Tractor Pull: Power, Mass, and Velocity

Using Spheros

Today we will use Spheros to investigate the relationships between power, mass, and speed. Your challenge is to build a tractor that Sphero will drive, which has a place to put extra weight. We will then vary power and mass, and we will measure speed.

One confusing thing to mention right from the beginning: the SpheroEdu app calls the power of the Sphero engine "speed". It is not speed – speed is determined as distance divided by time. So anytime you see the word "speed" on the SpheroEdu app, read it as "power".

Part 1: Collect Baseline Data

1. Wake up your Kindle Fire tablet by tapping the screen or quickly pushing the power button.
2. If Sphero Edu app is not already running, click on its icon to start it. When prompted, click as a Guest user.
3. Tap on the second icon along the bottom to open the programs. Find "Tractor Pull" and tap on it.
4. You will see a very simple program – just one block. Make sure that it is set to "roll 0^{o} at 150 speed for 5 s". If any of the fields are incorrect, just tap on them and correct them.
5. Now you need to pair the tablet with your Sphero. Along the top, there are three icons on the right. Tap on the middle one (looks like a semicircle with speed lines extending to the left). Find your Sphero ID in the list and tap on it.
6. Bring your tablet and Sphero to the area taped out on the floor. Place Sphero on the starting line. Next, you need to aim Sphero. Tap on the icon that says AIM on the top-right of your tablet screen. Drag the blue dot around until the blue tail-light of the Sphero is pointing at you (opposite the direction the Sphero will go). Then back out of that screen.
7. When you're ready, tap Start, and start your timer. When the Sphero reaches the 5m line, tap Stop and stop your timer.
8. Record the time it took for your Sphero to travel 5 meters in Data Table 1 (below). Do this two more times so you have a total of 3 trials.

Part 2: Build Your Tractor

1. Gather building materials and design a Sphero-driven tractor that is capable of transporting an added weight 5 meters. Your teacher has examples of tractors that have been built and worked in this experiment before to get you started.
2. How will the tractor affect Sphero's movement (kinetic energy)?
3. Predict the time it will take the Sphero-driven tractor to travel 5m:

   ____ sec (at power 150 with no added weight)

   ____ sec (at power 150 with an added weight)

4. Place the Sphero-driven tractor at the starting line with no extra weight, and aim it as you did before.
5. Tap Start and start your stopwatch. When Sphero crosses the 5m line, tap Stop and stop your stopwatch. Record this time in Data Table 1. Do this two more times so you have a total of 3 trials.
6. Now repeat steps 4 and 5 with an added weight on your tractor.

Data & Analysis for Parts 1 & 2

	Time to travel 5m (s)		
	Sphero alone	Sphero with tractor	Sphero with tractor AND extra weight
Trial 1			
Trial 2			
Trial 3			
Average			
Velocity: $\frac{5\text{ m}}{\text{ave speed}}$			

1. Refer to your predictions in Part 2, step 3. How accurate were you?

2. What was your variable in Part 1 and 2? What were our controls?

3. How did your variable affect the velocity of your Sphero?

Part 3: Exploring Power

1. Look at the program block in the SpheroEdu app. What are the three variables that you can alter?

We are going to leave the time and direction variable alone – these are set so that the Sphero will run down our track correctly. We can, and will, however change the power.

2. Predict what will happen if you increase the power by 50 and 100:

3. In the program block, change the power to read 200.
4. Place the Sphero-driven tractor at the starting line with extra weight on it, and aim it as you did before.
5. Tap Start and start your stopwatch. When Sphero crosses the 5m line, tap Stop and stop your stopwatch. Record this time in Data Table 2. Do this two more times so you have a total of 3 trials.
6. Repeat steps 3-5, but change the power to read 250.
7. When you are done with all your trials, change the power back to its original number – 150 – to be ready for the next class.

Data & Analysis for Parts 1 & 2

	Time to travel 5m (s)		
	At Power 150 (copy from data table 1)	At Power 200	At Power 250
Trial 1			
Trial 2			
Trial 3			
Average			
Velocity: $\frac{5\text{ m}}{\text{ave speed}}$			

1. Refer to your predictions in Part 3, step 2. How accurate were you?

2. What was your variable in Part 3? What were our controls?

3. How did your variable affect the velocity of your Sphero?

Summarize Your Results:

1. We had two variables we tested today. What were they?

2. What is the relationship between power and velocity?

3. What is the relationship between mass and velocity?