy and Forces** ▪ A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Highlights indicate the primary practice(s) & crosscutting concept(s) uilized; Highlights indicate the secondary practice(s) & crosscutting concept(s) utilized**

Possible Preconceptions/Misconceptions

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions
** Teacher prep: create class recording sheet (samples or template attached)
**Teacher prep for Slide: With a piece of making tape mark off sections of the slide where the slope begins at the top and another where the slope stops at the bottom.
**Teacher prep for Merry-go-round: With a piece of making tape mark off one of the rungs on the merry-go-round. Also mark the ground straight out from the marked rung. This will give you a reference for recording the time it takes to make 1 rotation.

Day 1 – 5 minutes
To engage the class, tell them that they are going to be doing science on the playground. If using the slide for your exploration Before they go outside, put a piece of masking tape on their pants, across their sides, level with their hip bones. This is a visual aid for the timing of the sliding in the exploration. Nothing extra is needed if using a merry-go-round. Line up and head outside to the slide or merry-go-round.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions
Day 1 (20 Minutes)

- Gather around the slide or merry-go-round to hold a "brainstorming session" and discussion
- Discuss how to plan an investigation: I wonder questions & I think statements (hypothesis); plan, carry out plan, record data and form a conclusion
- Help guide students to investigate bigger pushes on a slide or merry-go-around

SLIDE:
Each person will take turns sliding three ways:

- No Push – *When they are sitting at the top of slide not moving, they are "at rest."* Sit at the top of the slide just above the top tape mark. Hold your position until the timer (the other adult and perhaps a student volunteer after modeling) says, "Go!" Let go, cross your arms, and wiggle

forward until gravity starts to pull you down, and slide. The timer stops the watch when the tape crosses the tape line at the bottom.

- Self Push – Get into the same starting position as above, but this time, when the timer says, "Go!" push yourself off with your hands and arms. Timing happens the same way.
- Partner Push – Once again, start in the same position. This time have a friend push you down the slide when the timer says, "Go!" Timing happens the same way.
- NOTES: The teacher or adult volunteer will record the times for each slider on a slip of paper or sticky note for each student. This data will be used in a chart on Day 2.
- NOTES: **This does not have to happen in a whole group. If you have access to other slides and adult volunteers, kids can slide in small groups.

MERRY-GO-ROUND:
Each student will take turns pushing the marry-go-round three ways:

- Self Push: Have student push from the marked rung and start at the marked spot on the ground. Record the time that it takes the student to push the marry-go-round around one whole turn.
- Partner Push: Have two students push, the first student needs to push from the marked rung and start at the marked spot on the ground. Record the time that it takes the students to push the marry-go-round around one whole turn.
- Team of Three Push: Have three students push, the first student needs to push from the marked rung and start at the marked spot on the ground. Record the time that it takes the students to push the marry-go-round around one whole turn.
- NOTES: You can have children on the merry-go-round while doing this investigation. Just make sure the same students are on the merry-go-round for all three pushes (introduce the term "fair test").

EXPLAIN: Concepts Explained and Vocabulary Defined
Day 2 – 25 minutes

- Remind kids of their playground investigation they did yesterday. Present the chart with all of the children's names on it and some of the times recorded on the chart. The blank times will be filled in during explanation and discussion.
- Model filling out a Scientific Method Sheet (attached)This would be a great place to introduce the I Wonder…pages in their Student Journals. Model writing some I wonder questions and explain that this is where they will write anything they are Wondering about (specifically having to do with pushes and pull, but not limited to).
- Give each student their sticky note with their three times on it. Ask the students, one at a time, what their "missing time" is and record it on the chart.
- When the chart is complete, ask the class, "Which kind of push was the fastest…no push, self push, or partner push?" or for merry-go-round: "…self push, partner push, or team of three push?" (*Slide answers could be either self or partner push, depending on weight or strength of the students involved. *Merry-go-round answer should be the team of three push because of the bigger push power.)
- "Which push was the strongest?" (*Answer: same as above.)
- "Do you think the size and weight (or mass) of the person doing the pushing makes a difference in how fast someone goes down the slide? Why?" (*Answer: Yes, a bigger person can usually push harder.)
- *You can introduce the term "mass" in the correct context here.*
- Explain to kids that a big push = a big distance and faster time and a little push = a shorter distance or slower time. They are directly related.
- You can also explain to the class that they were being pushed in the direction they were sliding. A push down = sliding down…

ELABORATE: Applications and Extensions
Day 2 – 5 minutes

- Look at the chart and see who was the fastest, slowest, and the same. Ask the kids why this could happen.

EVALUATE:
Formative Monitoring (Questioning / Discussion):

- Through activity observations, questioning, and participation in designing and conducting the experiment

Summative Assessment (Quiz / Project / Report):

- Time chart and comparison discuss questions.

Elaborate Further / Reflect:

- OPTIONAL: Merry-go-round – have students explore having different number of students on the merry-go-around and the number of students pushing the merry-go-around.

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
x	Class chart with all students names (created by the teacher, example attached)		**n/a**
X	Scientific Method Sheet (attached)		**n/a**
1	Masking tape		
	I wonder page		

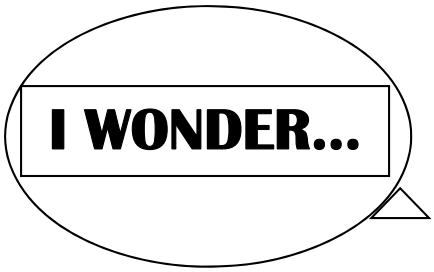
Pushes & Pulls Time Sheet – Slide

Student Name	No Push	Self Push	Partner Push

Push and Pull Time Sheet: Merry-go-round

Student Name	Self Push	Partner Push	Team of 3 Push

??????????????????


I WONDER...

??????????????????

Name:_____

Scientific Method

Push and Pulls

	Ask a Question *(I wonder…)*	*I wonder* what would happen if I _____ _____ _____.	
	Make a Hypothesis *(I think…)*	*I think* that _____ _____ _____.	
	Experiment *Investigation*	Materials	My Plan

Scientific Method

	Ask a Question *(I wonder…)*
	Make a Hypothesis *(I think…)*
	Experiment *Investigation*
	Record Data *Observe*
	Draw Conclusions *I learned that…*

	Record Data *Observe*	I found…
	Draw Conclusions *I learned that…*	*I learned that* _____ _____ _____.

NGSS Lesson Planning Template

Grade: Kindergarten	**Topic:** Forces and Interactions: Pushes and Pulls	**Lesson (number/title):** 4

Brief Lesson Description:
Students will spend time planning and investigating the motion of objects using a ramp over about three days. They will explore push and pull. They will be introduced to different objects (balls, cars, string, etc.) to explore on the ramp.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*

Specific Learning Outcomes:

- I can plan an investigation on how objects move
- I can explore motion and direction by using a ramp
- I can explain the difference between a push and a pull
- I can share/discuss my observations
- I can describe and understand how objects move

Narrative / Background Information

Prior Student Knowledge:

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	**PS2.A: Forces and Motion** • Pushes and pulls can have different strengths and directions. (KPS2-1),(K-PS2-2) • Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) **PS3.C: Relationship Between Energy and Forces** • A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Primary- Highlighted yellow** **Secondary- Highlighted green**

Possible Preconceptions/Misconceptions

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions
Day 1

- Review examples from T-Chart of things that need a push (balls, swings, toy cars, push door closed, push down lids, etc.) to start moving and objects that require a pull (wagon, tug-of-war, shade pulls, rope on the flag, pull up socks/pants/zipper, pull doors, etc.)
- Demonstrate pushes and pulls with the class by playing a quick game of tug-of-war (you can use a big rope and include everyone all at once or use a smaller rope (jump rope) and have a few students participating at a time).

- Use different scenarios using more students on one side, have one side push and one side pull, both pulling, both pushing, etc. (you can pose these as questions, "What would happen if…" and "What happened when…")
- Have the students explain the difference between pushes and pulls.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

- Students will explore the path of moving objects and describe motion by working in groups with balls, toy cars, cylinders (toilet paper rolls, cans, water bottles), ramps, string, and weights and measuring tools-rulers, tape measurers, stopwatches, timers (have this extension material available, but not assessed).
- Give students sufficient time to conduct simple investigations into the motion of objects down the ramps. *At this stage in their learning, students ask and answer "What would happen if…" questions as they change their angle of their ramps and find other objects to roll down the ramp.
- You can prop the ramps up on chairs, desks, walls, books, or any stationary objects.
- Facilitate the student activity by circulating among the groups and listening to their ideas and observing their simple investigations. To make it more challenging add a different shaped item to the students' objects, such as a block or cube, and ask students to describe the motion of the block down the ramp.

Day 2

- Give students a few minutes to refresh their memory on the investigations that went on the day before by letting them explore again with the objects and ramps.

EXPLAIN: Concepts Explained and Vocabulary Defined

- After students have had a short time exploring motion again with the ramps, ask students to share their observations.
- Ask students what started the objects moving down the ramp. (push or pull?)
- What object went down best?
- Did the height or length of the ramp make a difference?
- Did any objects change direction when exploring?

ELABORATE: Applications and Extensions

Note: This activity can be done in pairs, in small groups, or in a whole group depending how many ramps there is:

- Refer back to the activity done on the playground previously
- Ask the students what steps they took to lead them to their investigation? Then what did they do after their investigation was complete? (ask questions, make hypothesis's (guesses to their questions), draw/write out a plan, carry out investigation, record data, and form a conclusion)
- Tell the students that their job is to plan out an investigation using the ramps and objects (use template-Scientific Method) and model each step:
  - First ask yourself an, "I wonder…" question about *what would happen if…* (fill in blanks best they can, teacher can scribe as they walk around)
  - Second stop, think, and make an educated guess, hypothesis, *I think…* about what you think will happen (fill in blank best they can, again teacher can scribe)
  - Third draw and label a plan of action for your investigation (including what materials and steps they will take if able)

  ****Doing the investigation tomorrow will enable you to look at their plan to make sure the materials are readily available and they are on the right track****

Day 3

- Today have students get out their Scientific Method worksheets in Journals to review their question, hypothesis, and investigation plans (talk with anyone who needs to tweak their plan).
- Carry out the investigations
- As students finish, or when everyone is finished, ask them what (data) they have found and how that helps answer their question?
- Model filling in, if not already filled in, the data section and model writing a conclusion (remind them of the conclusion statement from the playground investigation).

- Have them create a conclusion sentence by filling in the blanks as you walk around.

Closing:

- Have students share their findings and review the scientific method chart quickly.

EVALUATE:

Formative Monitoring (Questioning / Discussion):

Observation, Discussion, Participation, and Questioning during investigation with ramps.

Summative Assessment (Quiz / Project / Report):

Scientific Method worksheet

Elaborate Further / Reflect:

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
	Rope or Jump Rope		
	Ramps		
	Round objects (golf balls, ping pong balls, cotton balls, Styrofoam balls, marbles, wooden spheres)		
	Cylinder objects (wooden cylinders, toilet paper rolls, soup cans, water bottles, pop cans)		
	String		
	Toys cars		
	Weights (anything can be used to add weight)		
	Rulers		
	Stop Watches		
	Tape Measurers		
	Scientific Method pages in Student Journal		

Name:_____

Scientific Method

Push and Pulls

	Ask a Question *(I wonder…)*	*I wonder* what would happen if I _____ _____ _____.	
	Make a Hypothesis *(I think…)*	*I think* that _____ _____ _____.	
	Experiment *Investigation*	Materials	My Plan

Scientific Method

	Ask a Question *(I wonder…)*
	Make a Hypothesis *(I think…)*
	Experiment *Investigation*
	Record Data *Observe*
	Draw Conclusions *I learned that…*

	Record Data *Observe*	I found…
	Draw Conclusions *I learned that…*	*<u>I learned that</u>* _____ _____ _____.

NGSS Lesson Planning Template

Grade: Kindergarten	**Topic:** Forces and Interactions: Pushes and Pulls	**Lesson (number/title): 5**

Brief Lesson Description:
Students will be using a ball and playing kickball to explore the interactions between colliding objects which stop, start, and change speed and direction of the object.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*

Specific Learning Outcomes:

- I can identify a push and a pull
- I can explain the difference between a push and a pull
- I can explore motion and direction by using a ball
- I can share/discuss my observations
- I can explore, understand, and explain how objects move or stop after they collide with another object
- I can investigate how a big push or pull speeds an object up or slows an object down.

Narrative / Background Information

Prior Student Knowledge:

Science & Engineering Practices:

- ☐ Asking questions (science) and defining problems (engineering)
- ☐ Developing and using models
- ☐ Planning and carrying out investigations
- ☐ Analyzing and interpreting data
- ☐ Using mathematics and computational thinking
- ☐ Constructing explanations (science) and designing solutions (engineering)
- ☐ Engaging in argument from evidence
- ☐ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas:

PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (KPS2-1),(K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)

PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change potion. (K-PS2-1)

PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)

Crosscutting Concepts:

- ☐ Patterns
- ☐ Cause and effect: Mechanism and explanation
- ☐ Scale, proportion, and quantity
- ☐ Systems and system models
- ☐ Energy and matter: Flows, cycles, and conservation
- ☐ Structure and function
- ☐ Stability and change

Primary- Highlighted yellow
Secondary- Highlighted green

Possible Preconceptions/Misconceptions

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

- Read Push and Pull, by Charlotte Llewellyn (Investigate series)
- Review the definitions of Push and Pull
- Have the students sit in a big circle.

- Tell them to push the ball, flat handed, without stopping it to another person, keeping the ball moving.
- Discuss what the ball is doing and ask I wonder why it is doing that?
- Then have them stop the ball (by letting it collide with their hand) each time it gets to them and then start it back up again.
- Discuss what the ball is doing, what happens when you stop it (what do you do to stop it), what happens when you start it again (what do you do to start it).

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

- Another outdoor or gym day
- Play a quick game of kickball observing and discussing what is happening
- Take pictures **or** video of the game **or** if you do not have that option stop the game when students notice a push, pull, start, stop, change of direction, speed up, slow down, or collision of the ball **or** tell the students to pay attention to these motions during the game and have a discussion after the game.

EXPLAIN: Concepts Explained and Vocabulary Defined

- Watch the video **or** look at the pictures and discuss what the students see (the ball rolling towards a person then the person's foot colliding with the ball and the ball going away (changing position) from the person at different speeds. The ball rolls one way then goes another…I wonder why that happened?)
- **OR** this would be the time to have your discussion after the game (as said in EXPLORE section)

ELABORATE: Applications and Extensions

Day 2

- Review the findings learned through yesterday's exploration/investigation
- Brainstorm further questions about objects being pushed or pulled and then colliding with other objects (i.e. I wonder what would happen if a ball was pushed lightly into a wall compared to if it was pushed hard into a wall? I wonder what would happen if I pulled the tricycle towards me on the grass and then on the cement?)- Write their questions down, then they could choose one to write down on their Scientific Method sheets in their journals.
- Discuss a few hypotheses with the students about these questions, and then they could write down what they think.
- Have students plan an investigation (model if needed)
- Next have students carry out their investigations and ask probing questions to further their learning.
- Discuss the findings and students could complete the Recording Data and Conclusion part of the Scientific Method sheet.

EVALUATE:

Formative Monitoring (Questioning / Discussion):

Observe students during investigations, exploration activity, and discussions. Look for evidence that they understand.

Summative Assessment (Quiz / Project / Report):

If the Scientific Method sheet was filled out then check that in their journals for understanding.

Elaborate Further / Reflect:

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
	Push and Pull, by Charlotte Llewellyn		
	Kickball/soccer ball		

NGSS Lesson Planning Template

Grade: Kindergarten	Topic: Physical Science – Pushes & Pulls	Lesson (number/title): 6 Push & Pull Centers

Brief Lesson Description:
Students will be participating in six push and pull centers over two days. Instructions below.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design works as intended to change the speed or direction of an object with a push or a pull.

Specific Learning Outcomes:

- I can conduct an investigation about pushes and pulls.
- I can make predictions to create investigations.
- I can use objects to pull and push paint.
- I can recognize pushes and pulls in pictures.
- I can sort pushes and pulls.
- I can compare and contrast pushes and pulls.
- I can describe the cause and effects of pushes and pulls.
- I can build and knock over dominos.

Narrative / Background Information

Prior Student Knowledge:
Pushes and pulls

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information NOTE: based on center 5; many practices utilized on other centers.	**PS2.A: Forces and Motion** ▪ Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2) ▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) **PS2.B: Types of Interactions** ▪ When objects touch or collide, they push on one another and can change motion. (K-PS2-1) **PS3.C: Relationship Between Energy and Forces** ▪ A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Highlights indicate the primary practice(s) & crosscutting concept(s) uilized;** **Highlights indicate the secondary practice(s) & crosscutting concept(s) utilized**

Possible Preconceptions/Misconceptions

LESSON PLAN – 5-E Model

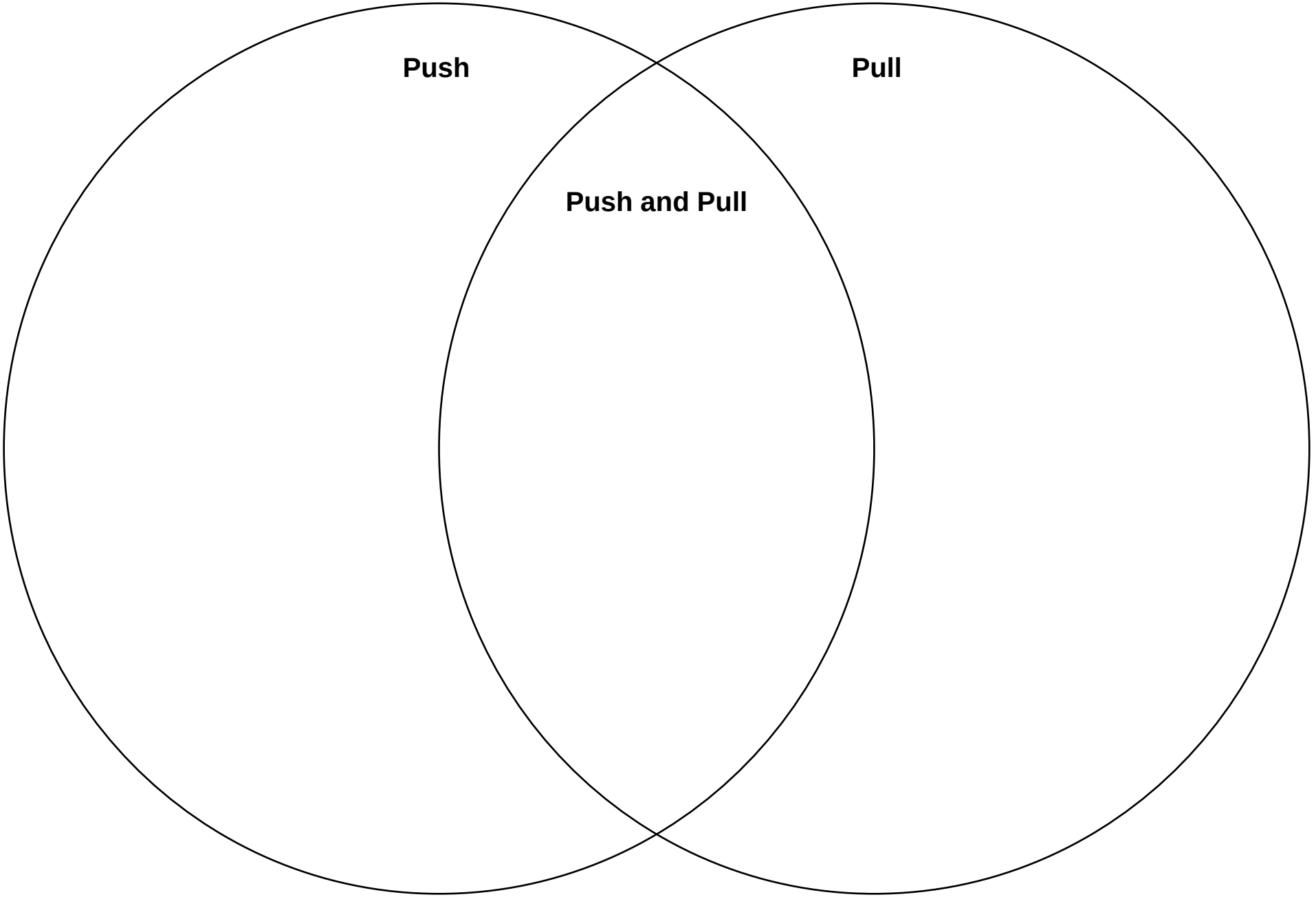
Day 1 5 min	**ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions** Day 1 Three centers! Day 2 Three centers! Explain and preview the Science Centers. 1. Exploration with Journal 2. Magazine Cut and Sort (T-chart) 3. Straw painting 4. Book Look/Technology 5. Venn Diagram (Teacher Lead) 6. Dominos
30 min (10 min	**EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions** Center 1: Exploration with Journal • You will need to provide many of the previous lessons (see lesson 4; balls, ramps, cars, etc.)

per center)	• Students may bring their journals if they would like to write or access I wonder statements and or scientific method sheets. • This center is meant to be a free exploration of pushes and pulls. They may design and conduct investigations as they choose. Center 2: Magazine Cut and Sort • Materials: magazines, scissors, glue, pencils, T-chart worksheet. • Students cut out push and pull action pictures and glue them under the correct side of the T-chart. Center 3: Straw Painting • Materials: straws, a variety of Tempera or water-based paint, white paper, eye droppers, and pencils. • This could be messy, so smocks, drop cloths, and trays may be necessary. • Have the students use the eye dropper to suck up (pull) a small amount of paint. Have them drop (push) the paint on their paper. Then use the straw to blow (push) the paint making very cool splashes of color. Center 4: Book Look / Technology • Materials: books on pushes and pulls, sticky notes in two colors, pencils, computers (with games/activities loaded). • This is a two part center. • 1st part - Book Look: have students look at and read books. Encourage students to find 5 pushes and 5 pulls in their books. When they find a push (1st colored sticky note) or a pull (2nd colored sticky note) write their name on the correct sticky note and place it on the picture. • 2nd part – Technology: allow students to engage in some of the following websites. • http://www.bbc.co.uk/schools/scienceclips/ages/5_6/pushes_pulls.shtml (activity) • http://www.bbc.co.uk/bitesize/ks1/science/forces/play/ (activity) Center 5: Venn Diagram (Teacher Lead) • Materials: hula hoops, objects or images of objects to physically sort, compare, and contrast and venn diagram sheet to record findings. Optional: word cards to go with pictures or images. (NOTE: if you do not have hula hoops you can use yarn or string or anything else to create circles for a venn diagram. • Students work together to physically sort the objects or pictures. Then through discussion compare and contrast their findings. • As time allows have students complete the venn diagram sheet with some or all of their findings. Center 6: Dominos • Materials: dominos • Give students the dominos. Students will set them up and knock them over with a push!...I wonder how do you knock dominos down with a pull?
	EXPLAIN: Concepts Explained and Vocabulary Defined Explain pushes and pulls during the preview of the centers and during the centers, themselves.
Day 3 30 min	**ELABORATE: Applications and Extensions** • Push and Pull Bar Graph – cut and paste activity
15 minutes	**EVALUATE:** **Formative Monitoring (Questioning / Discussion):** • Venn Diagram Center **Summative Assessment (Quiz / Project / Report):** • Center 2 (magazine sort) • Bar Graph Activity
	Elaborate Further / Reflect:

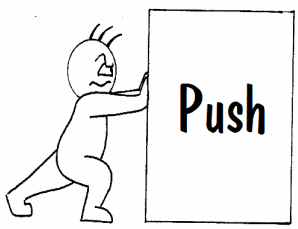
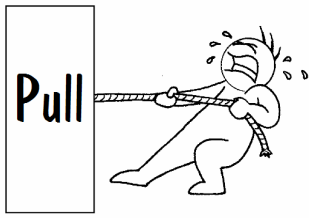
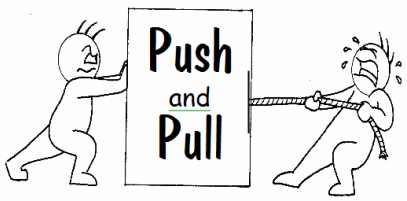
Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
	Straws		
	Pipettes		
	Paint		
	Dominos		
	Books: push & pull		
	Sticky notes (2 colors)		
	Magazines		
	Scissors		
	Glue		
	T-chart		
	Venn diagram sheet		
2	**Hula hoops**		
	Objects/images (sorting)		
	Objects from lesson 4		

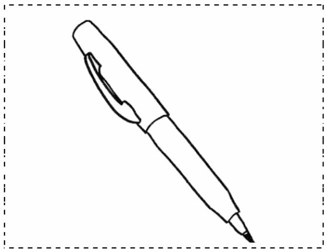
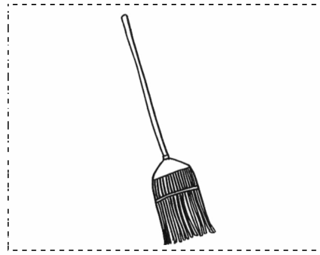
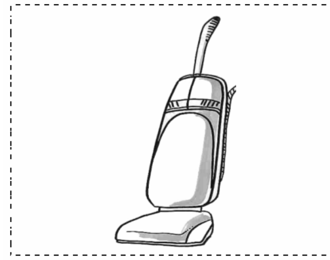
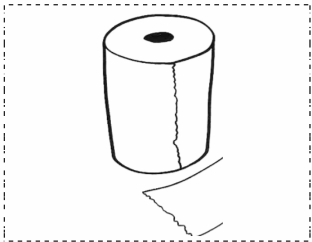
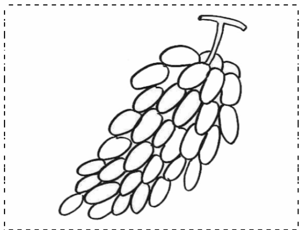
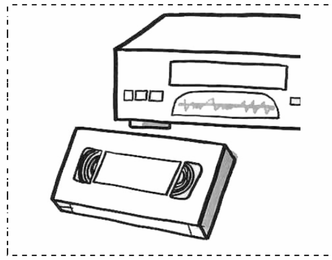
Push and Pull Venn Diagram



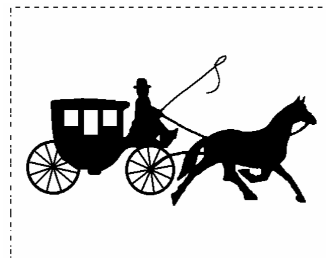
Push and Pull Bar Graph

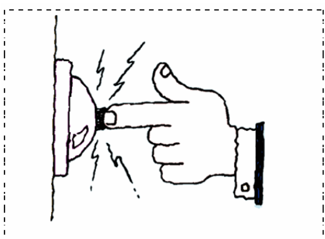
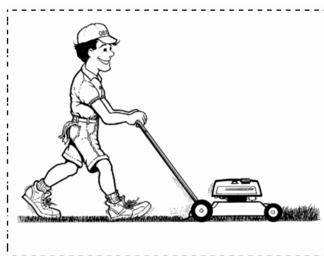
		

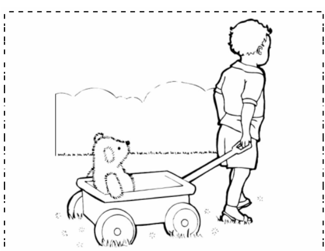
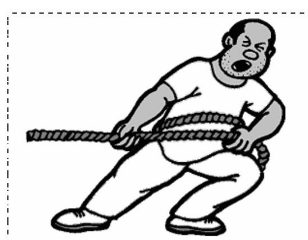
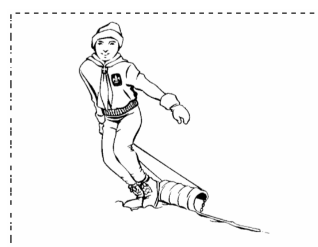
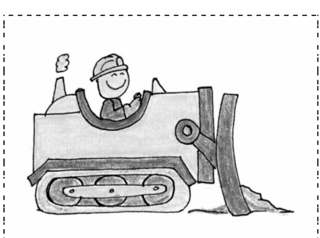
Student Pictures for Push and Pull Construction Paper Graph

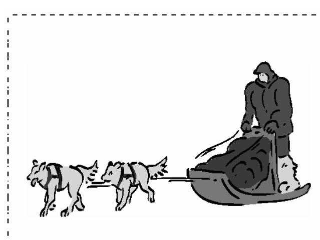










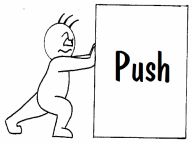
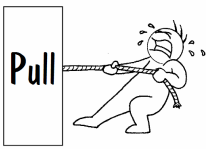
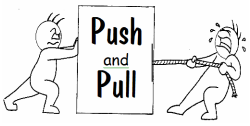
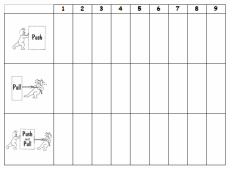



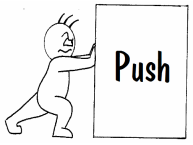
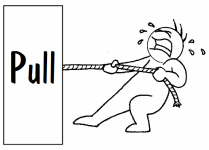
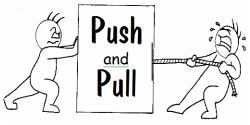
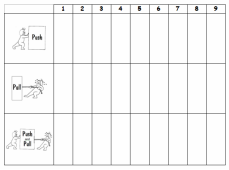









Push & Pull Assessment

Student Name: _____		Y	N
	"What does it mean to push something?" "Can you think of something that can be pushed?"		
	"What does it mean to pull something?" "Can you think of something that can be pulled?"		
	"What does it mean to push and pull something?" "Can you think of something that can be pushed and pulled?"		
	Please cut out these pictures that show things that can be pushed, pulled, or pushed and pulled. Sort them into three piles depending on if they can be pushed, pulled, or pushed and pulled. Then create a graph using the piece of construction paper and graph labels/titles. When you are finished, create a bar graph by coloring the graph to show how many push, pull, and push and pull things you found.		

Push & Pull Assessment

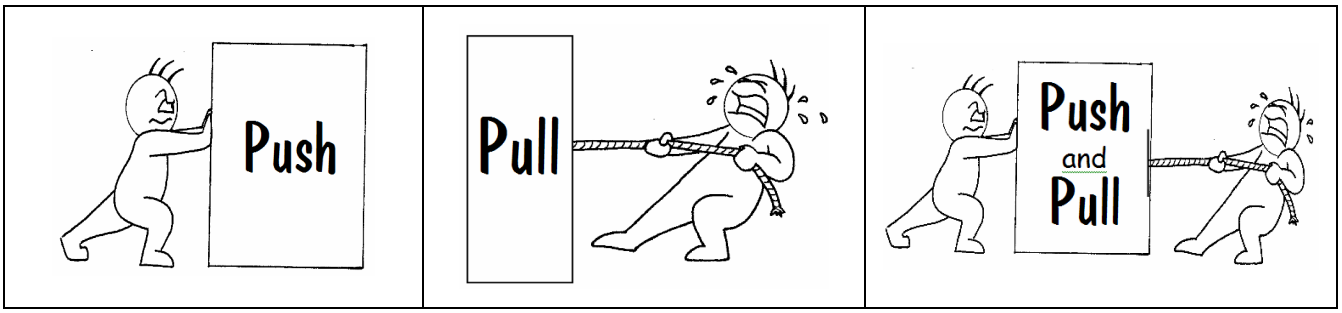
Student Name: _____		Y	N
	"What does it mean to push something?" "Can you think of something that can be pushed?"		
	"What does it mean to pull something?" "Can you think of something that can be pulled?"		
	"What does it mean to push and pull something?" "Can you think of something that can be pushed and pulled?"		
	Please cut out these pictures that show things that can be pushed, pulled, or pushed and pulled. Sort them into three piles depending on if they can be pushed, pulled, or pushed and pulled. Then create a graph using the piece of construction paper and graph labels/titles. When you are finished, create a bar graph by coloring the graph to show how many push, pull, and push and pull things you found.		

Assessment Directions:

1. *Cut out picture cards. Show all picture cards to student, asking student question prompts.*
2. *Record student response in the question prompt box or on the reverse side of the assessment sheet.*
3. *Record "y" or "n" based on students understanding of the standard and benchmark.*
4. *Distribute student graphing sheets.*
5. *Distribute large sheet of 12x18 piece of construction paper.*
6. *Distribute student push, pull, and push & pull pictures.*
7. *Distribute student graph labels/titles.*
8. *Allow student to create a push, pull, and push & pull graph.*

NOTE:
Many of the pictures could be placed in more than one category. Prompt students to put pictures in the space where push, pull, or push & pull is/are being used the most. If students are able to "explain" or "justify" why they put a picture under a category, credit should be given.

Student Titles/Labels for Push and Pull Construction Paper Graph



NGSS Lesson Planning Template

Grade: Kindergarten	Topic: Physical Science – Pushes & Pulls	Lesson (number/title): 7 Let's Make a Book!

Brief Lesson Description:
Students are going to show what they know by contributing to a class book.
Students will take part in a Unit assessment.

Performance Expectation(s):
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Specific Learning Outcomes:

- I can write a caption for a photograph.
- I can pre-write, rough draft, and make a final copy to put in a class book.
- I can identify pushes and pulls.
- I can discuss my ideas with my teacher and class.

Narrative / Background Information

Prior Student Knowledge:
Pushes and pulls

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	**PS2.A: Forces and Motion** ▪ Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2) ▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) **PS2.B: Types of Interactions** ▪ When objects touch or collide, they push on one another and can change motion. (K-PS2-1) **PS3.C: Relationship Between Energy and Forces** ▪ A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: Flows, cycles, and conservation ☐ Structure and function ☐ Stability and change **Highlights indicate the primary practice(s) & crosscutting concept(s) uilized;** **Highlights indicate the secondary practice(s) & crosscutting concept(s) utilized**

Possible Preconceptions/Misconceptions

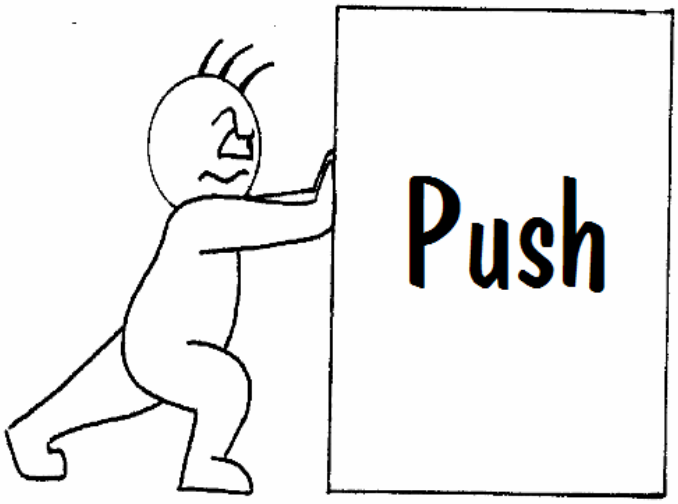
LESSON PLAN – 5-E Model

Day 1 5 min	**ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions** ***Teacher Prep: Print off or develop class pictures taken throughout this unit. Teacher will show the class the collection of photographs taken of the class as they have done this Push and Pull Unit.
15-20 min	**EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions** Students will choose a picture (of themselves or one they like) and use the picture as a writing prompt to describe what is happening in the picture. Using science vocabulary, students will write a rough draft of a caption for this picture.
	EXPLAIN: Concepts Explained and Vocabulary Defined Have students read their rough draft to the teacher and peers. Make sure their writing focuses on description of position (from observer's view), motion (push and pull), and gravity; and use of science terms. Facilitate student discussion about their observations found in the pictures
Day 2 15-20	**ELABORATE: Applications and Extensions** • Re-write captions for final copy and attach to photo. • Combine all pictures to form a class book.
15 minutes	**EVALUATE:** **Formative Monitoring (Questioning / Discussion):**

	N/A **Summative Assessment (Quiz / Project / Report):** • Using the class photos, individually assess student learning from this unit. Below are suggested activities for this assessment. • Find a push • Find a pull • Find something that changes motion (a stop or a start) • Find something that changes direction (example: collision)
	Elaborate Further / Reflect: • Share their book page with the class.

Materials Required for This Lesson/Activity

Quantity	Description	Potential Supplier (item #)	Estimated Price
1	Disposable camera (use if you do not have access to a digital one)		
	Construction paper or tag board (for book cover)	School	**x**
	Paper (for book pages)	school	X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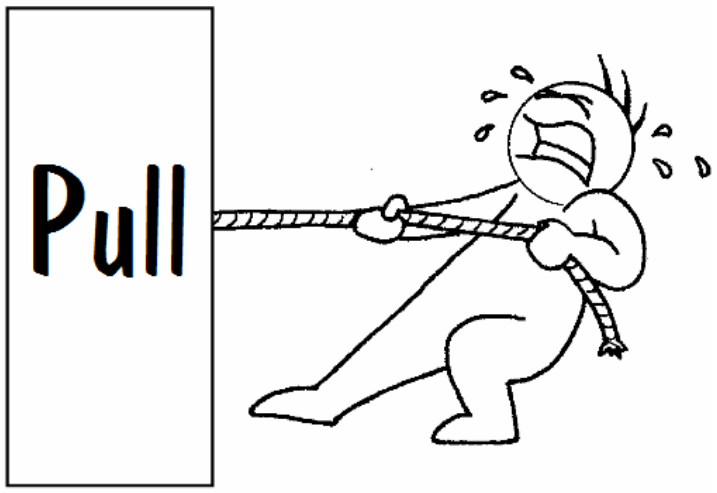
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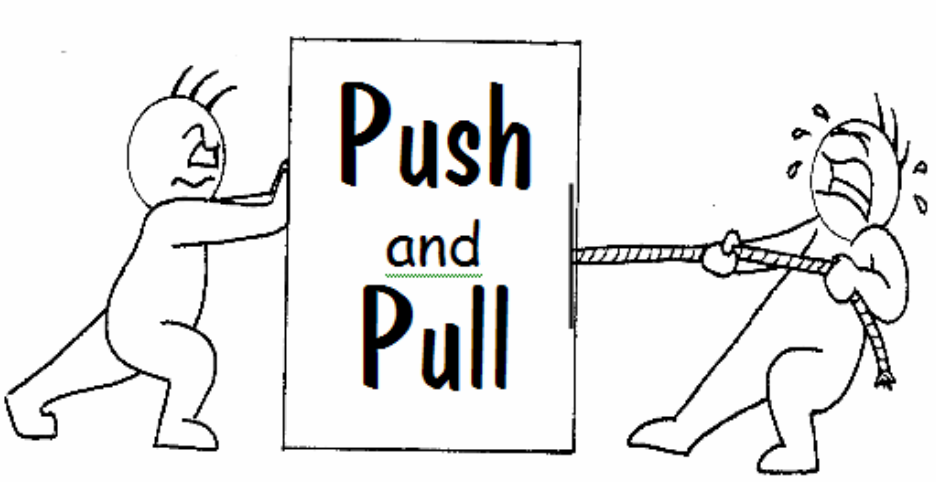
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