Physics 03-02 Potential Energy and Conservative Forces *Name:* _____

Potential Energy

Energy due to _____

Gravitational potential energy

$$PE_g = mgh$$

Since the force of gravity is _____ and the displacement and force must be in same _____, we only worry about the _____ distance

The _____ the object takes doesn't matter, just the _____ _____

Potential Energy is not _____; it is a _____

h is measured from _____ point. Just be _____.

Spring potential energy

$$PE_s = \frac{1}{2}kx^2$$

Conservative Forces

A force where the _____ it does is _____ of the path

Only thing that matters is _____ and _____ point

Energy can be _____ from one _____ to _____.

Law of Conservation of Mechanical Energy

$$PE_f + KE_f = PE_0 + KE_0$$

if only _____ forces do net work

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?

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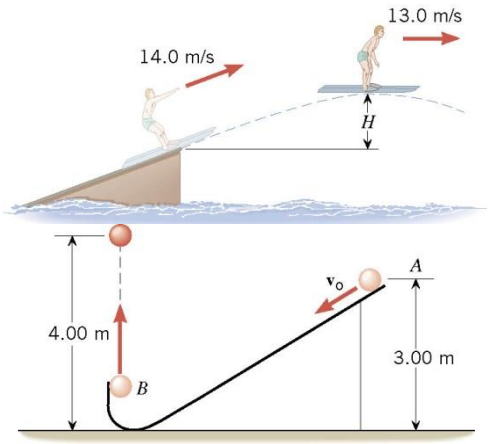
Homework

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. Does the work you do on a book when you lift it onto a shelf depend on the path taken? On the time taken? On the height of the shelf? On the mass of the book?
4. What is a conservative force?
5. Relative to the ground, what is the gravitational potential energy of a 55.0-kg person who is at the top of the Sears Tower, a height of 443 m above the ground? (Cutnell 6.27) $\mathbf{2.39 \times 10^5\ J}$
6. A hydroelectric power facility converts the gravitational potential energy of water behind a dam to electric energy. What is the gravitational potential energy relative to the generators of a lake of volume 50.0 km^3 (mass = 5.00×10^{13} kg), given that the lake has an average height of 40.0 m above the generators? (OpenStax 7.16) $\mathbf{1.96 \times 10^{16}\ J}$
7. A 75.0-kg skier rides a 2830-m-long lift to the top of a mountain. The lift makes an angle of 14.6° with the horizontal. What is the change in the skier's gravitational potential energy? (Cutnell 6.29) $\mathbf{5.24 \times 10^5\ J}$
8. "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) $\mathbf{2.3 \times 10^4\ J}$
9. 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**
10. 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**



11. 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**

12. 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**
13. 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) $\mathbf{7.81 \times 10^5\ N/m}$
14. 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**
15. 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**