Engineering Motion with Paper Roller Coasters

Florida State Standard: SC.4.P.10.1 - Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.

A. TEACHER:

B. GRADE LEVEL: 4th Grade

C. SUBJECT: STEM/Science

D. DATE:

E. DURATION: 60 minutes (plus additional sessions as needed for project completion)

F. LESSON FOCUS: Understanding the physics of motion, energy, and forces through building and testing paper roller coasters.

G. MATERIALS:

- Cardstock or thick paper
- Scissors
- Tape
- Rulers
- Marbles or small balls
- Cardboard bases (optional, for stability)
- Pencils and paper (for design sketches)

H. LESSON OBJECTIVES:

- Students will understand the concepts of kinetic and potential energy.
- Students will observe how gravity, friction, and inertia influence motion.
- Students will design, construct, and test a paper roller coaster that demonstrates energy conversion and the effect of forces on motion.

I. PROCEDURES:

1. INTRODUCTION: (10 minutes)
Begin by discussing roller coasters and the physics behind their motion, including gravity, energy, and the roles of potential and kinetic energy. Explain how potential energy is stored at the top of the coaster and turns into kinetic energy as the ball moves downward. Ask students to brainstorm what they think makes a successful roller coaster and record their ideas on the board.

2. EXPERIMENT: (30 minutes)

- Divide students into groups and provide each group with materials.

- Have students sketch their roller coaster designs, thinking about the height and angles needed to move the marble through the entire course.
- Guide them to build their roller coasters, starting with a sturdy base and gradually adding ramps, curves, and loops. Encourage students to test small sections to ensure stability and smooth movement.

3. OBSERVATION: (10 minutes)
Allow students to observe the motion of the marble on their roller coaster. Encourage them to note when the marble speeds up, slows down, or stops, and discuss what might be causing these changes (e.g., friction, height, angle). Have them make adjustments to their designs as needed to improve performance.

4. GENERALIZATION: (5 minutes)
Lead a discussion on how changes in height (potential energy) or slope angle affect the marble's speed (kinetic energy). Explain how friction and gravity influence the ball's motion, and reinforce that this process demonstrates real-world engineering and physics concepts.

5. ASSESSMENT: (5 minutes)
Ask students to write a brief reflection on what they learned about energy and motion from the project. Questions could include:

- What changes did you make to improve your roller coaster?
- How does the height of a hill affect the marble's speed?
- Why does the marble sometimes stop or slow down on certain parts of the track?

Note 1: Safety
Remind students to handle scissors and other sharp objects carefully and to keep all materials on their desks to avoid tripping hazards. Since the activity involves moving marbles on elevated tracks, caution them not to place the tracks too high and to keep all roller coaster elements securely taped to avoid falls or accidental tipping.

Note 2: Accommodations for Diverse Learners
For English Language Learners (ELLs), provide labeled diagrams of roller coasters and key terms related to energy and motion. Pair ELL students with supportive classmates for guidance. For Exceptional Student Education (ESE) students, offer additional one-on-one support to help with steps and allow them more time to build. If possible, use larger, easy-to-manipulate materials for students with fine motor difficulties and provide visual or auditory step-by-step instructions as needed.