Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow. The Motion Close-Up series helps children understand how forces use energy to move objects and how to observe, describe, and measure motion. The Motion Close-Up Teacher’s Guide is filled with engaging, inquiry-driven lessons that help students develop their understanding of motion in the world around them.

The lesson plans in this guide are experiment-based and designed for grades 1-3, and focus on developing critical thinking and problem-solving skills that are needed to explore and investigate scientific properties and draw conclusions upon completion of experiments.

Although each lesson plan in this guide can be used as a stand-alone resource, the lessons follow a sequential order that build off previous understandings and can be taught as such. Reproducible worksheets and assessment tools accompany each lesson plan. The titles in Motion Close-Up include:

- Changing Direction
- Pushing and Pulling
- Speeding Up, Slowing Down
- What is Motion?
# PACING CHART AND VOCABULARY

<table>
<thead>
<tr>
<th>Lesson Plan Title</th>
<th>Pacing</th>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is Motion?</td>
<td>1-2 class periods*</td>
<td>back and forth direction motion sliding zigzag circular jumping movement spinning</td>
</tr>
<tr>
<td>Push and Pull</td>
<td>1-2 class periods</td>
<td>force pull movement push</td>
</tr>
<tr>
<td>Strength and Direction of Forces</td>
<td>2-3 class periods</td>
<td>forces pull motion speed observations weight push direction strength hypothesis record collide</td>
</tr>
<tr>
<td>Friction</td>
<td>1-2 class periods</td>
<td>friction observations rough textured measure record smooth</td>
</tr>
<tr>
<td>Contact vs. Non-Contact Forces</td>
<td>1-2 class periods</td>
<td>contact force gravitational force muscular force friction magnetism non-contact force</td>
</tr>
<tr>
<td>Shapes and Motion</td>
<td>1 class period</td>
<td>3D shapes physical property flat round roll slide</td>
</tr>
<tr>
<td>Race Car Culminating Task</td>
<td>4-6 class periods</td>
<td>design distance force hypothesis movement pull record round surface direction flat gravity motion observations push rough speed smooth</td>
</tr>
</tbody>
</table>

* 1 class period = 40-60 minutes
ACCOMMODATION STRATEGIES

Accommodations provide equal access to learning and equal opportunity to demonstrate what is learned. Accommodations allow a student access to the subject or course without any changes to the knowledge and skills the student is expected to demonstrate.

Educators are encouraged to adapt the instructional approach, activities, and assessments included in this guide to best meet the diverse interests, needs, and abilities of their students. Possible accommodations may include:

### Instructional Strategies
- Break tasks into parts with accompanying time lines
- Provide extra time for processing of oral information.
- Pair oral instructions with visual ones (writing or symbols)
- Pre-teach new vocabulary and regularly review previously taught vocabulary
- Provided model of completed work
- Frequently check with the student to get him/her started
- Provide oral and visual instructions and examples
- Provide a checklist of tasks for the student

### Environmental Strategies
- Proximity to teacher
- Strategic seating
- Flexible or mixed-ability grouping
- Provide an alternative setting for learning that is free from visual and auditory distractions.

### Assessment Strategies
- Build in extra time to allow student to process questions asked and answers given
- Provide written instructions and rubrics for assignments
- Offer a choice of assessment activities so that the student can choose one suited to their strengths
- Space out or extend assignments to prevent student feeling overwhelmed
- Reduce the number of tasks used to assess skill or concept
- Allow students to use assistive devices or technology
LESSON 1
What is Motion?

Curriculum Correlations

Ontario Science:
- Grade 2 Understanding Structures and Mechanisms: Movement
- Overall Expectations: 2 and 3
- Specific Expectations: 2.2 and 3.1

Ontario Language Arts:
- Grade 1 Reading
- Overall Expectation: 1
- Specific Expectation: 1.5

Ontario Arts:
- Grade 1 Dance
- Overall Expectations: A1 and A2
- Specific Expectations: A1.1, A2.1

Common Core:
- CCSS.ELA-LITERACY Grade 1 RI.K.1

Objectives

Students will:
- Define the term motion.
- Explore different words to describe motion ex. slide, jump, spin, swing, back and forth, zigzag, circular.

Setting the Stage

Ask students to define the term “motion”. What does it mean for something to be in motion? Look for examples around the classroom. The clock hand is moving and it is in motion. The students raise their hands to answer questions and they are in motion. Outside the classroom a lawnmower is rolling along the grass and it is in motion. What do all of these objects have in common? They are moving!

Therefore, motion is movement. Write the definition on the board or on a piece of chart paper. Explain that not everything in motion moves in the exact same way. As you read the select pages in What is Motion? (5, 8, 10, 12, 13), invite students to describe the motion shown in the pictures. Record these terms on the board or chart paper.

Show the students the pictures on page 5 and ask them to describe the motion of each of the children on the page. Words they may use include jumping, sliding, and spinning. Write these words down around the definition of motion. Then turn to page 8 and ask the class what both of the pictures have in common with their movement. What terms could be used to describe how rocking chairs and waves move? (back and forth). Turn to page 10. Ask the students what terms could be used to describe the movement of a Ferris wheel and a merry-go-round. What do these two objects have in common in the way they move? (They move in a circular motion). Turn to pages 12 and 13. Ask the students to identify the type of movement on the ski hill and from the children moving through the tires. (They are both moving in a zigzag motion).

Remind the students that motion is movement. Things around us are in motion all the time and there are different terms to describe the motion of different objects. Explain to the students that today they will be creating dances in small groups that will demonstrate at least five of these types of motion.

At this point, the teacher can provide a few examples of how some of these terms might look in a dance movement. For example, for the term “circular” they can spin around once.

The teacher can also take the time to share or co-create a success criteria for the dances with the students. An example of a success criteria list has been provided for reference.

Materials

- What is Motion? p. 5, 8, 10, 12, 13 from Motion Close-Up book series
- Chart paper
- Blackboard or Whiteboard
- Marker, pencils
- In Motion Dance Recording Sheet
- In Motion Dance Checklist
- Motion Exit card
**Setting the Stage**

**In Motion Dance Success Criteria**

1. Students will include at least five types of motion in their dance.

2. Students will include “back and forth”, “circular”, and “zig zag” as three of their dance moves.

3. The dance moves can be clearly identified as one of the terms to describe motion.

4. All group members are participating in the group dance to their best capacity.

**Activity**

Place students in groups of 3-4 people. Have students select 5 of the words used to describe motion that the class has decided upon and record these terms on their In Motion Recording Sheet. Have the students decide what each term will look like as a dance movement. Explain to the students that the movement should visually describe the word so their classmates can guess which of the terms they’ve included in their dance. Tell students to write down the order of their movements on their recording sheet. Allow ample time for practice so that all group members feel comfortable with sharing their motion dance with the class.

**Extensions**

- Students can provide a star and a wish comment as peer feedback during the dance presentations. For the star comment, students can share something they liked about their classmate’s presentations. For the wish comment, students can share something they wished their classmate did differently as a piece of constructive feedback.

- For students who are not able to participate in the dance they can have the option to draw the types of motion on a piece of paper and label them, or can circle and identify different types of motion for different objects. Example questions can be found in the *What is Motion?* book in the Motion Close-Up book series.

- Props can also be added to the dances such as scarves or ribbons to enhance the representations of the types of movements.

**Wrap-Up**

Students will present their motion dances to the class. After each dance, the class will name the types of motion included in the dance.

After all the groups have presented, students will be provided a Motion Exit Ticket to complete. Students will hand in their exit tickets upon completion.

**Assessment**

Assess student’s understanding of motion and different words to describe motion during their dance presentations using the *In-Motion Dance Checklist*. Additionally, assess *Motion Exit Tickets* to determine if students can identify different types of motion. Use observational or anecdotal notes during class discussion to determine level of understanding. Revisit the term motion to clarify any misunderstandings.
| In Motion Dance Recording Sheet | What it Looks Like  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Draw a picture of the movement</td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

Name: _____________________________________________  Date: ____________________
<table>
<thead>
<tr>
<th>In Motion Dance Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yes</strong></td>
</tr>
<tr>
<td>Group Members include at least 5 interesting and distinct dance moves that accurately represent 5 terms to describe motion.</td>
</tr>
<tr>
<td>✅ Yes: __________________</td>
</tr>
<tr>
<td>Notes: __________________</td>
</tr>
<tr>
<td>_________________________</td>
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<td>_________________________</td>
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<td>_________________________</td>
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<tr>
<td>_________________________</td>
</tr>
</tbody>
</table>

The class and the group members are able to identify the types of motion demonstrated in the dance.  
| ✅ Yes: __________________ | ✅ No: __________________ |
| Notes: __________________ | Notes: __________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |

All group members are encouraging one another to participate. 
| ✅ Yes: __________________ | ✅ No: __________________ |
| Notes: __________________ | Notes: __________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
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| _________________________ | _________________________ |

The group members have completed their plan on the recording sheet demonstrating careful consideration and planning of movements. 
| ✅ Yes: __________________ | ✅ No: __________________ |
| Notes: __________________ | Notes: __________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |
| _________________________ | _________________________ |

Names of group members: __________________________________________________________
Motion Exit Ticket

Look at page 9 in the book *What is Motion?* Which objects in the picture move back and forth?

____________________________________________________________________________

____________________________________________________________________________

Look at page 11 in the book *What is Motion?* The things that move in a circular motion are:

____________________________________________________________________________

____________________________________________________________________________

The things that do not move in a circular motion are:

____________________________________________________________________________

____________________________________________________________________________

Motion Exit Ticket

Look at page 9 in the book *What is Motion?* Which objects in the picture move back and forth?

____________________________________________________________________________

____________________________________________________________________________

Look at page 11 in the book *What is Motion?* The things that move in a circular motion are:

____________________________________________________________________________

____________________________________________________________________________

The things that do not move in a circular motion are:

____________________________________________________________________________

____________________________________________________________________________
LESSON 2
Push and Pull

Curriculum Correlations

Ontario Science
Grade 2 Understanding Structures and Mechanisms: Movement
Overall Expectations: 2 and 3
Specific Expectations: 2.2 and 3.1

Grade 3 Understanding Matter and Energy: Forces
Causing Movement
Overall Expectation: 3
Specific Expectations: 3.1 and 3.4

Ontario Language Arts
Grade 1 Oral Communication
Overall Expectation: 2
Specific Expectations: 2.3, 2.4 and 2.7

Grade 1 Writing
Overall Expectation: 1
Specific Expectation 1.2, 1.3 and 1.4

Common Core Language
CCSS.ELA-LITERACY Grade 1 W.1.7, W.1.8 and SL.K.3

NGSS
Grade 1 Standards K-PS2-1 and K-PS2-2
Disciplinary Core Ideas PS2.A: Forces and Motion and PS2.B: Types of Interactions
Crosscutting Concepts: Cause and Effect

Materials
- Chart Paper (one per group)
- Pictures of things in motion (either push or pull)
- Book Series: Motion Close-Up—Changing Direction, What is Motion?, Speeding Up, Slowing Down and Pushing and Pulling
- Push and Pull Investigation Checklist
- Tape or Glue (one per group)
- Marker (one per group)

Setting the Stage

Pose the question, “How do objects come into motion?” If this question is too abstract for students give them an example (i.e. if I had a ball and I wanted to make it move what would I have to do?).

Possible responses include:
- Kick it
- Bounce it
- Throw it
- Hit it
- Push it

After brainstorming some answers ask the students, “If I placed the ball down on the ground and just left it there would it move?” Students should answer no to this question. Explain that in order for something to be in motion something needs to happen to it and that something is called a force. The two forces that put objects into motion are push and pull.

Activity

Put students into groups (recommended group size: 3) and have them conduct a hunt for pushing and pulling pictures. Provide each group with a piece of chart paper and a t-chart drawn with the labels push and pull. Provide each group with various pictures from the book series Motion Close-Up that show objects in motion from a push or a pull. Each group is responsible for sorting the pictures on the t-chart and then co-constructing a definition of what it means to push something (objects are moving away from you) and what it means to pull something (objects are moving away from you).

If students are having trouble sorting the pictures by just looking at it have them act out the motions in the pictures.

Objectives

Students will:
- Understand that forces cause objects to be in motion.
- Understand the forces (push and pull) and what they look like.
- Be able to define what a push is and what a pull is.
**Activity**

Examples of pictures you could use from the book series: *Motion Close-Up*

Invite students to work with a partner and come up with a list of objects that use a pushing or pulling motion. Post a large t-chart with the headings push and pull. Have students write pushing and pulling objects on sticky notes to add to the chart throughout the unit.

Pairs will present their t-charts and their definitions to the class. As a class finalize a definition for push and pull.

Ask students to stand up and act out the motion you are describing (i.e. cutting the grass, closing the fridge, putting on your socks). After they have acted out the motion have them tell you if the motion is a push or pull and explain how they know.

**Wrap-Up**

Assess students understanding during lessons using observational and anecdotal notes. Use the checklist attached to assess the group activity. Review students work to clarify misunderstandings as needed.
1. Students were able to properly sort all pictures  
   If not how many were they able to sort correctly: _____ out of _____
2. Students came up with a proper definition for push and pull
3. Students collaborated well with one another

Mark:

Names of group members: ____________________________________________________________
Begin the lesson by telling the students that today they will be learning about the strength and direction of forces. Read page 16 in Changing Direction (Motion Close-Up). Tell the students that they will be testing how the strength of the force impacts the distance and speed of an object.

This activity can be completed in the gymnasium or outdoors. Provide pairs of students with a ball. Ask the students to take 10 big steps away from one another. Ask the students if they are going to need to apply a lot of force or throw the ball very hard to get to their partner. After they have shared their hypothesis, ask them to test out their hypothesis by throwing the ball to their partner. Ask them to share their observations of the amount of force they had to apply to get the ball to their partner.

Next, ask the students to take only three steps away from their partner. Point out that this is a much shorter distance. Ask the students if they think they will have to throw the ball with more strength or less strength this time. Have them test out their hypotheses. Ask them to share their observations with their partner.

Once back in the classroom, have a classroom discussion about the students’ observations. How is strength related to distance? Did they have to throw the ball with more strength to have the ball travel a farther distance? Or with less strength? Write their observations on the board or on a piece of chart paper. Guide the students toward the main takeaway, the stronger the force, the farther distance an object travels.

Ask students if they have ever been bowling. What happens to the ball and the pins? (They collide or they bump into each other). Define the word “collide”. Tell the students that today they will be testing how speed and direction relates to how objects move. They will be completing a bowling experiment to test how the speed of the ball and the direction at which the ball is thrown impacts the direction at which the pins fall down when these two objects collide.

They will provide a hypothesis or an educated guess as to how the speed and the direction at which they throw the ball will impact the direction at which the pin falls and then will test out their hypotheses and record their observations and conclusions.
Divide the students into groups of 2-4. Have the students fill out their hypotheses on their bowling experiment recording sheet. Next, have the students retrieve 5 pins and a ball. Have them set up their pins and their ball about 5-10 steps away from each other. The teacher can demonstrate the setup of the bowling pins and ball prior to the kids setting up their own bowling lanes if needed. This experiment can additionally be completed outside, in the hallway, or in the gymnasium if there is not enough space in the classroom.

Have students follow the prompts on their bowling experiment task card. Students will practice rolling the ball fast, slow, from a left diagonal direction, a right diagonal direction, and straight on. Students will record their observations as to how the pins move given these different scenarios.

After students have completed their observations sheet, they will then record if their hypothesis was correct or incorrect. If it was incorrect, they will write what actually happens and how speed and direction of a force impacts the direction of an object when two objects collide.

Activity

An additional activity that can be completed to help students understand how it is possible to change the direction of a force is to complete a wind investigation. Have students place objects at a “starting line” on a piece of chart paper. The objects should be of different sizes and weights. For example, objects with these different traits include a feather, a rock, a pompom, and a toy car. Place the objects outside where they can be impacted by the wind. Leave them outside for one week. Ask the students to describe what happened to the objects after the week has passed. Did any of the objects move? What force caused them to them? (push or pull). Why did some of the objects move more or less? Discuss how weight can be a factor in how far an object travels.

Students can also read the Changing Direction book in the Motion Close-Up series to solidify concepts learned throughout the lesson.

Extensions

Wrap-Up

Review the students’ findings as a whole class. What happened when they rolled the ball hard and fast toward the pins? What happened when they rolled it softer and slower? What happened to the pins when they rolled the ball from the left direction? What happened to the pins when they rolled the ball from a right direction? Based on their findings, how does speed impact the movement of two objects when they collide? (Fast objects will move farther distances in a shorter amount of time. The harder the force, the faster the object will move. When two objects collide at a faster pace, they will move more as a result.) How does the direction at which the objects collide impact the direction they move in? (When two objects collide, they will change directions. When a bowling pin is hit straight on by a ball it is pushed backward. A pin hit on its left side will move the pin right. A pin hit on its right side will move left.)

Finally, pass out a Bowling Exit Ticket to each student. Students will complete the exit tickets and hand them in at the end of the lesson.

Assessment

Assess Bowling Experiment Recording Sheets and Bowling Exit Tickets for understanding of strengths and directions of forces. Assess student understanding during lesson using observational notes.
Bowling Experiment Recording Sheet

What do you think will happen if you roll the ball very fast and hard toward the pins?
____________________________________________________________________________
____________________________________________________________________________

What do you think will happen if you roll the ball slowly and softly toward the pins?
____________________________________________________________________________
____________________________________________________________________________

What do you think will happen if you roll the ball from the left side toward the pins? What do you think will happen if you roll the ball from the right side toward the pins?
____________________________________________________________________________
____________________________________________________________________________

Findings: What really happened to the pins...

When I rolled the ball fast and hard: ________________________________________________
____________________________________________________________________________
____________________________________________________________________________

When I rolled the ball slowly and softly: ____________________________________________
____________________________________________________________________________
____________________________________________________________________________

When I rolled the ball from the left side: ___________________________________________
____________________________________________________________________________
____________________________________________________________________________

When I rolled the ball from the right side: ___________________________________________
____________________________________________________________________________
____________________________________________________________________________
Bowling Experiment Task Card

1. Record your hypothesis.
2. Line up your 5 bowling pins.
3. Take 10 steps away from the bowling pins.
4. Roll the ball straight toward the pins as fast and hard as you can.
5. Record what happened to the pins.
6. Repeat steps 1 and 2.
7. Roll the ball straight toward the pins as slow and soft as you can.
8. Record what happened to the pins.
9. Repeat steps 1 and 2.
10. Take 3-5 steps to the left. Roll the ball toward the pins.
11. Record what happened to the pins.
12. Repeat steps 1 and 2.
13. Take 3-5 steps to the right. Roll the ball toward the pins.
14. Record what happened to the pins.
15. Record your findings.
Bowling Exit Ticket

How does the speed and strength that you throw the ball impact how the pins will move? (Sentence starter: If I throw the ball harder and faster, the pins will…)

____________________________________________________________________________
____________________________________________________________________________

How does the direction of where you roll the ball impact how the pins will move? (Sentence starter: If I roll the ball from the left, it will make the pins go…)

____________________________________________________________________________
____________________________________________________________________________

Name: _____________________________________________  Date: ____________________
## Bowling Experiment Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>The student has used investigative thinking in order to formulate a response that is accurate. The student's response is articulated clearly and is well written.</td>
<td>The student has used investigative thinking in order to formulate a response that is accurate.</td>
<td>There is some evidence that the student has used investigative thinking in their response. The response is somewhat accurate.</td>
<td>There is little to no evidence that the student has used investigative thinking in their response. The response is not accurate.</td>
</tr>
</tbody>
</table>
Curriculum Correlations

Ontario Science
Grade 2 Understanding Structures and Mechanisms: Movement
Overall Expectations 2 and 3
Specific Expectations 2.2, 3.1 and 3.2
Grade 3 Understanding Matter and Energy: Forces Causing Movement
Overall Expectation 3
Specific Expectations 3.3 and 3.5

Ontario Language Arts
Grade 1 Writing
Overall Expectation 1
Specific Expectations 1.2, 1.3, 1.4, 1.5 and 1.6

Common Core
CCSS.ELA-LITERACY Grade 1 W.1.2, W.1.3, W.1.5, W.1.7, W.1.8 and SL.K.3

NGSS
Grade 1 Standards K-PS2-1 and K-PS2-2
Disciplinary Core Ideas PS2.A: Forces and Motion and PS2.B: Types of Interactions
Crosscutting Concepts: Cause and Effect

Setting the Stage

Have students sit on the floor in two straight lines facing each other so that there is a clear space down the middle. Roll a ball down the middle and tell students that no one is to touch it. Ask students what they noticed about how the ball moved. Guide students to the answer that the ball starts off moving fast and slows down the farther it gets until it reaches a full stop. Let students know that the reason the ball slows down and stops is due to a force called friction. Read page 12 of the book series Motion Close-Up: Speeding Up, Slowing Down aloud as a class.

Activity

Divide students into groups (3 per group) and tell students that today they will be doing an investigation on friction.

Pose the question, “Which surfaces create more friction?”

Each group will be given a toy car and four different types of materials (ensure some create lots of friction and some do not). You can decide which materials to use or use the suggested list under materials.

Each student will also be given a Friction Investigation Worksheet that they must complete during the activity. Students will launch the toy car on each material and record observations on the Friction Investigation Worksheet. Students will use the snap blocks to measure how far the car went on each surface.

Go through the worksheet with the students before they begin the experiment.

Materials

- Speeding Up, Slowing Down- p.12 and 19 in Motion Close-Up
- Friction Investigation Worksheet
- Toy car (one per group)
- Four different types of materials cut into long strips per group (i.e. sandpaper, carpet, construction paper, bubble wrap, tinfoil etc.). Ensure two materials would produce lots of friction and two materials would not.
- Snap blocks (a handful for each group)
- Friction Exit Ticket
- Friction Investigation Worksheet Checklist
- Friction Exit Ticket Rubric

Objectives

Students will:

- Understand what friction is and what it does.
- Understand which surfaces create more friction and which surfaces create less friction.
- Investigate what would happen if friction did not exist.
**Activity**

Have students look at page 19 of the book *Speeding Up, Slowing Down* and answer the question on the page (gymnasts put chalk on their hands before they swing on the bars). Do you think chalk creates more or less friction? Explain your thinking.

**Extensions**

Have students come together with their worksheets and share their group’s discoveries. Students should have discovered that smoother surfaces cause less friction because the car moves for a longer distance. Rougher and textured surfaces cause more friction because the car moves for a shorter distance or does not really move at all.

**Wrap-Up**

Pose the question what do you think would happen if there was no friction at all in the form of an exit ticket.

Possible answers include:

- Things would never stop moving.
- When we walk we would slip or fall.
- Cars would not be able to brake and crash into each other.

**Assessment**

Have students hand in their worksheets to assess their understanding. Assess students understanding during lessons using observational and anecdotal notes. Use checklist attached to assess worksheet and the rubric attached to mark the *Friction Exit Ticket*. Review students work to clarify misunderstandings as needed.
Friction Investigation

Predict which material you think will create the most friction ________________________________.

Why? _________________________________________________________________________.

<table>
<thead>
<tr>
<th>Material</th>
<th>How far did the car go?</th>
<th>Is the material smooth, textured or rough?</th>
<th>Does the material produce a lot of friction?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Name: _____________________________________________ Date: ____________________

Which material produced the most friction? How do you know? __________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Which material produced the least friction? How do you know? __________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Why do you think some materials create more friction than others? __________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Friction Exit Ticket

What do you think would happen if friction did not exist? ________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Name: _____________________________________________  Date: ____________________

Friction Exit Ticket

What do you think would happen if friction did not exist? ________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Name: _____________________________________________  Date: ____________________
Friction Investigation Work Sheet Checklist

1. Students observational chart is accurately filled out
   
2. Students were able to explain which material produced the most friction and why
   
3. Students were able to explain which material produced the least friction and why
   
4. Students accurately explained why some materials produced more friction than others

Mark:

Name: _____________________________________________  Date: ____________________

Friction Investigation Work Sheet Checklist

1. Students observational chart is accurately filled out
   
2. Students were able to explain which material produced the most friction and why
   
3. Students were able to explain which material produced the least friction and why
   
4. Students accurately explained why some materials produced more friction than others

Mark:

Name: _____________________________________________  Date: ____________________
<table>
<thead>
<tr>
<th>Category</th>
<th>Level 4</th>
<th>Level 3</th>
<th>Level 2</th>
<th>Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>The student has used investigative thinking in order to formulate a response that is accurate. The student’s response is articulated clearly and is well written.</td>
<td>The student has used investigative thinking in order to formulate a response that is accurate.</td>
<td>There is some evidence that the student has used investigative thinking in their response. The response is somewhat accurate.</td>
<td>There is little to no evidence that the student has used investigative thinking in their response. The response is not accurate.</td>
</tr>
</tbody>
</table>

Name: _____________________________________________  Date: ____________________
LESSON 5
Contact vs. Non-Contact Forces

Curriculum Correlations

Ontario Science
Grade 3 Understanding Matter and Energy: Forces Causing Movement
Overall Expectation 3
Specific Expectations 3.3, 3.4 and 3.5

Ontario Language Arts
Grade 1 Writing
Overall Expectation 1
Specific Expectations 1.2 and 1.3

Common Core Language
CCSS.ELA-LITERACY Grade 1 W.1.2, W.1.5, W.1.7 and W.1.8

NGSS
Grade 1 Standards K-PS2-1 and K-PS2-2
Disciplinary Core Ideas PS2.A: Forces and Motion and PS2.B: Types of Interactions
Crosscutting Concepts: Cause and Effect

Setting the Stage

Begin by telling students that forces fall into one of two categories; contact or non-contact. Have students partake in a think, pair and share. Ask them to describe a contact force and a non-contact force. Listen to students’ responses and if needed, guide students to come up with the response that a contact force means that there must be contact in order to create movement, while a non-contact force means that contact is not needed in order to create movement. Contact is when two objects touch.

Introduce the names of the four forces (muscular force, gravitational force, friction, and magnetism). Ask students what they think muscular force is and have them share their thoughts with the class. Repeat for the next three forces.

Materials

• Contact vs. Non-Contact Forces Investigation Worksheet
• Magnet (one per group)
• Paper clip (one per group)
• Chair (one per group)
• Sponge (one per group)
• Ball (one per group)

Objectives

Students will:
• Understand the four different types of forces (muscular force, gravitational force, friction and magnetism).
• Understand the difference between a contact vs. a non-contact force.
• Determine which forces are contact forces and which are non-contact forces.
Activity

Divide students into groups. Each group will receive a magnet, a paper clip, a chair, a sponge and a ball. Each group member will receive a Contact vs. Non-Contact Forces Investigation Worksheet. Group members will work together using the materials provided to determine if the forces are contact forces or non-contact forces. Each student is expected to work cooperatively and complete a worksheet. Go through the worksheet with the students prior to them completing it.

Extensions

Use various pictures from the Motion Close-Up series and have students decided whether it is showing a contact force or a non-contact force and explain how they know.

Wrap-Up

Have students come together with their worksheets and share what their group has discovered. Students should have discovered that muscular force and friction are contact forces because objects need to be touch in order for movement and/or the force to be created. Students should have also discovered that gravitational force and magnetism are non-contact forces because contact is not needed for movement and/or the force to be created.

Assessment

Have students hand in their worksheets and assess their work for understanding. Assess students' understanding during lessons using observational and anecdotal notes. Review students work to clarify misunderstandings as needed.
Contact vs. Non-Contact Forces

Predict whether each force is a contact force or a non-contact force. Use the materials to test whether your prediction was correct or incorrect. Explain how you know whether the force is a contact force or a non-contact force.

1. Muscular Force

Prediction: _______________________________

Make the chair move using muscular force. Is muscular force a contact or a non-contact force? How do you know?

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2. Gravitational Force

Prediction: _______________________________

Toss the ball into the air and let it hit the floor. Is gravity a contact or a non-contact force? How do you know?

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3. Friction

Prediction: __________________________________________

Rub the sponge across the surface of your desk to create friction. Is friction a contact or a non-contact force? How do you know?

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4. Magnetism

Prediction: __________________________________________

Place the magnet directly above the paper clip and observe what happens. Is magnetism a contact or a non-contact force? How do you know?

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Contact vs. Non-Contact Forces (extension)

Is this a contact or non-contact force? How do you know?

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Is this a contact or non-contact force? How do you know?

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Is this a contact or non-contact force? How do you know?

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Is this a contact or non-contact force? How do you know?

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Is this a contact or non-contact force? How do you know?

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LESSON 6
Shapes and Movement

Setting the Stage

Begin with a class discussion. Pose the question, “What does it look like when something rolls?” (The object spins when it moves). Next, ask students “What does it look like when something slides?” (The object still moves but it is not spinning while it moves). Finally, ask students if they think that the shape of an object will affect how it moves? Take votes and place information on a t-chart drawn on a piece of chart paper.

Divide students into groups. Each group will receive a magnet, a paper clip, a chair, a sponge and a ball. Each group member will receive a Contact vs. Non-Contact Forces Investigation Worksheet. Group members will work together using the materials provided to determine if the forces are contact forces or non-contact forces. Each student is expected to work cooperatively and complete a worksheet. Go through the worksheet with the students prior to them completing it.

Activity

Have students sit in a circle and hold a sphere for them to see. Ask students to name the shape. Then ask students if they think the sphere will roll or slide and why they think that. Conduct the experiment by launching the sphere from one end of the circle to the next. Ask students to explain what they saw (students should say that the sphere rolled and did not slide because it was spinning while it was moving).

Have students conduct a roll and slide investigation individually, using the rest of the 3-D shapes. Have them test each shape to see whether the shape rolls, slides, or does both. Have them fill in a Roll or Slide Investigation Worksheet. Go through the worksheet prior to the students’ completion.

Objectives

Students will:

• Understand that the shape of an object affects how it moves.
• Understand that round shapes roll and flat shapes slide.
• Understand that some objects movement is smoother than others due to their shape.
Extensions

• Have students read pages 20-23 What is Motion? Have students answer the question, “Is it easier to move something that has a flat bottom or a round bottom? If the object was heavy would your answer stay the same or change? Why or why not?”

Wrap-Up

Debrief on the experiment as a class and take up the answers with the students. Create a larger version of their chart on a larger piece of chart paper and fill out the answers as students tell you. Have students share their responses with the class for the longer questions. Ask students what physical property do the 3-D shapes that roll have in common? (They have a round side). Then ask what physical property do the 3-D shapes that slide have in common? (They have a flat side). Lastly, ask students why do some shapes roll and slide? (They have a round and a flat side). Turn students’ attention back to their initial vote on the question “Does the shape of an object affect the way it moves?” Ask the question again and have students respond (they should all agree that the shape of an object affects the way it moves).

Pose the question, “If you were to push a ball and a book at the same time with the same amount of force which one do you think would go farther? Explain your thinking?” Have students write their response on the Shapes Exit Ticket. After collecting all the Shapes Exit Tickets and marking them, sort them into two categories: ball vs. book. Conduct the experiment with your students and debrief on what happened and why.

Assessment

Have students hand in their worksheets and assess their work for understanding. Assess students understanding during lessons using observational and anecdotal notes. Use the rubric attached to mark the exit ticket. Review students work to clarify misunderstandings as needed.
Do I Roll or Do I Slide?

Test each 3-D shape to see if it rolls or slides, or if it does both! Fill in the chart below.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Do I Roll?</th>
<th>Do I Slide?</th>
<th>Do I Roll and Slide?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cube</td>
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<tr>
<td>Sphere</td>
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<tr>
<td>Cylinder</td>
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<tr>
<td>Rectangular Prism</td>
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</tbody>
</table>

What do the shapes that rolled have in common?

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What do the shapes that slide have in common?

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What do the shapes that both rolled and slid have in common?

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Which shapes went the farthest? The shapes that rolled, slid, or the ones that did both?

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Shapes Exit Ticket

If you were to push a ball and a book at the same time using the same amount of force which one do you think would go farther? Explain your thinking.

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Shapes Exit Ticket

If you were to push a ball and a book at the same time using the same amount of force which one do you think would go farther? Explain your thinking.

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<thead>
<tr>
<th>Category</th>
<th>Level 4</th>
<th>Level 3</th>
<th>Level 2</th>
<th>Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>The student has used investigative thinking in order to formulate a response that is supported by logic and reason. The student was able to take what they had learned from the investigation and apply it to this question. The student's response is articulated clearly and is well written.</td>
<td>The student has used investigative thinking in order to formulate a response that is supported by logic and reason. The student was able to take what they had learned from the investigation and apply it to this question.</td>
<td>There is some evidence that the student has used investigative thinking in their response. The response is somewhat supported by logic and reason.</td>
<td>There is little to no evidence that the student has used investigative thinking in their response. The response is not supported by logic and reason.</td>
</tr>
</tbody>
</table>
**Curriculum Correlations**

**Ontario Science**
Grade 2 Understanding Structures and Mechanisms: Movement
Overall Expectation: 3
Specific Expectation: 3.2

Grade 3 Understanding Matter and Energy: Forces Causing Movement
Overall Expectation: 3
Specific Expectations: 3.1, 3.3, 3.4

**Ontario Language Arts**
Grade 1 Writing
Overall Expectation 1
Specific Expectations 1.2, 1.3, 1.4, 1.5 and 1.6

**Common Core Mathematics**
CCSS- Mathematics Grade 1: K.MD.A.1

**NGSS**
Grade 1 Standards K-PS2-1 and K-PS2-2
Disciplinary Core Ideas ETS1.A: Defining Engineering Problems
Crosscutting Concepts: Cause and Effect

**Materials**
- Toy cars (1 per student)
- Whiteboard or blackboard
- Marker, pens, pencils
- Timer
- Race Car Design Sheet
- Race Track Design Sheet
- Observations Recording Sheet
- Race Finale Exit Card
- Race Car Culminating Rubric
- Race Day Time Keeping Sheet

**Setting the Stage**
Remind the students that there are things in motion all around us. Many different factors contribute to the movement of objects. Ask the students to share some of the factors that impact movement. Write down students’ suggestions on the board. This conversation will serve to remind the students about the various terms and concepts they have learned throughout the unit.

If students need prompting, ask them about the motion of a car. How does a car move? What helps it move faster? What direction does a car move in? Students might mention that the round shape of the wheels help it move faster. That the car can move in a forward, backward or side direction. That the surface the cars moves on can change its movement. For example, a car would move slower in sand than on a flat road because of friction. Record student’s thoughts on a chart paper or on the board.

Tell the students that they will be using all that they have learned throughout the unit to help them design a race car and track! The goal is for their car to move the farthest distance in the fastest time. This will be a multi-step activity that will take several days. Each day, the teacher is encouraged to read the instructions for that day’s task and check for understanding before students begin their work for the day.

Prior to students beginning the design of their car and track, a checklist or list of considerations should be either provided or co-created with the class to ensure that students are aware of what needs to be considered when designing their car and track. Below is a sample list of items to consider that could be provided to the students.

**Race Day Considerations**
It is your job to create a track and car that will travel the fastest and the farthest! Use all that you have learned to help you complete this task.

When creating your car and track, make sure to carefully consider the following:

1. What shape will your wheels be to help your car move faster?
2. What type of surface will your track have to help your car move?
3. What force will start your car? (Push or pull)
4. How can gravity help your car travel farther?

Make sure to test your car before the big race and record your observations and any changes you make along the way!

**Objectives**
Students will:
- Explore the concepts learned throughout the unit including speed, surface, gravity, force, pull, push, force, motion, shape, and direction through an investigation.
- Design and test cars and tracks based on their knowledge of these concepts.
- Undergo investigative procedures including developing a hypothesis, testing, recording observations, and developing findings.
**Activity**

On the first day of the car and track activity, students will be provided a race car and track design sheet where they can plan the design of their car and track as well as the materials they will need to bring in. After these sheets are checked by the teacher, students should send these sheets home to keep track of the materials they need. Students will then bring in the materials and will begin the building process. During the building process they are encouraged to write down their observations after completing trial runs of their car down their track. They are encouraged to document any changes they make to their car or track.

Finally, students will compete in a race day event! The car that travels the farthest distance in the fastest time wins. On race day, in small groups students will line up their tracks side by side at a starting line and will let their cars go at the same time. The cars will be timed for speed. The winners of each group will compete in a final round to determine the champion.

*Optional: The winner can choose a prize for the rest of the class. Some examples of prizes include 5 minutes of extra free time, an outdoor class period, or any other activity the students enjoy!*

During the race the teacher and the students can discuss possible reasons for errors in timing. For example, one student starts ahead or behind the other students in the group. These potential errors should be considered and avoided when possible to conduct equitable race conditions.

**Extensions**

- Students can think of other surfaces to help their cars travel farther and faster. Students might think of using a slide or a ramp to move their cars farther and faster.
- Obstacles such as a block can be added after the student’s tracks and students can predict how the obstacle will change the direction of their car.
- Allow students to research for their cars and tracks through reading the Motion Close-Up Series.

**Wrap-Up**

Students will complete their Race Finale Exit Card and hand them in at the end of the lesson.

**Assessment**

Assess student Observation Recording Sheets and Race Finale Exit Cards to determine understanding of how objects move and what forces impact their movement. Observe student contributions and investigative processes during the race car trials and finale.
Race Car Design Sheet

Here is a picture of how I want to build my race car:

The materials I need to build my car include:

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____________________________________________________________________________
____________________________________________________________________________

The materials I have used and the design I have created will make my car travel fast and far because:

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Race Track Design Sheet

Here is a picture of how I want to build my race track:

![Image of race track design]

The materials I need to build my track include:

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The materials I have used and the design I have created for this track will make my car travel fast and far because:

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<thead>
<tr>
<th>Trial Number</th>
<th>What happened?</th>
<th>What will I keep the same?</th>
<th>What will I change?</th>
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Race Car Finale Exit Card

What my final car and track looked like:

How did the design and the materials used in both your car and your track help your car move farther and or faster? Are there any final changes you would make? If so, what are they?

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### Race Day Time Keeping Sheet

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<thead>
<tr>
<th>Student Name</th>
<th>Time</th>
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<th>Student Name</th>
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<th>Student Name</th>
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</table>
# Race Car Culminating Task Rubric

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<tr>
<th></th>
<th>Level 4</th>
<th>Level 3</th>
<th>Level 2</th>
<th>Level 1</th>
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</thead>
<tbody>
<tr>
<td><strong>Investigative Process</strong></td>
<td>Student demonstrates a great deal of consideration and time in undergoing their investigation. Student has demonstrated considerable evidence of providing a hypothesis, testing their hypothesis, and building upon their hypothesis by making necessary changes to their car and track models.</td>
<td>Student demonstrates some consideration and time in undergoing their investigation. Student is missing and or not considering parts of the investigative process including the hypothesis, testing their hypothesis, and building upon their hypothesis by making necessary changes to their car and track models.</td>
<td>Student demonstrates a lack of consideration and time in undergoing their investigation. Student has demonstrated little to no evidence of providing a hypothesis, testing their hypothesis and building upon their hypothesis by making any necessary changes to their car and track models.</td>
<td>Student demonstrates a lack of consideration and time in undergoing their investigation. Student has demonstrated little to no evidence of providing a hypothesis, testing their hypothesis and building upon their hypothesis by making any necessary changes to their car and track models.</td>
</tr>
<tr>
<td><strong>Understandings</strong></td>
<td>Student demonstrates an excellent understanding of how forces, shape, gravity, direction, and surface impact an object in motion. Their understanding is evident in the design of their car, their race track, and their exit ticket answers.</td>
<td>Student demonstrates a good understanding of how forces, shape, gravity, direction, and surface impact an object in motion. Their understanding is evident in the design of their car, their race track, and their exit ticket answers.</td>
<td>Student demonstrates some understanding of how forces, shape, gravity, direction, and surface impact an object in motion. Their understanding is somewhat evident in the design of their car, their race track, and their exit ticket answers.</td>
<td>Student demonstrates a lack of understanding of how forces, shape, gravity, direction, and surface impact an object in motion. Their understanding is not evident in the design of their car, their race track, and their exit ticket answers.</td>
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