Power Up! The Physics of Finishing First

Student Activity

Name ______________

Class ______________

Open the TI-Nspire document *Power_Up!.tns.*

Have you ever raced a friend in the pool? What about on a bicycle? Or how about a running race? Have you ever done all three in the same race? If so, then you did a triathlon! A triathlon is a combination race of swimming, biking, and running. There are several types of triathlons based on the distance. In this lesson you will learn about Kelly Kutach who has a master's degree in electrical engineering and is also a triathlete!

Kelly will explain how a good understanding of science and math can help with both engineering and athletics. Specifically, you will learn about the concepts of work, energy, and power as it relates to racing. You will also compete in a virtual triathlon with your classmates! So, stay sharp and pay attention because what you learn in this lesson will help you be more competitive when it is time to race!

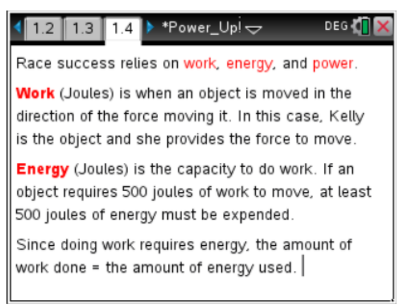
Move to pages 1.2—1.3.

Pages 1.2 and 1.3 explain triathlons and introduce Kelly Kutach. Kelly is an electrical engineer and triathlete.

1. Read through these pages to become familiar with triathlons and Kelly Kutach. Later in this lesson, she will provide clues that can help you compete in your own virtual triathlon!

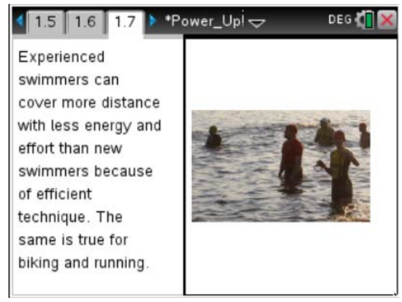
Move to page 1.4—1.6.

2. Pages 1.4 to 1.6 provide definitions of work, energy, and power, as well as the mathematical equations for each topic.



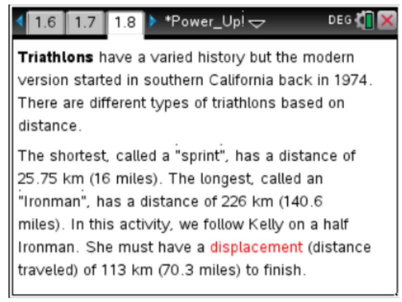
Move to page 1.7.

3. Page 1.7 provides an example of how, in a triathlon, conserving energy and effort with good technique can improve performance.



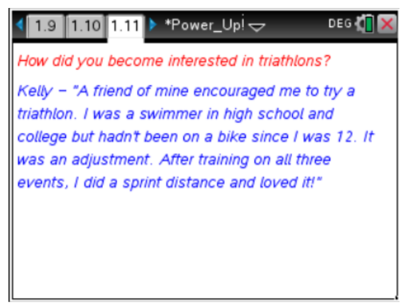
Move to page 1.8.

4. Page 1.8 explains where triathlons came from and the differences in different types. It also introduces the concept of displacement which will be used several times in this activity.



Move to page 1.9--1.14.

5. Pages 1.9 to 1.14 present a conversation with Kelly Kutach about her interest in engineering and triathlons. Pay attention to clues Kelly provides in this discussion in preparation for your virtual triathlon.

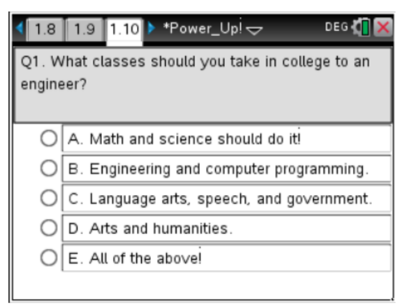


Move to page 1.10.

Answer the question here and/or in the .tns file.

Q1. What classes should you take in college to be an engineer?

A. Math and science should do it!
B. Engineering and computer programming
C. Language arts, speech, and government
D. Arts and humanities
E. All of the above!

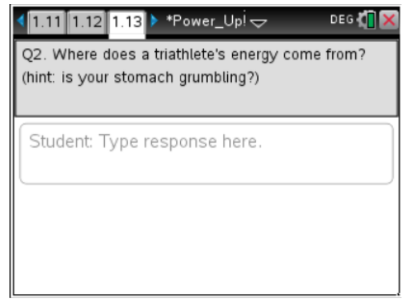


Page 1.13.

Answer the question here and/or in the .tns file.

Q2. Where does a triathlete's energy come from?

(hint: is your stomach grumbling?)



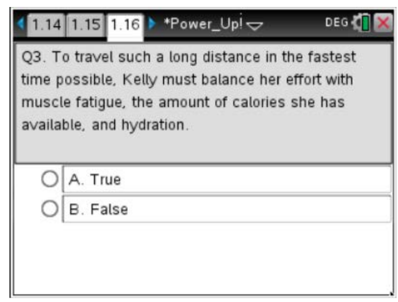
Move to page 1.16.

Answer the question here and/or in the .tns file.

Q3. To travel such a long distance in the fastest time possible, Kelly must balance her effort with muscle fatigue, the amount of calories she has available, and hydration.

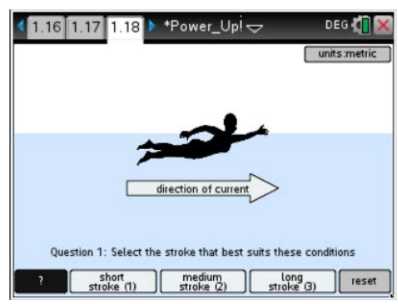
A. True

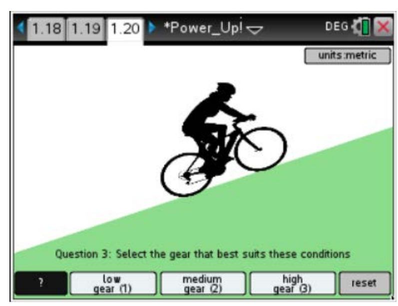
B. False

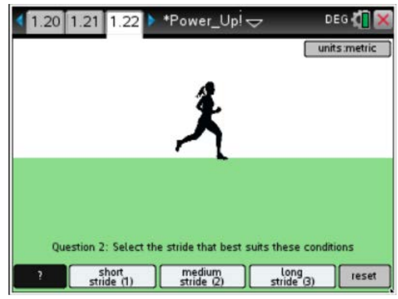


Move to pages 1.16—1.22.

6. Pages 1.16 to 1.22 take you through a virtual triathlon. You must make decisions several times during each of the three legs of the race. Your decisions will save you time or cost you time depending on your choices. At the end, you should compare your times with classmates and discuss why your time was faster or slower.





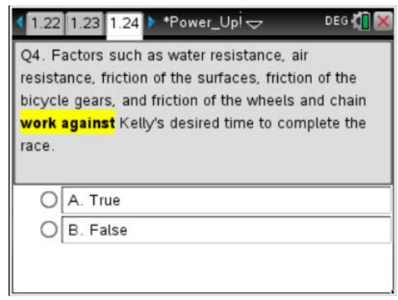


Move to pages 1.24—1.28.

Answer the questions here and/or in the .tns file.

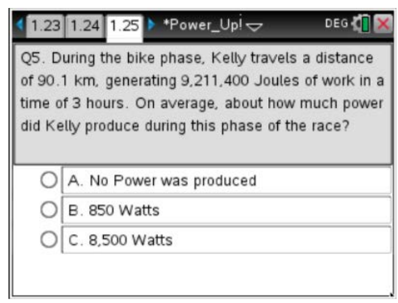
Q4. Factors such as water resistance, air resistance, friction of the surfaces, friction of the bicycle gears, and friction of the wheels and chain work against Kelly's desired time to complete the race.

A. True
B. False



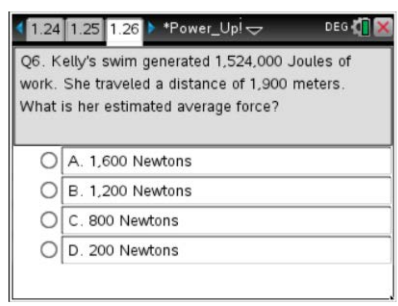
Q5. During the bike phase, Kelly travels a distance of 90.1 km, generating 9,211,400 Joules of work in a time of 3 hours. On average, about how much power did Kelly produce during this phase of the race?

A. No power was produced
B. 850 Watts
C. 8,500 Watts

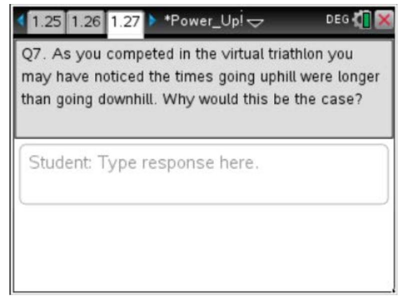


Q6. Kelly's swim generated 1,524,000 Joules of work. She traveled a distance of 1,900 meters. What is her estimated average force (per stroke)?

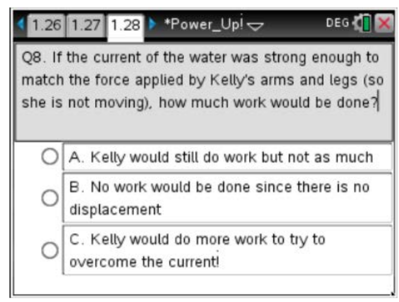
A. 1,600 Newtons
B. 1,200 Newtons
C. 800 Newtons
D. 200 Newtons



Q7. As you competed in the virtual triathlon you might have noticed the times going uphill were longer than going downhill. Why would this be the case?

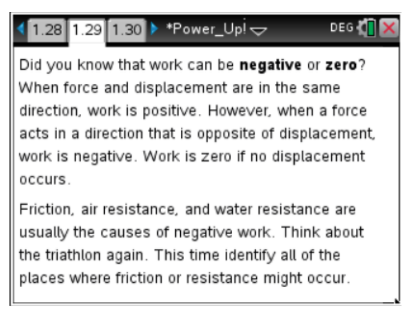


Q8. If the current of the water was strong enough to match the force applied by Kelly's arms and legs (so she is not moving), how much work would be done?



Move to page 1.29.

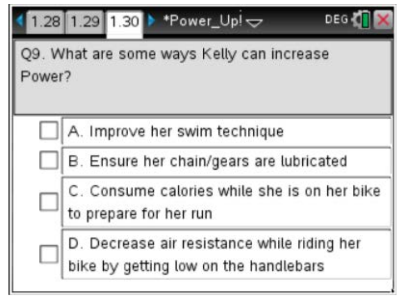
7. Page 1.29 discusses the possibility of work being positive, negative, or zero. Negative work happens when the direction of the force is opposite the direction of the motion.



Move to page 1.30.

Answer questions here and/or in the .tns file.

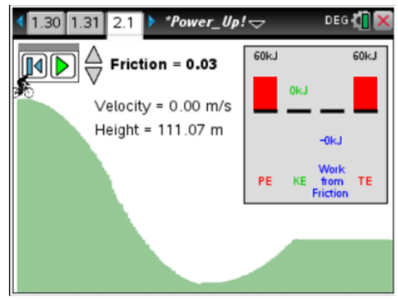
Q9. What are some ways Kelly can increase Power?



A. Improve her swim technique
B. Ensure her chain/gears are lubricated
C. Consume calories while she is on her bike to prepare for her run
D. Decrease air resistance while riding her bike by getting low on the handlebars

Move to pages 1.31—2.1.

8. Pages 1.31 to 2.1 enable students to experiment with changing the friction of Kelly's bike to observe the changes in potential, kinetic, and total energy. They can also see negative work produced which is the work from friction. What are the possible sources of friction within and around Kelly's bike?

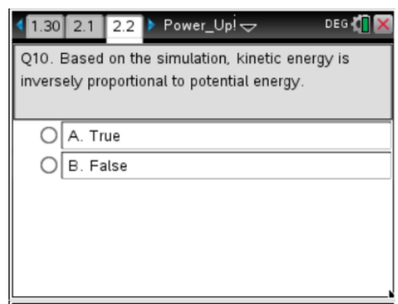


Move to pages 2.2—2.8.

Answer question here or in the .tns file.

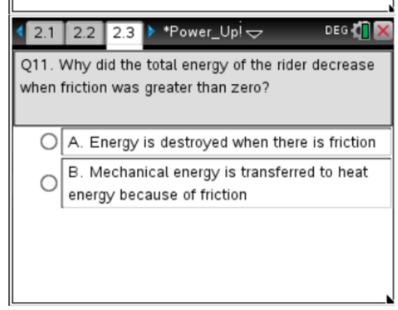
Q10. Based on the simulation, kinetic energy is inversely proportional to potential energy.

A. True
B. False



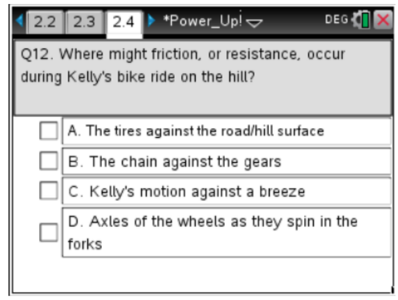
Q11. Why did the total energy of the rider decrease when friction was greater than zero?

A. Energy is destroyed when there is friction
B. Mechanical energy is transferred to heat energy because of friction



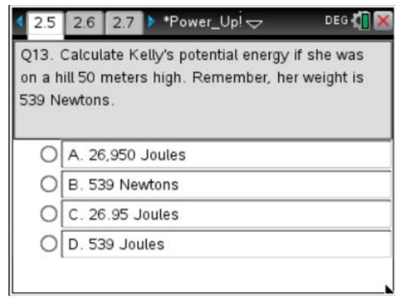
Q12. Where might friction, or resistance, occur during Kelly's bike ride on the hill?

A. The tires against the road/hill surface
B. The chain against the gears
C. Kelly's motion against a breeze
D. Axles of the wheels as they spin in the forks



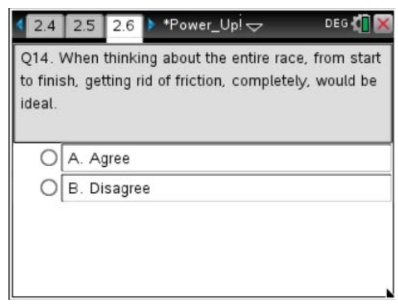
Q13. Calculate Kelly's potential energy if she was on a hill 50 meters high. Remember, her weight is 539 Newtons.

A. 26,950 Joules
B. 539 Newtons
C. 26.95 Joules
D. 539 Joules

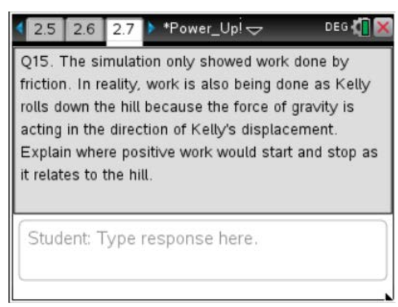


Q14. When thinking about the entire race, from start to finish, getting rid of friction, completely, would be ideal.

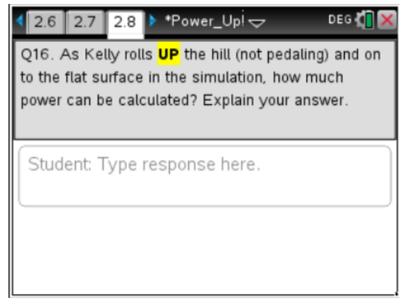
A. Agree
B. Disagree



Q15. The simulation only showed work done by friction. In reality, work is also being done as Kelly rolls down the hill because the force of gravity is acting in the direction of Kelly's displacement. Explain where positive work would start and stop as it relates to the hill.



Q16. As Kelly rolls UP the hill (not pedaling) and on to the flat surface in the simulation, how much power can be calculated? Explain your answer.



Move to page 2.9.

9. Page 2.9 concludes the activity with congratulations to the students and encouragement to try a triathlon!