Physics 06-03 Mechanical Energy Conservation *Name:* _____

Energy can be _____ from one _____ to _____.

Law of Conservation of Mechanical Energy

$$PE_f + KE_f = PE_0 + KE_0$$

if only _____ and _____ energy

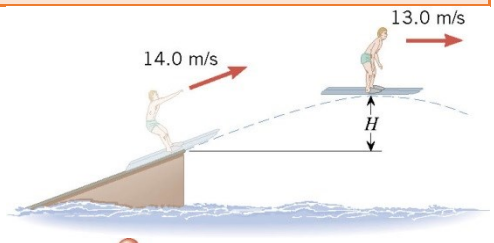
A toy gun uses a spring to shoot plastic balls (m = 50 g). The spring is compressed by 3.0 cm. Let k=2.22 × 10^5 N/m. (a) Of course, you have to do some work on the gun to arm it. How much work do you have to do? (b) Suppose you fire the gun horizontally. How fast does the ball leave the gun? (c) Now suppose you fire the gun straight upwards. How high does the ball go?

A 1500-kg car is driven off a 50-m cliff during a movie stunt. If it was going 20 m/s as it went off the cliff, how fast is it going as it hits the ground?

Practice Work

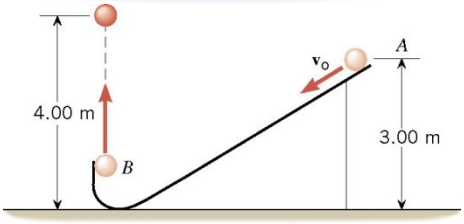
1. Suppose the total mechanical energy of an object is conserved. (a) If the kinetic energy decreases, what must be true about the gravitational potential energy? (b) If the potential energy decreases, what must be true about the kinetic energy? (c) If the kinetic energy does not change, what must be true about the potential energy?
2. A person is riding a Ferris wheel. When the wheel makes one complete turn, is the net work done by the gravitational force positive, negative, or zero? Justify your answer.
3. Ancient Israel used a sling as a weapon. If the 250-g stone were accidentally launched straight up at 25 m/s, how high would it go? (RW) **31.9 m**
4. David used a sling against Goliath. If the 250-g stone were launched at 25 m/s at an angle of 60° above the horizontal, how high would it go? (Hint: At the highest point, the speed is not zero.) (RW)
5. "Rocket man" has a propulsion unit strapped to his back. He starts from rest on the ground, fires the unit, and is propelled straight upward. At a height of 16 m, his speed is 5.0 m/s. His mass, including the propulsion unit, is about 136 kg. Find the work done by the force generated by the propulsion unit. (Cutnell 6.31) $\mathbf{2.3 \times 10^4}$ **J**
6. Suppose a 350-g kookaburra (a large kingfisher bird) picks up a 75-g snake and raises it 2.5 m from the ground to a branch. (a) How much work did the bird do on the snake? (b) How much work did it do to raise its own center of mass to the branch? (OpenStax 7.18) **1.8 J, 8.6 J**

7. A water-skier lets go of the tow rope upon leaving the end of a jump ramp at a speed of 14.0 m/s. As the drawing indicates, the skier has a speed of 13.0 m/s at the highest point of the jump. Ignoring air resistance, determine the skier's height H above the top of the ramp at the highest point. (Cutnell 6.34) **1.4 m**



8. A particle, starting from point A in the drawing, is shot down the curved runway. Upon leaving the runway at point B, the particle is traveling straight upward and reaches a height of 4.00 m above the floor before falling back down. Ignoring friction and air resistance, find the speed of the particle at point A. (Cutnell 6.38) **4.43 m/s**

9. A 100-g toy car is propelled by a compressed spring that starts it moving. The car follows the curved track. Show that the final speed of the toy car is 0.687 m/s if its initial speed is 2.00 m/s and it coasts up the frictionless slope, gaining 0.180 m in altitude. (OpenStax 7.20) **0.687 m/s**



10. A 5.00×10^5-kg subway train is brought to a stop from a speed of 0.500 m/s in 0.400 m by a large spring bumper at the end of its track. What is the force constant *k* of the spring? (OpenStax 7.22) **7.81×10^5 N/m**

11. A pogo stick has a spring with a force constant of 2.50×10^4 N/m, which can be compressed 12.0 cm. To what maximum height can a child jump on the stick using only the energy in the spring, if the child and stick have a total mass of 40.0 kg? (OpenStax 7.23) **0.459 m**

12. A water slide is constructed so that swimmers, starting from rest at the top of the slide, leave the end of the slide traveling horizontally. As the drawing shows, one person hits the water 5.00 m from the end of the slide in a time of 0.500 s after leaving the slide. Ignoring friction and air resistance, find the height H in the drawing. (Hint: Start by using projectile motion to find the speed when the person hits the water, then use conservation of mechanical energy to find the height.) (Cutnell 6.41) **6.33 m**