Active Learning Community Partnership

Friction Investigation

STEM Focus Area: Forces and Motion

Learning Goal: Friction is a force that opposes (slows down) motion.

LEARNING ENVIRONMENT

Activity Duration: 50 minutes
Class Size: Large or Small
Type of Space: Indoor
Age of Youth: 3-5 (ages 9-11 years)

Guiding Question: *What is the question to explore OR the problem or challenge to solve?*
What impact does the surface of the ball have its motion as it rolls down a ramp?

Through this activity, youth will:

- Build a cardboard ramp;
- Test and record how the surface materials of four different balls (wood, glass, plastic, rubber) affects the motion of the ball when rolling down the ramp;
- Measure and record how different objects move;
- Interpret data and draw conclusions about how friction changes motion; and
- Communicate the results of their investigation.

Facilitator Checklist in the Learning Environment:

- ✓ **Predict and hypothesize**
- ✓ **Develop and use models**
- ✓ **Measure materials**
- ✓ **Observe**
- ✓ **Investigate**
- ✓ **Record observations**
- ✓ **Analyze and infer**
- ✓ **Share and communicate data**
- ✓ **Interpret data**
- ✓ **Test and revise**
- ✓ **Draw conclusions and relationships**
- ✓ **Have voice and agency, make decisions and guide their own learning**

PREPARATION

Facilitator prep:
When you kick a ball, it doesn't move forever. It gradually slows down and stops. The force that makes the ball slowdown is friction. Friction is a force that opposes motion. Friction occurs between two surfaces that are touching, such as the surface of a ball and the ground. Some surfaces produce more friction that others.

Friction is the resistance of motion when one object rubs against another. Anytime two objects rub against each other, they cause friction. Friction works against the motion and acts in the opposite direction. When one object is sliding on another it starts to slow down due to friction.

Literacy Connection: Skateboard Sibby by Clare O'Conner is a great story about a girl who loves to skateboard! This chapter book could be a way to engage youth in thinking about friction and how it impacts skateboarding making the Friction Investigation activity relevant to their real lives.

Materials

- 1 piece of heavy cardboard cut to measure 12" by 12"
- 1" balls (ping pong, bouncy ball, large marble, wooden ball) *all available on Amazon*
- Several books (*used to adjust the ramp to a 6" height)*;
- Masking tape; and
- Tape Measure
- Friction Investigation recording sheet (attached)

Room: This activity needs a lot of open floor space for the balls to roll unimpeded until they come to a full stop.

Content: Friction is the force required to move one object over another. Friction is what holds objects in place until another force is strong enough to overcome the friction and move the object (for example: gravity). The resistance caused by friction keeps an object from moving as far or as quickly as it might with less friction.

Two main causes of friction are surface roughness and surface adhesion. Roughness can be demonstrated using smooth and rough surfaces (for example, printer paper as opposed to sandpaper), and adhesion can be demonstrated with different "tacky" materials, for example, tape or non-slip shelf liner. Remember, you can feel friction!
Inquiry:

To allow youth to do the thinking and reasoning, it's important to let them lead the discussions with the facilitator acting as a guide during this friction investigation. Prompting questions as youth are conducting their investigations include:

Why do you think the ball only rolled this far?

What do you think is causing the ball to slow down?

What do you think will happen?

Can you describe what the ball feels like?

What other kinds of materials would make a ball roll faster? Slower?

Facilitator Checklist for Preparation:

- ✓ Organization: I practiced the activity/technology, prepared materials/extras/place to record youth ideas, completed an activity (including timings).
- ✓ Materials: Materials are appropriate for teaching the learning goals; youth will be able to use them and will think they are appealing.
- ✓ Space Utilization: The space is set up appropriately for the activity and there will be no safety issues or distractions.
- ✓ Relevance: I have researched why the content matters to youth's everyday lives.
- ✓ Content Learning: I have become familiar with the content.
- ✓ Inquiry: I have become familiar with how authentic, age-appropriate inquiry practices look in this activity.

INTRODUCTION TO ACTIVITY (15 MINUTES)

Introduce the following vocabulary words and initiate a discussion about friction and how it might relate to real-world experiences.

- **Direction** is the line along which anything lies, faces, moves, etc., with reference to the point toward which it is directed.
- **Distance** is the amount of space between two places.
- **Force** is a push or a pull exerted on an object.
- **Friction** is a force that resists motion between two bodies in contact.
- **Gravity** is the natural force that attracts any two objects with mass toward each other.
- **Motion** is moving or changing position (straight, zigzag, round and round, back and forth, fast and slow).
- **Speed** is how fast or slow something moves.

Friction is all around us. Like gravity, friction is a force. When people hear the word *friction,* they think about things rubbing together, and that's exactly what friction is: THE BIG RUB!

Whenever two things rub together, some of the energy they have is lost to friction. Basically, in things like car engines, the wheels of your skates, and the chain of your bike, friction is a force that slows you down. In order to overcome friction, you have to work harder. However, the energy doesn't just disappear — it's turned into heat!

Try rubbing your hands together as fast as you can. What do you feel?

As it turns out, the rougher two surfaces are, the more friction there is between them when they rub together. By making things really smooth, or by adding lubricants like grease and oil, engineers work hard to reduce friction and in the long run, save energy.

Friction isn't always bad though. If you've ever tried to start running on a wet floor, you know that too little friction can just make you slip and slide. You need a certain amount of friction to get a grip in order to get yourself going. That's why winter car tires usually have deeper treads than regular tires. The extra grooves make the surface rougher and help them get a grip on ice and snow.

Everyone take a look at the bottoms of your shoes. What do your shoe bottoms look like? Whose shoes would be better for running? Whose shoes would be better for sliding around on the gym floor?

Today we're going to do a science investigation about friction! We'll going to focus on what types of surfaces produce the most and the least friction.

Divide youth into small science investigation groups of 2-3 kids per group. Show the teams the materials that you have already prepared for them to use with this investigation. Hold up the individual balls (wood, plastic, glass, and rubber) and ask what words best describe the surfaces of the different balls. *(Youth may use words like smooth, rough, slippery, soft, hard, sticky, etc.)*

Facilitator Checklist for Introduction to Activity:

- ✓ Space Utilization: I will use the space informally avoiding the lecture hall format.
- ✓ Purposeful Activities: This intro section gets youth on track for the learning goal.
- ✓ Content Learning: If age appropriate, I will accurately present content.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Relationships: I will make each youth feel welcome.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

ACTIVITY ENGAGEMENT (20 MINUTES)

Before constructing their ramp, ask youth teams to predict which ball will roll down the ramp and travel the furthest. Ask them to record their predictions on the Friction Investigation recording sheet.

Instruct youth to build a ramp that is 12" long and 6" high. Youth should use the books and measuring tape provided to construct a 6" cardboard ramp.

Once the ramp is ready, youth can begin testing the motion of the four different types of balls as they roll down the ramp. Instruct the teams to perform three tests for each 1" ball provided (wooden, plastic, glass, and rubber) and to mark and record the distance traveled by each ball as data on the Friction Investigation recording sheet.

Facilitator Checklist for Activity Engagement:

- ✓ Space Utilization: I will use the space informally avoiding the lecture hall format.
- ✓ Participation: All youth will have access to the activity.
- ✓ Purposeful Activities: This core section helps youth to move toward the learning goal.
- ✓ Engagement: This activity has youth physically engaged with their hands while engaged with their minds.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Reflection: If appropriate, I will ask youth questions during the core activity tht will help them make sense of what they are learning.
- ✓ Relationships: I will take steps to share my enthusiasm and create a nurturing, safe learning environment.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

FINAL REFLECTION AND RELEVANCE (15 MINUTES)

Create a way for the teams to share their results visually with the entire classroom. You could create a Results Chart on a chalkboard, a large piece of poster board, an overhead projector, or even with post-it notes on the wall. The chart should show each team's name, their individual predictions, and their results of the 3 friction tests.

Once the results are all on display, ask youth what surprised them while learning about friction? Did the balls move faster or slower than you predicted?

Ask students with a show of hands which surface material has the most friction causing it to move the slowest and least distance? What surface material has the least friction causing it to move the fastest and the furthest? How do the other two surface materials rank?

As a way to make this investigation relevant to youth, ask:

- Can you think of a way that friction works "for you"? What is a situation where friction is helpful to you in your everyday life?

- Can you think of a way that friction works "against you"? What is a situation where friction is unhelpful to you in your everyday life?

Facilitator Checklist for Activity Reflection & Relevance:

- ✓ Space Utilization: Again, I will use the space informally.
- ✓ Participation: I will prompt youth who do not have access to the activity to participate.
- ✓ Purposeful Activities: The closing section helps youth to reach the learning goal.
- ✓ Content Learning: I will help youth make connections between different ideas. I will create opportunities for youth to ask questions/provide ideas that show a deeper level of understanding.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Reflection. I will provide youth with a sustained opportunity to make sense of their learning.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

NGSS STANDARDS RELEVANT TO THIS ACTIVITY

3-PS2-1 Motion and Stability: Forces and Interactions

- Plan and conduct an investigation to provide evidence of balanced and unbalanced forces on the motion of an object.
- Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.