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.

Activity #1: From a Distance
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.

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

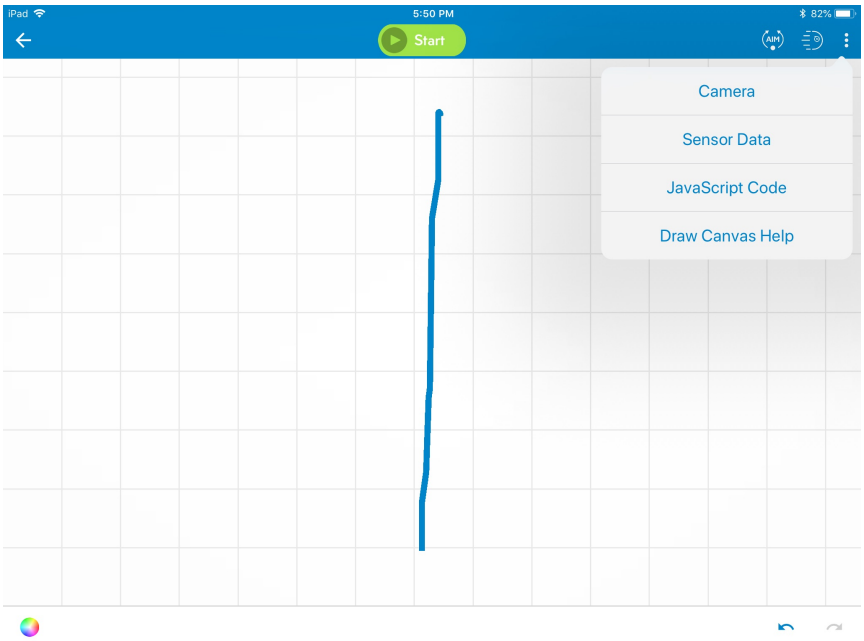
Time (sec)	**Speed**	**Distance (m)**	$v = \Delta x / \Delta t$
2	30		
4	30		
6	30		
8	30		

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

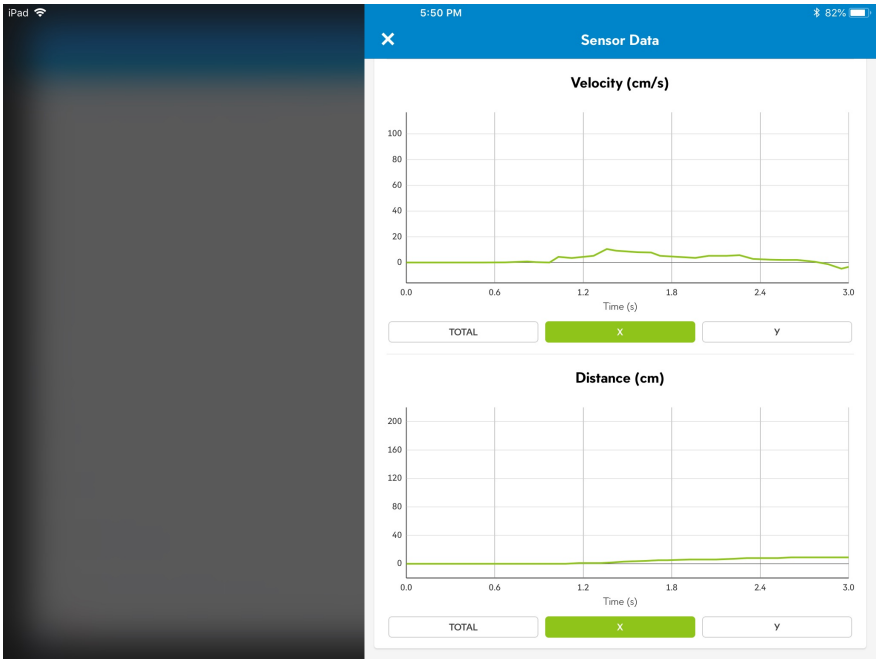
Q1. Were there outliers in your data? If so, why do you there are? What caused them?
Q2. Cross off any outliers from your data.
Q3. Looking at your data only, what relationship exists between speed, time and distance?

Advanced Data Analysis

For your most recent run, tap on the three dots in the upper right corner and select Sensor Data from the menu.



Scroll down to the velocity and distance data.



Q4. Is the velocity of your Sphero constant? Justify your answer.

Q5. Does your distance v time graph support your conclusion to Q3? Justify your answer.

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

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?

Activity #3: Kris Kross Will Make You Jump Jump
Do different speeds change the landing distance after jumping off a ramp?
Physics Concept: Projectile Motion

Speed	Trial 1	Trial 2	Trial 3
Slow			
Medium			
Fast			

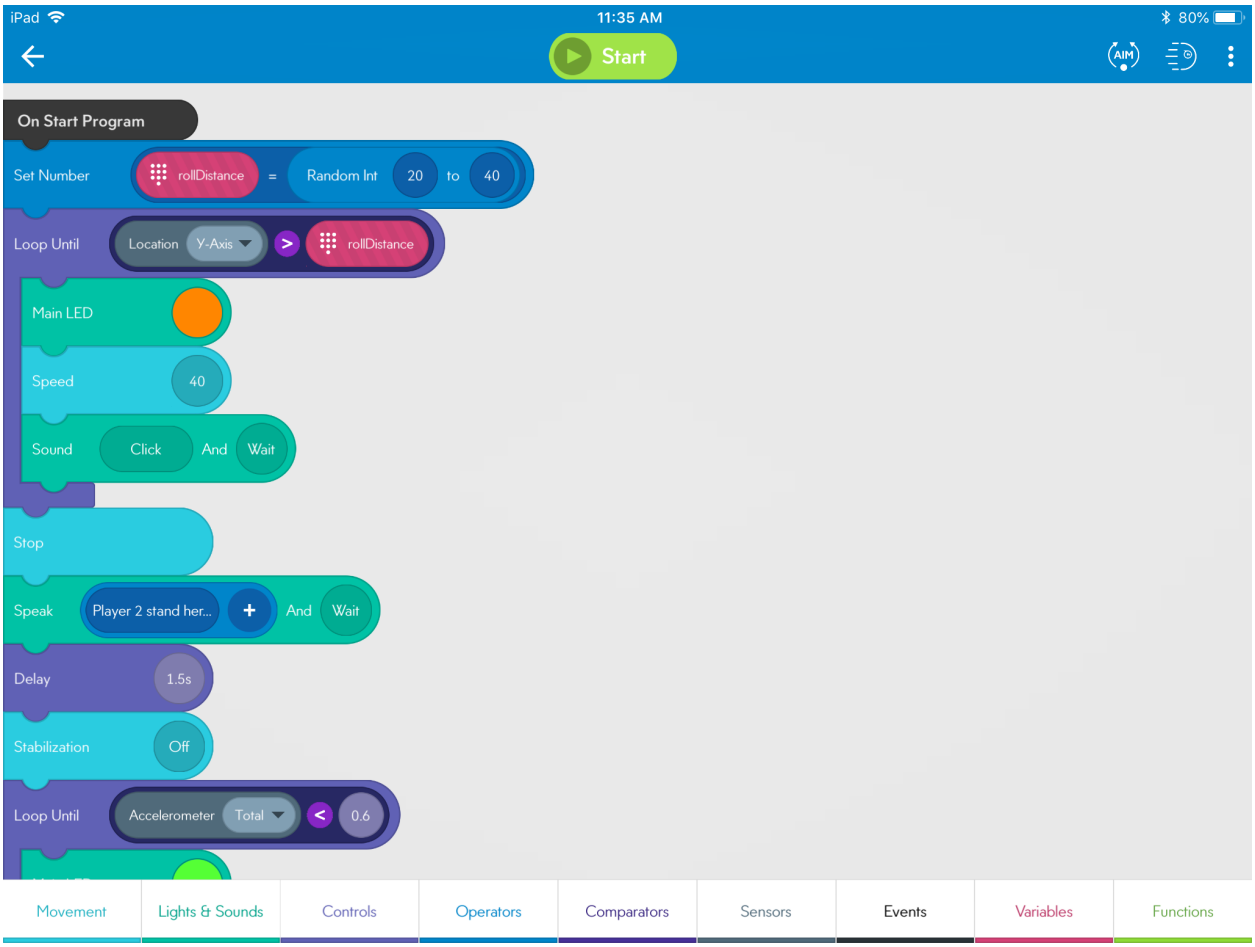
Analysis
Q1. Based on the data you collected, how would you calculate the initial velocity of the SPRK+?
Q2. How would the angle of incline of the ramp change your results? Test this prediction and record your data below.

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?

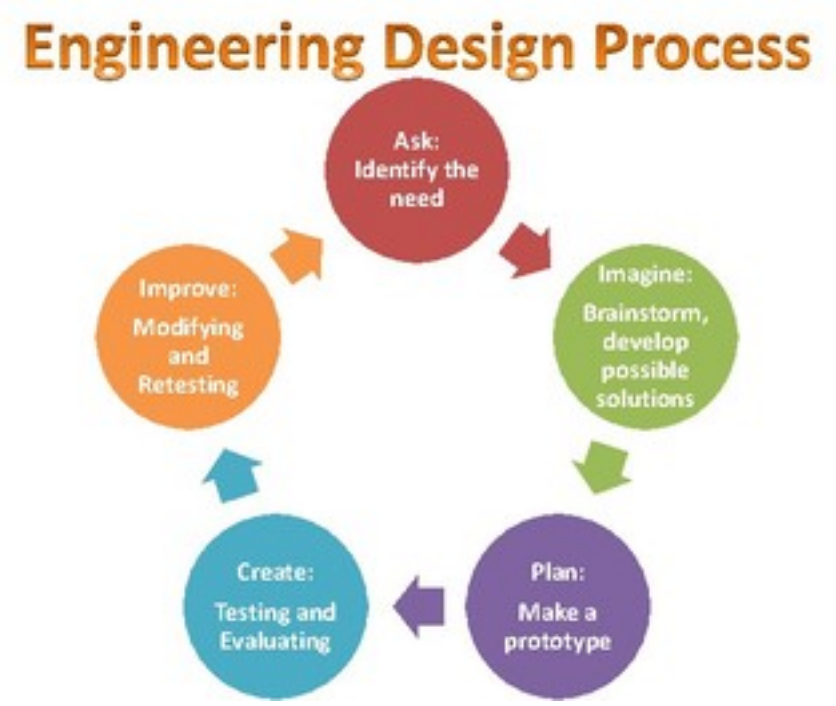
Q3. Sketch your general graphs of velocity v time and distance v time below.

Activity #5: Swing Low, Sweet Chariot
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

Presenter Information
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