*sprk*ing student interest in stem

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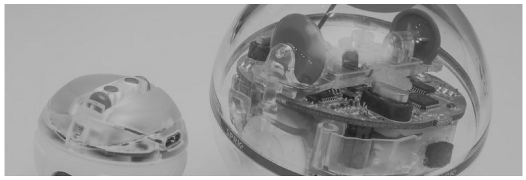

The Sphero SPRK+ allows students to construct their own knowledge and understanding in all science content areas, with a particular focus on:

- Identify questions that can be answered through scientific investigations
- Design and conduct a scientific investigation
- Use appropriate mathematics, tools and techniques to gather data and information
- Analyze and interpret data
- Develop descriptions, models, explanations and predictions
- Think critically and logically to connect evidence and explanations
- Recognize and analyze alternative explanations and predictions
- Communicate scientific procedures and explanations

There are many teacher developed activities on the Sphero website (https://edu.sphero.com/cwists/category). We are going to build our understanding of physics by completing several small activities by focusing on: coding as a tool for learning, not teaching code.

Workshop Agenda
Introduction
Code as a Tool for Teaching Physics
Sphero and Sphero Edu App Functionality
Free Explore (20 minutes)
Share
Structured Activities (40 minutes)
Share
Chariot Design Challenge (60 minutes)
Q&A

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Activity #1: Displacement, Time and Velocity (or Distance, Time and Speed)
Physics Concepts: Kinematics

Your goal in this activity is to determine the relationship that exists between displacement, time, and velocity. You will also develop an understanding of estimation and outliers.

Predict: The relationship between displacement, time and velocity.

Time (sec)	Speed	Distance (m)	$v = \Delta x / \Delta t$
2	10		
4	10		
6	10		
8	10		

Time (sec)	Speed	Distance (m)	$v = \Delta x / \Delta t$
2	30		
4	30		
6	30		
8	30		

Time (sec)	Speed	Distance (m)	$v = \Delta x / \Delta t$
2	50		
4	50		
6	50		
8	50		

Q1. Were there outliers in your data? If so, why do you there are? What caused them?
Q2. Cross off any outliers from your data.
Q3. Looking at your data only, what relationship exists between speed, time and distance?

Advanced Data Analysis
Q4. For your most recent run, tap on the three dots in the upper right corner and select Sensor Data from the menu.
Q5. Scroll down to the velocity and distance data.
Q6. Is the velocity of your Sphero constant? Justify your answer.
Q7. Does your distance v time graph support your conclusion to Q3? Justify your answer.
Q8. Explore your CSV data to Graphical Analysis. Use this data to determine the acceleration of the Sphero for your last trial.
Q8. Sketch a representative graph of displacement v time for each trial below.

Activity #2: Losing Touch
How far can the SPRK+ travel without losing contact with the iPad?
Physics Concepts: Kinematics

Predict: How far do you think the SPRK+ can travel without losing contact with the iPad? (This is not an easy prediction to make but give it your best shot!)

Trial	Settings	Distance Traveled
1		
2		
3		

Conclusion

Extension
Q1. Does the surface over which the SPRK+ travels affect how far it can go without losing contact with the iPad?
Q2. Does it matter if the SPRK+ travels indoors or outdoors?
Q3. Code the SPRK+ to stop just before it loses contact and return to you.
Q4. Code the SPRK+ to stop just before it loses contact and return to you and speak "I'm home" when it returns.

Activity #3: Do different speeds change the landing distance after jumping off a ramp?
Physics Concept: Projectile Motion

Predict: Which SPRK+ speed will produce the greatest range?

Speed	Trial 1	Trial 2	Trial 3
Slow			
Medium			
Fast			

Analysis
Q1. Based on the data you collected, how would you calculate the initial velocity of the SPRK+?
Q2. Use the initial velocity of the SPRK+ from your Sensor Data to calculate a theoretical range of your SPRK+. Discuss some possible sources of error.

Extension
Q3. Code your SPRK+ to speak "I'm landed" when it lands on the ground.
Q4. Code your SPRK+ to change colors when it lands on the ground.
Q5. Design an experiment to determine how the angle of incline of the ramp affects the landing distance. Test this prediction and record your data.
Q6. Design an experiment to determine how the coefficient of friction between the surface and the SPRK+ affects the landing distance. Test this prediction and record your data.

Activity #4: Hang Time
Physics Concept: Free Fall Motion

In this activity, you will sse the built-in timer and the formula for speed to calculate the air time and speed when you throw your robot. One person stands at a starting point and starts the program, and the robot will roll a random distance between 2 - 4 meters. Based on where it stops, a second person stands, picks up the Sphero, and tosses it back to the first player. The air time and air speed are reported back through the speak block.

This program uses the accelerometer which reads close to 0g when in free fall. We then set the "startTime" variable equal to the Time Elapsed in the program. When the robot lands and the accelerometer reads over 1g, we then set the "landTime" variable equal to the time elapsed in the program. After that, we just subtract startTime from landTime which equals the air time. Lastly, the horizontal air speed equals the airtime divided by the distance rolled. Check it out and get some air! (Source: edu.sphero.com)

Procedure
1. In the community section of the Sphero Edu App, find the program: **Air Time**.
2. Run the program.

Analysis
Q1. After the program has completed, look at the data for velocity v time and distance v time. How would you use this data to determine the acceleration of the SPRK+? (Note: you can download the CSV data into Vernier Graphical Analysis.)
Q2. How would you change the program to change v_x and v_y as well as the distance traveled?
Q3. Sketch your general graphs of velocity v time and distance v time below.
Q4. Deconstruct the code. What happens in each section?
Q5. What happens if you change the accelerometer value? Test your prediction and record your conclusions.

Activity #5: Hit Me
Physics Concepts: Conservation of Momentum

In this activity, you will determine how far various objects travel when hit by the Sphero. Be sure to control the following variables: speed, location of impact, distance from object

Materials: SPRK+, 3 objects, measuring tape, iPad

Predict: Find three objects in the lab. Which object do you predict will travel the farthest after being hit by the Sphero?

Object	Distance traveled (m) – Trial 1	Distance traveled (m) – Trial 2	Distance traveled (m) – Trial 3

Q1. Was your prediction correct? Why or why not?
Q2. Look at the sensor data to determine the velocity of the Sphero just before the collision.
Q3. Use this data and any other data available to calculate the "experimental" value for the mass of the Sphero.
Q4. Design an experiment to determine how the "impact angle" of the SPRK+ influences the travel distance of the object.

Activity #6: Olympic Curling
Physics Concepts: Accuracy and Precision

Curling is played by teams of 4 players. The teams go back and forth sliding stones towards the circular target (called the house). The object is to have more stones closer to the center than your opponent. Each player throws two stones, while their teammates sweep and direct the stone towards the house.

Now it is your turn to compete in the CODE4her Olympic curling event! Program your "stone" to roll as close to the center of the target as possible! You will be given about 10 minutes to practice, then you will make four "official" throws!

Rules

- Refer to the picture of the target for scoring
- Each teammate will get two throws, so your team will get four throws total
- Your score will be the total score of your four throws added together
- If a "stone" is touched while in motion, it is disqualified!

Activity #7: Golfing
Physics Concepts: Kinematics +

In this special activity, you will get to play golf with the Sphero SPRK+. There are 6 reversible holes, in effect allowing you to complete 12 complex mazes. While programming the SPRK+ along the fairway, you will develop your coding and computational thinking skills. Trial and error is a must and is very important as students learn about distance and time while using angles and concepts of geometry through each hole.

In the Sphero Edu App, search for **Sphero Golf Mat**.

Challenge

Take a look at the Sphero Golf Mat - Hole 1 Project attached to this activity. It is a Block Project and includes the blocks to get you started on the first hole on the mat. You will have to work together with your peers to complete the rest of the holes on the mat.

Evidence

While completing the holes on the Sphero Golf Mat take images and videos and upload them at the end of this step as evidence that you have completed it. It's always good to share your successes!

Tip: To further extend the challenge you can complete the holes backwards.

Activity #8: Morse Code

Create and share a message using Morse Code by programming your Sphero to light up in the correct series of dots, dashes, and spaces.

Introduction

Samuel Morse was a painter and an inventor. In 1836, he developed the first language and device for sending information electronically. Morse Code is still used today and is especially helpful in situations where there are poor signals and a voice cannot clearly be understood.

In this activity, you will learn how to program dots and dashes and string them together to create secret messages.

Plan Your Message

Plan the message you want code. Keep it short and use a different color for each letter.

- Write the words vertically (up and down) instead of horizontally, like in the image below.
- Why is it helpful to use a different color for each letter?
- In Morse Code, a space between words is seven units. With Sphero, how else could you let your recipient know they've finished decoding each word?

Programming

Use the Sphero Edu app to program your Morse Code message. Configure your block program.

- Choose the "Strobe" action and assign it a color.
- Choose what your intervals will be (we coded our Morse Code as 0.5 sec. = dot; 1.5 sec. = dash; but you can use a longer or shorter unit).
- Set the count to the number of repitions needed for that letter.
- Add a "Delay" action and make it last 0.5 sec.
- Repeat until every letter is accounted for and remember to switch between colors for each "Strobe" action.

Challenge

Cryptographers have saved lives by decrpyting dangerous information. Alan Turing, a pioneer in Computer Science, was a cryptographer! Cryptographers and software engineers share one thing in common: a fondness for puzzles.

For this challenge, share your Morse Code message with a friend, and see if they can decode it.

Activity #9: Bungee Jumping
Physics Concepts: Simple Harmonic Motion

Sphero wants to try his luck at the extreme sport of bungee jumping. Your mission is to write a code, engineer a bungee cord system, and document his adrenaline packed adventure!

Materials: Sphero, Ipad, Turbo Nubby cover, rubber bands, cable tie, metric measuring tape, Fast Camera APP, balance, spring scale

Procedure

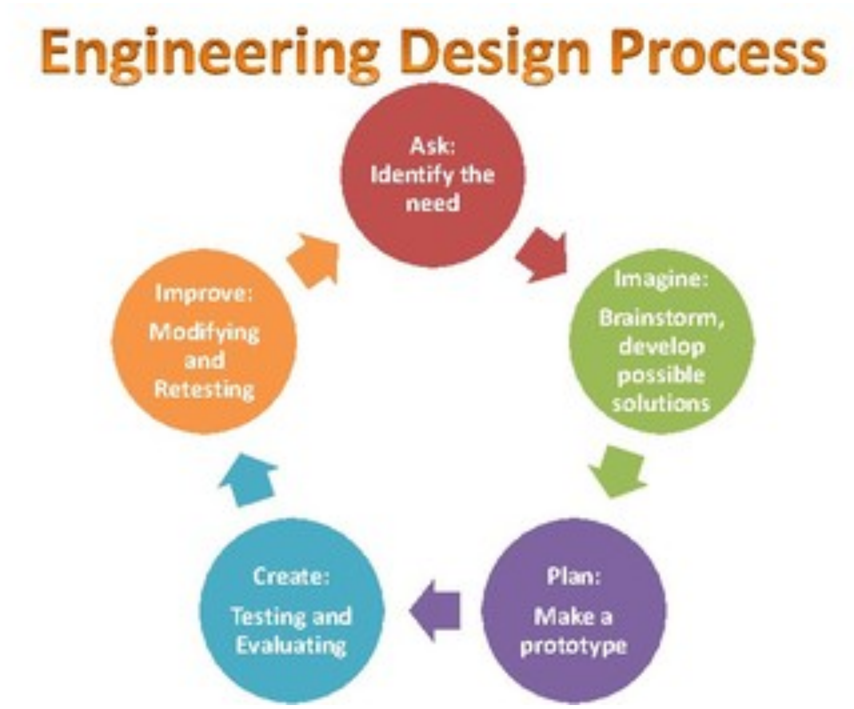
1. Put Sphero in his turbo nubby jump suit.
2. Use duct tape in the opening of the cover to make a loop to which to attach the first rubber band.
3.Find the mass of Sphero (in his jump suit) on a balance and test the elasticity of the rubber bands using a spring scale (with one end of the band on the spring scale, add mass weights on the other end of the rubber band and test until failure).
4. Measure the distance from the jump platform to the floor. Use all this data to make a reasonable guess as to how many rubber bands should be linked to get Sphero the closest to the floor without hitting.
5. Write a code that will roll him off the platform, turn green to show he is ready, turn yellow on free fall and turn red on collision.
6. Attach one end of the bungee cord system to Sphero's jump suit and cable tie the other to the suspended ceiling cross member. 3-2-1-JUMP!
7. Use your rapid camera app to find the lowest distance traveled in Sphero's death-defying plunge.
8.Be prepared to share your still frame picture as evidence that you were closest to the floor.
9. Any Sphero that turns red from collision is out.

Activity #10: The Chariot Challenge
Physics Concepts: Kinematics

In this activity, you will design and create a unique Sphero chariot, then create a program for Sphero to navigate the race course.

Materials: Paper, tape, cardboard, Knex, CDs, cups, felt, glue, Sphero

Sphero Chariot Challenge Video: https://youtu.be/hB2Q5CHQTRQ
Ultimate Sphero Chariot Race: https://youtu.be/HY1qofNIJmg



2. Take a blank piece of paper and fold it in half. Fold it in half again so you have four quadrants. Now, think of **eight** unique ideas and draw each one in a separate quadrant. Crazy and weird ideas are encouraged.

3. (optional) Research chariots from historical time periods or regions. Be sure to focus your research on the design and function of the chariots.

4. (optional) Make a short presentation to the class about the chariots you researched. Include:

- Photo of a chariot from your time period or region.
- What materials are they made of?
- What were chariots used for?
- How many wheels and how big were the wheels?
- How many horses/other animals were used to pull them?
- One other interesting fact about chariots in that culture

5. (optional) Now that you have learned more about chariots, brainstorm again. Fold another piece of paper into quadrants and sketch **eight** new ideas. Select your favorite idea and share it with your team.

6. Build and test your chariot. In the Sphero Edu App, create a program for the track. With a little guess and check, you can easily modify the program to fit the dimensions of the course.

7. (optional) As a group, make a presentation to the class about your chariot. Your presentation should include the following:

- Why you chose your design
- What was the hardest part of building
- How you expected it to perform and any problems you anticipated.

8. Race your chariot through the course. The chariot that completes the course in the shortest time and with the most accuracy is declared the winner.

9. Write your reflections on this activity:

- What worked and what didn't
- How would you do things differently in the future
- Why do you think that the culture you studied used that chariot
- What materials worked the best
- What was the most challenging part of the activity
- How did the size of the wheels or other design characteristics impact the results?
- What was challenging and what worked well within your team

Credits: Leah LaCrosse, Sphero Edu