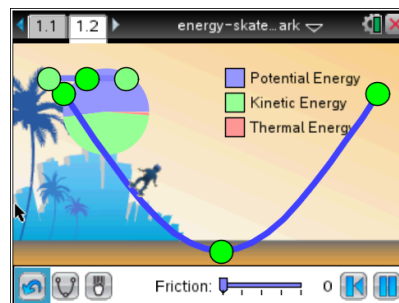



Open the TI-Nspire document *energy-skate-park.tns*.

In this simulation, you will adjust the track of the skateboarder to discover how the sizes and shapes of the dips and inclines in the track affect the motion. First, you will compare how the dips and inclines of the track and friction affect his travel. Then, you will compare the skateboarder's ride on Earth, on our moon, and on Jupiter. Finally, you will make your own track to meet certain ride requirements.



What physics principles apply when a skateboarder stands at the top of the first hill? When sliding down a hill? Or when coasting up another hill? Think about **potential (stored) energy** due to gravity of the skateboarder–celestial object system as the skateboarder is poised at the top of the hill and ready to roll. Then consider **kinetic energy** (energy in motion) as the boarder rolls down a hill and up the next.




If gravity affects the motion, how do you think his motion will differ on our moon and on Jupiter? **Gravity** is the force of attraction between all masses in the universe. How would **friction**, a force that opposes motion, change his ride?

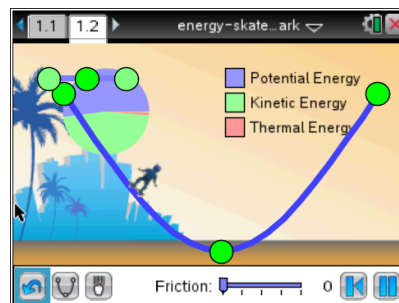
Sir Isaac Newton made observations and conducted experiments to formulate the Laws of Motion. As you work with this simulation, see if you can arrive at some of these same conclusions.

Part 1: Friction and Gravity

In Part 1 of the simulation, you will use preset skateboard tracks and observe the movement of a skateboarder. Then you will change the friction slider to determine how frictional force affects the ride. Finally, you will experiment with changes in the force of gravity on the motion of the skateboarder. Read the directions on page 1.1.

Move to page 1.2.



1. The background with palm trees shows the skateboarder on Earth. The amount of friction is set at 0. The track should be a “U” shape. If not, press the Track button  until a U-shaped track is displayed.
2. Select and drag the skateboarder to the top left of the track. Release the skateboarder. The Reset button  will place the skateboarder on the ground so you can start over. The Pause button  will stop and start his motion.
3. Now select and drag the friction slider to change the amount of friction to 25. Run the simulation several times by placing the skateboarder at the top of the track and letting him go. Then set the friction to 50, 75, and 100.

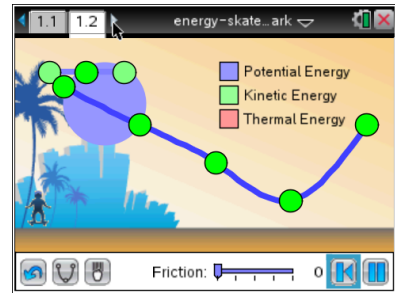




Q2. As you increase the amount of friction, how does the distance covered by the skateboarder change?


Q3. How does the motion of the skateboarder change?

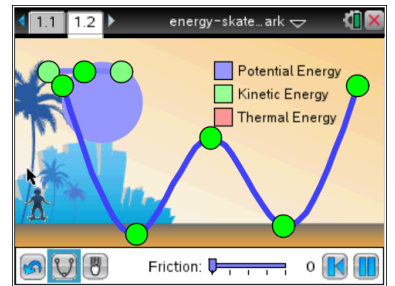
4. Select the track button  to change the shape of the track to a “dipper.” Run the simulation with the friction set at 0, 25, 50, 75, and 100. Select the Reset button  to place the skateboarder on the ground between trials.





Q4. What do you notice about the skateboarder’s ride with a dipper shape as compared to the U-shaped track?

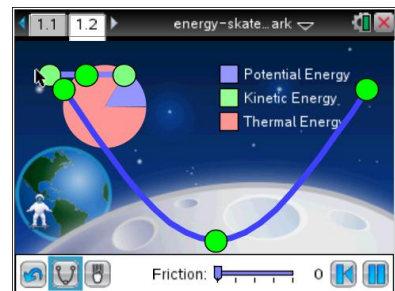
Q5. As the amount of friction increases, what happens to the skateboarder’s motion?

5. Select the track button  to change the shape to a “W.” Run the simulation with the friction set at 0, 25, 50, 75, and 100.



Q6. What happens to the skateboarder’s motion when the friction is set to 0? 25? More than 25?


6. Select the Reset button . Select the Gravity button  to change the location of the skateboarder to the moon. Set the friction to 0.



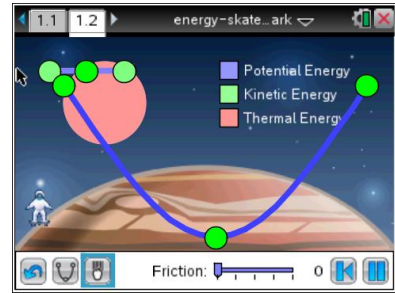
7. Allow the skateboarder to ride each of the three track shapes on the moon.

Q7. How does the motion of the skateboarder on the moon compare to the motion on Earth?



8. The gravity on Jupiter is more than the gravity on Earth. Select the Gravity button  to change the location of the skateboarder to Jupiter. Keep the friction to set to 0.

9. Allow the skateboarder to ride each of the three track shapes on Jupiter.



Q8. How does the motion of the skateboarder on Jupiter as compared to the motion on Earth?

10. Go back to the moon. Change the friction to 25, 50, and 100. Allow the skateboarder to only ride the U-shape track. Now go to Jupiter. Change the friction to 25, 50, and 100. Keep the skateboarder on the U-shape track.

Q9. What happens to the motion of the skateboarder when you increase the friction on the moon? On Jupiter?

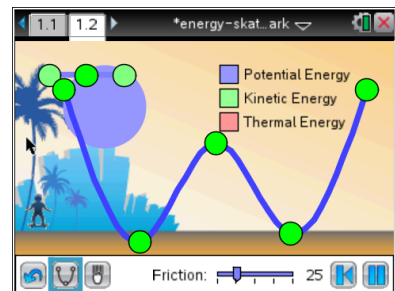
Q10. In general, how does gravity affect the skateboarder's ride? How does friction affect the skateboarder's ride?

Part 2: Make Your Own Ramp

In this part, you will change the size of the dips and inclines on a track. Your goal will be to make a track so the skateboarder performs as described.

11. Set the track shape to a W and the gravity location to Earth. Set the amount of friction to 25. Grab and drag the green dots to change the shape and size of the track. When you release the skateboarder, he must:

- 1) complete the entire track, and
- 2) stay in contact with the track without jumping or falling off.

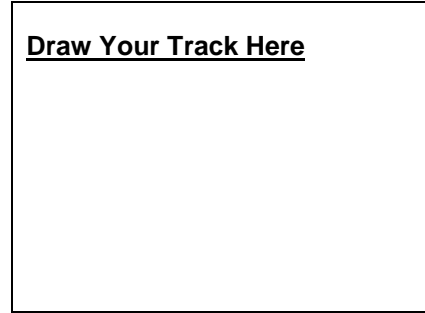


Q11. What adjustments did you make to the shape and/or length of your first track to meet the requirements?




Q12. Draw your track shape to the right.

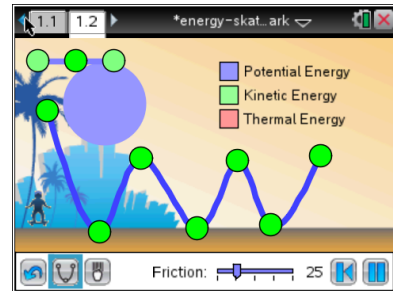
Draw Your Track Here



Q13. How did you figure out the best possible potential energy (stored energy), meaning how high to start the first hill for the skateboarder so he had enough energy to complete the track?

Q14. How did you figure out the best possible kinetic energy (energy in motion), meaning how high/low and long for the hill in the middle to be so the skateboarder remained in contact but had enough energy to make it up the hills?

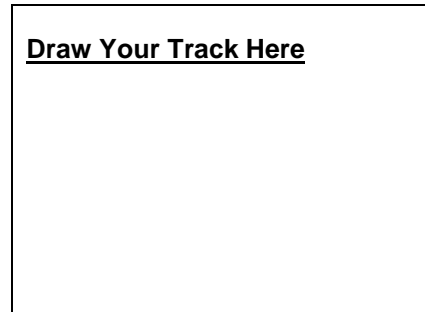
12. Now use the track enhancer  in the top left corner to make more hills in the ride. Grab the center dot and drag it to one end of the track so that a light green dot is touching the track. The light green dots will turn yellow when connected to the track. Release the dot.



13. Change the track so that it has more hills than the W-shape. Remember the skateboarder has to complete the entire track and stay in contact with the track without jumping or falling off. Keep the amount of friction at 25.

Q15. Draw your track shape to the right.

Draw Your Track Here



Q16. How do the height and length of the hills on this track compare to the hills on your W-shape track?



Analysis Questions

Q17. Since friction was involved in this experiment, how might some of the kinetic energy been transformed to another kind of energy? Explain.

Q18. How does the size of the first hill affect the travel of the skateboarder? Why do you think this is so?

Q19. How do these same physics principles apply to a roller coaster?