

8B Efficiency and Energy

Read:

Efficiency describes how well energy is converted from one form into another. A process is 100% efficient if no energy is “lost” due to friction, to create sound, or for other reasons. In reality, no process is 100% efficient.

Efficiency is calculated by dividing the output energy by the input energy. If you multiply the result by 100, you will get efficiency as a percentage. For example, if the answer you get is 0.50, you can multiply by 100 and write your answer as 50%.

$$\text{Efficiency} = \frac{\text{Output energy (J)}}{\text{Input energy (J)}}$$

Example:

You drop a 2-kilogram box from a height of 3 meters. Its speed is 7 m/s when it hits the ground. How efficiently did the potential energy turn into kinetic energy?

Looking for	Solution
You are asked to find the efficiency.	
Given	
The mass is 2 kilograms, the height is 3 meters, and the landing speed is 7 m/s.	
Relationships	
Kinetic energy = $\frac{1}{2}mv^2$	
Potential energy = mgh	
Efficiency = (output energy)/(input energy)	
	$E_p = (2 \text{ kg})(9.8 \text{ m/s}^2)(3 \text{ m}) = 58.8 \text{ J}$ $E_k = (1/2)(2 \text{ kg})(7 \text{ m/s})^2 = 49 \text{ J}$ <p>The input energy is the potential energy, and the output energy is the kinetic energy.</p> $\text{Efficiency} = (49 \text{ J})/(58.8 \text{ J}) = 0.83 \text{ or } 83\%$ <p>The efficiency is 0.83 or 83% (0.83×100).</p>

Practice:

- Engineers who design battery-operated devices such as cell phones and MP3 players try to make them as efficient as possible. An engineer tests a cell phone and finds that the batteries supply 10,000 J of energy to make 5500 J of output energy in the form of sound and light for the screen. How efficient is the phone?

- What's the efficiency of a car that uses 400,000 J of energy from gasoline to make 48,000 J of kinetic energy?

- A 1000-kilogram roller coaster goes down a hill that is 90 meters tall. Its speed at the bottom is 40 m/s.
 - What is the efficiency of the roller coaster? Assume it starts from rest at the top of the hill.

b. What do you think happens to the “lost” energy?

c. Use the concepts of energy and efficiency to explain why the first hill on a roller coaster is the tallest.

4. You see an advertisement for a new free fall ride at an amusement park. The ad says the ride is 50 meters tall and reaches a speed of 28 m/s at the bottom. How efficient is the ride? Hint: You can use any mass you wish because it cancels out.

5. Imagine that you are working as a roller coaster designer. You want to build a record-breaking coaster that goes 70.0 m/s at the bottom of the first hill. You estimate that the efficiency of the tracks and cars you are using is 90.0%. How high must the first hill be?
