Defying Gravity: The Physics and Precision of Trampoline Flight

Lesson Overview

In this lesson, learners will transform their trampoline into a physics laboratory. By exploring concepts like gravitational potential energy, kinetic energy, and Hooke’s Law, students will learn why they bounce and how to control their "flight" for maximum height and safety.

Materials Needed

- Trampoline (properly assembled with safety netting)
- A smartphone or tablet with a slow-motion video recording feature
- Measuring tape or a yardstick (taped to a safety pole if possible)
- A small variety of balls (tennis ball, basketball, soccer ball)
- Notebook and pen (or digital equivalent)
- Chalk (optional, for marking the trampoline mat)

Learning Objectives

By the end of this lesson, you will be able to:

- Define and identify Gravitational Potential Energy (GPE), Kinetic Energy (KE), and Elastic Potential Energy (EPE) in action.
- Explain Hooke’s Law in the context of trampoline springs.
- Demonstrate the conservation of momentum through a "Transfer of Energy" experiment.
- Design a "Precision Routine" that utilizes physical principles to control movement.

1. Introduction: The Hook (10 Minutes)

The Scenario: Imagine you are an astronaut training for a low-gravity moon landing. On Earth, gravity is constantly pulling you down, but for a split second at the peak of a trampoline jump, you are weightless. How do we get that height? Is it just leg strength, or are we "stealing" energy from the trampoline?

The "Big Idea": A trampoline is essentially a massive energy storage device. Every time you land, you are "charging" the springs with energy to be used on your next launch.

Quick Check: Ask the learner: "When do you feel the heaviest during a bounce? When do you feel the lightest?"

2. Content & Practice (The "I Do, We Do, You Do" Model)

Part A: The Energy Loop (I Do - Instruction)

Explain the three stages of a bounce using 14-year-old friendly terms:

- **Gravitational Potential Energy (GPE):** When you are at the very top of your jump. You aren't moving yet, but you have the "potential" to fall.
- **Kinetic Energy (KE):** As you fall, that potential turns into motion. You are at your fastest right before you touch the mat.
- **Elastic Potential Energy (EPE):** As you hit the mat and the springs stretch, the KE turns into EPE. The springs are "storing" your fall to push you back up.

Part B: The "Super-Bounce" Experiment (We Do - Guided Practice)

Let's test energy transfer with an assistant or by using different objects.

1. **The Tennis Ball Trick:** Hold a tennis ball about a foot above a basketball. Drop them simultaneously so the basketball hits the trampoline mat first, with the tennis ball right on top of it.
2. **Observation:** The tennis ball should fly significantly higher than it would if dropped alone.
3. **The Discussion:** Why did this happen? (The basketball's energy was transferred into the smaller mass of the tennis ball).
4. **Safety Check:** Practice "Kill Bounces." Have the student jump and, upon landing, immediately bend their knees to absorb the energy. This demonstrates how to "cancel" the EPE and stop the energy loop safely.

Part C: Slow-Mo Analysis (You Do - Independent Practice)

Now, the student will apply the science to their own body movements.

1. **The Experiment:** Set up a camera to record the student jumping in slow motion from the side.
2. **The Task:** Perform three different types of jumps:
    - A standard vertical jump using only legs.
    - A jump using a full arm swing (upward momentum).
    - A "Seat Drop" (landing on the bottom and bouncing back to feet).
3. **Data Collection:** Review the footage. Identify the exact moment of maximum EPE (when the mat is lowest) and maximum GPE (when the student is highest).
4. **Measurement:** Use the measuring tape/yardstick in the background of the video to estimate the height difference between the three jump styles.

3. Application: The Precision Routine

Challenge: Design a 30-second "Physics Routine." The routine must include:

- One "Energy Build" (three consecutive jumps getting higher each time).
- One "Momentum Transfer" (using arms or a specific body tuck to change rotation speed).
- One "Precision Landing" (landing exactly on a chalk mark or specific spot on the mat).
- A "Kill Bounce" finish to show control of energy.

Success Criteria: The routine must be performed fluently without losing balance, demonstrating that the student understands how to manage the forces acting on their body.

4. Conclusion: Recap & Reflection (10 Minutes)

Summary: We’ve learned that trampolining isn't just "jumping"—it's a constant cycle of energy being traded between the air, your body, and the metal springs.

Review Questions:

- If we replaced the metal springs with stiff rope, would you still bounce? Why or why not? (Relate back to Hooke's Law and Elastic Potential Energy).
- How does tucking your knees into your chest during a flip or jump change your movement? (Momentum/Center of Gravity).

Final Takeaway: Physics is the difference between a random bounce and a controlled flight.

Assessment Methods

- **Formative (During the lesson):** Successful execution of the tennis ball energy transfer and the "Kill Bounce" safety maneuver.
- **Summative (End of lesson):** The "Physics Flight Log"—a brief write-up or verbal explanation of the slow-mo video analysis, identifying the different types of energy at specific timestamps.

Adaptability & Differentiation

- **For Struggling Learners:** Focus purely on the feeling of GPE vs. EPE. Use a "Slinky" toy alongside the trampoline to show how springs stretch and return.
- **For Advanced Learners (The "Physics Pro" Extension):** Have the student calculate their GPE at the peak of their highest jump using the formula $GPE = mgh$ (mass × gravity × height). Use a bathroom scale to find mass (kg) and the video footage to estimate height (meters).
- **Classroom Context:** If a trampoline isn't available, this lesson can be performed using a "mini-trampoline" or even a large exercise ball to demonstrate the same energy transfer principles.