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Pseudoscience Lesson: Gravity Hill

- **Background for Teachers**

Introduction Video

YouTube Videos: https://www.youtube.com/watch?v=8UyEvOZaa5c

https://www.youtube.com/watch?v=WAOAxXBjvcQ

Just Because Something Appears to Roll Uphill, that doesn't mean it is

In the video the car is not traveling in the direction anticipated. Although the hill that the car is on, slopes downward, the car appears to being going uphill. This is actually an optical illusion. The plants and trees on the hill distort our perception of the horizon which gives the observer the illusion that the car is moving uphill, even though it is not.

- **Student Lesson Plan**

NGSS Performance Expectations:

- Students know how to apply the law F=ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).
- Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.
- Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- Design, build, and refine a device that works within given constraints to convert one form of energy to another form of energy.

Principles illustrated:

- Optical Illusion
- Center of Mass
- Gravitational force
- Newtonian Physics

Today's Objective(s):

- Understand that Newton's laws predict the motion of most objects
- Understand energy conversion, kinetic energy, potential energy, conservation
- Design and construct an object based on constraints (e.g. materials) to achieve goals
- Record and analyze experimental data
- Compare designs
- Refine design based on data

Agenda Overview: (scaffolding)

Question: Can something roll uphill on its own? Recreate a scenario where this is possible.

Part 1

- **Introducing Newton's second law, gravity, center of gravity, forces(?)**
- watch ghost children video
- **Watch video** (get students to share ideas about the video)
    - - pause and ask "what do you expect to happen?"
    - **Predictions**
        - **Use CER to explain how the car seemingly is rolling upwards**
        - **Evidence should come from observations of the video or any prior knowledge**
    - Why did the car roll uphill? Was it really the ghost children?
- **Students will be asked to explain the phenomena with a 3-D model of a Gravity Hill**
    - **What information do you need to model the hill?**
    - **How will you collect this information?**
    - **What materials will you need?**
    - **What will make the same thing happen as in the video?**

Part II - make the model

- Testing
    - Model timing/data collection
    - Data sheet

    - Collection of videos (use video analysis software) - tracker
- Refinement
    - Analyze the data
        - Measure center of gravity
        - Look for patterns in the data (categorize shapes)
        - Graph results
        - Report on results - CER
    - Look at videos of rolling (gallery walk)
    - Rolling vs sliding (rotational kinetic energy)
    - Revise design
        - Time constraints
- Competition
    - Optional competition/judging
    - multiple categories (best design, fastest, most improved)
- Discussion
    - Explain the success of best design (CER - about the model)
    - What is the best possible design (no limits on materials)?
    - Real world applications - why are wheels important?

Part III

Assessment:

Lab report

- Intro questions
- Initial design
- Data analysis
- Final design
- Reflection

Explanation:

- Optical illusions use light, color, and patterns to create images which deceive the human mind. Some display multiple images in one picture, while others affect one's perception of orientation in the image. Optical illusions happen when our brain and eyes try to speak to each other in simple language but the interpretation gets a bit mixed-up. For example, it thinks our eyes told it something is moving but that's not what the eyes meant to say to the brain. Our brains and eyes evolved to be quite sensitive about movement because in prehistoric times it was a big help if you could spot movement early and often. A slight rustle in the bushes could mean a predator was nearby and it was time to run away. Spotting movement early could save your life!
- Examples of optical illusions
- How is gravity hill an optical illusion?
- Bressan et al. found that perceived slope depends on the height of the visible horizon; that surface slant tends to be underestimated relative to the horizontal plane; and that when preceded, followed, or flanked by a steep downhill slope, a slightly downhill stretch is perceived as uphill (Bressan, 2003).

Source: Bressan, Paola, et al. "Antigravity Hills Are Visual Illusions." *Psychological Science*, vol. 14, no. 5, 2003, pp. 441–449., https://doi.org/10.1111/1467-9280.02451.

Exit Activity/Homework:

- **Teacher Resources and Handouts**

Lesson Plan

DAY 1	**DAY 2**	**DAY 3**
- Introduce gravity hill	- Time to work on lab assignment	- Introduce optical illusions

CER	
CLAIM - a statement that answers the question	

EVIDENCE - scientific data and details that support your claim	
REASONING - explains "how" or "why" the evidence supports the claim	

Discussion Notes	
Overview - What happened when you tested your model?	
What do you like about your model and why?	
How would you change your model? What materials could you use to improve on your model?	
Did your model answer the question?	

Lab Report Criteria

	Exceeds 3pts	**Meets 2pt**	**Below 1-0pt**
Question	The problem is **accurately** stated	The problem is stated	The problem is not stated
Hypothesis	Is clearly stated with **supporting** details	Is clearly stated with details	Hypothesis is not clearly stated
Materials	All need materials are clearly listed **including the quantity needed (like 2 beakers? 3 test tubes?).** The correct terminology and spelling of the materials are present in the lab report	All need materials used are listed including the quantity needed	Some, but not all of the materials are listed, or correct quantity is missing/incorrect

Procedures	All lab **procedures** are clear accurate, and numbered in correct sequence	All lab procedures are stated in correct sequence	Some, but not all of lab procedures are stated or are out of sequence
Data collection	Data, which is recorded and collected by observation and/or measurements, is accurate and follows the procedures. **Data is then put into a chart, graph or table that is neat and clearly shows results**	Data, which is recorded and collected by observation and/or measurements, is accurate and follows the procedures	Some or no Data is present
Conclusion	Is clear, complete, and accurately supported by the **evidence from your data**. States clearly if the **hypothesis was proven right or wrong**	States clearly if the hypothesis was proven right or wrong. Hypothesis does not reflect evidence from data	Hypothesis does not state clearly if the hypothesis was proven right or wrong