TE 804 - Science

FORCE AND MOTION

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5th Grade

Michigan GLCEs

(http://www.michigan.gov) (Michigan 5-7 Science GLCE companion document)

Science Processes

Inquiry Process, Inquiry Analysis and Communication, Reflection, and Social Implications

The science processes in middle school expand the students' inquiry abilities from simply raising questions based on observations, to generating scientific questions based on observations, investigations, and research. Students begin to recognize the question they are asking, the background knowledge that framed the question, and what steps they take to answer their question. Fifth grade students will design and conduct their own scientific investigations, with consideration of fair tests, variables, and multiple trials and sets of data. Students are expected to use data and research in their analysis and evaluation of data, claims, and information, and relate their findings to different situations and real-world problems. The instructional activities of a scientific inquiry should involve students in establishing and refining procedures, materials, and data they will collect. It is crucial for students to recognize the benefit of cooperating with their peers and sharing data and experiences through collaborative science discourse. (Science Grade 5 Michigan GLCE,www.michigan.gov)

Inquiry Process

K-7 Standard S.IP: Develop an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems.

S.IP.M.1 - Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

- (**S.IP.05.11**) - Generate scientific questions based on observations, investigations, and research.
- (**S.IP.05.12**) - Design and conduct scientific investigations.
- (**S.IP.05.13**) - Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens) appropriate to scientific investigations.
- (**S.IP.05.14**) - Use metric measurement devices in an investigation.
- (**S.IP.05.15**) - Construct charts and graphs from data and observations.
- (**S.IP.05.16**) - Identify patterns in data.

Inquiry Analysis and Communication

K-7 Standard S.IA: Develop an understanding that scientific inquiry and investigations require analysis and communication of findings, using appropriate technology.

S.IA.M.1 - Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

- (**S.IA.05.11**) - Analyze information from data tables and graphs to answer scientific questions.
- (**S.IA.05.12**) **-** Evaluate data, claims, and personal knowledge through collaborative science discourse.
- (**S.IA.05.13**) **-** Communicate and defend findings of observations and investigations using evidence.
- (**S.IA.05.14**) **-** Draw conclusions from sets of data from multiple trials of a scientific investigation.
- (**S.IA.05.15**) **-** Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Reflection and Social Implications

K-7 Standard S.RS: Develop an understanding that claims and evidence for their scientific merit should be analyzed. Understand how scientists decide what constitutes scientific knowledge. Develop an understanding of the importance of reflection on scientific knowledge and its application to new situations to better understand the role of science in society and technology.

S.RS.M.1 - Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.

- (**S.RS.05.11**) - Evaluate the strengths and weaknesses of claims, arguments, and data.
- (**S.RS.05.12**) - Describe limitations in personal and scientific knowledge.
- (**S.RS.05.13**) - Identify the need for evidence in making scientific decisions.
- (**S.RS.05.15**) - Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
- (**S.RS.05.16**) - Design solutions to problems using technology.
- (**S.RS.05.17**) - Describe the effect humans and other organisms have on the balance in the natural world.
- (**S.RS.05.19**) - Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures

Physical Science

Forces and Motion

Students participate in an in-depth study of motion as related to a point of reference, distance, time, and direction. Their exploration into motion also presents high interest content for students to hone their skills in metric measurement and the use of tools and equipment appropriate to scientific investigations. The middle school experience of investigating balanced and unbalanced forces, and their relationship to the size of change in motion, provide concrete experiences on which a more comprehensive understanding of force can be based at the high school level. Students can move from qualitative descriptions of moving objects in the elementary grades to quantitative descriptions of moving objects and the identification of the forces acting on the objects. (Science Grade 5 Michigan GLCE,www.michigan.gov)

K-7 Standard P.FM: Develop an understanding that the position and/or motion of an object is relative to a point of reference. Understand forces affect the motion and speed of an object and that the net force on an object is the total of all of the forces acting on it. Understand the Earth pulls down on objects with a force called gravity. Develop an understanding that some forces are in direct contact with objects, while other forces are not in direct contact with objects.

P.FM.M.2 - FORCE INTERACTIONS: Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force, and gravitational force.

- (**P.FM.05.21**) - Distinguish between contact forces and non-contact forces.

- (**P.FM.05.22**) - Demonstrate contact and non-contact forces to change the motion of an object.

P.FM.M.3 - <u>FORCE</u>: Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

- (**P.FM.05.31**) - Describe what happens when two forces act on an object in the same or opposing directions.
- (**P.FM.05.32**) - Describe how constant motion is the result of balanced (zero net) forces.
- (**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.
- (**P.FM.05.34**) - Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

P.FM.M.4 - <u>SPEED</u>: Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

- (**P.FM.05.41**) - Explain the motion of an object relative to its point of reference.
- (**P.FM.05.42**) - Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.
- (**P.FM.05.43**) - Illustrate how motion can be measured and represented on a graph.

Unpacking the Michigan GLCEs

(http://www.michigan.gov) (Michigan 5-7 Science GLCE companion document)

Physical Science - Forces and Motion

P.FM.M.2 - FORCE INTERACTIONS:

- **(P.FM.05.21) - Distinguish between contact forces and non-contact forces.**
  - *Instructional Clarifications*
    1. Distinguish means to recognize or know the differences between contact forces and non-contact forces.
    2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of force.
    3. Contact forces are pushes and pulls that result from direct touching of objects (for example: a foot kicking a soccer ball, a bat striking a baseball, hand pushing on an object, shoes/feet against a floor).
    4. Friction is the rubbing of two surfaces. It is the force of two surfaces in contact with each other.
    5. Non-contact forces are pushes and pulls that result without direct touching of objects acting at a distance (for example: gravity, magnet attraction and repulsion, and electrical fields).

  - *Assessment Clarifications*
    1. Contact forces are pushes and pulls that result from direct touching of objects.
    2. Non-contact forces are pushes and pulls that result without direct touching of objects. (Gravity, magnets, and electrical fields are examples of non-contact forces.)
    3. A force is a push or a pull that causes an object to change its speed and/or direction in the direction of the force.

- **(P.FM.05.22) - Demonstrate contact and non-contact forces to change the motion of an object.**
  - *Instructional Clarifications*
    1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations changes in the motion of an object either by contact or non-contact forces.
    2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of the force.
    3. Contact forces are pushes and pulls that result from direct touching of objects (for example: a foot kicking a soccer ball, a bat striking a baseball, hand pushing on an object, shoes/feet against a floor).
    4. Non-contact forces are pushes and pulls that result without direct touching of objects (for example: a magnet attracting or repelling another magnet or magnetic material through a distance, gravitational pull on objects on earth and/or in space).
    5. Change in motion is a change in direction, speed or both.

  - *Assessment Clarifications*
    1. Show how contact forces change the motion of an object.
    2. Show how non-contact forces change the motion of an object.

P.FM.M.3 - <u>FORCE</u>:

- (**P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposing directions.**
    - *Instructional Clarifications*
        1. Describe means to tell or depict in written or spoken words how two forces act on an object in the same or opposing directions.
        2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of its application.
        3. Two forces acting on an object in the same direction cause the object to accelerate (speed up, slow down and/or change direction) in the direction of the forces.
        4. Two forces acting on an object in opposing directions can be of equal strength and are, therefore, balanced (zero net force). The result will be that if the object is at rest, it will stay at rest (not move). If the object is moving, it will continue to move a constant speed in a straight line.
        5. Two forces acting on an object in opposing directions can be of unequal strength and, therefore, are unbalanced (non-zero net force). The result will be motion (starting or speeding up) in the direction of the stronger force.

    - *Assessment Clarifications*
        1. A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
        2. Two forces acting on an object in the same direction cause the object to accelerate (speed up, slow down and/or change direction) in the direction of the forces.
        3. Two forces acting on an object in opposing directions can be of equal strength and are, therefore, balanced (zero net force). The result will be that if the object is at rest, it will stay at rest (not move). If the object is moving, it will continue to move a constant speed in a straight line.
        4. Two forces acting on an object in opposing directions can be of unequal strength and, therefore, are unbalanced (non-zero net force). The result will be motion in the direction of the stronger force.

- **(P.FM.05.32) - Describe how constant motion is the result of balanced (zero net) forces.**
    - *Instructional Clarifications*
        1. Describe means to tell or depict in written or spoken words how constant motion is the result of balanced forces.
        2. A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
        3. Forces acting on an object in opposing directions of equal strength are balanced (zero net force).
        4. When all forces are balanced an object that is moving will keep moving in a straight line at a constant speed.
        5. If an object is at rest, not moving, it will stay at rest if all of the forces are balanced.

    - *Assessment Clarifications*
        1. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of its application.
        2. Forces acting on an object in opposing directions of equal strength are balanced (zero net force).
        3. When all forces are balanced an object that is moving will keep moving in a straight line at a constant speed.

4 If an object is at rest, not moving, it will stay at rest if all of the forces acting on it are balanced.

- (**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.
    - *Instructional Clarifications*
        1 Describe means to tell or depict in written or spoken words how changes in motion of objects are caused by a non-zero force.
        2 An object experiencing a change in its motion (speeding up, slowing down, or changing direction) is said to be accelerating. A common misconception is that acceleration is limited to an increase in speed.
        3 A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of the force.
        4 Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
        5 An object at rest will begin to move if a non-zero net force is applied to it. It will move in the direction of the non-zero net force.
        6 An object that is in motion will speed up, slow down and/or change direction if a non-zero net force is applied to it. It will speed up, slow down, or change direction in the direction of the non-zero net force.

    - *Assessment Clarifications*
        1 A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
        2 Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
        3 An object at rest will begin to move if a non-zero net force is applied to it. It will move in the direction of the force.
        4 An object that is in motion will speed up, slow down, and/or change direction if a non-zero net (unbalanced) force.

- (**P.FM.05.34**) - Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.
    - *Instructional Clarifications*
        1 Relate means to establish an association or a connection between size of the change of motion to the strength of unbalanced forces and the mass of the object.
        2 Magnitude (size) refers to a force's strength.
        3 Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
        4 A change in motion is change in speed and/or direction.
        5 Mass is measured in grams or kilograms using a balance. Mass is related to an object’s resistance to changes in motion. The greater the mass of an object the greater force is required to change the motion of the object.

6 The strength of an unbalanced force is the measurement of how strong (greater) or weak (lesser) the push or pull is that causes the change in motion. A weaker or lesser force causes a small change; a strong or greater force causes a larger change in the motion of objects.

- *Assessment Clarifications*
  1 Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
  2 A change in motion is change in speed and/or direction.
  3 Mass is measured in grams or kilograms using a balance. Mass is related to an objects resistance to changes in motion. The greater the mass of an object the greater the force is required to change the motion of the object.
  4 The strength of an unbalanced force is the measurement of how strong (greater) or weak (lesser) the push or pull is that causes the change in motion. A weaker or lesser force causes a small change; a strong or greater force causes a larger change in the motion of objects.

P.FM.M.4 - <u>SPEED</u>: Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

- (**P.FM.05.41**) - Explain the motion of an object relative to its point of reference.
  - *Instructional Clarifications*
    1 Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports or verbally the motion of an object relative to a point of reference.
    2 Motion is relative to something else (point of reference).
    3 A point of reference offers all observers a common frame through which to judge motion and its changes. A point of reference is the point from which movement is determined.
  - *Assessment Clarifications*
    1 Describe the motion of an object in relation to a point of reference.

- (**P.FM.05.42**) - Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.
  - *Instructional Clarifications*
    1 Describe means to tell or depict in written or spoken words the motion of an object in terms of distance, time, and direction.
    2 Speed is the ratio of distance covered per unit of time, S=D/T.
    3 The direction of the motion is in relation to a point of reference. Direction can be described as up, down, right, left, north, south, east, west, forward and backward.
    4 An object's motion can be described in terms of speed and direction.
    5 The term distance describes amount of space between two things or points. Distance is measured in millimeters, centimeters, meters, and kilometers.
  - *Assessment Clarifications*
    1 Speed is the ratio of distance covered per unit of time, S=D/T.

2. The direction of the motion is in relation to a point of reference. Direction can be described as up, down, right, left, north, south, east, and west.
3. An object's motion can be described in terms of speed and motion.
4. The term distance describes amount of space between two things or points. Distance is measured in millimeters, centimeters, meters, and kilometers.

- (**P.FM.05.43**) - Illustrate how motion can be measured and represented on a graph.
  - *Instructional Clarifications*
    1. Demonstrate means to show through manipulation of materials, drawings, and written or verbal explanation with a graph how motion can be measured and represented.
    2. An object's motion can be measured by its position and speed.
    3. An object's position can be measured and graphed as a function of time.
    4. An object's speed can be measured and graphed as a function of time.
    5. Represent motion on a position versus time graph.
    6. Represent motion on a speed versus time graph.

  - *Assessment Clarifications*
    1. An object's motion can be measured by its position and speed.
    2. An object's position can be measured and graphed as a function of time.
    3. An object's speed can be measured and graphed as a function of time.
    4. Represent motion on a position versus time graph.
    5. Represent motion on a speed versus time graph.

BIG Ideas

(Michigan 5-7 Science GLCE companion document)

- Every force is part of an interaction between two objects.
- Forces are pushes and pulls that can be contact or non-contact forces.
- Motion is described relative to something else (point of reference).
- A change in motion is due to unbalanced forces.
- No change in motion and an object at rest are due to balanced forces.

Vocabulary

(Michigan 5-7 Science GLCE companion document)

Critically Important State Assessable

- balanced force
- change of direction
- change of motion
- change of speed
- constant speed
- direction of motion
- force
- force strength
- friction
- graph
- gravitational force
- magnetic attraction
- magnetic repulsion
- mass
- normal force
- relative position
- speed
- unbalanced force
- zero net force / non-zero net

PART 1

Learning Goals

Describe the Science Process GLCEs and Standards that you will address in your unit, and give examples of how you might address these standards in the unit.

Michigan Grade Level Content Expectation
Inquiry Process
(S.IP.05.11) - Generate scientific questions based on observations, investigations, and research. • Watch a short movie clip of actual people sledding. Based on the observations of the movement of the sleds, inquire as to what is causing the specific movements. Build off this idea and formulate the question "how does sledding work?" • Using sleds (scooters with wheels) students will investigate how to make their sled move and not move. What are things that students can do / not do, which will affect the movement of the sled? How can we make the sled move? • Observe how their actions of push/pull affect the sled's movement. • Watch a short movie clip of a high speed car chase. Based on the observations, construct questions as to how the police officer can tell that the car is speeding. Build off of this idea and formulate the question "How do we measure speed?" **(S.IP.05.12) - Design and conduct scientific investigations.** • Students will plan out what materials and procedures they would go through and how they would collect data to test the speed of a dropping ball to gain ideas to solve the question "how do we measure speed?" Students will work in small groups to conduct the experiment they designed according to their planned materials, procedures, and data collection techniques. • Students will work in their table teams to develop a plan to win the teacher sled race. They will work to develop their plan on paper (in the form of a free write) explaining the things they will do to make their teacher's sled move faster than the other team's sled. • Investigate using a sloped/slanted board and different materials (popsicle sticks, yarn, string, cloths of different materials, bottle caps, etc.) accomplish the goal of rolling a marble down the board as slow as possible. Students will work in groups to try to make their ball move as slow as possible and use experimentation to try different techniques to accomplish this goal. • (OTHER idea) After showing a video clip of the 4 teachers sled racing ask the question: If there were four different sleds to choose from, how could we tell which one is the fastest? Ask students to share their initial ideas. Write them on the board. As a class explore their ideas. Tell them that we have 4 hills (books and wood planks), and we have 4 sleds (4 blocks of wood. 1 wrapped in sandpaper, 1 wrapped in wax paper, 1 wrapped in plastic wrap, and 1 that is just wood.) Ask students in their groups to design an experiment to try to figure out which sled is the fastest. How should we set up the materials? What

procedures do we need to follow during our experiment? How will we know which sled is the fastest? What do you think will happen?

(S.IP.05.13) - Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens) appropriate to scientific investigations.

- Using stopwatches, time how long it takes a ball to fall a specific distance and record the time trials to find out how long it takes a ball to drop a specified distance.
- Use yardsticks and/or measuring tapes to determine the distance that a falling ball will travel.
- These two activities will help students begin to solve their question "How do we measure speed?"
- (*OTHER idea*) Using stop watches and tape measures to record and set up the teacher sled race. Record the time it takes to go from the starting line to the finish line and record that set distance. This will investigate the real world question of who is faster and lead into ways of asking the purposeful question "Is there ways to make our sled faster?"

(S.IP.05.14) - Use metric measurement devices in an investigation.

- (*OTHER idea*) Use metersticks and/or metric measuring tapes to determine the distance that a ball travels when it is dropped from a certain point.
- (*OTHER idea*) Use metersticks and/or metric measuring tapes to determine the distance of the movement of sleds in a sled race.

(S.IP.05.15) - Construct charts and graphs from data and observations.

- Students will create a T-chart for organizing their investigation of how to make their sled move.
- Students will create a chart for organizing their data/observations for which teams win the sled race and what causes affected the outcome.
- Students will collect three time trials for each height from which they drop a ball. They will also record the heights of each ball drop. Using their data, students will plot points on a graph to examine the patterns between time and height (distance the ball moved).

(S.IP.05.16) - Identify patterns in data.

- Examine charts and graphs created from experiments to see any patterns that may arise.
- Conduct several experiments with forces and motion and record data to look for patterns.
- Use graphs of data collected in the Ball Drop Experiment to analyze and identify patterns of the relationship between time and height (distance the ball moved).

Inquiry Analysis and Communication

(S.IA.05.11) - Analyze information from data tables and graphs to answer scientific questions.

- Examine the charts created using data from experiments, such as dropping a ball, that may explain the phenomena observed.
- Analyze tables and graphs of data collected from timing a ball as it falls specific measured distances.
- As a class, share observations and experiences from the T-Chart that they organized their data for what actions moved/didn't move their sled and develop an explainable pattern or rule to explain how to make a sled move.
- (*OTHER idea*) Using data and observations collected from the teacher sled race, investigate and formulate

patterns that explain how they were able to make the sled move faster.

- (*OTHER idea*) After collecting data to determine which teacher's sled is the fastest, ask students to take some individually to reflect on their experiment. What were the patterns we observed? Why did we get those results? Do they support your hypothesis, or do you now have a different idea about which one is the fastest? As a class decided on which sled was the fastest. Try to explain why? (less friction, which is an opposing force allowed it it to move faster.)
- (*OTHER idea*) Analyze tables and graphs of data collected from timing cars that drive by in front of the school to identify different car speeds and check for speeding.

(S.IA.05.12) - Evaluate data, claims, and personal knowledge through collaborative science discourse.

- Participate in partner, group, and whole class discussions to analyze experiences, see patterns, and form explanations created from the sled race experiment, teacher sled race, impression 5 experiences of making a ball move as slow as possible, Ball Drop Experiment, and other shared experiments as well as personal experiences.
- Engage in a U-class discussion (physically moving the desks into a U so all students have visibility of one another) and assign them the goal of talking their experiences from the "Make your sled move" investigation and use them to create a rule or pattern that could be applied and followed all the times to achieve the result of moving the sled. (*OTHER idea*) If appropriate and student learning is ready, help to guide the new goal to shift towards figuring out a pattern or rule for moving the sled in specific ways (fast, slow, turning, going over jumps).

(S.IA.05.13) - Communicate and defend findings of observations and investigations using evidence.

- After rules have been established by the class that explain how to make a sled move, introduce scientific knowledge through texts and determine if their rule "fits" with the research and knowledge that the scientific community has established.
- Use graphs created from data collected during the Ball Drop Experiment as evidence to explain and defend findings and observations.
- Use illustrations or recreations of experiments to prove theories to classmates.
- Discuss and defend these assertions during both small group and whole class discussions, as well as individually in quick-writes.

(S.IA.05.14) - Draw conclusions from sets of data from multiple trials of a scientific investigation.

- Use charts/records from the Ball Drop Experiment to look at the patterns that may explain how to measure speed. Students will conduct this Ball Drop experiment and recreate the experiences several times to gain numerous sets of data that may lead to patterns that will lead to explanations. Students will record the time it took for a ball to drop from different recorded heights. Students will choose different heights to drop the ball from and do three time trials at each height and plot the recorded data on a graph and analyze the patterns shown from the graph.
- (*OTHER idea*) Using a "mini skateboard," have students design a ramp and test the speed of their skater. Allow for different factors to be involved (weight of skater / size of skater / height of incline / materials of ramp). Using a "Goldilocks chart" (too fast, too slow, just right) have them organize their different models and record the speeds of the skateboarder. Using this data, students will draw conclusions of visible patterns.
- (*OTHER idea*) After recording the speed of their homemade "blimp" [balloon on a straw on a string] or compare it to something more real life for them - new classroom instant messenger (add requirement that they must attach a note) / give them multiple supplies to make their blimp (big balloon, small balloon, big

straws, small straws, different kinds of string, yarn, twine) students will try to identify and explain different visible patterns.

(S.IA.05.15) - Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

- Use grade appropriate texts to read and introduce scientific knowledge. Students will use these definitions and laws/ideas about force and motion to evaluate the strengths of the class created rules for making a sled move based on observations and experiences of investigations/experiments.
- Analyze records/charts created from the Ball Drop Experiment, as well as personal experiences to find patterns that will help explain the phenomena. Also analyze the records and charts to determine what will help solve "how can we measure speed?"
- Using patterns found from the Ball Drop Experiment, determine the merit of conclusions that explain how to measure speed.

Reflection and Social Implications

(S.RS.05.11) - Evaluate the strengths and weaknesses of claims, arguments, and data.

- Students will discuss and defend the conclusions they made from the patterns and data collected from their different experiences (Making the Sled Move, Teacher Sled Race, Sledding Videos) with classmates to determine if there are better explanations. Students will compare their class-created explanations to the scientific explanations found in textbook and other sources. This will help them to evaluate/compare the strengths and weaknesses of their own claims, arguments, and data.

(S.RS.05.12) - Describe limitations in personal and scientific knowledge.

- Through discussion, determine aspects of forces and motion that we cannot test in the classroom (sledding outside because of lack of snow) but understand that we can supplement by using our personal experiences and adapt them to help support these limitations in understanding force and motion.
- Identify the reasons why we cannot test the speed of speeding cars outside the classroom (dangerous, lack of tools, etc.).
- Identify and describe any human error in the Ball Drop Experiment and how these errors affect the data collected.

(S.RS.05.13) - Identify the need for evidence in making scientific decisions.

- When designing the Ball Drop Experiment, discuss the need for collecting data and decide what data should be collected to help solve the question "how do we measure speed?"
- Use given data, such as the distance a car travels and how long it takes to travel that distance, to determine the speed of the car.

(S.RS.05.15) - Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

- Create sketches, take photographs, and provide other depictions necessary to explain or give evidence of observations during the sled race and the Ball Drop Experiment.
- Recreate or illustrate personal experiences with force and motion.
- Illustrate and record observations seen during the Ball Drop Experiment to provide evidence and data to analyze after the experiment is over.

- Take notes and draw labeled illustrations of the forces and motion that affect sleds as they move down a hill and across flat ground, including what forces were acting on the sled as that caused it to move.

(S.RS.05.16) - Design solutions to problems using technology.

- Determine how to test how fast a ball will fall using a stopwatch and other necessary tools.
- Use evidence from personal experiences as well as the Ball Drop Experiment, and the graphed data, to construct explanations of how police measure how they know if a car is speeding.

(S.RS.05.17) - Describe the effect humans and other organisms have on the balance in the natural world.

- Use experiments, such as the sled race, to explain the effect of balanced and unbalanced forces on the motion of an object. Discuss what happens when a larger force is applied to the sled. Discuss what happens when a push and a pull in the same direction are applied to the sled. These real life examples will help students to see purpose in the outcomes of different forces in that we need different types/strengths of forces to complete different tasks. Class discussion about these topics will help to explain how forces such as gravity, friction, and physical contact affect the motion of an object.

(S.RS.05.19) - Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures

- (*OTHER idea*) Discuss scientists such as Newton and how his theories have influenced our understanding of the world around us.
- (*OTHER idea*) Discuss how police radar guns work to tell the speed of a moving vehicle.

Content Standards

P.FM.M.2 - FORCE INTERACTIONS

(P.FM.05.21) - Distinguish between contact forces and non-contact forces.

- (*OTHER idea*) Investigate the different ways to make a sled move: downhill movement (gravity - non-contact force), pushing it (contact force)
- (*OTHER idea*) Investigate the different ways to make a ball move: dropping it (gravity - non-contact force), moving it with magnetism (magnetic forces - non contact force), pushing it (contact force)
- (*OTHER idea*) Investigate friction using inclined plane and different surfaces. Allow students to investigate if sleds made out of different materials would impact their speed : cover inclined plane with sandpaper, cover inclined plane with wax paper

(P.FM.05.22) - Demonstrate contact and non-contact forces to change the motion of an object.

- (*OTHER idea*) Investigate having to move a ball through a maze under different conditions: allowed to touch it (push and change directions), not allowed to touch it (wind / gravity / inclined planes)

P.FM.M.3 - FORCE

(P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposing directions.

- (*OTHER idea*) Students must first have a concrete frame of reference/experiences with being able to explain and describe what happens when one force acts on an object. Simple simulations like pulling and pushing different objects (like a sled) are needed first. Before focusing on what happens as you sled down

a hill (downward force of gravity, horizontal force of push and friction), students need to understand them separately and the unique and individual roles they play.

- Drop a ball and observe the force(s) acting on it (gravity)
- (*OTHER idea*) Use equal forces (own strength) to pull/push an object in opposite directions.
- (*OTHER idea*) Use unbalanced forces (different strengths) to pull/push an object in opposite directions.
- (*OTHER idea*) Determine the forces and their directions that are acting on a ball when moving it through a maze.
- (*OTHER idea*) Determine the forces and their directions that are acting on a magnet as it moves in different directions. Give students the opportunity to experiment and investigate the interactions that result from different magnets acting on one another.

(P.FM.05.32) - Describe how constant motion is the result of balanced (zero net) forces.

- Investigate the different forces acting on a ball as it drops to the floor.
- (*OTHER idea*) Determine the forces acting on a magnet as it stays in a constant motion.
- (*OTHER idea*) Investigate the different forces acting on a billiards ball as it is hit towards a pocket.
- (*OTHER idea*) Investigate the different forces acting on a ball as it moves through a maze.
- (*OTHER idea*) Determine the forces acting on a balloon as it moves in a constant motion.

(P.FM.05.33) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

- (*OTHER idea*) Determine the forces acting on a magnet as it changes direction or speed.
- (*OTHER idea*) Determine the forces acting on a ball as it changes direction or speed moves in one direction.
- (*OTHER idea*) Determine the forces acting on a balloon as it changes speed as it moves in one direction.

(P.FM.05.34) - Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

- Sled Race: Students will measure the time it takes to pull different weights across a finish line from the same point of reference. They will then relate the time to how much effort was needed to overcome the frictional force of the specific masses being moved.
- (*OTHER idea*) Rollercoaster investigation: Using marbles, rubber hose cut in half, and plastic cup create a rollercoaster with different specifications. http://www.youtube.com/watch?v=3NMXPsBcvVM (Add requirements of measuring and drawing design) This requires students to know that multiple forces are acting on the object at the same time. For example, constant gravity, impulse forces from hands, and the objects are moving up, down, sideways, and in circular motion. All of these things make it difficult to analyze motion to 'see' what it's doing. This example will be used as a culminating one rather than an initial one.
- (*Other idea*) Basketball investigation: Measure force needed to shoot a basket upwards. (miniature scale using springs) Shoot different weighted balls into the same basket. Students can calculate shot statistics. This requires students to know that multiple forces are acting on the object at the same time. For example, constant gravity, impulse forces from hands, and the objects are moving up, down, sideways, and in circular motion. All of these things make it difficult to analyze motion to 'see' what it's doing. This

example will be used as a culminating one rather than an initial one.

P.FM.M.4 - SPEED

(P.FM.05.41) - Explain the motion of an object relative to its point of reference.

- Drop a ball from a specific height. Ask students to describe the movement of the ball relative to its point of reference/where it started. Ask students what caused the ball to move since there was no push or pull.
- (*OTHER idea*) Balloon Message Sender - Describe the direction and speed of the balloon using known aspects of its path as it travels from one point to another.
- (*OTHER idea*) Ask students, seated at their desks, if they are in motion. Have a few students answer aloud and challenge them to justify their answer. On the board, record justifications for "yes" and "no". It is not necessary to select a correct answer at this time; instead, students must discover that all motion is relative. So, point out that all of the answers could be correct, depending on the "reference point". Tell students that it is very important to be able to describe the motion of an object and in order to describe an object's motion you have to know where the object is. The location of any object is its position. Guide students to conclude that a position is always described by choosing a reference point. At the end of the activity, return to the original question and ask students if they are in motion. This time ask them to give a reference point. Students who use the earth as a reference point will understand that we are in constant motion with the earth. Students who choose the floor, the wall or other points that are considered to be stationary will say that they are not moving. Point out that their motion is "relative". Later students will explore measuring and describing their motion relative to a fixed point.

(P.FM.05.42) - Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

- Time and measure the distance of the movement of a ball as it drops from a specific height.
- Describe the point of reference of the ball as well as its movement in terms of direction, time, and distance.
- Determine the speed of the falling ball as it moves from its point of reference to its endpoint.
- (*OTHER idea*) Balloon Message Sender: Attach a balloon on a straw which is on a string. Measure the speed of the balloon using distance traveled and time of travel. Determine different forces acting on balloon and the affect they have on the balloon's speed. http://www.youtube.com/watch?v=VwpBQtvmqUE
- (*OTHER idea*) Hallway Speed: Measure the length of hallway from classroom to lunchroom. Time partners as they walk from the room to the lunchroom. Time the whole class walk from the classroom to the lunchroom. Determine the speed of individual walk time and class walk time. Compare and contrast the differences.

(P.FM.05.43) - Illustrate how motion can be measured and represented on a graph.

- Draw graphs of time vs. distance using data collected from the Ball Drop Experiment.
- Use measurement of time and distance to plot points on a graph. Discuss the patterns of movement and causes of this movement using the graph.
- (*OTHER idea*) Create charts to show and compare which version of the straw balloon is fastest.

EPE Chart for FORCE & MOTION Grade 5

Experiences	Patterns*	Explanations*
Watch a sledding video to introduce the topic and develop the question "How does sledding work?" Move a "sled" (scooter with wheels) in the gym in as many different ways as possible. Impression 5 field trip: Making different objects move and observing the effort/types of forces required. Create a ramp with materials that will cause a marble to take the longest possible time to reach the bottom. Homework: Go sledding. Push my teachers in a sledding race and see which team and cross the finish line first. Watching a sledding video to identify the different forces acting on the sled and how they affect the movement of the sled. Time how long it takes for a ball to drop. (*OTHER idea*) Examine the movement of a hacky sack whiffle ball as it drops. (*OTHER idea*) Examine the movement of a billiards ball being	More force in any one direction than another, causes an object to move in that direction (**P.FM.05.33).** Objects can move particular distances over time at the same rate, which is defined as speed (**P.FM.05.42).** It takes longer for an object to move a longer distance than a shorter distance (if the objects are moving at the same speed.) *The speed of the objects is not expected to be a part of the patterns students will make at this point (**P.FM.05.43**).	Unbalanced forces cause objects to change direction and location (**P.FM.05.33)**. Friction, gravity and other forces either increase or decrease the speed and direction of an object (**P.FM.05.42).** Speed is measured in the distance that something moves divided by the time it takes for the object to move that distance (**P.FM.05.43**).

shot across a table. (*OTHER idea*) Examine the movement of magnets using different tools (magnet, hands, gravity, etc). (*OTHER ideas*) Move a ball through a maze using different tools (wind, gravity, ramp, etc). (*OTHER idea*) Time the movement of a balloon taped to a straw on a string.		

* Document each statement with the code for national standards benchmarks or other source.

Unit Central Question and Model Response

Q: How does sledding work?
A: Sledding is an exciting activity because it uses force and motion for enjoyment. Understanding the different components of how sledding works is important because can help a sledder to accomplish different goals like not crashing, going fast, staying safe, and more.

When observing a sled laying on the ground, even though it is not moving there are still many forces acting on it. Gravity, the force that pulls an object towards the center of the earth, prevents the object from floating. Without gravity, objects would simply float in space making it difficult to sled down a hill. Gravity on earth is strong enough to keep us from floating away into the atmosphere, but not strong enough to compress us or squish us like it is on certain different planets with a very strong gravitational pull. The gravity pulls the mass or weight of the sled down towards the ground and the center of the earth. Resisting gravity is the force that pushes back from the ground. This is called the normal force, or the force perpendicular to the surface of contact like the solid ground which prevents objects from penetrating the surface. When the sled is not moving these two forces are balanced and result in no movement. If no one or nothing interacts with the sled, it will sit there forever.

In order to move the sled, for example across a flat snowy field, a sledder must exert a force, a push or a pull that changes the speed or direction of an object, strong enough to overcome any opposing forces, like friction. Friction is a force that resists movement and acts in resistance to an exerted force. The more friction between two objects, the more force required to move them. A sledder doesn't have to work as hard to move their sled across a field during the winter when there is snow, compared to the summer when there is grass and dirt, because snow and ice are very slippery surfaces that do not produce a lot of friction when they come into contact with other objects. Also, sleds are designed out of materials that reduce the amount of friction. For example slippery plastics or smooth metals glide easily across the snow because there is not a lot of opposing forces interacting between the two smooth and slippery surfaces.

A sledder can pull their sled across a field. While this would be easy because the sled would be light, it wouldn't be much fun. If the sledder wanted to move in their sled, they could push themselves using their hands, but this would require a lot of strength and force to push their own body weight. If the sledder brought a friend to push or pull them it would be more fun. They would not have to exert any force in order to move with the sled because the work would be done by their friend who is pushing or pulling with enough force to overcome the opposing force of friction and the force of gravity and move the sled. It will take some work for the friend to push/pull the sled with the sledder in it because now they have to exert a stronger force to overcome a larger force of gravity acting on the sled and the sledder. The total force of gravity has increased because now gravity is pulling the mass of the sled and the sledder down towards the ground. As you increase the mass of an object, you increase the force of gravity pulling down on that object.

By changing things like the amount of force, friction, or weight, you can also change the speed of the sled, or the time it takes to travel a certain distance. In order to make the sled to move faster, moving a set distance in a shorter amount of time, you have a couple of options. You can increase the force, so get someone stronger to pull or push you or you can decrease the friction, by clearing away and fallen sticks, leaves, and making sure the area is extremely icy and slippery. To decrease the speed of the sled and go slower, you have to increase the friction or decrease the amount of force pushing/pulling on the sled.

If a sledder doesn't have a friend to pull them, then in order to move fast without having to exert much effort they will need to use a large hill. When going down a hill, the sled is being pulled downward towards the center of the earth to the lowest possible point. All of the same forces still apply. The force of friction, while small, still pushes against the downward motion of the sled. Normal force pushes back perpendicular to the slanted line of the ground so the sled is able to stay on the snow and the ground, and the force of gravity pulls the sled downward with enough force to overcome that of friction.

Q: How can we make our sled move? (*NEW idea) How can we make our sled move in specific ways in order to make sledding more fun? For example, faster, slower, over jumps, etc.)
A: In order to make a sled move faster you must decrease the friction, and increase the force. To make it go slower, you must increase the friction, and decrease the force.

Q: How long does it take a ball to fall?
A: It takes the same ball different times to fall depending on how far it falls. If it falls for a longer distance, then it takes it longer to fall. If the ball falls from a shorter distance, it takes less time for the ball to fall.

Q: How can we measure how fast the same ball falls?
A: The speed of the ball is relatively the same if dropped from a longer distance or a shorter distance (within the classroom). Gravity forces the ball to fall to the floor at a certain speed. Since there are no other forces acting on the ball (i.e. tossing it up in the air, throwing it towards the floor), the speed of the falling ball should be relatively the same each time trial. However, human error can affect the accuracy of the time trials and the calculated speed. The measurement of the speed of the ball depends on how long it takes to travel a certain distance. In other words, the speed is measured in distance divided by time.

Central Question *OTHER Ideas* - (real world / motivating / investigating question)

Q: (*OTHER idea*) How can we help our basketball team make more baskets?
A: (OTHER idea) The basketball has mass. Gravity (a non contact force) is acting on the ball. The basketball player has to throw the ball with a force that is greater than the force of gravity to make it to the basket. You and your hand provide the contact force that gets it going. Gravity acting on the ball causes it to start falling and speeding up in the direction of the ground. When it hits the ground it stops which is another change in motion. In order to help our basketball players make more baskets we could encourage them to become stronger because the more force they are able to apply to the basketball as they shoot it, the farther distance it will travel. We can also explore ways of helping them run faster. More friction on the bottom of their shoes help them to run faster. We know if they are exercising that their bodies will build up more muscle and be able to exert a strong force which will increase their body's speed. We can measure their growth as athletes by timing their speed and strength of their force (lifting weights) and use that data to see change over time and growth.

Q: (*OTHER idea*) How does a rollercoaster move?
A: (OTHER idea) Friction and gravity are two forces that are acting on a rollercoaster as it goes down a ramp. Gravity affects the rollercoaster as it goes down the ramp by pulling it down. This makes it go faster. Friction affects the rollercoaster by slowing it down. When the wheels move along the metal the two forces push against each other causing the rollercoaster to slow down.

Q: (*OTHER idea*) Are the cars that drive by Attwood speeding? How do we know? Why is it important that they are not speeding?

A: (*OTHER idea*) We can tell if a car is speeding by first identifying that it is moving. We do that by choosing a reference point and observing if the object is changing distance or direction based off that reference point. To measure speed, we observe that object moving a certain distance and measure that over how long it took for that object to move that distance. It is important for cars not to speed because if they needed to suddenly stop (and the likelihood is high in front of a school with so many children around) that it would take more force and time to stop an object moving at a higher speed.

Q: (*OTHER idea*) Precious' dad is a stock manager at Meijer. He moves a lot of heavy boxes around to get the merchandise where it needs to go. But he needs your help. He has to train a new group of workers who don't know very much about how objects move. What advice would you give him for moving objects around, and what should his workers know?

A: (OTHER idea) It is easier to move an object when you don't have very much friction. The more an object weighs, the harder it is to move because it requires more force. When using a contact force (pushing or pulling the object yourself) you have to be part of the chain - meaning at some point you have to be pushing or pulling the object or an object connected to the original object, or causing something else (a simple machine) to be pushing or pulling the object). If using a noncontact force like gravity to move an object, force the object is in motion, it will move without you exerting a force on it until it comes in contact with a force that is great or equal to that of gravity.

PART 2

Pre-Assessment Assignment Instructions

Pre-assessment Assignment
Assessing Your Students' Resources for Learning

One of the important things for teaching effectively is to find out more about your students – particularly with respect to the subject matter or learning goal you will be teaching and their ways of knowing about the world – so that you can help bridge your learners with the subject matter. What do they know or think? Where are they coming from? What do they wonder about? How do they reason about the world? What kinds of experiences have they had? What can they do well and what will they need help in doing? Finding out such things is especially important for teachers who are teaching in a brand new situation (new school, new grade, new topic, etc.) and is always important for understanding individual learners since all people are unique.
This assignment is designed to help you find out more about where your students are so that you can better design and anticipate your science teaching. This means that you will need to find out what kinds of things your students already know and have experienced around your topic. You need to find out how they are reasoning about the topic and what kinds of funds of knowledge they can leverage and what are their ways of being (See references to these ideas in the readings). Remember that the best-designed lesson or unit is useless unless it helps **your** students learn and participate.

In order to do this, you will be exploring your students' science toolkits with two assessments or tasks, an interview or small group talk, and a small group observation. You will then analyze and interpret your students' prior knowledge and reasoning, incorporating what you know about any special needs your students have.

This assignment has two due dates: January 24 for the draft design of the 2 tasks and interview questions, and before your teaching (suggested Feb 14th) for your written interpretation of your students' conceptions, experience, and funds of knowledge. This gives you two weeks to perform the pre-assessment and write up your analysis after getting feedback.

1. **Students' Ideas and Reasoning (Two Assessments or Tasks)** – Design, administer, and interpret 2 tasks aligned with your learning goals to understand what ideas and reasoning your students bring to learning about your assigned unit. (See examples of pre-assessment assignments for ideas.) Choosing meaningful tasks that can give you useful information for your teaching is the most challenging aspect of this assignment. If you ask simple recall or vocabulary questions, you have very little information about what students really understand and know how to do. Choose at least one open-ended task that asks for a follow-up explanation or reasoning (e.g., Draw a picture of how the drum makes the sound and how this sound gets to my ear. Use words to describe how and why this happens.)

2. Students' Cultural Resources for Learning (Small Group Talk and Observation) Design, administer, and interpret a small group meeting/talk to assess students' funds of knowledge. Make sure you ask students questions about their everyday and life experiences they have around the topic you will be teaching. You'll be surprised at what they tell you! Also, spend some time observing a small group of students participating in science or other related school topic and in an informal situation (e.g., free time, recess) to understand their ways of participating in science and their ways of being that can be resources for learning science.

3. Students' Special Needs – From what you know about your students' needs and what your MT can share with you, identify any special needs your students have, the implications for your planning and instruction, and how you will accommodate these needs.

Your assignment will be graded according to (a) the quality of the tasks and questions you design/administer (b) the quality and reporting of the analysis; the accuracy and depth of your analysis as well as the supporting evidence for the claims made, and (c) the thoughtfulness of the implications for your teaching.

PART 2 - #1

Student Ideas and Reasoning: 2 Assessment Tasks

Reiteration of Learning Goals:

Students will be able to...

- Describe the speed of an object in terms of distance traveled over time.
- Identify forces acting on a moving object as well as objects at rest.
- Illustrate how an object moves
- Collect, interpret, and analyze collected data.
- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.
- An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

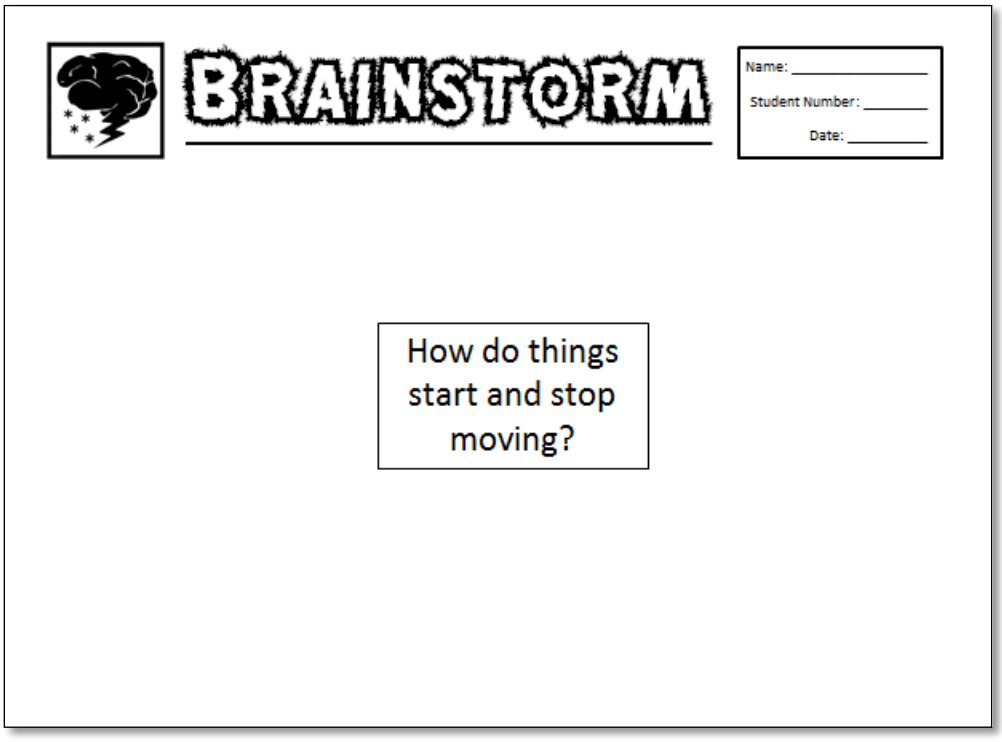
Pre-Assessment #1 – Brainstorm Web

Task Label: HOW do things move?

Task Description: The pre-assessment task was focused on the Big Idea of the entire unit: force and motion. The students were given a concept map (bubble map) to fill out and given a question as a prompt for their ideas. The question the students had to brainstorm about was: "How do things start and stop moving?" This pre-assessment prompt was open enough for students to give their own examples, and not to direct their thinking in any particular way. Students were completely free to write anything that came to their minds, which then allowed me to pre-assess ANY ideas they have prior to formal instruction about force and motion. (https://www.msu.edu/~zenkcarl/PDF%20files/Portfolio_PDF/TE804_Assignment3.pdf)

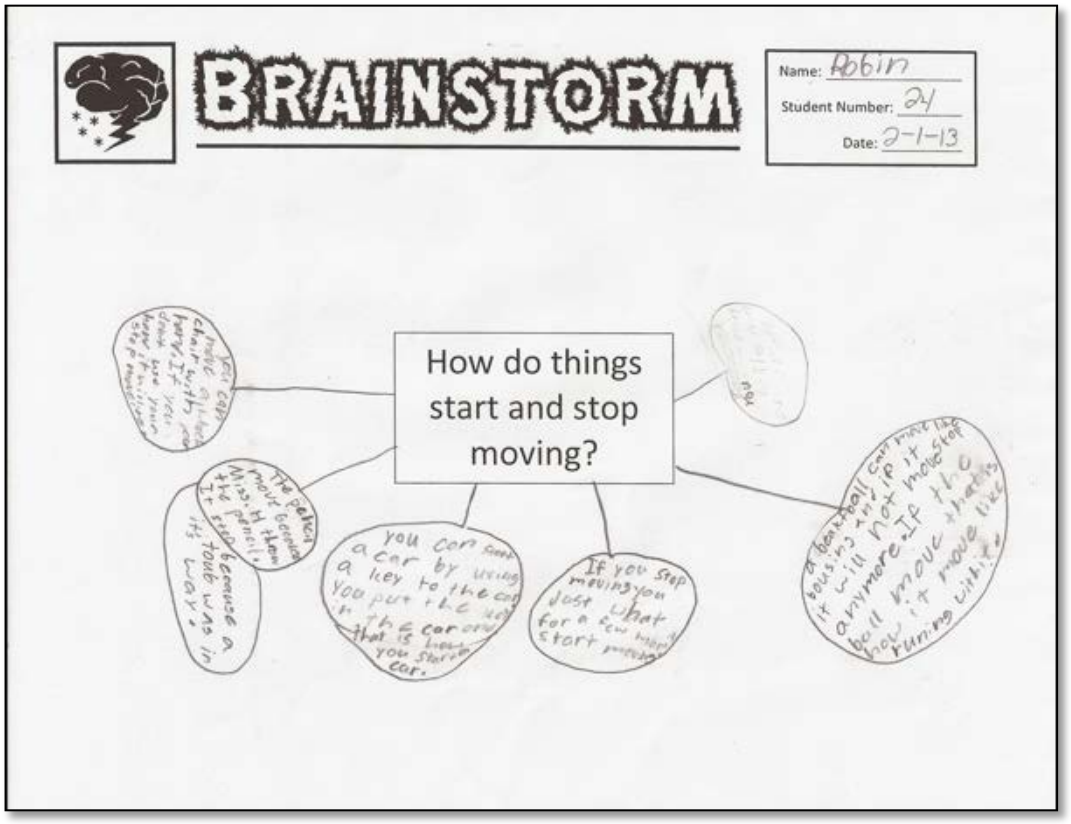
If students are stuck or unable to come up with an idea, introduce an illustration of a soccer ball at rest on the ground. Then, they will be asked to draw and write to explain HOW the ball will move when a player kicks it (which way it will move, what make the ball move, will the ball stop, what will stop the ball, etc. and explain why these things are happening?)

Rationale (What you hope this task will help you probe or understand about student thinking): This task will allow us to understand what students already know about force. Do they use common vocabulary like force, friction, mass, speed, etc. A soccer ball is something that they are very familiar with and the act of making a soccer ball move is something they have experienced before outside at recess.



Student Responses for Pre-Assessment #1

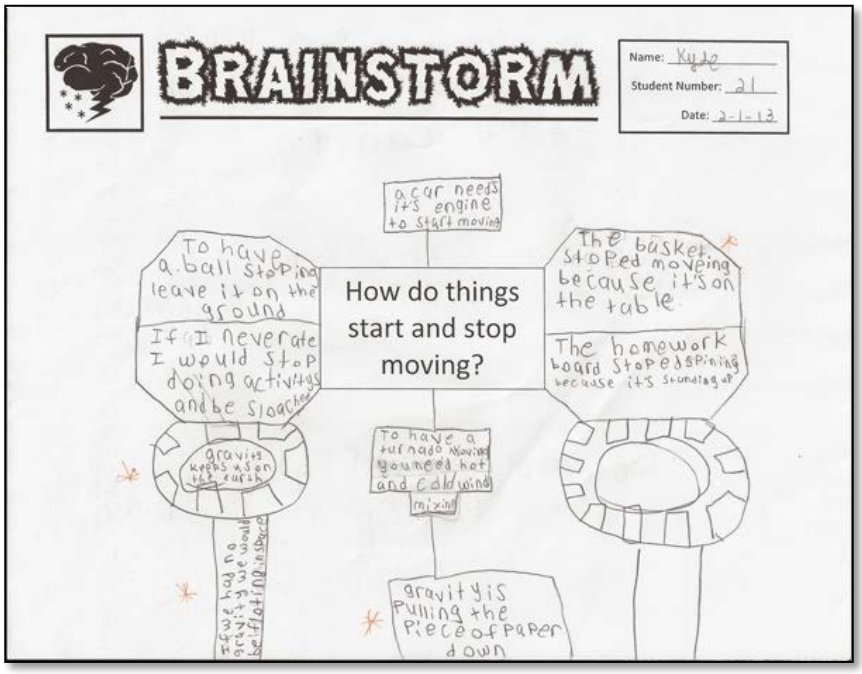
Student Response #1

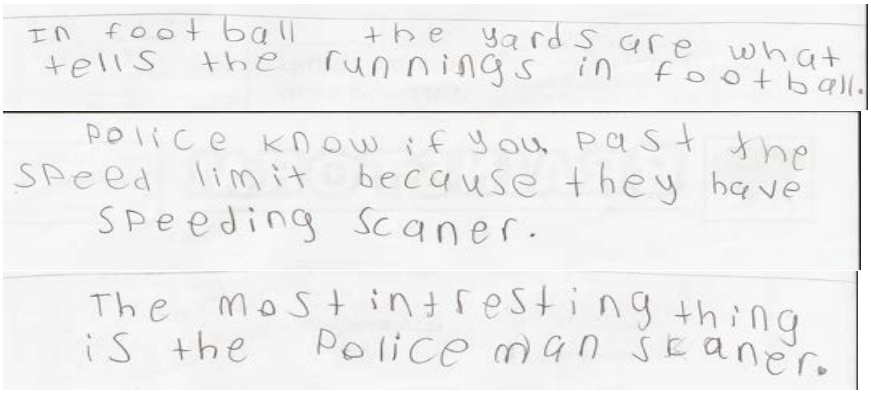


Interpretation #1

- Student 2 also thought of a car moving at first, but his thoughts were more focused on the movement rather than turning a car on/off. He said, "a car moves with gas and it stops with the brakes." He seemed to understand that it took a certain action to get the car moving, as well as an action to stop the car's movement. He also said that, "the wind moves a plastic bag and stops because the wind stops." This showed me that he was thinking specifically about the force acting on the object - if the force (wind) stops, the object stops moving, and vice versa. From these responses, it seems he may have some of the same misconceptions as Student 1 - the idea that there are multiple and opposing forces acting on an object. Student 2 also added that "you throw something and it stop[s] because of gravity." This showed me that he knew some scientific vocabulary, but did not really demonstrate whether or not he actually knew how gravity was acting on an object since he did not explain how gravity would stop the object.

Student Response #2




In foot ball the yards are what tells the runnings in football.

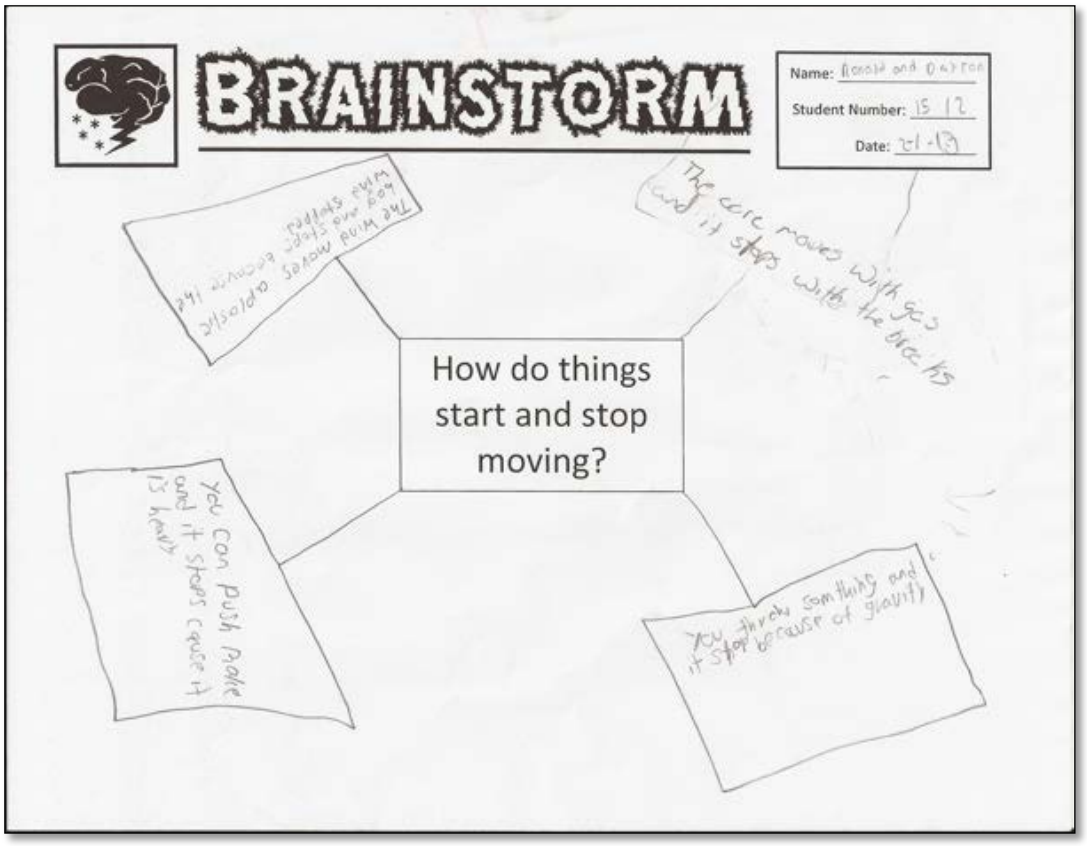
Police know if you past the speed limit because they have speeding scaner.

The most interesting thing is the Police man scaner.

Interpretation #2

- "You can start a car by using a key to the car. You put the key in the car and that is how you start a car." This was his first response to the question, "how do things start or stop moving?" His initial thoughts were obviously of machinery because he also began to explain how to "start" a computer. However, after I prompted his thinking by pushing a pencil across the desk and asking him how it started and stopped moving, his response was "the pencil move[d] because Miss H. threw the pencil. It stopped because a tub was in its way." Here he began to show recognition of pushes and how they affect objects. He recognized that the pencil moved because I used a specific force to move it. This particular student struggles with writing, so I think his explanation would have been a little more extensive if he were able to share his thoughts orally. One area I think he might be struggling with, or have misconceptions about is the idea that there are multiple and opposing forces acting on an object. Since he stated that the pencil stopped moving because the tub was "in its way" tells me that he might have the idea that the only force acting on the pencil was the force of me pushing it in one direction.

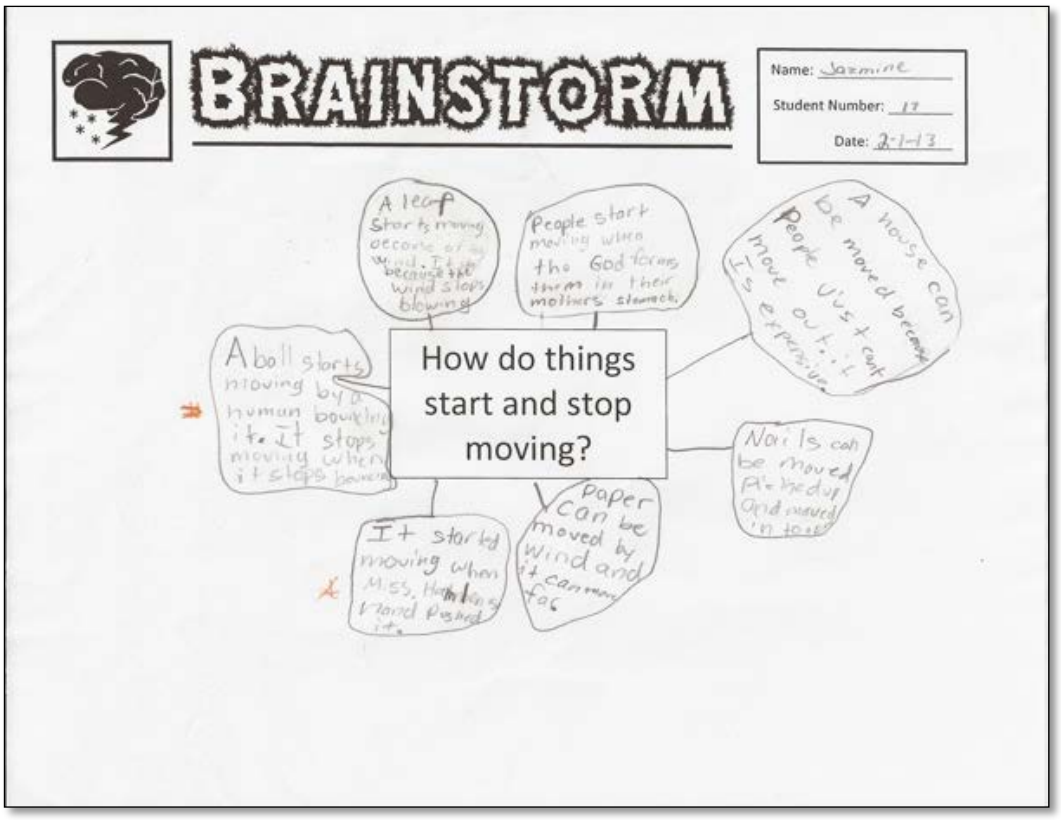
Response #3



Interpretation #3

- Again, Student 3 began his thinking about movement with a car; he said, “a car needs its engine to start moving.” However, he added many other ideas such as, “to have a ball stop moving, leave it on the ground - gravity keeps us on the earth, if we had no gravity we would be floating in space.” This use of vocabulary actually illustrated his understanding of what gravity is and what it does to objects. He also said “if I never ate, I would stop doing activities.” This shows that he is relating the question to his personal experiences or knowledge - he realized that his personal movement requires fuel. Although this is not directly related to the purpose of our unit, it still illustrates his ability to make sense of phenomena by drawing conclusions from personal experiences.

Student Response #4



Interpretation #4

- Student 4 had some different ideas than the first three students. Her first response was "people start moving when the god forms them in their mother's stomach." I thought this was a very unique answer to the question, but her point of view showed that she was thinking of this question in a personal way because he mother is going to have a baby soon. However, she did begin to demonstrate understanding of force and motion when she said that "a ball starts moving by a human bouncing it. It stops moving when it stops bouncing." This showed me that she realized that it takes some sort of force to move an object. Her misconceptions are very similar to the other students' misconceptions in that she does not show an understanding of the fact that there are multiple and opposing forces acting on an object.

Pre-Assessment #2 – Show what you KNOW!

Task Label*:* Show what you KNOW!

Show what you KNOW!

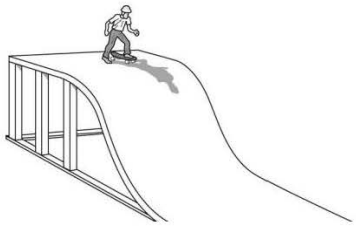
Name: _____

Student Number: _____

Date: _____

Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using physical science. Use your prior-knowledge of force and motion to help you in attempting to answer the following question. **Simply do your best**!

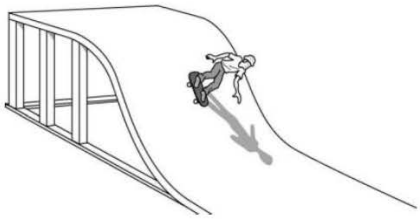
Chris pushes off the ramp platform with his right foot.



1. What force acts between Chris's foot and the platform as he pushes off?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

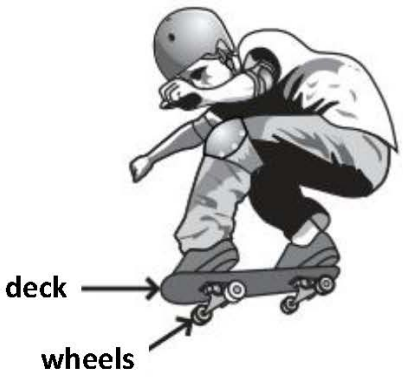
He quickly places his foot back on the board and rides down the ramp.



2. What force acts to pull Chris down the ramp once he begins his downward motion?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

Chris attaches a sheet of sandpaper to the surface of the skateboard deck.



3. What purpose does the sandpaper most likely serve?

- ○ **A**: It provides a protective coating to help prevent damage to the skateboard.
- ○ **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- ○ **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ○ **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

4. How sure are you that you knew the right answer for question 1?

- ○ **A**: Very sure, I have no doubts that it is the right answer.
- ○ **B**: I am pretty sure it is the right answer.
- ○ **C**: I might be right, but I am not sure.
- ○ **D**: I guessed

5. How sure are you that you knew the right answer for question 2?

- ○ **A**: Very sure, I have no doubts that it is the right answer.
- ○ **B**: I am pretty sure it is the right answer.
- ○ **C**: I might be right, but I am not sure.
- ○ **D**: I guessed

6. How sure are you that you knew the right answer for question 3?

- ○ **A**: Very sure, I have no doubts that it is the right answer.
- ○ **B**: I am pretty sure it is the right answer.
- ○ **C**: I might be right, but I am not sure.
- ○ **D**: I guessed

WORD BANK:

Rationale: This task is designed to narrow the field of thinking and pre-assess more specific force and motion concepts. This type of task asks more specific questions and tests for more specific knowledge allowing us to identify specifically what parts of force and motion students understand and which parts students are unsure about.

Student Responses for Pre-Assessment #2

PRE-TEST		Question	Confidence	Question	Confidence	Question	Confidence	
Mr. Clements		#1	#4	#2	#5	#3	#6	
KEY		B		A		D		
% Who got it right		52%		76%		43%		
								# Right
Ky'Juan	1	A	B	A	B	C	B	1
Raymon	3	C	C	A	B	C	C	1
Correanna	4	A	B	D	D	B	C	0
Sarina	5	B	B	A	B	B	B	2
Dezirae	6	A	C	C	D	B	B	0
Lukas	7	A	A	A	B	B	A	1
Rayna	8	B	B	A	A	D	D	3
Precious	10	B	A	A	B	D	A	3
Nevaeh	11	B	A	A	A	A	A	2
Brooklyn	12	B	C	C	C	A	C	1
Makiya	13	B	C	C	B	D	A	2
Victoria	14	A	C	A	D	C	C	1
Cody	15	A	A	A	B	D	A	2
Tre'Von	16	B	A	A	A	D	C	3
TajaNaye'	17	B	C	A	D	B	D	2
Bernardo	18	B	D	A	A	D	A	3
Indya	19	B	A	A	B	D	D	3
Taryn	20	A	C	B	C	B	C	0
Rayn	21	B	C	A	A	D	A	3
Lamariyee	22	C	D	A	B	D	C	2
Fatuma	24	C	C	A	C	B	C	1
								36

STATISTICS

Total # of Students	21

QUESTIONS

Total Right for #1	11
Total Right for #2	16
Total Right for #3	9
Total Correct Answers	36
Class Percent Correct	57%

CONFIDENCE

#4	A	6	29%	*"I am very sure I am right."*
	B	4	19%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	2	10%	*"I guessed."*
	Total	21		
#5	A	5	24%	*"I am very sure I am right."*
	B	9	43%	*"I'm pretty sure I am right."*
	C	3	14%	*"I might be right."*
	D	4	19%	*"I guessed."*
	Total	21		
#6	A	7	33%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	8	38%	*"I might be right."*
	D	3	14%	*"I guessed."*
	Total	21		

PRE-TEST		Question	Confidence	Question	Confidence	Question	Confidence	
Miss Hamilin's		#1	#4	#2	#5	#3	#6	
KEY		B		A		D		
% Who got it right		48%		71%		62%		
								# Right
Amber	1	B	B	A	C	A	C	2
Kimahri	3	D	C	A	C	D	C	2
Diego	4	A	C	A	C	C	D	1
Tisaun	5	A	C	D	B	C	D	0
Jesenya	6	C	D	A	C	A	B	1
Julya	8	B	A	A	A	D	A	3
Naudia H	9	B	A	A	A	D	B	3
Olivia	10	A	B	A	A	D	A	2
Aliyana	11	B	C	A	C	D	C	3
Dayton	12	A	C	B	C	D	D	1
Jr	13	A	A	A	A	D	A	2
Farida	14	A	B	B	B	D	B	1
Ronald	15	B	C	D	C	D	C	2
Nautiah M	16	A	C	B	A	D	A	1
Jazmine	17	B	A	A	A	D	B	3
Sara S	20	B	B	A	A	D	C	3
Kyle	21	B	C	A	B	D	A	3
Caitlyn	22	C	B	A	A	A	C	1
Alana	23	B	A	A	C	B	D	2
Robin	24	B	A	A	C	C	D	2
Kaden	25	A	D	B	A	C	B	0
								38

STATISTICS

Total # of Students	21

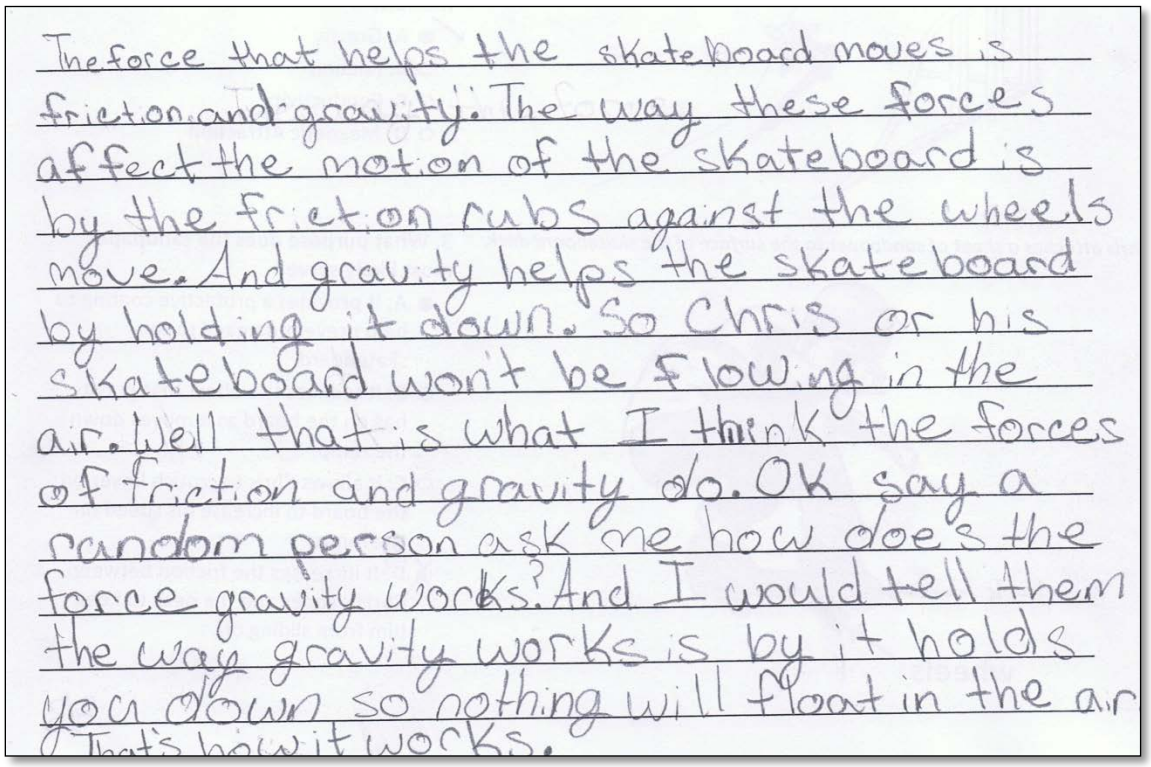
QUESTIONS

Total Right for #1	10
Total Right for #2	15
Total Right for #3	13
Total Correct Answers	38
Class Percent Correct	60%

CONFIDENCE

#4	A	6	29%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	8	38%	*"I might be right."*
	D	2	10%	*"I guessed."*
	Total	21		
#5	A	9	43%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	0	0%	*"I guessed."*
	Total	21		
#6	A	5	24%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	6	29%	*"I might be right."*
	D	5	24%	*"I guessed."*
	Total	21		

Student Response #1 **(Mr. C.'s Student #11)**

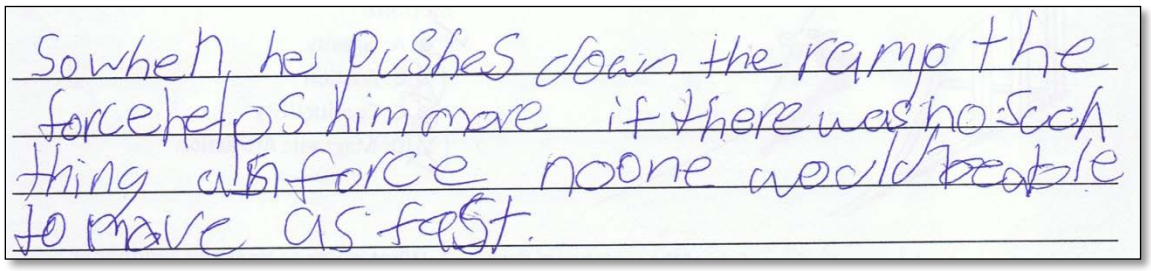


The force that helps the skateboard moves is friction and gravity. The way these forces affect the motion of the skateboard is by the friction rubs against the wheels move. And gravity helps the skateboard by holding it down. So Chris or his skateboard won't be flowing in the air. Well that is what I think the forces of friction and gravity do. OK say a random person ask me how doe's the force gravity works? And I would tell them the way gravity works is by it holds you down so nothing will float in the air. That's how it works.

Interpretation #1

- This student understands a lot about force and motion. She was able to identify two forces that were acting on the skateboard as it moved down the ramp; friction and gravity. She explained friction as "rubs against the wheel" showing she understands that friction has to do with the resistance between things that are in contact with each other, but seems to believe that friction is the thing that is rubbing against the wheels instead of explaining it as a force acting between the ground and the wheels – as the wheels rub against the ground friction is the resulting force that acts against the objects movement down the ramp. She clearly understands the concept of gravity and that it is a force that "holds things down" and keeps things from "floating in the air." This student's background knowledge about force and motion is well beyond beginning and they seem to be very familiar with many ideas found in this unit.

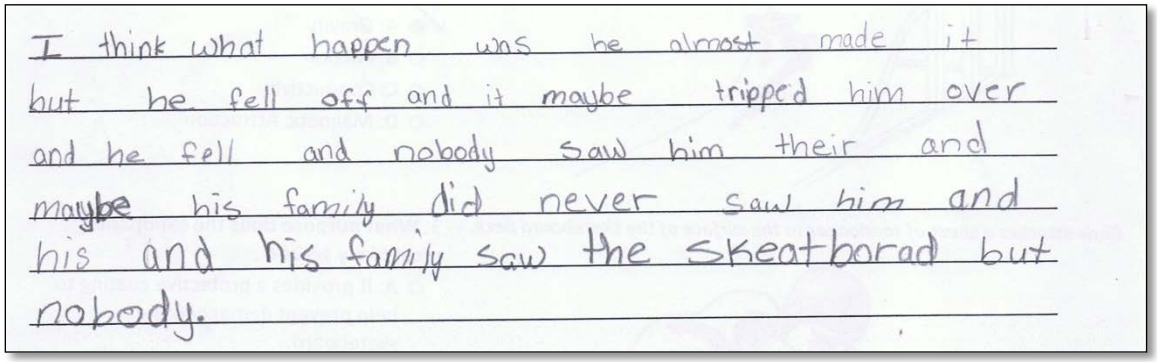
Student Response #2 **(Mr. C.'s Student #18)**



Interpretation #2

- This student understands that one way to move an object is to push. He understands that in order for the skate board to move, Chris had to push it down the ramp. He seems to understand that the force of the push helps Chris move forward. He then takes it to a level of higher thinking and discusses that if there were no such thing as force, nothing could move. He seems to clearly understand that force is the thing that moves an object.

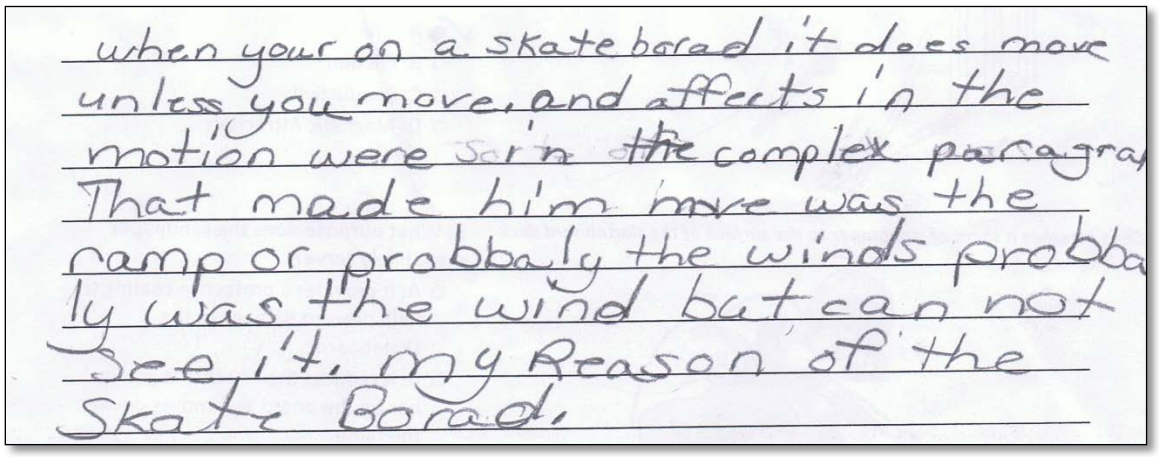
Student Response #3 **(Mr. C.'s Student #24)**



Interpretation #3

- This student was unable to directly identify any force acting on Chris the skateboarder. She does allude to the idea that Chris could "fall" which is the result of the force of gravity. This is an experience that she has – one that can be built off from. She understands that people can fall. It will be important for her to make a connection to the fact that the force of gravity is constantly acting on us and when a person doesn't have the opposing force of their legs or the ground acting in the opposite direction then a person will fall down. She seems to be unable to come up with the scientific terminology like force, gravity, friction, etc.

Student Response #4 (Mr. C.'s Student #14)


when your on a skateborad it does move unless you move, and affects in the motion were in the complex paragra That made him move was the ramp or probbaly the winds probba ly was the wind but can not see it, my Reason of the Skate Borad.

Interpretation #4

- This student might have some actually strong ideas about force and motion that will help her during this unit. She said when you are on a skateboard, it won't move unless you move. It could be argued that she is alluding to the idea that in order to move the skateboard you are on, you have to apply some type of force to move yourself AND the skateboard - that the two objects will move together. However, then she says that the ramp made him move. This is a misconception. Chris moved down the ramp, but it was the force of gravity acting on him and the skateboard that continued his motion down the ramp. She is trying to make sense of the phenomena by thinking about the result of gravity - the skateboard moves because of the ramp's incline. She also brings in the idea of wind. This is actually a valid point. Wind is a force – a contact force in fact – this idea is often hard for students to understand because they can't see the wind actually touching an object and making contact. She is thinking of the "push" of the wind. However she doesn't show understanding of the actual forces and how they act together to move or stop the skateboard.

PART 2 - #2

Student Cultural Resources: Small Group Talk

Funds of Knowledge - Using the Funds of Knowledge table in this document as a guide, ask about family knowledge and experience, and one other area that you would like to focus on (i.e. peer activities, talents, etc.). Describe a small group talk with several students that you will administer to help you learn more about their cultural resources for learning. In your talk and analysis, find out what sorts of experiences the students have about the topic and what kinds of connections they have about the topic.

Small Group Talk Questions:

1. Where do you see movement every day?
2. Tell me more about how some of these things move? What do you know about their movement?
3. Do you pay attention to the road signs? What do the speed limits tell you? Have you ever been in the car when the driver got pulled over for speeding and got a ticket?
4. Do you have any family or friends whose job it is to move stuff?
5. When do we need to know about speed or how fast something is moving?
6. What experiences have you had with motion? Have you ever been to a skate park? Have you been on a rollercoaster? Have you ever played a sport?

Small Group Talk Answers:

During a small group discussion with four different students, we learned about some very interesting ideas, misconceptions, and experiences our students had previously had with forces and motion. We began by asking them where they saw movement every day. Their initial response was confusion, probably because they thought they were being expected to think at a higher level than what we were actually asking them to. However, after they realized that we simply meant for them to tell us what kinds of movement they have had experiences with, they began answering with lots of different ideas. All four students began by giving experiences in the classroom, taking cues from things around them. For instance, one student said that “we all walk around the classroom, like get up and sharpen our pencils and stuff.” Another student built off that idea and started discussing how they all got to school in different ways - riding the bus, driving in a car, walking, maybe another way.

Then, we built off of the idea of driving in cars (since this led into another of our planned questions) and asked students what they knew about speed limits and what experiences they had with speeding. We even asked if any of them had been in the car when the driver had gotten pulled over for speeding. The first response we saw was students’ eyebrows shoot up and exaggerated nodding, and even a little giggling. Students also responded with lots of elaboration on their personal experiences with police officers, which was very interesting, but got us off topic a little. However, this told us that many students have had experiences and are somewhat interested in police officer, which would provide us with a similar experience to talk about when we begin our lessons on speed. For example, we can pose the question, “how can a police officer tell if someone is speeding?” Since students share an interest, or at least some previous experiences, with this topic, it will be more motivating and engaging for them to focus in on this specific idea relating to speed. They will also be able to use things that they already know about how police officers measure speed (radar guns), to pose new questions such as, “how does a radar gun work?” to inspire student thinking.

PART 2 - #3

Student Ways of Being: Observations of students

(A) How students participate together? *(Who takes leadership roles? Who hangs back? Who likes to do hands-on activities? Who likes to teach other students? Who lets others think or do things for them? Etc.)*

Mr. Clements' Class

- **Ky'Juan –** Likes to joke around, but is able to understand when it is time to get serious. He is able to be influenced to be off task if his friends decided they want to be. Very willing to let someone else do the work/thinking and hang back.
- **Destin –** Is a bright kid who pays a lot of attention to the details of his surroundings, but not always to his work. His disorganization often gets in his way of completing assignments. He follows students like Brent, but when he believes he is right will step up and make sure that his idea is heard. He is also always willing to engage in hands-on activities.
- **Raymon –** Willing to share his ideas which are often on track. He understands learning, and can be overheard trying to get his off-task classmates back on task.
- **Correanna –** Wants to do well. She is motivated and understands school. She is also dramatic, which can help her when we do those types of activities, but can also get in the way when she is asked to do group work. She will often take group assignment and simply to them by herself instead of working with her group.
- **Sarina –** Very smart and talented. She is a strong writer, and often chooses this role in a group. She gets distracted by certain boy classmates and continually struggles with wanting to do well in school but also be social.
- **Dezirae –** A very strong writer in the amount that gets on paper, but needs to keep working on slowing down to make sure what she is writing makes sense and is legible. She also has difficulty working with certain individuals and if she does not get to make the decisions, she becomes frustrated.
- **Lukas –** Is able to ask very thought provoking questions and make incredible connections to the content. Gets distracted very easily and often blurts out answers. Has difficulty working in groups and putting this ideas on paper.
- **Rayna –** Works well independently and produces very good work when given the time and when she focuses. In groups, she enjoys participating, unless she is upset by something and then it takes her a very long time to get back on track.
- **Brent –** Incredibly smart and capable. Is very knowledgeable, but depending on the day and the activity will sometimes share that and sometimes will refuse to participate.
- **Precious –** A very capable and smart student. She understands the point and purpose of school. she works well in a group and always completes her work with effort and helps other students do the same.
- **Nevaeh –** A very hard working student. When focused she completes work to very high standards.
- **Brooklyn –** Often very shy, but wants to do well. She likes to work with others and others like to have her in their group. She is a force of positivity.
- **Makiya –** A less out spoken student, but still willingly participates. Often confused after begin given directions and has to ask "what are we doing?"
- **Victoria –** She wants to be a strong student, but doesn't understand the process of achieving this goal. While she is very social, she is also sometimes disconnected/scattered in her thoughts. She has troubles

working with many of the other students, and strives to be the center of attention and accepted by her classmates.

- **Cody –** While he has a lot of experiences and knowledge, it is hard to know about because has selective mutism. Throughout the entire year he has not said one word out loud to the class (not even his own name when introducing ourselves). He always does his school work and attempts every assignment, but discussions are very hard for him to participate in verbally. He does talk easily to Brent who helps facilitate some of Cody's ideas out to the group when we do think-pair-share. If he is able to hid in a group, he will.
- **Tre'Von –** An all-around awesome student. He understands school, the purpose, and his role as a student. He works well with others and acts as a leader to organize, complete thoughtfully, and finish tasks. He listens to / follows directions well.
- **TajaNaye' –** A very sweet student who has been very shy but each day gains more confidence in herself. She works well with everyone, but when grouped with stronger personalities, even though she is sharing her ideas, they don't often get listened to. She tries very hard.
- **Bernardo –** A very intelligent student who makes brilliant connections, but is incredibly unorganized while leads to a lack of focus / completion of assignments. He lacks social capital in our classroom, and while very smart, is often perceived as immature by his classmates and unfortunately not taken seriously, even when his ideas are very strong.
- **Indya –** A bright hard working student. Often disorganization gets in the way of her being able to complete assignments. She works well in groups, but will follow the ideas of the students around her and has to be pushed to think and share her own original ideas.
- **Taryn –** When talking about non-school topics she is very sociable one on one. Bubbly, happy, and friendly. When topics turn to school or asking academic questions, even when she knows the answer she becomes inward, shy, reserved, and uncomfortable. It takes time for her to try and build up courage to answer the question. She often hangs-back in the class, and rarely if ever raises her hand to answer questions and provide her opinion on topics. When she gets sad/scared about learning, she refuses to participate in any of the classroom activities (especially if they involve physical movement).
- **Rayn –** Very intelligent and hard working. She understands the process of school and her role as a student.
- **Lamariyee –** A strong personality in the room, and depending on the day, that can benefit or hinder the class. She does well with project based learning, and will take charge on most assignments making sure that her voice and thoughts are heard.
- **Joel –** A strong leader and many of the students look to him to see what he is doing and how he is acting. Depending on the day he can be the student that takes charge and is very invested in an activity, or he can be the student that could seem to care less and wants nothing to do with any activity. Depending on the day and if given the opportunity, he will allow others to do the work if it is something he doesn't want to do. If it is an activity he does want to do, he will persuade his group (or just decided for his group) that he gets to do the activity.
- **Fatuma –** A very pleasant young girl. She works well with hands on activities but when given down time in class, (especially in the morning) falls asleep because of personal circumstances at home. She is very reserved, but quite energetic when she is with her friends. Unfortunately, because of cultural differences, she is sometimes bullied.
- **RJ –** Only recently joined our classroom and it has been a joy to have him. He is very good at sports, but he is also a strong student and he seems to be positively influencing a lot of the other students like Joel and Ky'Juan.

When students are given the opportunity to group themselves the following groupings are often observed.

- Joel, Lamariyee, Ky'Juan,
- Tre'Von, RJ

- Brent, Cody, Luke, Raymon, Destin
- Indya, Correanna, Dezirae
- Fatuma, Taryn, Brooklyn, Makiya, TajaNaye, Bernardo
- Rayna, Nevaeh, Rayn, Sarina,
- Precious, Victoria

Miss Hamlin's Class

- **Amber** - tends to hang back, but doesn't let other do work for her - more of an individual worker, but still works well with others.
- **Taura** - definitely hangs back and allows other to do work for her - tends to simply copy others' work when in groups instead of participating, even in a hands-on activity.
- **Kimahri** - takes on a leadership role unless grouped with stronger personality - enjoys hands-on and group activities.
- **Diego** - loves hands-on activities, enjoys working in small groups - participates more in small groups.
- **Tisaun** - tends to sit back and let others do most of the thinking, especially in whole class - small group and hands-on activities he participates more and speaks up more.
- **Jesenya** - very hard worker, makes great effort at understanding content, works well with others and independently.
- **David** - works well with some, especially with hands-on activities; easily distracted, does not like to write, prefers verbal explanation to written.
- **Julya** - works well with most, usually takes charge in group work as well as whole class; likes to teach others and prove her thinking.
- **Rolando** - tends to sit back and let others do the thinking for him, tends to participate a little more in hands-on activities.
- **Olivia** - very outgoing, likes to teach others but does not necessarily work well with others, likes to take charge and lead.
- **Aiyana** - tends to work better individually, likes to lead but doesn't always work well with others, does not accept others' explanations very well, but she does work well on her own.
- **Farida** - works well both in small groups and independently, tends to be more of a follower and does not really challenge or question others.
- **Austin** - very outgoing, works well with others, a bit of a leader with certain people but not with stronger personalities, constantly participates, likes hands-on activities.
- **Nautiah** - works well with some, not well with others, tends to sit back and allow others to do the thinking for her.
- **Naudia** - works well with most, tends to take a leadership role, loves hands-on activities and explaining her thinking.
- **Dayton** - tends to sit back and allow other to do the thinking for him, prefers hands-on activities.
- **Ronald** - works well with some, prefers small group work but tends to allow others to do most of the thinking for him, prefers hands-on activities.
- **Jazmine** - likes to be a leader, works well with some, likes hands-on activities, prefers to do things individually or in partners.
- **Sarah** - works well with others, not necessarily a strong leader, but will take charge if no one else does, hard worker, likes to teach others when she feels confident about the content.
- **Sara** - definitely a leader, works well with others, prefers small group situations, constantly participates in whole class activities, loves to teach others.
- **Kyle** - likes to be a leader, prefers small group work, works well with others, prefers hands-on activities, likes to teach others.
- **Caitlynn** - quiet in most situations, prefers small group interaction, likes to teach others when she feels confident in her knowledge.

- **Alana** - likes to work with certain students, prefers small group or partners to whole group, tends to let others do the thinking for her.
- **Robin** - likes small group work, likes hands-on activities, not a leader but doesn't just sit back and let others do all the thinking.
- **Kaden** - tends to allow others to do the thinking, hard workers, prefers hands-on activities and manipulatives.

(B) How do students interact with school and in school?

(What are their ways of being? Do they like to do things with their hands, write songs, act out skits? You need to look beyond the formal science or even formal class activities and watch students during informal times like recess, lunch, classroom free choice times, standing in lines, etc.)

Mr. Clements' Class

- **Ky'Juan –** He likes to play football (on a team). *(Ky'Juan has a great arm when I have seen him play football outside at recess. He is probably very successful during football practice. He also seems to really enjoy the sport when he gets to play it at recess.)*
- **Destin –** Destin likes to interact with his friends and thrives with a schedule. After school he likes to play Nintendo DS (Pokémon, Guitar Hero), and jump on trampoline ("makes me feel happy, like I am in my own world"). *(Destin's face lit up when I asked him why he liked to jump on the trampoline.)*
- **Correanna –** Enjoys talking with her friends and reading. After school she likes to plays sports with her brother (soccer, basketball, football, baseball), listen to music (Beyoncé, Mariah Carey), and dance.
- **Sarina –** Often is interacting with the boys and very aware of social relationships. She is a strong writer and after school she enjoys cheerleading, playing on laptop, texting, reading, and watching TV.
- **Dezirae –** A strong writer. She writes full pages in the time it takes her classmates to write a paragraph. After school she has soccer practice (on a team), and rides her bike outside.
- **Lukas –** Works best in a completely silent environment where everyone is completely focused. He is easily distracted by the slightest stimuli. After school he likes to hang out with friends and play basketball (best friend = Umjed). *(Lukas really enjoys playing basketball. He plays it every opportunity he has during recess. His friend Umjed went to MSU basketball camp.)* He has baseball and basketball practice (on a team), goes bike riding, and sometimes plays video games ("but I am not a videogame freak where I have to play when I get home"). He also likes to hang out with friends and family (has 3 brothers / 2 sisters who are all older: 17+) (2 are step bro/sis). *(His siblings are a lot older than he is so there is a large gap in age. His mom mentioned that this can sometimes be hard for him.)*
- **Rayna –** She is a talented artist. She takes her time with her work and sturggles with not having time to make an assignment perfect before she turns it in. After school she hangs out with friends (Jasmine), play basketball with friends, go in Jasmine's back yard and swim and jump on trampoline ("she has a fun backyard and lives across the street"), and swim at Vahala Park in Holt. She also enjoys watching movies at Celebration Cinema in Lansing.
- **Brent –** For Brent to complete an assignment, he as to buy-in completely. It is hard for him to do things when he doesn't agree with the purpose. He is 100% interested in video games. After school he plays video games (shooter), and then plays a lot more video games. (*He once said he plays 4-5 hours each night.)* play outside, go bike riding. (*He and Cody go to Everett Park and ride*)
- **Precious –** Enjoys socializing with her friends, is a strong writer, and love to sing. After school she plays with her dog, Little T. (He is a teacup chiwawa). She also loves to read.
- **Nevaeh –** She loves to read and play outside with friends. Nevaeh also like to color and draw.
- **Brooklyn –** She likes to read comics and read with a partner. After school she likes to play on the computer (Free Relms, Wizard 101). *(Those are online computer games designed for kids. They have mini-*

games and you can talk to other people playing from around the globe.) She also likes to play on the Wii and play basketball outside.

- **Makiya –** She enjoys coloring. After school she enjoys playing outside, drawing, and coloring.
- **Victoria –**She is a singer. ("I sing everywhere; the bathroom outside") After school she likes to play school with her neighbors.
- **Cody –** Likes to talk to Brent. He doesn't not enjoy being the center of attention but enjoys doing activities where everyone else is focused on something else. After school he likes to go bike riding with Brent, play soccer with friends, play videogames (Saints Row 3), *(Saints Row 3 is his favorite game. He has mentioned it multiple times and said he has beaten the whole thing 3 times now.)*
- **Tre'Von –** He loves to read i-Spy books and gets motivated when he is able to move. He also works well talking in groups.
- **TajaNaye' –** TajaNaye' loves using technology in the classroom. She excels during computers on Friday and loves is the biggest participant Schoology.com which is an online classroom. After school she loves riding an electric scooter, play kickball with sister, mom and dad, play soccer with family and friends ("I want to be on a soccer team"), ("I want to be a girl scout")
- **Bernardo –** Loves to work and play on the computer. He is always asking when it is his turn to be on the computers. After school he helps his mom and dad clean the house and take care of baby brother (3 years old with cerebral palsy). For fun he likes to play video games (Spiderman games, and super power games) ("after I am done helping my family") At home he speaks Spanish and English ("we speak mostly English"), mom: understands English but doesn't speak it (L1 is English), dad: from Mexico, born in MI and speaks both Spanish and English (L1 is Spanish), ("we use Spanish when we are happy like during the holidays and stuff")
- **Indya –** Indya likes to act things out. She also enjoys drawing and coloring. After school she likes to watch TV, cook with her mom (her favorite thing to make is chili dogs). She also likes to go outside and go to the movies.
- **Taryn –** When she is with her friends she loves talking and laughing. It takes her time to warm up to bran new activities, but if she buys in to the lesson, she is a willing participant. After school she likes to watch TV and play with my mom.
- **Rayn –** She likes to do hands on and engaging activities. After school she likes to go to grandmas and play with the dog, play on the computer (Movie Star Planet), watch TV (SpongeBob), go bike riding with dad, and play the Wii (Mario, Wii resort).
- **Lamariyee –** She loves to play basketball. She does well with writing.
- **Joel –** He likes to go outside and play football, basketball, and wrestle with friends or family (2 brothers / 2 sisters).
- **Fatuma –** She enjoys fun hand-on activities and group work. After school she plays outside with her friends.
- **RJ –** He enjoys challenging questions and is able to write his ideas out.

<u>Miss Hamlin's Class</u>

- **Amber** - likes to be around others, prefers to just hang out and talk with friends, likes to read.
- **Taura** - LOVES One Direction and Justin Bieber, very quiet in whole group setting, but very outgoing with kids her own age, loves to dance and listen to music, very into Twitter.
- **Kimahri** - participates in dance where she travels across states almost every weekend, likes to cheerlead - was on the cheerleading team this year.

- **Diego** - loves to draw, LOVES Batman, played on the basketball team this year and really enjoyed it, usually plays basketball on recess
- **Tisaun** - played on the basketball team, usually plays basketball on recess, likes to hang out with his friends and just chat at break time.
- **Jesenya** - likes cheerleading, likes to dance and act things out, loves to laugh, even if its at herself, very easygoing.
- **David** - can be quite hyper at times, likes to do a lot of different things - play basketball, play connect four, anything that is visually and actively stimulating.
- **Julya** - loves dogs and her family, enjoys school in general, likes to just walk and talk with friends on recess.
- **Rolando** - prefers to just hang out and talk with friends on breaks.
- **Olivia** - likes to be a leader, on recess she usually plays jump rope with others.
- **Aiyana** - likes to be a leader, mom is the cheerleading coach so she likes to help others learn new cheers, enjoys spending time with friends.
- **Farida** - best friends with Amber and doesn't socialize too much apart from her, likes to just chat with Amber and others. Farida is Muslim which I think makes her a little more timid because she is different, but others seem to like her and don't judge her for her beliefs.
- **Austin** - very outgoing, joins in with anyone, likes to play connect four on breaks.
- **Nautiah** - very sensitive to others' thoughts, loves to chat with the girls, usually jumps rope on recess, often gets caught up in "drama" with other girls, just wants to be accepted.
- **Naudia** - joins in with just about anyone, likes to be active and do things with others, spends time outside of school with her friends just talking and being silly.
- **Dayton** - very quiet, overshadowed by his older sister who is often suspended from school or the bus, a little bit of a loner.
- **Ronald** - likes to just laugh with friends, loves to play football.
- **Jazmine** - loves giraffes because she relates with them (being a taller girl), likes to chat with friends .
- **Sarah** - very family-oriented, likes to read, loves horses, hard worker in the classroom, not a huge socializer, but gets along with others very well.
- **Sara** - loves cheerleading and volleyball, usually jumps rope with the girls or practices cheerleading on breaks.
- **Kyle** - loves to explore and figure out new things, likes new challenges and making sense of everyday things.
- **Caitlynn** - loves her mom but doesn't get to see her very often, lives with grandma and grandpa who care for and love her, likes to write in her journal.
- **Alana** - loves to write in her journal and draw, tends to keep to herself, very sensitive to what others think or say, gets very easily discouraged, likes to talk with Caitlynn - these two are very close friends and feel comfortable with one another.
- **Robin** - He is Hmong and he loves to share his family traditions with others, especially topspin, which he brought in a showed us, very proud of his culture, gets along with others easily.
- **Kaden** - enjoys being a helper and doing things in the classroom, a little bit of a loner, usually happy just being around others and being at school.

Discussion of Student Ideas and Reasoning

Interpretations and Implications for your Teaching:

(i) An overall interpretation of student ideas about the topic and they way they are reasoning about the topic (What are the students' strengths? What are some common naïve ideas that you need to pay attention to? What aspects of their reasoning did you notice? How are they making sense of the phenomena)

After analyzing the different assessments we gave, we learned a lot about how our students have made sense of movement as well as some of the misconceptions they already have. For instance, some students seemed to understand and explain the movement of a car as caused by pushing on the gas pedal, which makes the car move, and when asked to explain more about how pressing the gas pedal makes the car move, they explain that the gas makes the tires turn and the car moves. This was interesting because it let us know that students already have a basic understanding of the fact that the tires are a part of what actually moves the car. Even though it took a little prompting to get this idea from them, they still understand that the tires have to move in order for the car to move. Another key idea they seemed to have a good understanding of was when we asked how a ball moved (especially when we gave a demonstration by pushing the ball across a desk). Many answered with comments such as "because you pushed it," or a variation of that explanation. When asked why the ball slowed down, some thought that it was because we weren't pushing it anymore, so it stopped moving. This showed us that many students understand that constant motion requires constant force. However, no student used the term "friction" or explained that the table was the cause of the ball slowing down its motion.

Students seemed very interested and motivated to learn about how things move. They enjoy hands on activities and "doing fun things" in science as opposed to "boring book stuff." This will be very important to incorporate into our lessons. One struggle our students seemed to have was using scientific vocabulary. Because of their experiences, they had good solid ideas about the concepts of force and motion but had difficulty expressing their ideas using accurate scientific vocabulary to label things like friction, force, and gravity.

(ii) The implications for your teaching (How can you use students' ideas and reasoning in your unit planning? Which of these ideas and ways of reasoning can you build from? Which ideas do you need to address by strengthening better ideas, addressing additional evidence and other ways of thinking?)

Since many of our students prefer hands-on activities and being active in general, we will plan to incorporate lots of movement and experiments into our lessons to keep student engaged and motivated. One way we will achieve this is to center our driving questions around an activity that we can actually do in the classroom. For instance, we will use the idea of sledding and how it works to drive lessons on forces and motion because we know that all of our students have had some experience sledding. This will also be motivating and exciting for our students because the snow will allow us to actually go outside and experiment hands-on with the way sledding works. Also, using the idea of sledding, we can build off of students previous experiences with this activity to create a better understanding of the forces at play when a sled moves and stops moving.

One idea that we will need to help students strengthen their understandings is expressing their ideas in a clear, scientific way. Students already have a good grasp of many basic ideas of force and motion, but they lack the vocabulary needed to be able to explain and expand on their own understanding. This has been a struggle for most

students in every subject this year, not just in science. However, to address this, we will plan to use scientific vocabulary as often as possible to reword student answers. We will also use visual aids, such as PowerPoint's, to help students see and write scientific vocabulary as often as possible.

PART 2 - #3

Special Needs

Special Needs

Use your knowledge of your students to describe any special needs that you know about that you need to make accommodations for in your planning and instruction. Discuss the implications of these needs for your teaching and how you will make accommodation.

- **Cody** = Very bright, but has selective mustism. This means he gets extremely anxious when asked to speak in front of large groups. He will only talk to only a very small number of students in the room. Extremely shy in front of the whole class, and gets nervous when expected to answer verbally or even only physically participate in front of whole class.
    - provide non-verbal class responses (thumbs up, raise hands, white boards)
    - pair him to work in a group he feels most comfortable in
- **Taryn** = struggle with reading
    - verbally explain directions
    - pair her with a partner who can read them out loud
- **David**= very bright, but gets off task easily, especially when assigned individual reading. Extremely hyper on most occasions and tends to distract others.
    - read directions out loud
    - pair him with partners who can read to them out loud
- **Kaden, Diego, Caitlynn, and Alana** = struggle with reading
    - read directions out loud
    - pair him/her with partner who can read to them out loud

PART 3

Instructional Approach

Motion & Force

Adam Clements & Allison Hamlin

Learning Goals

Students will be able to...

- Describe the speed of an object in terms of distance traveled over time.
- Identify forces acting on a moving object as well as objects at rest.
- Illustrate how an object moves
- Collect, interpret, and analyze collected data.
- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.
- An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

Day	No.	Activity Label	Activity Description	Activity Functions* (Why this activity in this sequence?)
2/20 Wed	**1**	**How does sledding work?**	Ask students to share their experiences sledding. Show images of Hawk Island sledding. Students watch the video: http://www.afv.com/top-10-sledding-wipeouts/ The teacher asks the question: "How does **sledding** work?" (This is the overarching BIG question. As the unit progresses, we will ask more specific questions like "How can we make the sled move?" "How can we make the sled move faster/slower?" "How can we make better jumps?" "How can we have fewer wipeouts?") Students will re-watch the video with this question in mind. The teacher will ask them to look for specific examples of what they are seeing that might answer this question.	ESTABLISH A QUESTION The question "How does sledding work" will provide a sense of purpose to our investigation of force and motion. It is relevant to their lives and well-timed for the winter season.

			Students individually think and write their ideas in their journals for a few minutes. They first brainstorm your own ideas. Then the teacher asks them to get into groups and discuss their ideas. Roles: Writer / Speaker / PPPP Police / Time Keeper After, the teacher asks the speaker to share his or her groups' ideas. The teacher writes down the ideas on the board and has the class copy these ideas into their journals. Group Work Reflection: 0-10 how well did your group do today? Why? 0-10 how well did you do today? Why? Reminder – bring warm clothes tomorrow – and GLOVES – we are going outside to try and test some of your ideas tomorrow.	<u>ELICIT STUDENTS' IDEAS</u> Students share their initial ideas to the question in groups and then out to the class.
2/21 Thur	2		Review ideas from yesterday. The teacher introduces the strategy of investigating a similar but simpler system. The teacher asks a new question: **"How can we make the sled move?"** Students (24) will be working in groups of 4 and each group will be given a sled. Explain that students will be going outside and will try to answer the question by creating their own designs and then testing them with their sled. Students may try to complete pre-listed challenges if they "finish" or run out of ideas. **Challenges**: - Will the sled move with everyone in the sled? - Will the sled move without touching it? - Will the sled move with everyone in the sled except the smallest person who must move the sled by him or herself? ROLES: numbers 1,2,3,4 Go outside and have students try to make their sleds move. #1 student will keep track of what worked (it moved) and what didn't work (it didn't move) using a T-Chart. – they are the recorder. When the teacher blows the whistle, they must pass the notes to the next person #2, and so on.	<u>ESTABLISH A NEW QUESTION</u> This new question is similar but focuses on a specific idea of how sledding works. <u>EXPLORE PHENOMENA FOR PATTERNS</u> Students explore their ideas on how to make the sled move.

			Everyone will have the opportunity to take notes and record their observations. Whistle and Write. During the investigation, the teacher will blow his whistle once. This means that students must stop where they are, take out their notes, and write down their ideas and observations. Collect notebooks and look at their ideas.	
2/22 Fri	3		Review ideas from yesterday. Give a few minutes for teams to add or finish writing down their ideas. Have class form a U-shape. Review the P.P.P.P.(The Productive Partner Pair Properties: Teamwork, Active Listening, and Respectful Responding) Ask a few specific groups to share using the elmo. Ask them why their designs worked or didn't work. After the groups share, ask if they can each come up with a "rule" to describe what they experienced that would answer our initial question of "How can we make the sled move?" Rules that usually would form would be about how - - you have to push or pull the sled. - if you had a hill it would slide down the hill after you push it. - you can't move it if you don't touch it in some way. - if the sled is heavy with people, you have to be strong enough to push it. Record these rules on the board and ask students to think about each one in their group. Talk about them for a minute and if they agree or disagree. Then class vote on each one using red and green sided cards. Record the vote next to the rules. Test the rules using a different example of a ball. Will the ball move if we follow these rules? Push them to use evidence from their experiences to support or negate the rules while you are discussing each. Have them call on each other while discussing. Share with them that science agrees with the rules they	<u>EXPLORE IDEAS ABOUT PATTERNS</u> Students are asked to reflect on the patterns they observed and explored yesterday. What did they notice? What moved the sled? What didn't? What rules can be made about moving things? <u>EXPLORE IDEAS ABOUT PATTERNS</u> Testing the rules on a different example will help students make more connections to the ideas behind force and motion and how "things" move. <u>STUDENTS EXPLAIN PATTERNS</u> Having them use the evidence from the sledding to support their ideas about making the ball move will help them to explain the patterns they observed.

			have come up with. That "An object at rest will begin to move if a non-zero net force is applied to it. It will move in the direction of the non-zero net force." Ask them if this rule fits? Does it relate to their sledding experiences? Does it relate to the ball? Ask the new question: "**We now have some ideas of how to make the sled move, but how did we tell if the sled was moving or not?"** Have them write their ideas in their journals. Collect journals and read their ideas. Discussion Reflection: 0-10 how well did the class do today? Why? 0-10 how well did you do today? Why? Homework: Go sledding and have a sled race. Write about your experience.	INTRODUCE SCIENTIFIC IDEAS Tell students the rule about moving an object that the scientific community has agreed upon. <u>COMPARE STUDENT AND SCIENTIFIC IDEAS</u> Ask them to reflect and decided if their experiences and observations supports this rule
2/25 Mon		Mad Scientist Monday	Elephant Toothpaste 3 min Real Scientist: Ameri Gurley Ameri gets blown away by her own research. That's because she's a graduate student at Texas Tech University where she studies the damaging affects of wind. In particular, Ameri looks at how house placement can reduce exposure to flying debris during a tornado or hurricane. http://pbskids.org/dragonflytv/scientists/scientist25.html	
2/27 Wed	4		Have students re-read their journal responses to the question "**We now have some ideas of how to make the sled move, but how could we tell if the sled was moving or not?"** Share some of the responses that were given in the journal write. Put a sled on the floor and have a student sit in it. Ask them "Is the student's sled moving? Why or why not? How do you know?" Have students move to one side of the room or the other – Yes vs. No	<u>ESTABLISH A NEW QUESTION</u> This question begins to introduce the idea of speed. An object moves over a set distance based on a reference point. <u>ELICIT STUDENTS IDEAS</u> Students will share their ideas about the question. <u>EXPLORE PHENOMENA FOR PATTERNS</u> Giving students a specific example will help them to focus their ideas around a common shared experience.

			Have students share their ideas. Write their ideas on the board and ask if people agree or disagree. If the idea doesn't come out on its own, have the student sit back down in the sled. Explain that we are going to get into a rocket ship and fly right out into outer space. Ask them to look at the globe and point out where MI is and where our classroom is. Put a sticker on it. Now spin the globe. Ask them to look back at our classroom on earth that we just left. Is the student still sitting in the sled? Is he moving? Rotate the globe as you are asking this question. Why or Why not? Have students answer by staying on their side of the room or moving to the other side in order to answer Yes or No. Have students return to their seats. Explain that we still seem to have disagreement about whether or not the sled is moving. Tell them we have explored our ideas and have tried to explain the patterns that we see, but now we need to introduce some scientific ideas to help give us some clarity on this question. Explain that many scientists have spent numerous hours and years studying this question and trying to answer it. One of those scientists was Einstein. Have an interactive conversation with Einstein where he will introduce the idea of "Point of Reference" – his theory of relativity explains that all motion is relative to a fixed point – that depending on what you are viewing the motion from the ground vs. outer space – the sled is moving or not moving. So both groups were scientifically accurate in their arguments. Students can review their explanations and figure out what their point of reference was when they were deciding if the sled was moving. Does the new scientific knowledge fit with their experiences?	<u>STDENTS EXPLAIN PATTERNS</u> Students are asked to support their ideas about what they are observing. <u>INTRODUCE SCIENTIFIC IDEAS</u> Students will be introduced to the scientific term of "Point of Reference." This explanation will help the class to understand that when we are talking about an object moving, we have to be aware of what our reference point is – that when something moves it moves away or towards that point of reference. For example, in a race, my fixed point or reference point is the starting line. I move away from it toward the finish line. There is a change in distance between the starting line and me. <u>COMPARE STUDENT AND SCIENTIFIC IDEAS</u> Students can use this knew knowledge to re-evaluate their answer to the first question pose. Do they have a new stance? Why?
3/1 Fri		Impression 5 Field Trip		
3/4 Mon		Mad Scientist	Dancing Raisins	

		Monday	3 min Real Scientist http://pbskids.org/dragonflytv/scientists/scientist9.html Bruce Roberts Bruce always loved solving the "puzzles" given to him in math classes. He now enjoys daily mathematical challenges as an engineer for Harley Davidson Motorcycles in Milwaukee, Wisconsin. Along with his math skills, Bruce uses the latest cool computer programs to dream up the safest, fastest, and best designs for these powerful "bikes."	
3/6 Wed	5		Show video clip of the 4 teachers sled racing. Ask the question: **If there were four different sleds to choose from, how could we tell which one is the fastest?** Ask students to share their initial ideas. Write them on the board. As a class explore their ideas. Tell them that we have 4 hills (books and wood planks), and we have 4 sleds (4 blocks of wood. 1 wrapped in sandpaper, 1 wrapped in wax paper, 1 wrapped in plastic wrap, and 1 that is just wood.) Ask students in their groups to design an experiment to try to figure out which sled is the fastest. 1 = How should we set up the materials? 2 = What procedures do we need to follow during our experiment? 3 = How will we know which sled is the fastest? 4 = What do you think will happen? Ask each group to report some of their ideas and set up the experiment so that you race all 4 sleds at the same **time** and they travel the same **distance** and the sled that crosses the finish line first is the fastest. (The sleds have to start at the same time and travel the same distance) As a class, run the experiment. Record the data on the board? Ask students to take some individually to reflect on their experiment. What were the patterns we observed? Why did we get those results? Do they support your hypothesis, or do you now have a different idea about which one is the fastest? As a class decided on which sled was the fastest. Try to explain why? (less friction, which is an opposing force allowed it it to move faster.) Journal Write: **How fast did it go? If we only had one hill – how would we tell which is the fastest? What additional**	<u>ESTABLISH A QUESTION</u> This question narrows our focus even further to be able to actually understand what speed is? <u>ELICIT STUDENT'S IDEAS</u> Students share their initial ideas. <u>EXPLORE PHENOMENA FOR PATTERNS</u> Allowing students to design the experiment give more meaning to the exploration. Doing it as a class gives everyone a shared experience. Students will observe the different trials and come to a conclusions about which one was the "fastest." <u>EXPLORE IDEAS ABOUT PATTERS</u> Students will look back at their initial ideas and compare them to this new experience. Do they make sense. They will try to develop a conclusion. <u>STUDENTS EXPLAIN PATTERS</u> Students will use what they have previous learned, to try to figure out how they knew that the one sled was the fastest.

			materials would we need? Group Discussion: Have you ever had experiences of being timed during a race? Do you all start at the same spot? Why not? So what else do we need to make sure is the same? (distance) Students will determine that in order to figure out how fast something is (or its speed) we need to figure out something that has to do with the time it took to go a certain distance. Explain that tomorrow students will be running this experiment to figure out just how fast each sled is by recording the time it takes for each sled to slide down the hill. Review that the distance must be the same so the starting and ending points must be the same for each trial. Students will be given one hill (books and a wood plank) and 4 sleds (4 blocks of wood. 1 wrapped in sandpaper, 1 wrapped in wax paper, 1 wrapped in plastic wrap, and 1 that is just wood.) Roles: Recorder / PPPP Police / Time Keeper / Materials Manager Group Work Reflection: 0-10 how well did your group do today? Why? 0-10 how well did you do today? Why? Collect journals	What is the criteria for determining the fastest? What explanations can they gather from the patterns they saw? Bringing in other patterns will help to make this idea more clear.
3/7 Thur	6		Review the patterns that were observed yesterday. Review that students shared out about what they thought they might need to find out how fast something is going. (stop watch, ruler) As a class re-build up to the idea that speed = distance / time. Ask for examples of where they have seen distance of time before. (speed limits 60 miles/hour, gravity running speed = 10 miles/hour, comet moves at 200,000 miles per hour) Share parts of the book "How Fast Is It?" and give kids examples of different speeds – highlighting the point that it is a set distance over a set time. Explain to students that we will be trying to figure out the speed of the different sleds. Students will be in groups of 4. They will be given a hill (textbooks and a plank of wood) and 4 sleds (4 blocks of wood. 1 wrapped in sandpaper, 1 wrapped in wax paper, 1 wrapped in plastic wrap, and 1 that	<u>INTRODUCE SCIENTIFIC IDEAS</u> Students will be told that speed does in fact have to do with a relationship between distance and time. s = d/t <u>COMPARE STUDENT AND SCIENTIFIC IDEAS</u> Students can use this knew knowledge to figure out the speeds of the objects.

			is just wood.) Students will be asked to design an experiment to try to figure out which sled is the fastest. Roles: Recorder / PPPP Police / Time Keeper / Materials Manager Have them compare their data to see if the fastest speed matches the fastest sled we decided on yesterday? Why is that?	
3/8 Fri	7		Online force and motion exploration day. http://www.bbc.co.uk/schools/scienceclips/ages/10_11/forces_action.shtml Ask students to make their own conclusions after each activity. When they finish have them pair up and test each other's conclusions. Students will also continue with yesterday's experiment and data gathering.	
3/11 Mon		Mad Scientist Monday	Fireworks in a Jar	
3/13 Wed	15		Begin the lesson by asking students what they learned from the sled race with Mr. C & Mr. J to see a basis of what patterns they understood and if they can explain the patterns they saw. Introduce the idea of speed by asking students how they would know who won the sled race if Mr. C and Mr. J would have raced at different times, or if they hadn't been right next to each other during the race. After students have had a few minutes to share their ideas, introduce the idea of speed as a way to see who was going faster. Pose the question "How do the police know if cars are speeding?" Allow students to share some of their ideas. In order to give some students a visual, and to inspire more motivation, we will watch a short video of a high-speed car chase. Students will then work on a K-W-L worksheet to elicit what they know about speed: "What do you **know** about measuring how fast or slow something moves?" "What do you **want to know** about speed? What is interesting about	<u>ESTABLISH A QUESTION</u> This question will help students relate what they saw in the sled race with Mr. C to what they have seen in their lives outside of school <u>ELICIT STUDENTS' INITIAL IDEAS</u> Students can explain what they know about speed and measuring speed with the K-W-L worksheet

			speed?"	
3/14 Thur	16		Formulate an experiment to test the movement of a ball. Students will work in small groups of 4-5 to formulate an experiment that tests how long it takes a ball to fall. They will be required to list all the materials they will need, the procedures they will go through, and what factors they think will affect the timing of the falling ball. Students will each be responsible to have the information in their worksheet before we begin the experiment tomorrow. We will discuss as a class the different materials that each group came up with and how they will use them. This will allow some groups to modify their materials or procedures before they actually begin the experiment.	<u>ESTABLISH A QUESTION</u> This new question will give students a more testable challenge <u>ELICIT STUDENTS' INITIAL IDEAS</u> Students will have a chance to explain their own understandings of forces by creating their own experiments to test how long it would take for a ball to fall from a specific height
3/15 Fri	17		Ball Drop Experiment: Students will get into their groups and collect the materials they need. They will spend the class period collecting data from their experiment. Students will work in their groups. We will take a quick minute to discuss appropriate group work and I will give them the suggestion to have a data recorder, ball dropper, timer, and measurer. They can also rotate positions so that each student has a chance to do all of the activities. I will also ask students if there will be possibility for us to make mistakes such as not pressing the timer button at exactly the moment that the ball hits the floor. I expect students to realize that there will be a bit of error in their measurements. Therefore, their data sheet will include spots for them to record three different times for each height. Students will be required to record the height that they dropped the ball from as well as how long it took for the ball to travel that far. They will use their data sheet to record their findings into.	<u>EXPLORE PHENOMENA FOR PATTERNS</u> Students collect data from an experiment where they drop a ball from different heights and time how long the ball is in motion <u>EXPLORE IDEAS ABOUT PATTERNS</u> Students explore how to measure how far the ball will travel as well as how long it take to travel that distance
3/18 Mon	18	Mad Scientist Monday	Fireproof Balloon	
3/20 Wed	19		We will review some of the patterns that students saw during their experiment last week. Since quite a few days will have passed since the experiment, we will spend quite a bit of time remembering what things they saw and what patterns they made. Students will have time to discuss with their groups and then we will share some patterns in whole	<u>EXPLORE SOME IDEAS ABOUT PATTERNS</u> Students will make assumptions about what they experienced during the experiment as well as how those experiences align or

			group. As students discuss their findings, I will select some students to record some of their data onto a class chart. Both classes will contribute their measurements to the class charts. We will use both the class chart of measurements, as well as their individual measurements to compare and contrast data and to determine some patterns dealing with the time it takes for a ball to fall long distances (i.e. 120 inches) vs. the time it takes the same ball to fall short distances (i.e. 40 inches). During this discussion I will ask students if they think the speed of the falling ball would be different or the same for each height. We will begin to discuss ways that we could measure the speed of the ball so that we can determine if it moves faster from a higher height.	don't align with their previous experiences <u>STUDENTS EXPLAIN PATTERNS</u> Students will attempt to make explain what was happening as well as what patterns they saw with the different sets of data they collected. They will also try to explain how to measure the speed of the ball and how they compares to what they already know about calculating speed
3/21 Thur	20		In order to look at the data in a different way, students will plot their data as well as data from the class chart (to add more to their graph so that they can hopefully see more patterns) on a graph. Students will analyze their graphs with their groups and determine any patterns present. We will then discuss the graphs as a class. Primarily, we will discuss how the time changed in accordance with the change of distance that the ball had to move. We will wrap up the lesson with discussion about the speed of the ball being measured in inches per millisecond.	<u>STUDENTS EXPLAIN PATTERNS</u> Students will analyze their own graphs to see patterns in the data (i.e. it takes more time for the ball to drop from a higher height than from a lower height)
3/22 Fri	21		Students will begin this lesson by reviewing their K-W-L chart and adding in anything they learned about speed over the last few days. We will then share some of those ideas with the class. Students will also discuss some of the ways that we measure speed that they had written down in their K-W-L sheet. As students discuss the different ways we describe speed (mph, inches per millisecond, etc.), I will write them on the board. Then, we will compare and contrast the different ways in which we measure speed. I will lead students to see the pattern that speed is always measured in distance and time. Then, I will introduce the scientific formula for speed as speed = distance / time. We will wrap up the lesson by using this new formula to calculate the speed of the ball from their data sheets.	<u>INTRODUCE SCIENTIFIC IDEAS</u> Students will compare their findings from the experiment and their personal experiences with speed to the scientific explanation of measuring speed <u>COMPARE STUDENT & SCIENTIFIC IDEAS</u> Students will compare the scientific formula for speed to their own findings about measuring speed
3/25 Mon	22	Mad Scientist	Slime	

		Monday		
3/27 Wed	23		We will begin the lesson by reviewing what speed is and how we calculate it. Students will then use what they know to find the speed of the fastest car, boat, train, and airplane in the world given a distance they can travel and how long it takes them to travel that far. While students are working on finding the speeds of different autos, I will circulate and observe students as they work and discuss with their classmates to see how well they have grasped the concept of speed. We will spend the last 10-15 minutes going through the problems together. I will ask students to explain exactly how they got their answer. I will collect these problems to evaluate later.	<u>APPLY TO NEAR & DISTANT CONTEXTS WITH SUPPORT</u> Use what we learned about speed and calculating speed to calculate how fast the fastest car, train, airplane, and boat can go
3/28 Thur	24	(MT Sub Day) MSU	Post-Test: Force & Motion	<u>APPLY WITH FADING SUPPORT</u>

* Describe the activity functions using I-AIM.

Planning Resources

http://www.michigan.gov/documents/F05_GR5_SCI_REL_35_2_158509_7.pdf
- Released MEAP question about force and motion and scoring guide

http://www.michigan.gov/documents/F05_Gr5_Sci_Rel_145958_7.pdf
32. Chris pushes off the ramp platform with his right foot. He quickly places his foot back on the board and rides down the ramp. What force acts between Chris's foot and the platform as he pushes off?
A gravity
B friction
C conductivity
D magnetic attraction

33. What force acts to pull Chris down the ramp once he begins his downward motion?
A gravity
B friction
C conductivity
D magnetic attraction

34. Chris attaches a sheet of sandpaper to the surface of the skateboard deck. What purpose does the sandpaper most likely serve?
A It provides a protective coating to help prevent damage to the skateboard.
B It reduces the effect that gravity has on the board as it moves down the ramp.
C It allows Chris to crouch lower on the board to increase his speed on the ramp.
D It increases the friction between Chris's shoes and the deck to keep him from sliding off.

http://www.physics4kids.com/files/motion_intro.html
- Helpful definitions - content is a bit over

http://idahoptv.org/dialogue4kids/season12/force_and_motion/facts.cfm
Great picture definitions and explanations

http://www.cape.k12.mo.us/blanchard/hicks/News%20Pages/scienceforce.htm
Teacher lessons plan ideas and resources!

http://www.learner.org/interactives/parkphysics/parkphysics.html
Rollercoaster Park Physics! Updated version! - Really great

Project Idea: (create a theme-park) - research/identify/label the forces going on in your ride.

Lansing Skate Park- 3201 E. MIchigan Ave, Lansing, MI 48912

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&ved=0CH0QFjAH&url=http%3A%2F%2Fwww.sciencea-z.com%2Fscienceweb%2Fdownload.do%3FunitId%3D60%26mtId%3D20%26filename%3D%2Funit%2F60%2Fpdf%2Fforce_and_motion_5-6_unit_guide.pdf&ei=K0D8UJv9Nsy02AWqrIHoBA&usg=AFQjCNH4yyHCP7_LzzFu3O0W06GwmAnzow&sig2=AZwDuX4HyCVBmPQREutmBA&bvm=bv.41248874,d.b2I
Force and motion - science a-z: Great questions and answers for force and motion - helpful ideas for investigations.

http://www.lakeshorelearning.com/media/product_guides/DD354.pdf
Possible experiments

http://www.bbc.co.uk/schools/scienceclips/ages/10_11/forces_action.shtml
Online force and motion manipulative/game

Read the book - THE MAGIC SCHOOL BUS PLAYS BALL: A Book About Forces by Joanna Cole.

Science Writing Journals - prompts - drawings - use explicitly

turn it into a challenge

PROVE THEM WRONG
“Many people in the world believe these statements to be true. Can you prove them wrong?

Common misconceptions about force and motion:
University of Leicester School of Education website:
http://www.le.ac.uk/se/centres/sci/selfstudy/fam5.htm

- An object stops moving because “the push wore off.”
- An object that moves has that ability to do so by itself (in-built ability to move).
- “People move because they have legs” or “Bikes move because they have wheels.”- a part of an object creates the motion.
- Things fall because you let them go, but to go UP you have to push them up.
- An object stops because of the lack of action to keep the object going.

The National Science Digital Library website

http://nsdl.org/resource/2200/20061003155721785T

- The only "natural" motion is for an object to be at rest.
- If an object is at rest, no forces are acting on the object.
- Only animate objects can exert a force. Thus, if an object is at rest on a table, no forces are acting upon it.
- Force is a property of an object. An object has force and when it runs out of force it stops moving.
- The motion of an object is always in the direction of the net force applied to the object.
- Large objects exert a greater force than small objects.
- Friction always hinders motion. Thus, you always want to eliminate friction.
- A force is needed to keep an object moving with a constant speed.

PART 4

Lesson Plans

Lesson Plan #1

How Stuff Works (Science): How Does *Sledding* Work?
Introduction: Asking a Question
Adam Clements

Day 01

Lesson Title:
"How Does Sledding Work?" - Asking the Question

Lesson Connection to Unit Big Ideas:

- A change in motion is due to unbalanced forces.
- No change in motion and an object at rest are due to balanced forces.

Learning Goals (GLCES):
(S.IP.05.11) - Generate scientific questions based on observations, investigations, and research.

- **Activity**: Video Clip
  - Students will watch video clip of people sledding and use observations to generate a question about how they are able to move in specific ways. Expand this question to include asking how the act of sledding works on a scientific level in dealing with force and motion concepts.
- **Activity**: Turn and Talk
  - Students will share their initial observations of video with their group and compare ideas / answers. Using talk and discussion, students will evaluate each other's initial ideas and begin constructing their own initial answers to the question.
- **Activity**: Quick Write
  - Students will write down their initial ideas to the question that the class has generated. They will be able to refer back to this at the end of the unit and see how their ideas have changed, developed, or stayed the same.

I-AIM Functions and Rationale:
For this introductory lesson, students will be creating their unit investigatory purpose in the form of a question. By first establishing a question, it poses a question that will drive the overall inquiry and provide a sense of purpose. Our established question of "How does sledding work" will provide a sense of purpose to our investigation of force and motion. It is relevant to their lives and well-timed for the winter season. After our question has been established it is important to elicit student's initial ideas. This invites students to share their initial ideas about possible answers to the question and helps to find out how they understand the question and

where they are in their level of understanding of the scientific concepts. It will be highly effective for my students to first share their ideas in groups and then share out to the class. This will scaffold their ideas and answers and help all students to feel included.

Materials:

- **Projector**
- **Laptop**
- **Science Day 01 – PowerPoint**
- **AFV Sledding Video:** http://www.youtube.com/watch?v=IVIq42hVJN0
- **How Stuff Works Journal Notebooks**

Total Time: 40 min

Welcome **5 min**

Students will be welcomed to How Stuff Works.

- Welcome students to How Stuff Works
- Use a countdown timer to let students know how much time they have to come in and get settled and ready to go. (About 3 min)
- Use this time to go around and talk to specific students who need behavioral reminders:
    - Luke: "I am always really glad with how many connections you make and ideas you want to share. During today's lesson work on raising your hand when you have a thought to share. It is important to give your classmates time to think of their own ideas before we start sharing. Raising your hand lets me know that you have your idea and you are willing to wait for your classmates to think of their ideas. Do you think you can remember to do that today?"
    - Victoria: "I love how much you have to share with us during the lessons. Today when I ask some questions to the class, I want you to try and really work hard at thinking of one really good thing to share. Do you think you can remember to do that today?"
    - Taryn: "Today we are going to do a bit of writing. I know you are a wonderful writer, and that you take your time and plan out what you are going to write in your head first. If you need more time writing today, let me know by raising your hand and I will come help you when the rest of the class is set and working independently. Do you think you can remember to do that today?"

Setting Up and Preparing for a New Unit **5 min**

Students will take some time to set up their new How Stuff Works journal.

- Pass out the blank red covered journals
- Explain to students that these are their new "FORCE and MOTION" science journals and we will be filling these with notes, observations, experiments, data, and other scientific knowledge we gain as we go through our unit these next few weeks. Remind them that these should be brought to class every day and that they will be turned in at the end of the unit for a final grade. They should stay neat and reflect your best effort as a 5th grade student.
- Ask students to take a few minutes to number their journals in the bottom outside corner of each page (front and back). Use one student's journal to model your directions before you tell them to go.
- When most students have finished, ask them to neatly write their name in the upper right hand

corner. They should also include their student number.

- Ask students to neatly writhe "How Stuff Works" on the front center and underneath that to write "FORCE and MOTION" on the front center of the cover.
- Explain that at home or during free choice time they may draw or color designs on the back of their notebook as long as they connect to or are related to the unit topic in some way.
- Give students a few minutes to follow these directions.

Initial Question **5 min**

Propose an initial question to students to elicit background knowledge about the topic.

- **Q:** How many of you have been sledding before?
- Ask students to take a few minutes to turn and talk to their table teams and share their sledding experiences at their tables.
- While walking around and monitoring participation and engagement, if groups seem to struggle at starting a conversation pose thinking questions.
    - When was the last time you went sledding?
    - What did you have to do?
    - What was the best part?
    - Have you ever seen sledding on TV or in a movie? When? What did you see?
    - Why is sledding fun? What are the best parts about sledding?

AFV Sledding Video Clip **10 min**

Show the America's Funniest Videos clip of the 10 greatest sledding wipeouts.

- Introduce the clip and that it comes from AFV. AFV compiled all their hilarious sledding videos and picked the top 10 best sledding wipeouts.
- Play the video.
- After the video is done ask them what kinds of scientific questions we could ask about this video. Make a list on the whiteboard as students brainstorm different questions.
- When complete, summarize all the questions and explain that in How Stuff Works we want to examine and understand how the world around us works, and that if we take all these questions and put them together, we can ask one BIG question of… "How does SLEDDING work?"
- Explain that they will now be re-watching the video with those questions that they just came up with in mind as well as trying to answer our BIG question "How does sledding work?"
- Replay the video.

Quick Write **10 min**

Students will write their responses and their initial ideas down on paper.

- Explain to students that they will now be taking some independent work time to write down any and all their initial ideas to the question "How does sledding work?"
- Explain to them the importance of not only talking about our initial ideas but also writing them down. As scientists, keeping data and records is very important because it not only helps us stay accurate, but it also helps us look back and compare our new ideas to what we once though. This helps us see growth in our learning.
- Ask students to fill in the first row of their Table of Contents with the date, title and page number.
- Ask students to set up their page with the title, their name, student number, and the question.
- Give students about 10 – 15 minutes to write down their answer.
- Explain that students are only "done" when the timer goes off. As scientists, they may write down all their ideas, draw diagrams, explain and define scientific vocabulary, use bullet points to outline their

ideas, etc.
- Ask students to begin writing down their ideas.

Turn and Talk **5 min**

Students will read/share their initial ideas to their table team.

- Students will be asked to turn and talk to their table teams. They may read what they wrote during the quick write, or simply talk about some of the ideas they came up with.
- Remind students of the P.P.P.P. (Productive Partner Pair Properties) and that Teamwork, Active Listening, and Respectful Responding are important tools to use when having a discussion. Refocus the class's attention to the P.P.P.P. anchor chart.
- Have students begin discussing.
- Walk around and monitor student participate and engagement. Refocus off task students by engaging them back into the discussion with specific and thought provoking questions.
    - **Q**: What ideas did you come up with?
    - **Q**: What were some of the ideas you have heard that you agree with?
    - **Q**: Have you ever had similar experiences to the things you saw in the video?
    - **Q**: What types of things could you do with this information that you have?
    - **Q**: What types of things do you still wonder about?

Reminder for Tomorrow

- Explain to students that tomorrow we will be going outside to experiment and investigate how sledding works first hand. The best thing about being a scientist is when we get to be minds on AND hands on. Tell them that they need to dress warmly and bring things like snow pants, a coat, hats, gloves, boots, etc.

Assessment:

After, read through the students quick write responses. Evaluate them on…

- **Effort**: Did the student write/draw/illustrate/diagram an appropriate amount for their level?
- **Relevance**: Did the student respond to the question posed? Did they stay on topic?
- **Ideas**: Did the student come up with purposeful and thoughtful ideas?
- **Level of Understanding**: Where is the student at in their understanding of the concepts related to FORCE and MOTION? Advanced / On Level / Beginning

Academic, Social and Linguistic Support for Focus Students:

Visual Learners: All information and directions will be provided on the screen accompanied by visual images. This will help learners comprehend the auditory directions by also accompanying them with visual images.

Social Learners: Incorporating a "Turn and Talk" allows students who learn best through talk and interacting with others and their ideas, the opportunity to compare and contrast their thinking with someone else's.

LD Learners: The quick write is open enough so that students who are not strong writers are still able to share their ideas through images, diagrams, or incomplete sentences. It allows students the freedom to write what makes sense to them, but still gives the teacher an opportunity to see where they are in their thinking and how they answered the question. They will also be given extra time to respond to the writing prompt.

Lesson Plan #2

Let's Go Sledding!
Exploring the Phenomena and Looking For Patterns
Adam Clements

Day 02

Lesson Title:
"Let's Go Sledding" - Exploring the Phenomena and Looking for Patterns

Lesson Connection to Unit Big Ideas:

- A change in motion is due to unbalanced forces.
- No change in motion and an object at rest are due to balanced forces.

Learning Goals (GLCES):
(**S.IP.05.12**) - Design and conduct scientific investigations.

- **Activity**: Sledding
    - Students will set up a T-chart to organize their observations during the investigation. They will be tasked with the challenge of figuring different ways of making their sled move and not move.

I-AIM Functions and Rationale:
For this lesson, students will be narrowing the larger unit question of "How does sledding work" to a more specific focus. They will generate the question of "How can we make our sled move." By refining and refocusing our unity question, it helps to pose a more specific purpose that will drive our inquiry and lesson. It is relevant to their lives and well-timed for the winter season. They have elicited their prior ideas in the previous lesson and will be given the opportunity during this lesson to explore their ideas and look for patterns. The phenomena of making things move and stay still is important to understand as a basis of building more force and motion knowledge. They will investigate and explore answers to the question by working with a group actually testing out their ideas.

Materials:

- **Projector**
- **Laptop**
- **Science Day 02 – PowerPoint**
- **How Stuff Works Journal Notebooks**
- **Pencils**
- **Whistle**
- **Timer / Watch**
- **6 sleds**
- **Large open flat space outside**

Total Time: 50 min

Welcome **5 min**

Students will be welcomed to How Stuff Works.

- Welcome students to How Stuff Works
- Use a countdown timer to let students know how much time they have to come in and get settled and ready to go. (About 3 min)
- Use this time to go around and talk to specific students who need behavioral/social reminders:
    - Brent: "We are going to be doing a really fun hands-on investigation today outside. I think you are really going to enjoy it, but I want you to remember that even though we are going outside, we are still in school and our number one priority is to be learning. I am wondering if you can help be a leader today and help set a good example that your classmates can follow. Do you think you can remember to do that today?"
    - Bernardo: "We are going to be doing a fun hands-on investigation outside today. And even though it is going to be a lot of fun, it will still require students to focus and follow the rules. In science it is really important to follow rules when we do investigations so that we can make sure our data is accurate. Do you think you can remember to do that today?"
    - Taryn: "We are going to be doing a really fun hands-on investigation today. And I know that sometimes you sometimes get nervous when we do physical activities. I placed you in a group with a few of your friends so I hope you can be really brave today and participate. Do you think you can remember to do that today?"

Reviewing Yesterday's Ideas / Purpose **5 min**

Students will review their quick write from yesterday and bring back their prior knowledge.

- Q: How does sledding work?
- Explain that yesterday we watched a funny video of AFV's top 10 sledding wipe-out videos. After that we shared some of our own sledding stories and talked about this big question in small groups. Then you had to write a Quick Write about these ideas.
- Give students a few minutes to re-read their Quick Write.
- After, give them a few more minutes and have students share any new ideas they came up with between yesterday and today with their groups.
    - **Q**: When you went home, what else did you remember about sledding and how it works?
    - **Q**: What science words might you be able to use to explain your ideas?
- Explain the purpose of today's lesson: "In less than an hour… you will have explored your initial ideas about how sledding works and look for patterns. These patterns will help you to build your own explanations for how sledding works."

Generating A More Specific Question **5 min**

The class will work together to generate a more specific question that they can investigate.

- Re-post the large unit question: "How does sledding work?"
- **Q**: What are some questions we can ask that are more specific?
- Generate a list of questions on the board. As students give responses, lead the class in a small discussion of why each might be an important and purposeful question to ask. Guide the students to focusing on the question "How can we make our sled move?" Explain that in order to make our sleds move in certain ways that we want (over jumps, faster, slower, etc.) we first need to understand how they move.

Setting Up the Exploration Lab **10 min**

Explain to students the procedures of the lab and the safety rules.

- Explain to students that they will be traveling outside to do an exploration lab.
- They should have brought their warm clothes (snow pants, gloves, hats, etc.). If they didn't they may use some of the schools extra supplies.
- In Table Teams (the groups of four students at a table), students will be working together to try and make their sled move.
- At their tables, each student has a number on their desk. Explain that each student will have a specific role while they are outside.
    - #1 - **Materials**: Gets supplies for group and puts them away when the lab is over.
    - #2 – **Recorder**: Accurately records all ideas of the group. Their work is sued as reference for the rest of the group later.
    - #3 - **Time Keeper**: Using a stop watch, they will make sure the team stays on time. Everyone should get at least 3 min riding the sled.
    - #4 – **Task Monitor**: Makes sure all parts of the task are completed when the group finishes.
- Allow students a few moments to make sure they understand their roles and their responsibilities of each job.
- **Q**: What are your questions?
- Explain to students the CAUTIONS: LAB SAFTEY expectations. First explain the importance of lab safety in science. Take a few moments to discuss with them how scientists follow rules to prevent injury to self, others, or materials.
    - ALWAYS…
        - Be safe.
        - Be responsible.
        - Be respectful.
    - Specifically for today…
        - Be careful of fingers when you are on the ground. Make sure that others don't step on them and make sure that you don't step on fingers.
        - Treat the supplies with respect. Broken sleds mean no supplies and no supplies means no labs.
        - If an accident does occur, tell the teacher right away.
- **Q**: What are your questions?
- Have students open their science journals and begin filling in the necessary information in the Table of Contents. The title of this lab is "Exploration Lab: Making Our Sled Move."
- And their next available page, have students set up their observation note page. Each lab page should include a title: Exploration Lab, their name, and date. Ask them to write down our focus question for this lab, the one we are going to try to answer by exploring with our hands and looking for patterns. "How can we make our sled move?"
- Engage students in a short discussion about how we might want to set up our notes in a neat and organized way.
- **Q**: If we try something and it causes the sled to not move, would that be important information to write down?
- Lead students towards a T-Chart and talk about the benefits of this organization style. Explain that in science it is just as important to understand the things that don't work, as it is to understand the things that do.
- Remind students that during their lab observations they should be detailed and use descriptive scientific words. Diagrams are also very helpful for explaining things and it is very important to be detailed and thorough. Someone else should be able to pick up your journal and know exactly what

you did.

- **Q**: What are your questions?
- Lastly, explain the concept of Whistle & Write. Labs can be very fun and exciting. So sometimes students forget to record their observations and information. So, when students hear the whistle, they must FREEZE. Whatever they are doing, wherever they are, they must FREEZE. They must then grab their journal, and take about 1 minute to record some of their ideas and observations. When they hear the whistle blow again, they may return to experimenting and investigating.
- **Q**: What are your questions?
- Have students line up with their science journals, a pencil, a clipboard, and grab their warm clothes.

Exploration Lab **20 min**

Students explore different ideas they have about making the sled move.

- Once outside, ask the materials person to each come get one sled for their group and a stop watch.
- Give students the go ahead to begin exploring.
- Monitor behavior to make sure all students have understood directions, and are following the lab safety rules. Also monitor thinking and when appropriate, challenge certain students in their ideas and their thinking.
- **Q**: Why might that be working? / Why is that not working?
- **Q**: What other way can you make your sled move?
- **Q**: Which ways are harder? / Which ways are easier?
- **Q**: Are there ways you can make your sled move? Is there another way?
- Every 4 – 5 minutes, blow the whistle and have students confer with the recorder and write down the observations in their journals.
- Also, record each group and their investigations. (These will be used to analyze during later lessons.)
- When it is time to come inside, blow the whistle twice, and have them line up. The materials person should collect the sleds and stop watches and bring them back in side.

Reflection **5 min**

Have students reflect on what they learned and their successfulness in working with their Table Team.

- Pass out the ¼ sheet reflection paper to each student. It asks them to explain what they did today, state something they learned, and then evaluate how well they did on a scale of 1 to 10 and how well their group did on a scale of 1 to 10.
- Give students a few minutes to complete this and then collect the reflection sheets when they are done.

Assessment:

After, read through the student's reflections. Evaluate them on…

- **Effort**: Did the student complete the reflection?
- **Relevance**: Did the student respond on topic? Did the student respond honestly?
- **Ideas**: Did the student come up with purposeful and thoughtful idea about what they learned?
- **Level of Understanding**: Where is the student at in their understanding of the concepts related to FORCE and MOTION? Advanced / On Level / Beginning

Academic, Social and Linguistic Support for Focus Students:

Visual Learners: All information and directions will be provided on the screen accompanied by visual images. This will help learners comprehend the auditory directions by also accompanying them with visual images.

Social Learners: Incorporating discussions allows students who learn best through talk and interacting with others and their ideas, the opportunity to compare and contrast their thinking with someone else's.

Kinesthetic Learners: By including the lab, which requires movement, students who understand best through doing will have the opportunity to move around and understand some of the ideas they wrote about yesterday and experience them in the real physical world.

LD Learners: The recording of observations is open enough so that students who are not strong writers are still able to share their ideas through images, diagrams, or incomplete sentences. It allows students the freedom to write what makes sense to them, but still gives the teacher an opportunity to see where they are in their thinking and how they answered the question.

Lesson Plan #3

Preparing for Impression 5
Working to Explain Patterns
Adam Clements

Day 04

Lesson Title:
"Preparing for Impression 5" – Working to Explain Patterns

Lesson Connection to Unit Big Ideas:

- A change in motion is due to unbalanced forces.
- No change in motion and an object at rest are due to balanced forces.

Learning Goals (GLCES):
(**S.IP.05.16**) - Identify patterns in data.

- **Activity**: Reviewing Our Class Made Rules
    - In the previous lessons, students spent time discussing the observations they made while sledding. They worked as a class to come up with a rule for how to make a sled move that fits all of their experiences and observations. Today students will apply those rules to their homework and see if those new experiences fit or if they need to adapt and change their rule.

(**S.IA.05.12**) **-** Evaluate data, claims, and personal knowledge through collaborative science discourse.

- **Activity**: Turn and Talk
    - Students will turn and talk with their neighbors and compare their homework experiences of sledding. They will determine if their agreed upon rules from the last lesson match up with their new experiences or if they need to revise them.

(**S.IA.05.14**) **-** Draw conclusions from sets of data from multiple trials of a scientific investigation.

- **Activity**: Preparing for Impression 5
    - Students will prepare to make conclusions after investigating their rule using many different experiences found in impression 5. They will be tasked with testing their rule to see if it holds true in different situations when trying to make other things move. After they will make conclusions using these different sets of observational data.

I-AIM Functions and Rationale:
For this lesson, students will be preparing to go to Impression 5. They will be building off their prior experiences of sledding outside and sledding at home for homework. As a class they used their experiences outside to build an explanation for how to make their sleds move. This was done by using their observations to find patterns and using those patterns to generate a rule that would explain and answer the question. These explanations will be further explored and compared to the scientific knowledge they will gain at impression 5.

Materials:

- **Projector**
- **Laptop**
- **Science Day 04 – PowerPoint**

- **How Stuff Works Journal Notebooks**
- **Pencils**

Total Time: 40 min

Welcome **5 min**

Students will be welcomed to How Stuff Works.

- Welcome students to How Stuff Works
- Use a countdown timer to let students know how much time they have to come in and get settled and ready to go. (About 3 min)
- Use this time to go around and talk to specific students who need behavioral/social reminders:
    - Brent: "We are going to be doing some writing today. I know you are a great writer, but that sometimes you are not all that interested in what we are writing about. I tried to give you options about what you wanted to write about today so I am expecting that you choose the one you are most interested in and that will help motivate you. Do you think you can remember to do that?"
    - Victoria: "I love how much you have to share with us during the lessons. Today when I ask some questions to the class, I want you to try and really work hard at thinking of one really good thing to share. Do you think you can remember to do that today?"
    - Taryn: "Today we are going to do a bit of writing. I know you are a wonderful writer, and that you take your time and plan out what you are going to write in your head first. If you need more time writing today, let me know by raising your hand and I will come help you when the rest of the class is set and working independently. Do you think you can remember to do that today?"

Reviewing the Questions & Yesterday's Rules **5 min**

Students will review the questions that they are asking, why they are asking them, and what they have learned.

- Ask students if they remember what your big question is that we are trying to answer.
- **Q**: How does sledding work? / Q: How can we make our sled move?
- Engage in a short small discussion about why this is important? How does answering this question help students to better understand their world? What is the IOS or why is learning about force and motion important for outside of school? What can it help students be able to do or what new skill does it give them?
- Write student's ideas on the white board to help them visually see their thinking.
- Review the rules that they came up with yesterday. Have students re-read them out loud for the class.
    - One way to make the sled move is to push the sled (from behind) with enough force to make it move.
    - Another way to make the sled move is to pull the sled forward with enough force to overcome the opposing force of friction.

Turn and Talk **5 min**

Students share their ideas with their table team.

- Ask students to recall their sledding homework. If students admit that they didn't go sledding for homework, express disappointment that they didn't gain that new experiences, and that in order to gain knowledge from today's lessons they will want to pay special close attention to the experiences

that others had.

- Give students a few minutes to turn and talk to their table teams. Ask them what they noticed when they went sledding. What patterns were similar or different to the ones they identified when they went sledding here at school.
- Remind students of the P.P.P.P. (Productive Partner Pair Properties) and that Teamwork, Active Listening, and Respectful Responding are important tools to use when having a discussion. Refocus the class's attention to the P.P.P.P. anchor chart.
- Have students begin discussing.
- Walk around and monitor student participate and engagement. Refocus off task students by engaging them back into the discussion with specific and thought provoking questions.
    - **Q**: How was this new experience similar?
    - **Q**: Does the rule work? How so? Can your prove it?
    - **Q**: Are there things you could do to make this rule untrue?
    - **Q**: What are the variables or the things we could change? What happens with more force or more friction? Did you experience those differences? How so?
    - **Q**: What types of things do you still wonder about?

Quick Write **10 min**

Explaining the Rules and Patterns

- Explain to students that as learners, it is really important to be able to see growth in our understanding of something new. Scientists take lots of notes and reflect all the time so that they can see how their thinking has developed or changed over time.
- Ask students to record a new journal title "Quick Write: Checking Out Patterns." Remind them that every journal entry should have a title: "Quick Write," their name, and the date.
- Explain to them that they will be answering the question "What rules did you come up with that will make the sled move? Why do they work?"
- For guided support include the two sentence starters "We came up with the rule…" and "It worked because…" This quick write will help students to sort through their current thinking and share their own explanations/reasons for the patterns they have been observing. It gives them an opportunity to share their ideas and gives the teacher an opportunity to assess their explanation and their level of understanding.
- Give students a few minutes to write.

Preparing for Impression 5 **10 min**

Students will prepare for the experiences they will have tomorrow at Impression 5.

- Begin by explaining/reviewing what Impression 5 is. It is a "dynamic, interactive space for families to play, create, and challenge their understanding of science. Their mission is to facilitate learners in scientific exploration through hands-on exhibits and participatory educational programming. The hands-on learning environment of Impression 5 opened in 1972 and has served nearly 3 million visitors over the past 40 years! Since 1982, Impression 5 has been located on Museum Drive in downtown Lansing. "Impression 5" still refers to the five senses and the way that each sense is engaged during a visit to the Science Center!"
- **Q**: I know that you will all be on your best behavior while we are visiting and that you will be the best students you can possibly be. Now, do I want you to touch things while you are at this museum?
- Explain to students that the purpose of Impression 5 is to touch, and experiment, and interact with the experiences that the museum has set up. Explain that while they are there they will be looking for different experiences to observe how things move in order to compare the ideas and rules that they

already have to see if they match up or if they are different.

- In order to prepare for the field trip, explain to students that it is important to get some before ideas down on paper so that after the field trip they can come back and compare. As such, they will be doing one last quick write.
- Ask them to title their next journal entry "My Impression 5 Field trip." On the journal page students need to include the title; "My impression 5 Field Trip), their name, and the date. For this quick write, students will be responding to two prompts/sentence starters of their choice. Each response should be well thought out and reflect a 5th grade writing level.
    - A question I have about Force and Motion is…
    - I am still confused about…
    - I am most excited to learn about…
    - I think Impression 5 will have…
    - I can't wait to see…
    - I hope I get to…
- Give students time to write. While they are writing, walk around monitoring for behavior and completion of task. Work with students who are struggling to write down their ideas by motivating them and offering them more guidance. If necessary offer them the option to draw their ideas.

Assessment:

After, read through the student's sentence starters. Evaluate them on…

- **Effort**: Did the student complete the response?
- **Relevance**: Did the student respond on topic?
- **Ideas**: Did the student come up with purposeful and thoughtful idea?
- **Level of Understanding**: Where is the student at in their understanding of the concepts related to FORCE and MOTION? Advanced / On Level / Beginning

Academic, Social and Linguistic Support for Focus Students:

Visual Learners: All information and directions will be provided on the screen accompanied by visual images. This will help learners comprehend the auditory directions by also accompanying them with visual images.

Social Learners: Incorporating discussions allows students who learn best through talk and interacting with others and their ideas, the opportunity to compare and contrast their thinking with someone else's.

LD Learners: The prompts and sentence starters are open enough so that students who are not strong writers are still able to share their ideas through images, diagrams, or incomplete sentences. It allows students the freedom to write what makes sense to them, but still gives the teacher an opportunity to see where they are in their thinking and how they answered the question.

Experiential Learning Field Trip to…

Science just got a whole lot more hands on…

Over the next 6 weeks, your student will be immersed in a hands-on, experience-based unit about **forces and motion** in his or her science class. In order to extend this interactive approach to science education, we will be taking a field trip to Impression 5 Science Center. Impression 5 is a hands-on learning environment that specializes in engaging the five senses in scientific exploration.

This trip is intended to build upon students' knowledge and understanding of forces and motion, but the learning experience will not end there. Impression 5 offers exhibits including "Build Zone," "MI Nature," "Electricity & Magnetism," "Light & Color," "Make Your Own Music," and many more. This will be such a fantastic learning experience, however there is a small cost involved. Student admittance to Impression 5 is $5.00.

Also, we would love to have one or two adult volunteer chaperones. If you are interested, please let us know before the field trip. (Admission for adult chaperones is free.)

Sincerely,

Mr. C & Miss Hamlin

WHO?

The 5th grade classes of
Mr. J / Mr. C
&
Mrs. Seagren / Miss Hamlin

WHAT?

Field Trip

WHEN?

Friday, March 1st
9:30 am – 11:30 am

WHERE?

Impression 5 Science Center
200 Museum Drive
Lansing, MI

WHY?

To learn more about…
Force & Motion

COST?

$5.00

I give permission for my child to attend a field trip to Impression 5 in Lansing with the 5th grade classes of Mr. J / Mr. C and Mrs. Seagren / Miss Hamlin on Friday March 1st from 9:30 – 11:30. I have included the $5.00 along with this permission slip.

(Parent / Guardian Signature)

Name: _____

Student Number: _____

Date: _____

Reflection Exit Slip

HOW STUFF WORKS - Reflection

Name: _____

Student Number: _____

Date: _____

What did you do today? _____

_____

What is one thing you learned? _____

_____

How well did your **GROUP** do today?

 0 1 2 3 4 5 6 7 8 9 10 

Why? _____

_____

_____

How well did **YOU** do today?

 0 1 2 3 4 5 6 7 8 9 10 

Why? _____

_____

_____

Accommodations

Science tells us: 3/6/13

"A force is a push or a pull on an object. When a force that is applied to an object is strong enough to overcome the opposing forces (like friction, gravity, or any other force going in the opposite direction), the result is an unbalanced force which causes a change in the motion of that object."

Lesson Plans

Date: 3/13

Overall lesson topic/title: Introduction to Speed

CCSS(s): **P.FM.05.33** - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Learning Target(s)/Objective(s): Elicit students' knowledge of and experiences with speed and how to measure speed

Rationale: By now, students have all shared some experiences with forces and how they affect movement. This lesson will not only allow them to share and expand their ideas and knowledge about how fast things move, but it will also elicit students' prior ideas about speed as an introduction and a transition into speed and motion. (Elicit Students' Initial Ideas)

Materials: K-W-L Worksheets (52 - enough for both classes)

Procedures and approximate time allocated for each event	***Academic, Social and Linguistic Support during each event for my focus students****:*
LAUNCH (Introduction to the lesson) *I will begin the lesson by asking students to explain the sled race between Mr. J and Mr. C. I will allow some students to share their understanding of forces and how different forces affected the race. I will prompt students to explain how they used force to move the sleds and what forces were acting against the forces they were exerting. As a transition into speed, I will ask students how we would know who won the sled race if Mr. C and Mr. J had raced at different times or places. I will then introduce the idea of using speed to determine who won the race and explain to students that we are going to begin using what we know about forces to learn more about speed and the motion of objects.* *(15 minutes)*	
EXPLORE (Outline of Key events During the lesson) *Next, I will explain the K-W-L worksheet to students and I will have paper passers hand out the K-W-L worksheet. This worksheet has columns for Know, Want to Know, and Learned ideas about speed. It also has at the top a question for students to focus their knowledge and ideas about speed and measuring speed – "What do you know about measuring how fast or slow something moves?" Students will fill in as much as they can on the worksheet individually. During this time, I will walk around the room and observe students' writing. I will also take this time to ask probing questions such as "how do your parents know how fast they are driving or how does a police officer know if someone is going faster than the speed limit?" to elicit their experiences with speed and how much they understand about speed in their own lives. As students work, I will be informally assessing both their knowledge of speed and motion as well as their interests and experiences with speed outside the classroom.* *(15 minutes)*	*I will show the K-W-L worksheet on the ELMO projector as I explain it so that students may have a visual while I give directions for each part.* *Writing down their thoughts will allow all students to participate and will help those who do not often participate in class discussions to write down their thoughts. Class discussion will*

SUMMARIZE (Closing Summary for the Lesson) *We will spend the last few minutes of class sharing first what students know about speed and measuring speed. I will continue to ask students to explain their thinking and expand on others' thoughts to really get a good understanding of what students already know and understand. Students will then get a chance to share what interests them about speed as we wrap up today's lesson. We will discuss what common ideas they share as well as patterns between their differing ideas and knowledge on speed and measuring speed. To wrap up today's lesson, we will try to make a plan for how to test their different theories and what kind of experiments or investigations we should do next.* *(10 minutes)*	*allow those who struggling with writing to give voice to their ideas more easily.*

Date: 3/14

Overall lesson topic/title: Formulate an Experiment

CCSS(s): S.IP.05.12 Design and conduct scientific investigations.

Learning Target(s)/Objective(s): Students will design an experiment to test how long it will take a ball to fall from predetermined heights.

Rationale: By actively participating in the creation of the experiment, students will be more motivated in the experiment itself. Designing the experiment will also require students to think about how to solve the challenging question. (Establish a Question & Elicit Student Ideas)

Materials: "Formulate the Experiment" worksheet (52 – enough for both classes), whiffle ball (for demonstration)

Procedures and approximate time allocated for each event	***Academic, Social and Linguistic Support during each event for my focus students****:*
LAUNCH (Introduction to the lesson) *We will begin the lesson by sharing a few of the ideas that students had about speed yesterday and then I will tell students that I have a challenge for them that will help us to determine how to measure speed. I will tell them that since they cannot drive yet, we will simply have to do an experiment inside the classroom. I will get out the whiffle ball and ask students how they can testing the speed of the ball if I dropped it from different distances. I will tell them that this would be similar to testing the speed of a car race, or Mr. C and Mr. J, as they were pulled across the finish line at different times. I will help students come to the conclusion that they need to time how long it takes for the ball to fall and how far it moved to find the speed. Then, I will explain that they will be responsible for setting up the experiment in groups. Students will have 2 minutes to get into groups of four or five and sit with their groups so that I can give further directions.* *(10 minutes)*	*Students have the choice to work with whomever they choose. This will allow students to pick others whom they feel most comfortable.*
EXPLORE (Outline of Key events During the lesson) *Once students have gotten into groups, I will display the "Formulate the Experiment" worksheet onto the screen using the ELMO projector, showing only the challenge: "How long does it take a whiffle ball to fall?" I will explain that their challenge is to determine how long it will take the ball to fall because this information will help us determine how fast the ball is moving. I will remind them of how we conduct our "Mad Scientist Mondays" – that we (Mr. C & I) always have a plan for how much of each ingredient to mix and when to mix it. We always prepare our materials ahead of time and plan out how we will conduct the experiment. I will explain that this will be their job before we actually do the experiment. Then, I will have paper passers distribute the worksheets so that groups can work as I explain each section of the worksheet. First, I will explain the "Make a Plan" section. Students will be required to determine how they will test the time of the ball as it drops. Then, I will explain the "Materials" section. Students will need to discuss and determine as a group what materials I will need to acquire for them. We will share some of these ideas out loud so that each group can make sure they have all of their materials listed that they may need. Then, I will explain the "Procedure" section where students will need to make a clear, organized list*	*Students will have time to discuss their plans before they record them on their worksheet. This will allow those who struggle with writing to simply copy the ideas onto paper while still participating in the group discussion.*

of how they will conduct the experiment. These procedures will be listed numerically in the order in which they plan to conduct their experiment. Once students have filled in their procedures, I will ask students how they plan to record the information that they collect. We will talk briefly about data collection and what data they will need to collect (i.e. height and time), as well as repetition for each height because of human error. (25 minutes) **SUMMARIZE (Closing Summary for the Lesson)** *We will wrap up the lesson by sharing some thoughts about what will happen during our experiments, including mistakes that could be made, hypotheses about how long students think it could take for the ball to drop, and other questions students might have.* *(5 minutes)*	
Formative Assessment *Class discussion, observation*	***Academic, Social, and Linguistic Support during assessment*** *For students who work better with visual aids, they will use their worksheets to record their thinking. For students who have trouble articulating their thoughts, they may discuss ideas and strategies with their group members and copy their group mates' writing.*

Date: 3/15

Overall lesson topic/title: Ball Drop Experiment

CCSS(s): **P.FM.05.42** - Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

Learning Target(s)/Objective(s): Students will gain similar experiences with forces and motion by conducting an experiment in small groups

Rationale: This experiment will give students a similar experience with forces and motion to discuss as a class. This experiment will also lead to understanding of speed as a measure of distance traveled divided by the time it took to travel that distance. (Explore Phenomena for Patterns)

Materials: Whiffle balls, measuring tapes, yard sticks, timers (8), Data Collection Sheet (52)

Procedures and approximate time allocated for each event	***Academic, Social and Linguistic Support during each event for my focus students:***
LAUNCH (Introduction to the lesson) *Students will get back into their groups and I will review all of the materials they have at their disposal. I will ask students how we can make sure that we will be able to compare and contrast our measurements. As students come up with ideas of using the same measuring tools, I will ask what measurement units we should use. Before we begin our experimenting, I will review appropriate group participation and the roles we discussed during the previous lesson (timer, measurer, ball dropper, data recorder, etc.) and remind students that they may rotate roles. I will also remind students that they should record three different times for each height they choose to drop the ball from.* *(10 minutes)* **EXPLORE (Outline of Key events During the lesson)** *Students will spend the majority of the class period conducting their experiments. They will be using their measuring tools to determine what height they will drop the ball from and record the height. Then, they will time how long it takes for the ball to fall to the ground. I will circulate during this time to check in with each group as they are working. I will be looking for students to be recording the data that they are collecting. I will also ask student to compare the three time trials to determine if the times were similar.* *(25 minutes)* **SUMMARIZE (Closing Summary for the Lesson)** *Students will return their materials to the appropriate places and return to their seats. We will wrap up the lesson by discussing any questions students had or issues they ran into while conducting their experiments.* *(5 minutes)*	*Students will all get a chance to participate in a hands-on way during this activity.*

PART 5

Analysis of Student Learning and Reflection

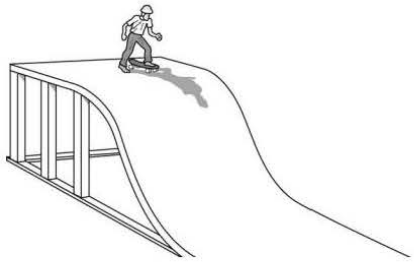
PART 1 - A

Analysis of Student Assessment Response Chart: Individual Student Responses

Assessment #1: Multiple Choice Questions

Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using physical science. Use your prior-knowledge of force and motion to help you in attempting to answer the following question. **Simply do your best**!

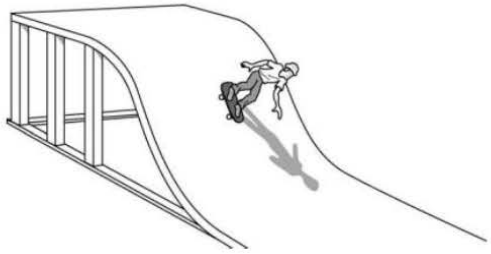
Chris pushes off the ramp platform with his right foot.



1. What force acts between Chris's foot and the platform as he pushes off?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

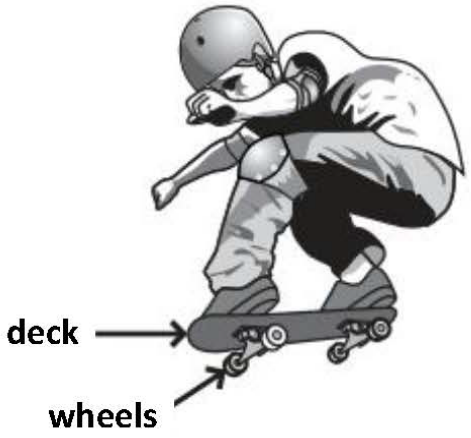
He quickly places his foot back on the board and rides down the ramp.



2. What force acts to pull Chris down the ramp once he begins his downward motion?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

Chris attaches a sheet of sandpaper to the surface of the skateboard deck.



3. What purpose does the sandpaper most likely serve?

- ○ **A**: It provides a protective coating to help prevent damage to the skateboard.
- ○ **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- ○ **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ○ **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

Individual Student Response Chart #1 – Assessment #1

Student: V

GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale: "Show What You Know. Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using science. Use your knowledge of force and motion to help you answer the following question. **Do your best**!" Students were given a sheet of paper with three multiple choice questions written out. Each question had for choices with circles next to them for the student to fill out. Accompanying each picture was a visual drawing or representation of the question. These questions ask them to identify the force that acts between Chris's foot and the platform as he pushes off, the force that pulls Chris down the ramp, and why he most likely put sandpaper on his skateboard. Using skateboarding as the topic will give students a realistic scenario of forces and how they affect the motion of an object. This assessment allows students to choose one best answer.

Assessment features:

- Identify friction as the force acting between Chris's foot and the platform.
- Identify gravity as the force that acts to pull Chris down the ramp.
- Explain that the purpose of the Sandpaper was most likely to increase the friction between Chris's shoes and the deck to keep him from sliding off.

1. What force acts between Chris's foot and the platform as he pushes off?

- ● **A**: Gravity
- O **B**: Friction
- O **C**: Conductivity
- O **D**: Magnetic Attraction

(**B**: I am pretty sure it is the right answer.)

2. What force acts to pull Chris down the ramp once he begins his downward motion?

- O **A**: Gravity
- O **B**: Friction
- ● **C**: Conductivity
- O **D**: Magnetic Attraction

(**B**: I am pretty sure it is the right answer.)

3. What purpose does the sandpaper most likely serve?

- O **A**: It provides a protective coating to help prevent damage to the skateboard.
- O **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- O **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ● **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

(**D**: I guessed)

Evidence from work sample of weaknesses in student understanding:	**Evidence from work sample of strengths in student understanding:**
List a specific feature or features in the student work sample that illustrates a weakness of the student understanding. • She did not correctly identify friction. • She did not correctly identify gravity as the force that acts to pulling Chris down the ramp. • She chose conductivity as the force that acts to pulls Chris down the ramp which was a force we never mentioned during lessons. *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* • This shows the student does not have a strong grasp at identifying the basic forces that were covered during the unit in this scenario. This shows poor mastery of the assessment because out of four choices, she was not able to identify the correct usage of the vocabulary or the term.	*List a specific feature or features in the student work sample that illustrates a strong student understanding.* • The student correctly identified that the purpose of the sandpaper was to increase the friction between Chris's shoes and the deck to keep him from sliding off. *Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* • No reliable claim can truly be made. The student responded that she guess on this question and based on the previous incorrect answer where she was unable to identify friction and the force acting between Chris's foot and the platform as he pushed off, it is unlikely that she understood friction as the force acting between Chris's shoe and the deck of his skateboard. The results are simply inconclusive and uncertain.

Individual Student Response Chart #2 – Assessment #1

Student: I

GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale: "Show What You Know. Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using science. Use your knowledge of force and motion to help you answer the following question. **Do your best**!" Students were given a sheet of paper with three multiple choice questions written out. Each question had for choices with circles next to them for the student to fill out. Accompanying each picture was a visual drawing or representation of the question. These questions ask them to identify the force that acts between Chris's foot and the platform as he pushes off, the force that pulls Chris down the ramp, and why he most likely put sandpaper on his skateboard. Using skateboarding as the topic will give students a realistic scenario of forces and how they affect the motion of an object. This assessment allows students to choose one best answer.

Assessment features:

- Identify friction as the force acting between Chris's foot and the platform.
- Identify gravity as the force that acts to pull Chris down the ramp.
- Explain that the purpose of the Sandpaper was most likely to increase the friction between Chris's shoes and the deck to keep him from sliding off.

1. What force acts between Chris's foot and the platform as he pushes off?

- O **A**: Gravity
- ● **B**: Friction
- O **C**: Conductivity
- O **D**: Magnetic Attraction

(**B**: I am pretty sure it is the right answer.)

2. What force acts to pull Chris down the ramp once he begins his downward motion?

- ● **A**: Gravity
- O **B**: Friction
- O **C**: Conductivity
- O **D**: Magnetic Attraction

(**A**: Very sure, I have no doubts that it is the right answer.)

3. What purpose does the sandpaper most likely serve?

- O **A**: It provides a protective coating to help prevent damage to the skateboard.
- O **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- O **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ● **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

(**D**: I guessed)

Evidence from work sample of weaknesses in student understanding: *List a specific feature or features in the student work sample that illustrates a weakness of the student understanding.* • She responded that she guessed on question #3. *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* • She got all questions correct and was able to identify the friction as the force that acts between Chris's foot and the platform as he pushes off, gravity as the force that pulls Chris down the ramp, and that he most likely put sandpaper on his skateboard to increase the friction between Chris's shoes and the deck to keep him from sliding off. However, she showed a lack of confidence in answering question #3 which could lead to uncertainty in her knowledge and understanding of the concept of friction and its purpose.	**Evidence from work sample of strengths in student understanding:** *List a specific feature or features in the student work sample that illustrates a strong student understanding.* o The student marked all questions with the correct response. *Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* o She was able to identify the friction as the force that acts between Chris's foot and the platform as he pushes off, gravity as the force that pulls Chris down the ramp, and that he most likely put sandpaper on his skateboard to increase the friction between Chris's shoes and the deck to keep him from sliding off.

Individual Student Response Chart #3 – Assessment #1

Student: A

GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale: "Show What You Know. Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using science. Use your knowledge of force and motion to help you answer the following question. **Do your best**!" Students were given a sheet of paper with three multiple choice questions written out. Each question had for choices with circles next to them for the student to fill out. Accompanying each picture was a visual drawing or representation of the question. These questions ask them to identify the force that acts between Chris's foot and the platform as he pushes off, the force that pulls Chris down the ramp, and why he most likely put sandpaper on his skateboard. Using skateboarding as the topic will give students a realistic scenario of forces and how they affect the motion of an object. This assessment allows students to choose one best answer.

Assessment features:

- Identify friction as the force acting between Chris's foot and the platform.
- Identify gravity as the force that acts to pull Chris down the ramp.
- Explain that the purpose of the Sandpaper was most likely to increase the friction between Chris's shoes and the deck to keep him from sliding off.

1. What force acts between Chris's foot and the platform as he pushes off?

- O **A**: Gravity
- ● **B**: Friction
- O **C**: Conductivity
- O **D**: Magnetic Attraction

(**A**: Very sure, I have no doubts that it is the right answer.)

2. What force acts to pull Chris down the ramp once he begins his downward motion?

- ● **A**: Gravity
- O **B**: Friction
- O **C**: Conductivity
- O **D**: Magnetic Attraction

(**A**: Very sure, I have no doubts that it is the right answer.)

3. What purpose does the sandpaper most likely serve?

- O **A**: It provides a protective coating to help prevent damage to the skateboard.
- O **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- O **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ● **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

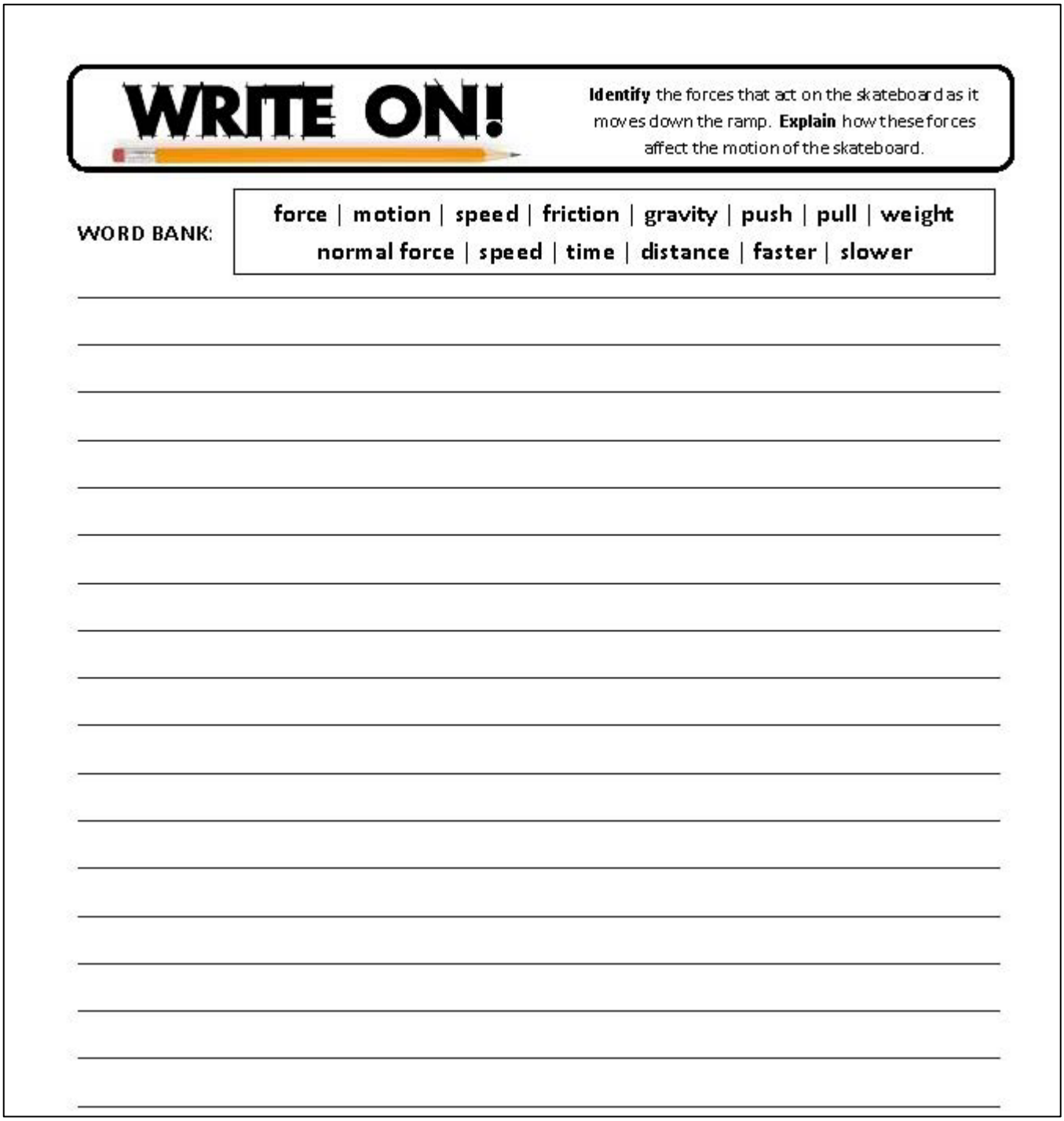
(**B**: I am pretty sure it is the right answer.)

Evidence from work sample of weaknesses in student understanding: *List a specific feature or features in the student work sample that illustrates a weakness of the student understanding.* o This student showed no weakness in their responses. *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* o The student marked all questions with the correct response. He was able to identify the friction as the force that acts between Chris's foot and the platform as he pushes off, gravity as the force that pulls Chris down the ramp, and that he most likely put sandpaper on his skateboard to increase the friction between Chris's shoes and the deck to keep him from sliding off.	**Evidence from work sample of strengths in student understanding:** *List a specific feature or features in the student work sample that illustrates a strong student understanding.* o The student marked all questions with the correct response. *Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* o He was able to identify the friction as the force that acts between Chris's foot and the platform as he pushes off, gravity as the force that pulls Chris down the ramp, and that he most likely put sandpaper on his skateboard to increase the friction between Chris's shoes and the deck to keep him from sliding off.

PART 1 - A

Analysis of Student Assessment Response Chart: Individual Student Responses

Assessment #2: Writing Essay Prompt



Individual Student Response Chart #1 – Assessment #2

Student: V

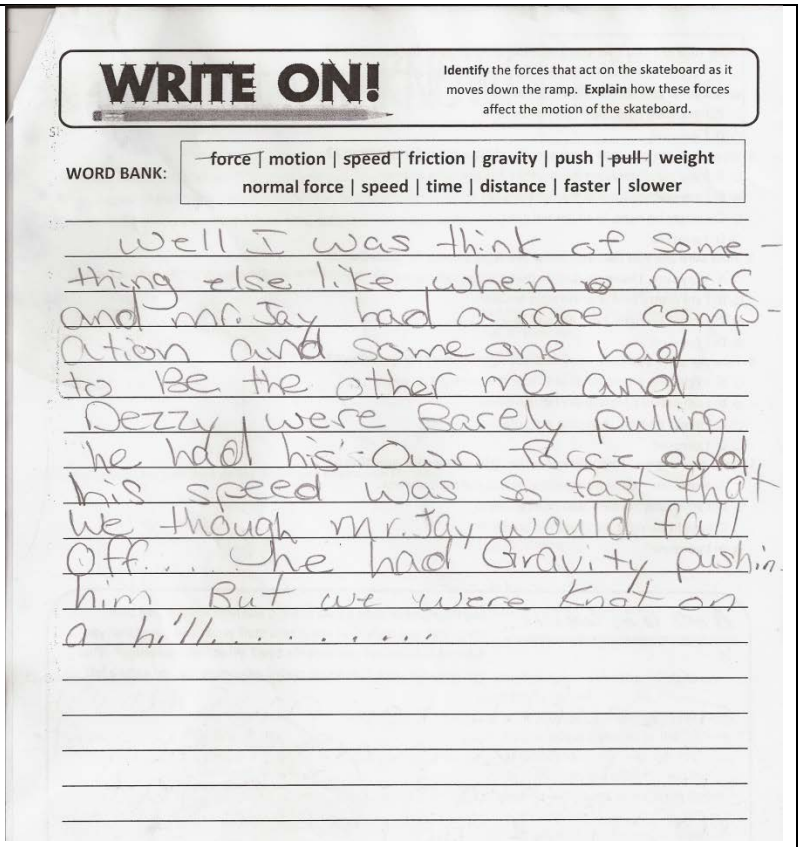
GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale:
"WRITE ON! Identify the forces that act on the skateboard as it moves down the ramp. Explain how these forces affect the motion of the skateboard." Students were given a word bank to help them write a paragraph explaining the forces that act on a skateboard as it moves down a ramp, as well as explain how the forces affect the movement of the skateboard. Using skateboarding as the topic gave students a realistic scenario of forces and how they affect the motion of an object. This assessment also allowed students to explain as much or as little as they know about forces and motion.

Assessment features:

- Identify gravity as a force
- Explain that gravity pulls the skateboard down the ramp
- Explain that gravity makes the skateboard go faster or increases its speed
- Identify friction as a force
- Explain that friction slows the skateboard down or decreases its speed
- Explain that friction acts between his foot and the ground to begin the motion



WRITE ON!

Identify the forces that act on the skateboard as it moves down the ramp. Explain how these forces affect the motion of the skateboard.

WORD BANK: ~~force~~ | motion | ~~speed~~ | friction | gravity | push | ~~pull~~ | weight | normal force | speed | time | distance | faster | slower

Well I was think of some-thing else like when Mr. C and mr. Jay had a race comp-ation and some one had to Be the other me and Dezzy were Barely pulling he had his Own force and his speed was so fast that we though mr. Jay would fall Off... he had Gravity pushin him But we were knot on a hill.....

"Well I was think of some-thing else like when Mr. C and mr. Jay had a race comp-ation and some one had to Be the other me and Dezzy were Barely pulling he had his Own force and his speed was so fast that we though Mr. Jay would fall off... he had Gravity pushin him, But we were knot on a hill....."

Evidence from work sample of weaknesses in student understanding:

List a specific feature or features in the student work sample that illustrates a weakness of the student understanding.

- She does not mention the skateboarder at all. Instead, she recalls facts she remembers

Evidence from work sample of strengths in student understanding:

List a specific feature or features in the student work sample that illustrates a strong student understanding.

- Student mentions that gravity influences the motion of a skateboard on a hill.

from the experience she had in class previously. In this experience, she says nothing about the force of friction. In addition, she describes gravity as a horizontal force that "pushes." *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* • The student seems to recall specific experiences with forces because she uses the words "push" and "pull" to describe the necessary force it took to move Mr. J and Mr. C when they had a sledding competition. However, she describes gravity as a "push" force, and seems to think that gravity would "push" someone down a hill, instead of "pull" them down. Since she does not mention friction at all, her misconception seems to be that there is only one force acting on the object at a time, instead of the fact that there must be an unbalanced net force on the object.	*Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* • Student shows understanding of the role of gravity when sledding downhill. Although she does not mention that there are other forces acting on the sled, she does give some indication that there is a need for multiple forces when she describes the pushes and pulls used to move the sled. She also shows a bit of understanding that the magnitude of the pushes or pulls affects the speed of the motion of an object.

Individual Student Response Chart #2 – Assessment #2

Student: l

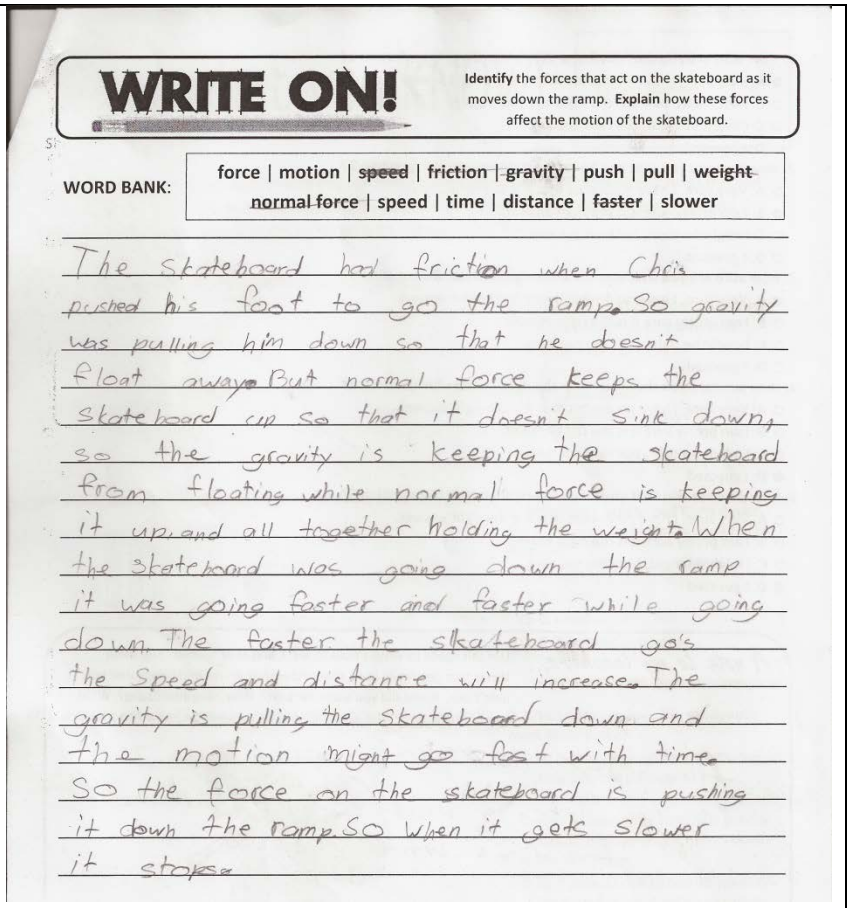
GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale:
"WRITE ON! Identify the forces that act on the skateboard as it moves down the ramp. Explain how these forces affect the motion of the skateboard." Students were given a word bank to help them write a paragraph explaining the forces that act on a skateboard as it moves down a ramp, as well as explain how the forces affect the movement of the skateboard. Using skateboarding as the topic gave students a realistic scenario of forces and how they affect the motion of an object. This assessment also allowed students to explain as much or as little as they know about forces and motion.

Assessment features:

- Identify gravity as a force
- Explain that gravity pulls the skateboard down the ramp
- Explain that gravity makes the skateboard go faster or increases its speed
- Identify friction as a force
- Explain that friction slows the skateboard down or decreases its speed
- Explain that friction acts between his foot and the ground to begin the motion



WRITE ON!

Identify the forces that act on the skateboard as it moves down the ramp. Explain how these forces affect the motion of the skateboard.

WORD BANK: force | motion | ~~speed~~ | friction | ~~gravity~~ | push | pull | weight | ~~normal force~~ | speed | time | distance | faster | slower

The skateboard had friction when Chris pushed his foot to go the ramp. So gravity was pulling him down so that he doesn't float away. But normal force keeps the skateboard up so that it doesn't sink down, so the gravity is keeping the skateboard from floating while normal force is keeping it up, and all together holding the weight. When the skateboard was going down the ramp it was going faster and faster while going down. The faster the skateboard go's the speed and distance will increase. The gravity is pulling the skateboard down and the motion might go fast with time. So the force on the skateboard is pushing it down the ramp. So when it gets slower it stops.

"The skateboard had friction when Chris pushed his foot to go the ramp. So gravity was pulling him down so that he doesn't float away. But normal force keeps the skateboard up so that it doesn't sink down, so the gravity is keeping the skateboard from floating while the normal force is keeping it up and all together holding the weight. When the skateboard was going down the ramp it was going faster and faster while going down. The faster the skateboard go's the speed and distance will increase. the gravity is pulling the skateboard down and the motion might go fast with time. So the force on the skateboard is pushing it down the ramp. So when it gets slower it stops."

Evidence from work sample of weaknesses in student understanding:	**Evidence from work sample of strengths in student understanding:**
List a specific feature or features in the student work sample that illustrates a weakness of the student understanding. • The weakness in this explanation of the forces acting on the skateboard as it moves down the ramp is that the student does not mention friction or its affects on the motion of the skateboard. She explains that the skateboard will eventually slow down and come to a stop, but she does not explain what forces will cause the skateboard to slow down and stop. *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* • This student shows an understanding of what will happen to the skateboard, but does not explain that friction acts between the skateboard and the ground to slow the motion down. This shows a lack of understanding that there is more than one force acting on the skateboard and that these forces are unbalanced, which causes the motion. The explanation demonstrates poor understanding of the opposing forces that are affecting the movement of the skateboard because there is really only description of gravity pulling the skateboard down. She is missing the idea that friction causes the skateboard to slow down and eventually stop.	*List a specific feature or features in the student work sample that illustrates a strong student understanding.* o This student shows a strong understanding of the affects of gravity on the motion of the skateboard. In addition, she also shows a strong understanding that the motion of the skateboard begins because of the friction between the skateboarder's foot and the ground. *Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* o She shows a strong understanding of the force of gravity because she describes this force as a pull that acts on the skateboard to force it to continue moving down the ramp. She also illustrates a basic understanding that gravity causes the speed of the skateboard to increase. This student also shows a strong understanding that there are multiple forces acting on the skateboard to hold it atop the ramp. She writes that gravity keeps the skateboard from floating away while normal force holds up the weight of the skateboard. Therefore, this student shows a strong understanding of what happens when two forces act on an object in opposite directions.

Individual Student Response Chart #3 – Assessment #2

Student: A

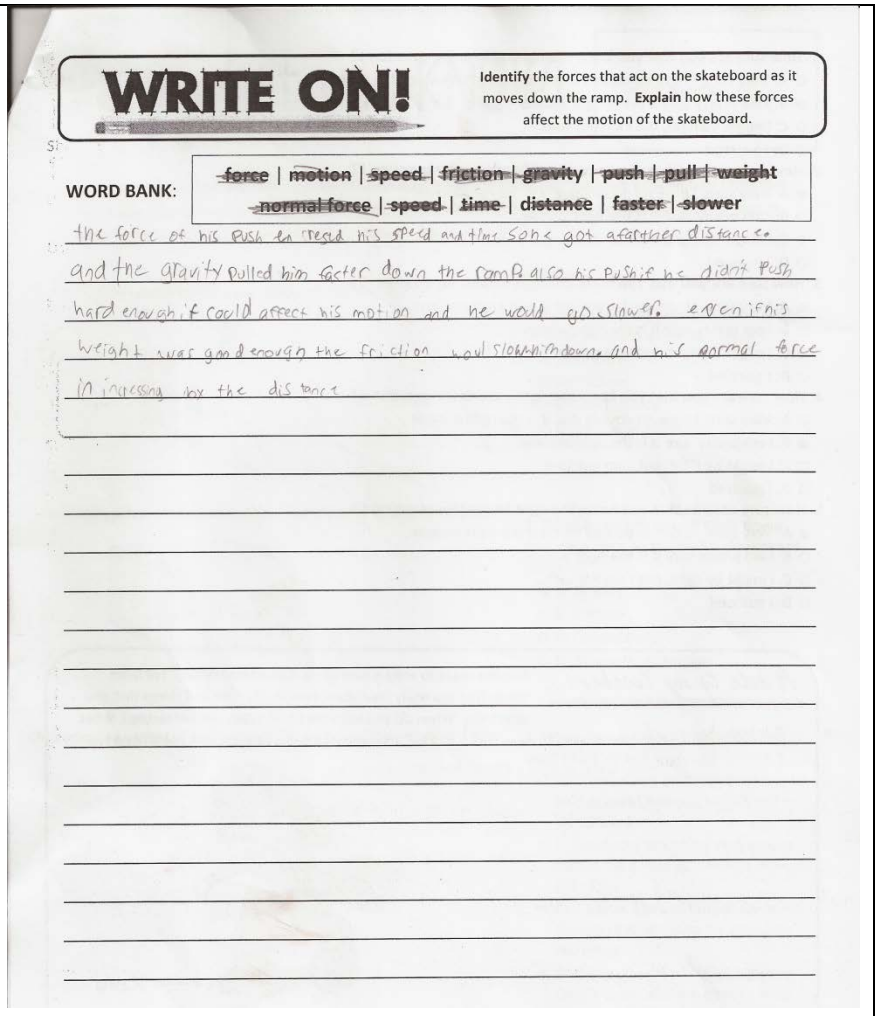
GLCE/Learning Goal: (P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(**P.FM.05.33**) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Assessment task description and rationale:
"WRITE ON! Identify the forces that act on the skateboard as it moves down the ramp. Explain how these forces affect the motion of the skateboard." Students were given a word bank to help them write a paragraph explaining the forces that act on a skateboard as it moves down a ramp, as well as explain how the forces affect the movement of the skateboard. Using skateboarding as the topic gave students a realistic scenario of forces and how they affect the motion of an object. This assessment also allowed students to explain as much or as little as they know about forces and motion.

Assessment features:

- Identify gravity as a force
- Explain that gravity pulls the skateboard down the ramp
- Explain that gravity makes the skateboard go faster or increases its speed
- Identify friction as a force
- Explain that friction slows the skateboard down or decreases its speed
- Explain that friction acts between his foot and the ground to begin the motion



WRITE ON!

Identify the forces that act on the skateboard as it moves down the ramp. **Explain** how these forces affect the motion of the skateboard.

WORD BANK: ~~force~~ | ~~motion~~ | ~~speed~~ | ~~friction~~ | ~~gravity~~ | ~~push~~ | ~~pull~~ | ~~weight~~ ~~normal force~~ | ~~speed~~ | ~~time~~ | distance | ~~faster~~ | ~~slower~~

the force of his push encresed his speed and time so he got a farther distance. and the gravity pulled him faster down the ramp. also his push if he didn't push hard enough it could affect his motion and he would go slower. even if his weight was good enough the friction would slow him down. and his normal force is increasing by the distance.

"The force of his push encresed his speed and time so he got a farther distance. and the gravity pulled him faster down the ramp. also his push if he didn't push hard enough it could affect his motion and he would go slower. even if his weight was good enough the friction would slow him down. and his normal force is increasing by the distance."

Evidence from work sample of weaknesses in student understanding:	**Evidence from work sample of strengths in student understanding:**
List a specific feature or features in the student work sample that illustrates a weakness of the student understanding. o This student's weakness is in his explanation of how the skateboarder begins the motion. Although he describes that there is force in the "push" that the skateboarder uses to get the motion started, he does no explain what that force is. He is not mentioning that this force is the friction between the skateboarder's foot and the ground working to start the movement of the skateboard. *Provide a claim for what this indicates about student understanding and a rationale of why this demonstrates poor/misunderstanding mastery of your assessment objective/GLCE.* o This student's explanation of the forces that affect the motion of a skateboard as a goes down the ramp indicates that he understands that gravity pulls the skateboard down the ramp and speeds it up. He also understands that friction acts on the skateboard to slow down its motion. This student also shows understanding that more force must act on the skateboard to begin its motion when it is at rest at the top of the ramp. However, he does not describe what force this is – the friction between the skateboarder's foot and the ground. This illustrates a poor mastery of the idea that unbalanced forces change the motion of an object.	*List a specific feature or features in the student work sample that illustrates a strong student understanding.* o Student A shows a strong understanding of the idea that there are multiple forces acting on the skateboard as it moves down the ramp. He explains that gravity acts on the skateboard to pull it down the ramp and increase its speed. He also describes that friction slows the motion of the skateboard. *Provide a claim for what this indicates about student understanding and a rationale for why this demonstrates a strong understanding/mastery of your assessment objective/GLCE.* o This indicated that Student A demonstrates understanding of the fact that there are multiple forces acting on the skateboard as it moves down the ramp. He shows understanding of the fact that gravity pulls the skateboard down the ramp as well as acts in increase the speed of its movement. He also explains how friction acts against gravity to slow the motion of the skateboard. Student A demonstrates a thorough understanding of the fact that multiple forces act in opposing directions to affect the movement of the skateboard.

PART 1 - B

Analysis of Student Assessment Response Chart: Whole Class Responses

Assessment #1: Multiple Choice Questions

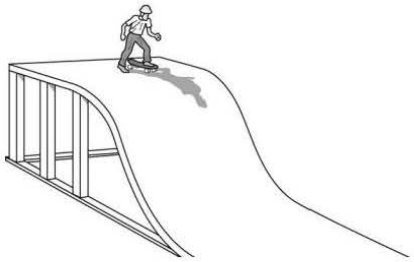
GLCE/Learning Goal:

(P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(P.FM.05.33) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Chris has joined a skateboarding team and purchased a new skateboard. The team captain tells Chris that being a good skateboarder means understanding and using physical science. Use your prior-knowledge of force and motion to help you in attempting to answer the following question. **Simply do your best**!

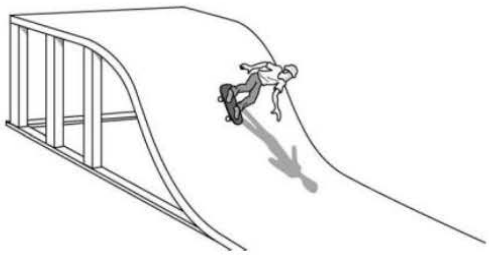
Chris pushes off the ramp platform with his right foot.



1. What force acts between Chris's foot and the platform as he pushes off?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

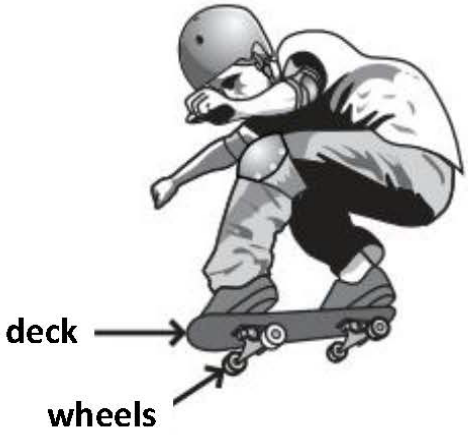
He quickly places his foot back on the board and rides down the ramp.



2. What force acts to pull Chris down the ramp once he begins his downward motion?

- ○ **A**: Gravity
- ○ **B**: Friction
- ○ **C**: Conductivity
- ○ **D**: Magnetic Attraction

Chris attaches a sheet of sandpaper to the surface of the skateboard deck.



3. What purpose does the sandpaper most likely serve?

- ○ **A**: It provides a protective coating to help prevent damage to the skateboard.
- ○ **B**: It reduces the effect that gravity has on the board as it moves down the ramp.
- ○ **C**: It allows Chris to crouch lower on the board to increase his speed on the ramp.
- ○ **D**: It increases the friction between Chris's shoes and the deck to keep him from sliding off.

PRE-TEST	Question	Confidence	Question	Confidence	Question	Confidence	
Miss Hamilin's	#1	#4	#2	#5	#3	#6	
KEY	B		A		D		
% Who got it right	48%		71%		62%		
							# Right
1	B	B	A	C	A	C	2
3	D	C	A	C	D	C	2
4	A	C	A	C	C	D	1
5	A	C	D	B	C	D	0
6	C	D	A	C	A	B	1
8	B	A	A	A	D	A	3
9	B	A	A	A	D	B	3
10	A	B	A	A	D	A	2
11	B	C	A	C	D	C	3
12	A	C	B	C	D	D	1
13	A	A	A	A	D	A	2
14	A	B	B	B	D	B	1
15	B	C	D	C	D	C	2
16	A	C	B	A	D	A	1
17	B	A	A	A	D	B	3
20	B	B	A	A	D	C	3
21	B	C	A	B	D	A	3
22	C	B	A	A	A	C	1
23	B	A	A	C	B	D	2
24	B	A	A	C	C	D	2
25	A	D	B	A	C	B	0
							38

STATISTICS

Total # of Students	21

QUESTIONS

Total Right for #1	10
Total Right for #2	15
Total Right for #3	13
Total Correct Answers	38
Class Percent Correct	60%

CONFIDENCE

#4	A	6	29%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	8	38%	*"I might be right."*
	D	2	10%	*"I guessed."*
	Total	21		
#5	A	9	43%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	0	0%	*"I guessed."*
	Total	21		
#6	A	5	24%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	6	29%	*"I might be right."*
	D	5	24%	*"I guessed."*
	Total	21		

POST-TEST	Question	Confidence	Question	Confidence	Question	Confidence	
Miss Hamilin's	#1	#1	#2	#2	#3	#3	
KEY	B		A		D		
% Who got it right	57%		71%		52%		
							# Right
1	A	B	A	C	B	B	1
3	B	B	A	C	D	D	3
4	A	C	B	C	B	C	0
5	C	C	D	D	D	B	1
6	C	C	A	B	A	D	1
8	B	A	A	A	D	A	3
9	B	A	A	A	A	D	2
10	B	A	A	A	D	A	3
11	B	B	A	B	B	C	2
12	C	C	D	D	A	C	0
13	B	A	A	A	D	A	3
14	B	A	A	B	B	D	2
15	B	C	A	C	C	C	2
16	A	C	A	B	D	C	2
17	A	B	B	B	D	A	1
20	B	A	A	A	D	A	3
21	B	B	A	C	D	A	3
22	D	C	B	C	D	B	1
23	A	D	C	A	D	C	1
24	B	C	A	D	C	D	2
25	B	A	A	B	A	C	2
							38

STATISTICS

Total # of Students	21
QUESTIONS	
Total Right for #1	12
Total Right for #2	15
Total Right for #3	11
Total Correct Answers	38
Class Percent Correct	60%

CONFIDENCE

#4	A	7	33%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	8	38%	*"I might be right."*
	D	1	5%	*"I guessed."*
	Total	21		
#5	A	6	29%	*"I am very sure I am right."*
	B	6	29%	*"I'm pretty sure I am right."*
	C	6	29%	*"I might be right."*
	D	3	14%	*"I guessed."*
	Total	21		
#6	A	6	29%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	7	33%	*"I might be right."*
	D	5	24%	*"I guessed."*
	Total	21		

PRE-TEST	Question	Confidence	Question	Confidence	Question	Confidence	
Mr. Clements	#1	#4	#2	#5	#3	#6	
KEY	B		A		D		
% Who got it right	52%		76%		43%		
							# Right
1	A	B	A	B	C	B	1
3	C	C	A	B	C	C	1
4	A	B	D	D	B	C	0
5	B	B	A	B	B	B	2
6	A	C	C	D	B	B	0
7	A	A	A	B	B	A	1
8	B	B	A	A	D	D	3
10	B	A	A	B	D	A	3
11	B	A	A	A	A	A	2
12	B	C	C	C	A	C	1
13	B	C	C	B	D	A	2
14	A	C	A	D	C	C	1
15	A	A	A	B	D	A	2
16	B	A	A	A	D	C	3
17	B	C	A	D	B	D	2
18	B	D	A	A	D	A	3
19	B	A	A	B	D	D	3
20	A	C	B	C	B	C	0
21	B	C	A	A	D	A	3
22	C	D	A	B	D	C	2
24	C	C	A	C	B	C	1
							36

STATISTICS

Total # of Students	21

QUESTIONS

Total Right for #1	11
Total Right for #2	16
Total Right for #3	9
Total Correct Answers	36
Class Percent Correct	57%

CONFIDENCE

#4	A	6	29%	*"I am very sure I am right."*
	B	4	19%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	2	10%	*"I guessed."*
	Total	21		
#5	A	5	24%	*"I am very sure I am right."*
	B	9	43%	*"I'm pretty sure I am right."*
	C	3	14%	*"I might be right."*
	D	4	19%	*"I guessed."*
	Total	21		
#6	A	7	33%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	8	38%	*"I might be right."*
	D	3	14%	*"I guessed."*
	Total	21		

POST-TEST	Question	Confidence	Question	Confidence	Question	Confidence	
Mr. Clements	#1	#1	#2	#2	#3	#3	
KEY	B		A		D		
% Who got it right	67%		76%		71%		
							# Right
1	B	B	A	B	C	D	2
3	B	B	A	B	D	C	3
4	B	C	A	B	D	C	3
5	B	A	A	A	B	A	2
6	B	C	A	B	C	C	2
7	B	A	A	B	D	B	3
8	B	C	A	C	D	A	3
10	D	C	A	A	C	C	1
11	B	A	A	A	D	A	3
12	A	B	C	D	D	C	1
13	A	C	C	A	D	D	1
14	A	B	C	B	D	D	1
15	D	C	A	A	D	B	2
16	B	A	A	A	D	C	3
17	A	C	C	C	D	C	1
18	B	A	A	A	D	A	3
19	B	A	A	B	D	A	3
20	B	C	A	C	C	C	2
21	B	B	A	B	D	B	3
22	C	C	D	B	A	C	0
24	B	A	A	A	D	A	3
							45

STATISTICS

Total # of Students	21
QUESTIONS	
Total Right for #1	14
Total Right for #2	16
Total Right for #3	15
Total Correct Answers	45
Class Percent Correct	71%

CONFIDENCE

#4	A	7	33%	*"I am very sure I am right."*
	B	5	24%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	0	0%	*"I guessed."*
	Total	21		
#5	A	8	38%	*"I am very sure I am right."*
	B	9	43%	*"I'm pretty sure I am right."*
	C	3	14%	*"I might be right."*
	D	1	5%	*"I guessed."*
	Total	21		
#6	A	6	29%	*"I am very sure I am right."*
	B	3	14%	*"I'm pretty sure I am right."*
	C	9	43%	*"I might be right."*
	D	3	14%	*"I guessed."*
	Total	21		

VERBAL POST-TEST		Question	Question	Question	
Mr. Clements		#1	#2	#3	
KEY		Friction	Gravity	It will help him not slide off.	
% Who got it right		65%	95%	93%	
					# Right
	1	Friction	Gravity	✓	3
	3	Friction	Gravity	✓	3
	4	Friction	Gravity	✓	3
	5	Friction	Gravity	✓	3
	6	Gravity	Fraction	1/2	0.5
	7	-	-	-	-
	8	Force	Gravity	✓	2
	10	Friction	Gravity	✓	3
	11	Friction	Gravity	✓	3
	12	Friction	Gravity	✓	3
	13	Gravity	Gravity	✓	2
	14	Force	Gravity	✓	2
	15	Friction	Gravity	✓	3
	16	Friction	Gravity	✓	3
	17	Normal Force	Gravity	1/2	1.5
	18	Friction	Gravity	✓	3
	19	Friction	Gravity	✓	3
	20	?	Gravity	✓	2
	21	Friction	Gravity	✓	3
	22	Friction	Gravity	1/2	2.5
	24	Normal Force	Gravity	✓	2
					50.5

STATISTICS

Total # of Students	20

QUESTIONS

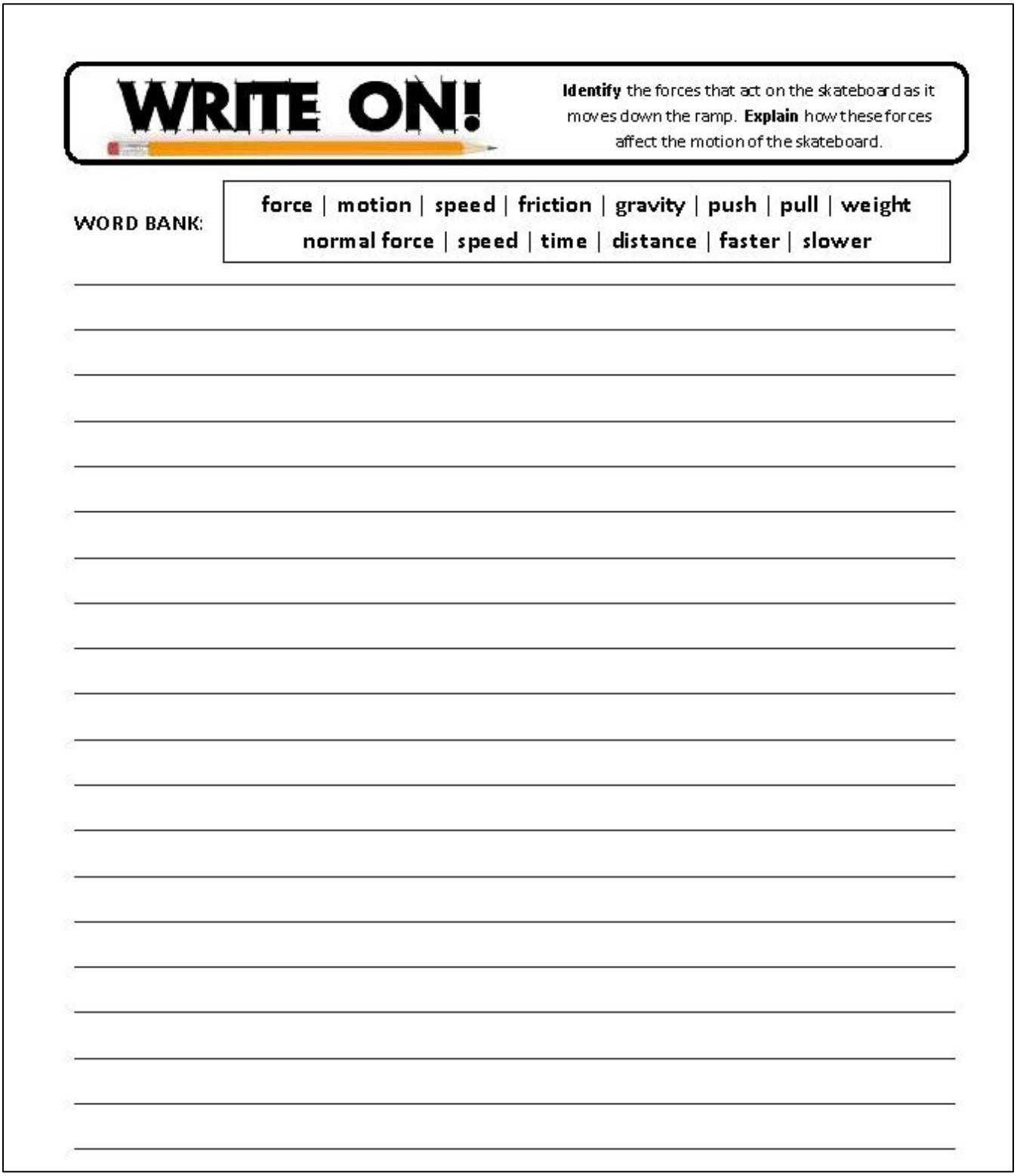
Total Right for #1	13
Total Right for #2	19
Total Right for #3	18.5
Total Correct Answers	50.5
Class Percent Correct	84%

Assessment #2: Writing Essay Prompt

GLCE/Learning Goal:

(P.FM.05.31) - Describe what happens when two forces act on an object in the same or opposite directions.

(P.FM.05.33) - Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force



Miss Hamlin's Class

Student #	Identified gravity as a force	Explained that gravity pulls the skateboard down to the ramp	Explained that gravity makes the skateboard go faster or increases its speed	Identified friction as a force	Explains that friction slows the skateboard down or decreases speed	Explains that friction acts between his foot and the ground to begin the motion
1				x	x	
2	x			x	x	
3	x		x	x		
4						
5	x			x	x	
6				x	x	x
7	x					
8	x	x		x		
9	x		x	x		
10	x			x		x
11	x		x	x		x
12	x			x		
13	x	x	x	x	x	
14	x					
15	x	x				
16	x			x		
17	x			x		
18	x	x		x	x	
19	x	x	x	x	x	x
20	x	x	x	x		
21	x			x		
22						
23						
24	x	x		x	x	
25	x	x	x			
#	20	8	7	18	8	4
%	80.0%	32.0%	28.0%	72.0%	32.0%	16.0%

Mr. Clements' Class

Student #	Identified gravity as a force	Explained that gravity pulls the skateboard down to the ramp	Explained that gravity increases the speed of the skateboard	Identified friction as a force	Explains that friction slows the skateboard down or decreases speed	Explains that friction acts between his foot and the ground to begin the motion
1	x	x	x	x	x	x
2	x	x	x			
3	x	x	x	x	x	x
4	x	x		x		x
5	x	x	x	x	x	
6	x	x		x		x
7	x			x		
8	x	x		x		x
9	x	x		x	x	x
10	x	x		x		
11	x			x	x	
12	x			x		x
13						
14	x					
15	x	x	x	x		
16	x	x		x	x	
17	x			x	x	
18	x	x	x	x		
19	x	x	x	x		x
20	x			x		
21	x	x		x		x
22	x			x	x	x
23	x	x	x	x	x	x
24	x	x		x	x	
25	x	x		x		x
#	24	17	8	22	10	12
%	96.0%	68.0%	32.0%	88.0%	40.0%	48.0%

PART 2

Identifying Patterns in Student Learning and Responses

There are many factors that influence students' learning. However, patterns of learning across students can often give us important insights into where our unit planning/instructional approach might need revision. Now examine the charts you have created to identify patterns in your results and write about your findings.

Did different students understand different aspects of the learning goal as reflected in the response features? Were certain features more problematic than others?

- Assessment #1: A majority of students were able to identify friction as the force acting between Chris's foot and the platform and gravity as the force acting to pull Chris down the ramp. 60% correctly identified friction, and 76% identified gravity. As a point of interest, when students were asked verbally to identify what force was acting to pull Chris down the ramp, without options or prompting 95% were able to produce the correct response of gravity. The most problematic feature was the third question. Only 57% of students were able to identify the purpose of the sandpaper. However, when this question was verbally asked and explained, 93% of students were able to explain that it was to help him not slide off because of the increased friction.
- Assessment #2: Almost all students were successful in explaining that gravity and friction were two of the main forces affecting the motion of the skateboard. Overall, 88% of students identified gravity as a force affecting the motion of the skateboard, and 80% of students identified friction as a contributing force. However, although most students could identify these forces, the explanation of how these two forces affects the motion of the skateboard proved a little more difficult for many. Some of the features that were most difficult for students were explanation of the beginning motion caused by the friction between the skateboarder's foot and the ground and the explanation that gravity acts to increase the speed of the skateboard as it moves down the ramp.

What ideas and practices were generally understood and what more preliminary (or naïve) ideas and practices remain?

- Assessment #1: Generally gravity was understood to be the force that acts to pull objects downward. Friction was more confusing for students to identify in action and in understanding its purpose. However, when asked to verbally explain, the ability for students to show understanding of this concept increased.
- Assessment #2: It was generally understood that gravity is a force that acts to pull the skateboard down or held it down to the ramp. Many explained that friction was another force acting on the skateboard as it was in motion. Students also showed an understanding that there are multiple forces acting on the skateboard, which causes its motion. However, most lacked the ability to explain how these forces affect the motion of the skateboard (i.e. gravity speeds the motion up, friction slows it down, etc.)

Try to account for the patterns of student learning in terms of your classroom teaching. Why did the students succeed and struggle where they did? Look at the specific examples from the individual student response chart above. How might your teaching need to change to help all sample students?

- Assessment #1: Most of the first and beginning lessons dealt with the forces of pushes and pulls. In trying to answer the question "How can we make our sled move" most of the responses and discussion dealt with the act of pushing or pulling and the secondary piece of information was to overcome the opposing forces of friction determined by the weight and the force of gravity pulling down on the object. For most of the unit

we dealt with only horizontal motion and sledding. Students were exposed to and brought downward motion into our conversations when they would talk about sledding on a hill, but for the main focus of the lessons gravity was not used in the context that it was presented on the test. Students did experience and learn about friction when they went to Impression 5 during the mini Force and Motion workshop. Students were tasked with the challenge of making their ball move down a ramp as slowly as possible. The Impression 5 instructor outlined the concept of gravity and that in order to be successful at this experiment, they would need to use materials that produced a lot of friction between the ball and the materials. This would cause the ball to go slower and result it taking a longer time to reach the bottom of the board. This experience took place mid-way through the entire unit. Also, it wasn't until the ball drop experiment that students were specifically observing gravity and its effects. I believe that more experiences would have helped students understand the concepts better. Because of time constraints, many experiences got cut from the original unit plan. This seems to have directly impacted students understanding of different concepts.

- Assessment #2: In general, students were successful in identifying the major forces that affected the motion of the skateboard. Most likely, this success could be attributed to the fact that identification is a simpler illustration of understanding, whereas explanation and analysis of the forces is a more in depth and difficult show of content understanding. Students tended to explain the first ideas that they could recall about forces as they affect motion. Therefore, as seen in Student V's explanation, she used her experience with the sled race and the forces that she could recall from that experience to explain what she knew. Although this was not common amongst all students' written responses, it shows that many use their personal experiences to explain new concepts that they do not necessarily understand. In the future, it would be very beneficial for students to have more experiences so they can practice applying known facts or concepts to new ideas and occurrences so that they will be more prepared to apply their knowledge to new ideas.

PART 3

Effectiveness of Assessment Strategies

In addition to analyzing student responses to your assessment opportunities for clear evidence of student understanding, you will also need to reflect upon the effectiveness of your assessment strategies.

What were the strengths and limitations of the types of assessments you chose?

- Assessment #1: The multiple choice portion of the assessment provided a very direct way of measuring student comprehension. There was one right answer and it was clear to tell if the student chose that answer or chose a different incorrect answer. Traditional assessments like multiple choice are challenging because they not only test content knowledge, but they assess test taking skills as well. As teachers, these tests are wonderful tools that are loved and enjoyed because they are easy to grade, quick to look at for numerical data, and they don't give wiggle room in interpreting the understanding... they either got the right answer or they didn't. This in itself is a strength and limitation. Often teachers are looking very hard for that right answer because they want to feel successful in their teaching and want students to get it. It is much easier to rationalize "yea I think they get it" on an essay than it is in multiple choice test. Also a student is limited by the test in that they can only show that they know what is specifically asked on the test. Often times students know a great deal more than what they can show on a few multiple choice questions.
- Assessment #2: The "Write On!" portion of our assessment provided many opportunities for students to explain what they know about forces and how they affect motion. Students were given a word bank to help them recall experiences with different forces and motion, and students could write as much or as little as they wished to answer the prompting question. However, our students usually struggle to verbalize their thoughts and feelings, therefore, a written assessment such as this provided quite difficult for many. Many struggle to formulate their ideas into words, especially when writing. Even though we provided the word bank, which seemed to help many students, writing about their knowledge proved to be a major struggle for most. Because many of our students are struggling writers (some of which receive resource room aid for this), a written assessment limited our ability to learn what our students actually know about gravity and friction and how these forces affect the motion of the skateboard as it moves down a ramp.

What changes would you make for your next class in order to get more information and/or a clearer picture of your students' progress in mastering your content and inquiry GLCE/learning goals?

- Assessment #1: Asking the questions verbally allowed students to be better able to show their understanding. They are also a good tool to use for quick and easy surface level questions. Perhaps using them to choose scientific definitions and assess a student's "book" or "MEAP" type of understanding and ability to show understanding is the best route to take. However, whatever route is taken it should be clear that only using a multiple choice test as an assessment tool is irresponsible and will not lead to a true representation of what students actually know and understand.
- Assessment #2: In the future, a good alternative to the "Write On!" portion, or perhaps an extension of this portion, would be to allow students to label a picture of the skateboard as it moves down a ramp. Students would be asked to label and draw arrows for the forces that act on the skateboard, as well as how they

influence its motion. This would allow students to illustrate their understanding of the content without testing their ability to write their understanding in words.

PART 4

Lessons Learned

***In this section, you should pull together ideas from the previous two sections to reflect upon the science learning that occurred as a result of your unit. Based upon your analysis and reflection above, answer the following questions*:**

Overall, how did your teaching go? Did your students meet the learning goals and learn the related practices?

- **Mr. C**: I was kind of nervous about teaching science. Since it was my MTs first year teaching science he was trying to figure it out just like I was. However, once I got rolling I found I really enjoyed it. Science is a great opportunity to explore some complex ideas about the world and the content can be so engaging that students become very interested and focused. One of my favorite parts about the science unit was "Mad Scientist Monday." It is a great opportunity to get students engaged in science and excite them about a possible career in the field. It may just be the influence of growing up in the Midland/Dow Chemical community, but I believe our success as a nation and world depends on more students being excited and interested in science. I found myself getting more excited for science on Mondays because it was always something hands on and engaging for the students. It offers students multiple levels of engagement. Students who are already advanced in science are able to expand on a new topic like chemical equations, or advanced physics and students at a more beginning level of understanding are able to practice their skills of observation or planning an experiment and following procedures. Back to the force and motion unit, I enjoyed being able to see students create their own learning. There was a moment when we were comparing our rules to the rules that science has agreed upon and when the students realized they were the same, it was great to be able to express to them the coolness that they had answered their own question without have to look it up. Instead they used the world around them and their experiences to answer it.
- **Miss Hamlin**: Teaching science this year has been a rollercoaster for me. In the beginning, Mr. C and I were generally excited about teaching force and motion, but once we began actually brainstorming ideas for a central question for our unit, we ran into some difficulties. While we tried to layout the unit, we went back and forth about what should be taught first – force or speed – since these were the two main ideas that the standards focused on. We decided that Adam should teach force first, and that I would follow up with speed. We planned on doing three weeks each, which I thought would be plenty of time to fit in multiple experiences so that students would begin to see patterns between their experiences. However, with Mad Scientist Mondays (which were a tremendous success) and all of the other rescheduling that always affects teaching, I felt that my lessons ended up being rushed. After seeing the results of the post assessment, I think students seemed to grasp the general concept of speed. Throughout the lessons, students built upon their own knowledge to construct the meaning of and formula for speed. In addition, my lessons seemed to build onto Mr. C's as students used their experiences with gravity and its affects on objects. Students were able to have in depth conversations about the motion of the ball in their experiment. Therefore, my lessons seemed to strengthen students' knowledge about gravity and forces as they did experiments with speed. By creating a unit that asked students to create their own understandings, it was so much more beneficial for them and it gave me a pride in my teaching because I was able to see their progress through simple observation as they talked through their experiment.

What might you keep, modify or extend in your unit planning next time? Why?

- **Mr. C**: I think I realized during this unit plan that experiences are so important. The more experiences the better. In order for students to fully understand a scientific concept, especially one as abstract and intangible as force and motion, experiences help them ground them in understanding and give them scaffold support to connect scientific information to. I struggled with the timeline of the unit. Some students were certainly ready to move on to a different concept while other students were still very lost even after multiple experiences and discussions. Differentiation in science is something I would love to explore more. I planned most of my lessons as group/whole class instruction. It would have been interesting to look at how I would go back and plan this unit with more of an emphasis on group work and center driven instruction.
- **Miss Hamlin**: In the future, I would certainly provide more time for students to experiment more with speed and measuring speed. I felt that their understanding of speed was not as strong as it could have been because they did not get to experiment enough with the speed of objects. I would, of course, plan for students to see different types of motion and find the speed of those objects. One such experiment that I wished I could have done would be the "Balloon on a String" experiment. In this experiment, students attach a balloon to a straw, which is threaded with a string. The string would be premeasured so that students could easily determine the distance that the balloon travels. The balloon is then held at one end of the string and blown up, then released. When the motion begins, students time the motion of the balloon – or time how long it takes for the balloon to travel the distance of the string. This experiment would give students an experience similar to the Ball Drop Experiment, but it would omit the affects of the force of gravity. Therefore, students would get another experience testing and finding the speed of an object, but without worrying about how gravity influences the speed of an object.

What have you learned from this experience that will influence your future science teaching?

- **Mr. C**: Experiences… experiences… experiences! Give students as many hands on – minds on activities centered on a topic helps students to understand the information in new ways that may end up being more effective and memorable. I noticed during discussions that students were more on topic and knowledgeable when they were able to connect to an experiences. They were able to apply the new science knowledge and patterns when they had actual experiences to apply them to.
- **Miss Hamlin:** From this teaching experience, I have learned many things. First, lessons always take longer than you expect them too, especially with a class of 25 students. This has taught me to always prepare as much as possible and have clear goals for students. Second, I have learned that a noisy classroom is not always a bad thing. During our experiments, I felt that our classes would wake up a sleeping bear, and I felt like I had lost control of everything. Although I still am not entirely a fan of allowing that much noise and, for a lack of better words, chaos in the classroom, I could see the benefits from later discussion. Students really enjoy and feel motivation from being the leader of their own learning. Therefore, I will continue providing these types of experiences for science learning in my classroom in the future.