6. Junior Pinball

LEGO Spike Essential - Crazy Carnival Games

Subject: STEAM, Science	**Topic or Unit of Study:** Energy, Energy Transfer
Grade/Level: Grades 3-5	**Time Allotment:** 1.5 hours
Objectives: ● We will apply ideas to refine a solution that converts energy from one form to another. ● We will test the solution to improve and refine its function. ● We will engage effectively in a range of collaborative discussions.	**Standards:** **4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. **ISTE 1.3d:** Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions. **5.AP.M.02:** Modify, remix, or incorporate portions of an existing program into one's own work, to develop or add more advanced features (grade-level appropriate). **ELA-LITERACY.SL.4.1:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-lef) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.
Synopsis: This unit will develop your students' understanding of energy, energy transfer, and collision. They'll explore ways of using observation skills as they anticipate the outcomes of changes in energy during a collision, describe the relationship between energy and speed, and predict how energy moves from place to place. They'll also broaden their understanding of energy conversion (potential and kinetic) by investigating a solution that converts energy from one form to another, testing the solution to improve and refine its function.	**Materials:** ● Teacher/instructor lesson plan ● Teacher/instructor Google Slides presentation ● Teacher computer with access to internet and teacher presentation ● Student computers with LEGO Education SPIKE App ● LEGO Spike Essential kit (one per two students) ● LEGO Minifigure Bio copy (one) ● Printed building instructions (optional)

SLIDE 1:

Display the RoboMasters info. Allow students/guardians time to scan the QR code for website access.

SLIDE 3:

Share basic definitions for the following words: *bumper, flipper, obstacle, predictable, transfer,* and *unpredictable*.

- *Bumper:* a device that prevents damage
- *Flipper:* something that is used in flipping
- *Obstacle:* an object that you have to go around or over
- *Predictable:* something you know in advance that it will happen
- *Transfer:* to move or shift
- *Unpredictable:* something that does not happen at expected times

SLIDE 4:

Show students the picture of the pinball machine. Re-iterate the elements of the pinball machine: bumper, flipper, obstacle.

Discussion Questions:

What are some things that are predictable in a pinball machine? A ball moves through the machine; eventually the ball will drop below the flippers; the ball will encounter some of the obstacles

What are some things that are unpredictable in a pinball machine? The direction of the ball movement; which obstacles the ball is going to interact with

What transfers in a pinball machine? The ball; the ball's energy between kinetic and potential energy

SLIDES 5 and 6:

Show students the video of the spinning top.

Discussion Questions:

- **What type of energy does a spinning top have before it starts spinning?** Potential Energy
- **What type of energy does a spinning top have while it's spinning?** Kinetic Energy

SLIDE 7:

Introduce your students to Sofie (using the LEGO minifigure bios) and the challenge: create and test the program that makes the ball stop at the target.

SLIDE 8:

Share the SOARing expectations for the LEGO kits.

SLIDE 9:

Distribute a Prime Essentials set to each pair of students.

Teacher/Instructor Note: It would be best to have pairs pre-selected.

SLIDE 10:

Have students open the LEGO Education SPIKE Essential App.

- Open the app
- Click SPIKE Essential
- Click Unit Plans
- Click Crazy Carnival Games
- Click Junior Pinball

SLIDE 11:

Students will read/listen to slides 1 through 3:

1. Sofie finds a game she doesn't recognize. It's a junior pinball game.
2. She thinks this junior pinball game will be easy. There's only one obstacle.
3. Build a junior pinball game like Sofie's and try it out!

SLIDES 12 and 13:

Have students navigate to Kahoot.It and play the Kahoot about Motors.

Teacher/Instructor Note: You will have to navigate to Kahoot.It and "start" the Motors Kahoot to get the students' game code.

If students do not do well on the Kahoot, show them the correct answers on Slide #13.

SLIDE 14:

Tell students that they are now going to build their pinball game. Explain to students that if they do not follow each direction exactly as shown, their game will not work properly.

SLIDES 15-40:

On Step 4, students will go through all twenty-six building steps in pairs using their Spike Essentials kits.

Circulate the instructional space to ensure students are building correctly.

Teacher/Instructor Note: There is a picture of each building step on a separate slide in the presentation.

SLIDE 41:

Discussion Questions:

- **How is the motor on the pinball game set up differently than the motor on the mini-golf game a few weeks ago?** The motor on the pinball game is set to move an object on a horizontal plane, whereas the motor on the mini-golf moved the "club" on a vertical plane. The pinball game motor was set up to keep a ball from moving before the program started, whereas the mini-golf motor was set up to initiate a ball's motion once it started.
- **How are they set up similarly?** Both motors were set to cause an element in the build to move once the motors were programmed to move.

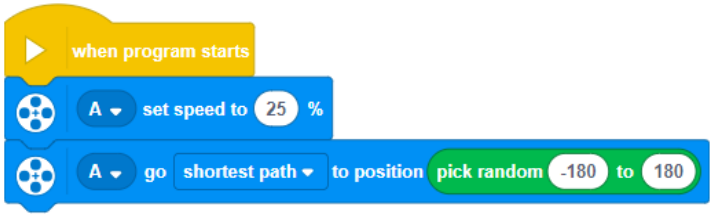
SLIDE 42:
Step 5 provides students with today's challenge: create the program that starts the junior pinball machine.

SLIDE 43:
Step 6 has students connect their Hubs to the Spike Essentials App using the white USB cable.

Pictures are included on the slide of where to connect the cable into the Lego hub.

SLIDE 44:
Students will begin their coding sequence. The App is interactive and shows students exactly which coding blocks to drag into the work area.

They will end up with this sequence:



Discussion Questions:
What does it mean when the speed is set to 25%? Is it close to full speed? It will move slowly; not even close to full speed, as no speed is 0% and full speed is 100%
In the third line, why did we set the parameters to -180 and 180? -180 and 180 means that the motor will swing the arm from the left side of the motor to the right side of the motor.

SLIDE 45:
Students will click the yellow PLAY button when directed to, to test their program.

Discussion Questions:

- **What happened?** The ball may not have moved from its starting position.
- **How can we modify our code to be more successful?** Modify the speed to greater than 25%, to ensure the ball will drop from its resting position each time.

SLIDE 46:
Provide students with time to modify and re-test their codes to start the junior pinball machine.

SLIDE 47:

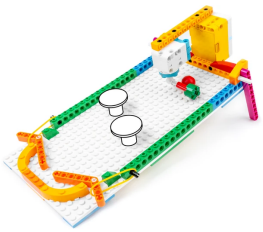
After the students complete this challenge, they'll be provided with three Inspiration Coding Blocks to help them modify their programs.

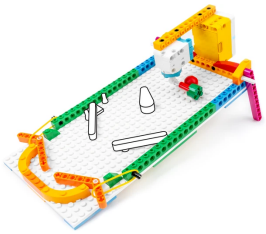
The Inspiration Coding Blocks are intended to spark their imaginations as they experiment to find their own solutions.

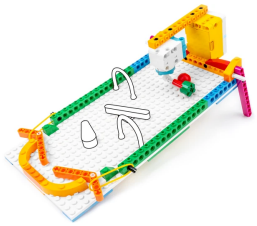
SLIDE 48:

Have the students iterate and test their models to complete today's challenge:

- Upgrade the junior pinball game by adding different obstacles.
  - The Inspiration Images are to help spark their imaginations as they experiment and change their models.







Teacher/Instructor Note: There aren't any building instructions for this challenge.

SLIDE 49:

Host a debrief discussion to reflect on the completed challenges. Ask questions like:

- **What refinements did you make to change how or when the game converted potential energy to kinetic energy?** Student responses will vary based on their modifications, however, students will describe how their obstacles slowed down the rate of conversion of potential energy to kinetic energy.
- **How did the different obstacles impact the energy conversion?** When the ball came into contact with the obstacles, the ball's energy rapidly transferred from kinetic energy to potential energy. After the ball started moving faster, it gained its kinetic energy back and lost its potential energy.

SLIDE 50:

Prompt your students to discuss and reflect on the process of refining their solutions to convert one type of energy to another.

- **How did the type of obstacle affect the ball's energy?** Each time the ball hit an obstacle, it transferred some of the kinetic energy to potential energy. This is visible by the change in speed of the ball.

SLIDE 51: Display the RoboMasters info. Allow students/guardians time to scan the QR code for website access.
SLIDE 52: Ask students, “How does today’s activity connect to robotics?”
SLIDE 53: Provide students with ample clean-up time, helping to ensure they are separating all pieces and placing them back appropriately.