**5E Learning Cycle Lesson Plan**

Your written lesson plan will be added to TK20 for final grading. This lesson plan should include the following items; please be sure to number them as they are numbered here. Except where noted, **please use an outline or bulleted format rather than a paragraph format** so it is easier to use.

1. **Title:** Force and Motion

2.**Overview and Statement of Purpose**: The purpose of this lesson is to help students understand the concepts of force and motion and the relationship between the two.

3. **Grade Level and Objectives:**

A. 5th grade

5.P.2 Understand force, motion and the relationship between them.

 5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.

 5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

B. These objectives will be met through the students gathering their own data. They will be recording their data found through the marble experiment and then asked to share what their data shows. Through the marble experiment they will be able to see that the mass of an object has an effect on the distance it will travel. The second objective will be met as students see that objects in motion tend to stay in motion until acted upon by an outside force. More particularly they will see that objects in motion will continue to travel in a straight line.

4.**Developmental Level/Student Background Knowledge.**

A. How does this lesson fit the students coming to you in terms of what they might have experienced in real life?

The experiment with the marbles is a great way for students to see that things with a larger mass will travel farther. This may help a student to explain why his father can travel farther down the hill on a sled than he can. Students will be able to find a relationship between the mass of the marble and the distance it is able to push the index card.

This demonstration with the glove will help students to understand why their body flies forward when the car brakes are hit in a car.

B. Explain how it is matched to their physical skills (what they can do with their bodies)?

With their bodies they can see that things travel in a straight line. If a student is standing still and then is pushed from behind, he does not fall to the side. He falls forward, moving in a straight line relative to where the push (force) came from.

C. How is it matched to their conceptual skills (what is going on developmentally in their minds)?

These students are able to think critically at this age. They are starting to analyze situations and start to formulate their own interpretations. This is why I think that the marble experiment will be so great for this age. They will be able to collect the data and then form a conclusion based upon this data. During this time the students are beginning to move from Piaget’s concrete operational stage into the formal operation stage. This means that students are beginning to be able to understand more abstract and complex concepts. The students are able to participate in logical reasoning and they are also starting to participate in steps towards systematic planning.

D. How does it relate to what they would have learned in previous grade levels (look at the curriculum!)?

In the third grade (two years ago) the students learned about the things involved with motion.

3.P.1 Understand motion and factors that affect motion.

 3.P.1.1 Infer changes in speed or direction resulting from forces acting on an object.

 3.P.1.2 Compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.

In the fourth grade (last year) students learned about the forces and motions that magnets and electrically charged objects have.

4.P.1 Explain how various forces affect the motion of an object.

 4.P.1.1 Explain how magnets interact with all things made of iron and with other magnets to produce motion without touching them.

 4.P.1.2 Explain how electrically charged objects push or pull on other electrically charged objects and produce motion.

E. How does it relate to what they will learn in the future (look at the curriculum!)?

When students get into the 6th grade they will be learning about matter and the atoms of different elements. They will also be talking about the motion of these atoms, which is directly related to the force and motion studied in the 5th grade.

6.P.2.2 Explain the effect of heat on the motion of atoms through a description of what happens to particles during a change in phase.

The students in the 6th grade will also learn about motion in reference to the Earth and the moon.

6.E.1.1 Explain how the relative motion and relative position of the sun, Earth and moon affect the seasons, tides, phases of the moon, and eclipses.

5. **21st Century Skills.**

A. Please list [21st Century Skills](http://www.p21.org/overview) targeted by this lesson.

* Communication
* Collaboration
* Critical Thinking and Problem Solving

B. Explain how you will meet each.

The students will be collaborating with one another while working on their marble experiments. They will have to work together in order to measure the distance that the marble traveled. Communication will be very important during this lesson. The students will have to decide on who will be dropping the marble and who will be recording the data. They will also be asked to talk amongst themselves about the information that they found. They then will have to talk with another group and find out if they found similar data. Students will be thinking critically in order to make predictions as well as conclusions for this experiment. They will have to decide why one marble travels farther than the other based upon the data that they have found.

6. **Curricular Integration.** (Note: You do not actually have to teach these activities during your 5E lesson. This just shows that you are aware of some ways that you could integrate).

A. First Activity:

i. What is an additional curricular integration activity (from language arts, social studies, health etc.) you could use with your lesson plan?

You could integrate a math lesson here with the use of graphing.

ii. How would you integrate this activity?

During the ‘explore’ phase of this lesson, the students will be recording their data. This data will be showing the distances that the marble travels. Students will take this data and put it into a line plot that shows how the mass of an object has an affect on how far it will travel.

iii. Which competency goal from your same grade does this activity address?

5.G Graph points on the coordinate plane to solve real-world and mathematical problems.

B. Second activity:

i. What is a second additional curricular integration activity (from language arts, social studies, health etc.) you could use with your lesson plan?

Language arts- reading two chapters out of a book.

ii. How would you integrate this activity?

I am going to read chapter four and five from the book *An Invisible Force*. This chapter explains Newton’s first three laws of motion in a way that fifth graders can relate to. Chapter five goes on to explain how Newton’s laws were used to make things that are part of our everyday life, such as clocks and rockets.

iii. Which competency goal from your same grade does this activity address?

RI.5.1 Quote accuracy from a text when explaining what the text says explicitly and when drawing inferences from the text

RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific, or technical text based on specific information in the text.

RI. 5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4-5 text complexity band independently and proficiently.

7. **Essential Knowledge (for teacher**).

For this lesson it is important that the teacher be very knowledgeable in the areas of Newton’s three laws of motion. These laws explain the concepts behind motion, which is part of our everyday lives. Isaac Newton was an English scientist and these three laws were said to be founded during the year of 1686.

1. This first law tells us that objects in motion will continue to stay in motion unless an outside force is acting upon the object. They will continue to travel in a straight line at the same speed. In the same manner that an object at rest will stay at rest unless acted on by an outside force. Inertia is a characteristic of an object that is directly related to its mass. An object’s inertia, or mass, will determine how far an object will move, relative to the force that has been applied. The inertia of an object will control the motion of that object. If an object has a larger inertia, it will in turn require a larger force to move it or stop it if it is already moving.

The motorcycle rider keeps traveling in a straight line even after his bike hits the tire wall.

This first law was actually first established by Galileo. Galileo had previously found that that an object would be put into motion with a small force, this was equivalent to a push or a pull.

1. Newton’s second law says that force is equal to the change in momentum (mV) per change in time. For a constant mass, force equals mass times acceleration. This law says that an object accelerates because of the force that is acted upon it. If you apply a stronger force to an object it will cause more acceleration, compared to if you applied a smaller force to the same object.



Along with this law is the concept that objects with larger mass require more force to change its motion.

When the marble is rolling along the floor the force of friction is also acting on the marble. Friction is a force that holds back the movement of a sliding force. This force is acting in the opposite direction that the object wants to slide.

1. Newton’s third law says that for every action, there is an equal and opposite reaction. There is usually more than one force that is acting on an object at the same time (friction, gravity, push, pull).

 This picture demonstrates Newton’s third law.

Gravity is constantly at work in our world. This is the force that is pulling objects back to the ground. This means that all objects that have mass, are being pulled towards the ground. This is called the gravitational pull. This explains why the egg falls straight down into the glass. Things with mass will fall in a straight line towards the ground.

FORCE BETWEEN ANY TWO OBJECTS= GRAVITY

 Gravitational potential energy is the energy that an object possessed because of its position on the gravitational field. Because gravity is constantly pulling objects towards the center of Earth, an object can increase its gravitational potential energy if it has the ability to fall. For example, a toy racecar that is placed at the top of a ramp has gravitational energy because it will eventually be traveling down the ramp and towards the ground. Because of its ability to fall it has gravitational potential energy while it is at the top of the ramp.

 The concept of gravity can be looked at in a different sense if you are talking about the solar system. The motion of the moon is affected by the Sun’s gravitational pull, as well as the gravitational pull of the Earth.

 Without the gravitational force between the sun and the earth, the earth would fly off in a straight line. The force between the sun and the planets (or the moon and the Earth) keeps things in orbit.

8. **List of Materials**

* Several raw eggs (in case any break you should have back up)
* Glass of water
* Small pie pan
* Empty toilet paper roll (just the cardboard part)
* Three different marbles (each with a different mass)
* Meter stick
* Index cards
* Ruler
* Block of wood

9. **Safety Considerations.**

This lesson is overall a very safe and student friendly experiment. Before beginning the experiment be sure to explain to students that the marbles are for rolling on the ground only. They are not to throw the marbles, or do anything other than roll them down the ramp. Their ramp materials are to stay on the floor as well.

10 . **Detailed Lesson Plan**. The Learning Cycle (5E’s) should be developed in enough detail for a knowledgeable substitute to use. (Be sure to see your [rubric](http://www1.appstate.edu/~goodmanj/elemscience/lessonplanning/5E_learning_cycle_rubric.htm%22%20%5Ct%20%22_blank) for specific details of what to include in each of the phases of the 5E Learning Cycle.)

A. Engagement with transition question, challenge, or problem

i. What will you do to engage the students?

I will be showing the students a demo that shows an egg dropping straight into a glass of water, after you hit a pie pan out of the way. **(Observing, Analyzing, Predicting)**

1. First start out with some questions for the students while you are setting up.
2. You will fill the drinking class about ¾ full of water. You can add food coloring for a little added affect if you would like to.
3. The pie pan is going to sit directly on top of the glass of water. The pan should be about center.
4. Then place the cardboard tube inside of the pie pan. The cardboard tube should be sitting directly about the center of the glass of water.
5. Next you are going to place your egg on top of the cardboard tube. You do not want your egg to be inside of the cardboard tube at all. Have it so that it is sitting horizontally on its side across the top of the tube.
6. Once your demonstration is completely set up, ask the students some of the questions below. Have them write in their journals what they think will happen.
7. After talking about what the students think will happen, you are going to give the pie pan a swift hit. You need to hit it pretty hard, and follow through the hit.
8. The lip of the pan should know the cardboard tube and therefore knock it in the same direction. The pan and the tube should fly off in a straight line. The egg will hopefully fall straight down into the glass of water.

ii. How will you connect to students’ everyday lives? **(Communicate)**

* What do you know about raw eggs and their durability? Raw eggs tend to break really easily. When they do break they are filled with a liquid inside.
* If you dropped an egg from your hand to the floor, what direction does it fall? Why? The egg will fall in a straight line until it reaches the floor. This reason it falls downward is because the force of gravity is pulling it towards the center of the earth. The reason it falls in a straight line is because inertia. An object will continue doing what it is doing until a force acts upon it.

iii. What questions will you ask? (Provide sample answers.)

* How would you design a plan so that you could get the egg inside of the glass of water if you can only touch one thing on the “tower”? (Students might say that they would pick up the pan and try to drop the egg in the water that way. They also might say to pick up the cardboard, and then move the pan out of the way. This would be incorrect because they touched the pan and the cardboard.)
* If you could rearrange the objects in this experiment to help you complete the task at hand would you? If so, draw your idea. You have to use all four objects: the pie pan, glass of water, cardboard tube, and the egg. (Students might say to turn the pie pan upside down. They might somehow try to squeeze the egg inside of the tube.)
* How would you explain in your own words why the egg dropped straight inside the glass of water? (Students might answer that the egg floated in the air for a second before dropping into the water. They could also say that because the egg is lazy it wants to keep doing what it is doing, which is sitting still. This is why the egg waited before dropping into the water.)
* Why does the egg not break when it is going into the water as opposed to hitting something hard? (The egg slows down in the water, so therefore there is less force on the egg).
* What other real world examples can you think of where you have seen inertia take place? (hitting the brakes in a car and your head flies forward, falling off of a skateboard and you keep traveling in a straight line).

B. Exploration

i. How will you set up this exploration? **(Observe, Measure, Organize, Infer, Hypothesize)**

Students will be calculating the distance that a marble can push an index card. Students will be grouped in groups of three to four and be given the necessary supplies. The students will be given a block of wood and a ruler to create a ramp. The block of wood should be placed where the corner of the wood is located at the 2cm mark. You could use any mark, as long as each group uses the same one. This allows for each of the groups ramps to have the same incline. The meter stick is placed on the floor at the end of the ramp. The index card should be placed at an equal distance from the end of the ramp, for every group. This allows for each groups measurements to be comparable. The students are going to roll the marble down the ramp (ruler and the block of wood), and measure how far the marble pushes the index card.

 Here is what the set up of the ramp should look like.

Wood Block

Piece of plywood

ii. What data will students gather? **(Organize)**

Students will be testing each marble a total of three times, and recording how far the marble pushes the index card. They should record this data in a chart and then find the average of their three attempts. The average is what we will be using to compare.

iii. How will you help students generate their own questions?

Be sure to stop at certain points during this lesson to ensure students are inquiring about the experiment.

Suggest that students play with the height of the ramp, what do you notice? (

iv. What questions will you ask? (Provide sample answers.)

Why do you take three measurements? (In order to be as accurate as possible. By taking three different measurements and then finding the average you eliminate error)

Why do you measure from the same spot? (Measuring from the same spot keeps the measurements accurate. If you measured from a different spot every time you would not be able to relate the data between rolls).

What are the controlled variables? What are the experimental variables? (Controlled= height of the ramp, the index card, the floor surface. Experimental= the three different balls used)

How could you make the data gathering process more accurate? (have the same person measure, start measure from same position)

What type of people might be interested in this experiment? (tire manufacturer)

How does this experiment connect to real life? (wheel chair ramps, football players and their size comparison to one another)

What are you noticing about the marbles? (That each marble pushes the index card with a different amount of force. Sometimes the marbles do not stay straight.)

How are you measuring the distance if the floor is causing the marble to roll sideways or slightly turn? (We are just creating a line horizontally from where the marble stopped and seeing where it is on the meter stick.)

Why do you think we are using marbles that have three different masses? (So that we can test if mass has any effect on the force against the index card.)

C. Explanation **(Organize, Infer, Hypothesize)**

i. How will you get students to share their data?

One student from each group will come to the front of the class and put their chart as well as their data on the whiteboard for everyone to see. They should show what distance each of their marbles averaged, as well as what their three separate rolls were measured at. As a class together we should discuss the data that we found.

ii. What guiding questions will you ask? (Provide sample answers.)

Why did we try each marble three different times? (So that we could get an accurate average on how far each marble will travel.)

How is the information on the board similar between the different groups? (The heavier marble was able to push the index card the farthest. The lightest marble had a harder time pushing the index card.)

What does this information lead you to conclude? (That objects with a heavier mass are harder to stop. The index card could not stop the heavier marble as easy as it could stop the lighter marble.)

iii. What ideas will you be trying to develop?

Friction- What force is causing the marble to stop? Why does it not keep going forever?

Friction is created when surfaces are moving relative to one another. The rubbing of the two surfaces opposes the motion of one surface across another. The friction that is created as the marble slides against the solid floor causes the marble to come to a stop.

Here we are trying to help the students to see that the marble with the larger mass will be able to push the index card farther than the marble with the smaller mass. Therefore showing that things with a heavier mass have more inertia, and are harder to stop than those with a lighter mass. The students will be able to see this data based upon their own attempts with rolling the marble down the ramp. They should have all attempts recorded into a chart.

http://www.youtube.com/watch?v=co4IAFMXB00

This video is a great way to show students the powers of inertia. These skiers keep falling forever. They prove the theory that an object in motion tends to stay in motion. They continue to roll down the hill until a fence or guard post stops them.

 Why do skiiers turn if things tend to go in a straight line? (The edges on their skis put a force on them that helps them to turn)

 What would help keep skiiers from falling? (They have poles that they use, it would also help if they were balancing on a wider surface area).

 Why are the walls they hit made of things that are soft? (Inertia causes the skier to keep traveling even after they have fallen, therefore if they are going to hit something with force it is better that it is something soft. Soft objects will absorb the impact much more than a hard object would.)

 How is gravity involved in what you are seeing? (The skier continues to fall in a downward motion. He is falling down towards the ground, as well as down the mountain. Gravity is constantly pulling him down.)

iv. What terminology will you introduce and how will you relate this to the data?

Inertia- “laziness”. The tendency for an object to keep doing what it is already doing unless acted on by an outside force. The object will keep traveling in a straight line unless acted upon by another force. We will talk about the inertia that each of the three marbles has, as well as the inertia of the index card.

Mass- The amount of “stuff” an object has. Mass refers to the weight of an object. The three different marbles each have a different mass. The students will talk about how mass is related to the weight of an object.

Force- The power of an object. The more mass something has the more force it takes to get it going as well as to be stopped.

Control variable- The part of the experiment that stays constant and unchanging. This variable is used as a standard for comparison. The students should be able to recognize which parts of the experiment are staying the same for each test they do. (The ramp incline, the distance at which the index card is placed)

Experimental variable- The experimental variable is the part of your experiment that will be changing. This is the independent variable. The students should understand what part of the experiment is changing. (ex: the mass of the marbles)

Gravity- The force of attraction towards the center of the Earth.

 Things that are farther away from Earth have less gravitational pull, and therefore weigh less. They have the same mass (amount of stuff) but they do not have the same amount of force pulling them downward and causing them to weigh more.

Friction- The force that occurs as two surfaces rub together relative to one another. (surface resistance)

D. Expansion **(Predict, Measure, Observe)**

i. What will students do in the Expansion phase?

Students will be creating a marble maze. They can use any materials they would like but they have to create a maze that a marble can follow. The maze must have at least 5 different turns, and the marble must be able to last inside the maze for at least 10 seconds.

ii. What concepts will you be having them apply?

They will have to apply their knowledge of mass and how this has an effect on the force an object has.

iii. How is this different but related to what came before?

The mass of the marble will be directly related to how long it takes the marble to reach the end of the maze.

iv. What guiding questions will you ask? (Provide sample answers.)

How did you decide where you should put your turns in the maze? (We thought they would fit best at the end of each tunnel. This way the marble would take as long as possible to go down the straight path.)

What forces played a role as your marble traveled down the ramp? How so? (Friction occurs as the marble slides across the surface of the floor, gravitational potential energy as the ball is at the top of the ramp, inertia is present through the index card as well as through the ball)

What role did the mass of the marble play? (The marble with the heaviest mass was able to push the index card the farthest. This is because the inertia of the heavier ball is greater than the inertia of the index card.)

E. Evaluation **(Observe, Communicate)**

i. What formative assessments will you use, and when in the lesson will you use them?

While students are working on conducting their tests with the marbles and ramps I will walk around and talk to each group. During this time I will carry a check sheet around and ask students questions about their experiment. Questions will be pertaining to their control and experimental variables. If students can answer the questions about the variables of experiments I will place a check next to their name. This is simply for me to know if we need any clarification of the variables.

After the students have done all of the experimental tries with the marbles they will write a short paragraph explaining their results that they found. In their paragraph they should explain what they think is happening with the marbles and the index card, and why they think so. These papers will be collected.

ii. What specifically will you be looking for in these?

I will be looking for the student to accurately describe their variables in the experiment. They should also be explaining their thoughts on why the marble with the heavier mass is able to push the index card farther.

iii. What summative assessment will you use?

The students will be creating a portfolio that will be turned in at the end of the experiment. This portfolio will include all of their notes they took during the demonstration of inertia, as well as all of their data collected during the marble experiment.

iv. What specifically will you be looking for in this?

I will be looking for accuracy within their notes. I will also be looking for complete date regarding the marbles and the distance traveled. The students should have included explanations for both the demonstration as well as the experiment.

A rubric may look like this:

|  |  |  |  |
| --- | --- | --- | --- |
| Student Name | Notes are lacking and demonstrate little to no evidence of understanding. There are no details on the experiments conclusion. (1) | Notes include data tables that are incomplete, and are lacking evidence that supports understanding. There are little details on the experiments conclusion. (2) | Notes include complete data tables and demonstrate evidence of understanding. Student notes provide supportive details on experiments conclusion. (3) |
|  |  |  |  |

v. Provide a sample response to the summative assessment.

The portfolio should be showing the teacher that the student has learning about the components of force and motion. The students should include any notes or charts drawn that help to show this information. There will be a checklist of things that need to be provided, and this will be the first page in the folder. The last page of the portfolio will be a page where the student has written what they have learned through this experiment.

11. **Modifications.**

A. How will you modify this lesson to meet the needs of students with ADD/ADHD?

For this lesson it will be important to group students together in an efficient way. Students with ADD/ ADHD will not be put into groups with other students who are usually hyperactive. These students will be asked to help hand out materials, as well as record information on the board in order to keep them busy.

B. How will you modify this lesson to meet the needs of learning disabled students?

Competency Goal 4 (Extended Standards): Explore, observe, communicate, and investigate forces of motion.

Have students demonstrate knowledge and awareness through observations. Students should demonstrate awareness through familiarity and expression.

Competency Goal 5: The learner will apply grammar and language conventions to communicate effectively.

Students with learning disabilities may be assigned to the role of writing the information down into chart form. If the student is high functioning than this will be a great way to involve them in the experimental process.

C. How will you modify this lesson to meet the needs of AG students?

For the AG students I will suggest that after they finish completing their chart with their three attempts, they may adjust the ramp in some way that they think will allow the marble to push the index card even farther (by increasing or decreasing the incline of the ramp). They should explain their findings in their portfolio.

D. How will you modify this lesson to meet the needs of ESL students?

For the ESL students I will cooperate with the ESL teacher. She may be able to help with translations. If she is not able to come into the classroom and help than I will be sure to visually show these ESL students what it is I am asking them to do. They can draw pictures or symbols to show their understanding of the experiment.

For example, they could draw a picture that showed the heavier marble traveling farther.

12. **Sources.**

A. The University of California. (2002). Balance and motion: Teacher guide. Berkeley, California: Delta Education.

This is an awesome guide for teaching the basics of balance and motion. This book offers teaching tips on assessment, content knowledge, and an investigations section. The investigations section offers some great experiments for teachers to help guide students towards their own findings.

Phelan, Glen. (2006). An invisible force: The quest to define the laws of motion. Washington, D.C: National Geographic Society.

This children’s book puts Newton’s Three Laws into words that are easy for a middle age Elementary student. I really enjoy how this book talks about how these three laws affect a very large part of our lives today.

Rader, Andrew. (1996). Physics 4 kids: Mechanics and motion. Retrieved from http://www.physics4kids.com/files/motion\_intro.html

This website has a large amount of information on motion and the forces that have an affect. It is a great site that kids can understand and it uses real life examples that help you relate to the concepts.

Spangler, Steve. (2012). Egg drop: Newton’s law of inertia. Retrieved from http://www.stevespanglerscience.com/experiment/egg-drop-inertia-trick

Steve Spangler offers a great website with all sorts of experiments that you can do with your students. These experiments work great for demonstrations and are a great way to engage your students. There are many different topics on this website that are great for the elementary age classroom.

B. List at least one video you could use showing this concept in real life. (This should be used somewhere in the 5E directly.)

  Ski Crash Montage

http://www.youtube.com/watch?v=co4IAFMXB00

This video shows how when the skier crashes, they continue to keep moving.

“an object in motion tends to stay in motion”