AP Physics 1

4.3 – Work and Gravitational and Elastic Potential Energies

4.4 – Conservative and Nonconservative Forces and the Conservation of Mechanical Energy

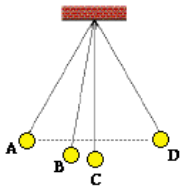
Assessment

"*Conserve* your *energy* wisely when *working* on these – show me your *potential* as a physicist!" (Four puns in one!)

Name: _____ Period: _____

Concepts

1) A person is standing next to her suitcase at an airport. Describe two instances in how she can do work on the suitcase.
2) Consider the motion of the pendulum shown below. At every point A) – D), qualitatively compare the amount of kinetic and potential energy. You may assume friction of the cable and air resistance are negligible.



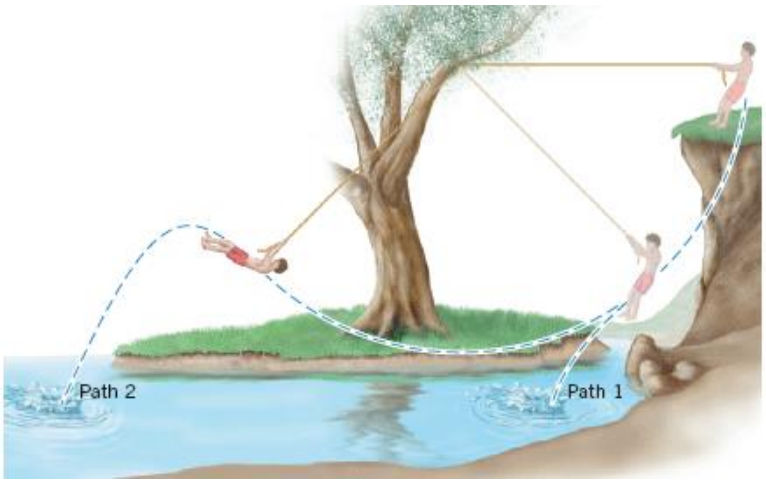
3) You are now told that the pendulum bob (above) has a potential energy of 2.4 J at position A and a kinetic energy of 2.0 J at position B. For every point A) – D), quantitatively find the potential energy and kinetic energy.
4) Consider the following statements. Which statement describes an external force doing negative work on the system (the person is not part of the system)?
    a. A person slowly lifts a box from the floor to a tabletop.
    b. A person slowly lowers a box from a tabletop to the floor.
    c. A person carries a box horizontally some distance s.
    d. A person holds a box while standing still.
5) Is energy a physical phenomenon, a model, or a physical quantity? Explain your answer.

Problems

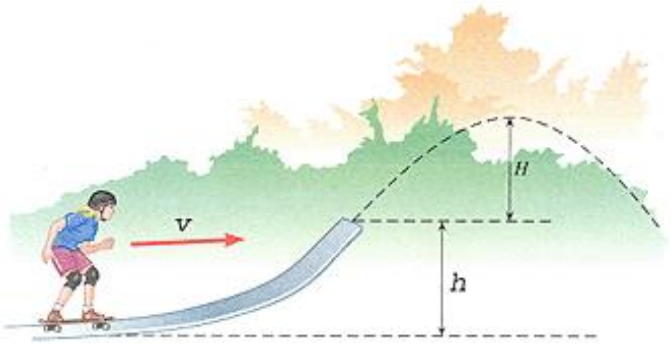
6) When an 81 kg adult uses a spiral staircase to climb to the second floor of his house, his gravitational energy increases by 2.00×10^3 J. By how much does the potential energy of an 18.0 kg child increase when the child climbs a normal staircase to the second floor?
7) Juggles and Bangles are clowns (why not?). Juggles stands on one end of a teeter-totter at rest on the ground. Bangles jumps off a platform 2.5 m above the ground and lands on the other side of the teeter-totter, launching Juggles into the air. Juggles rises to a height of 3.3 m above the ground, at which point he has the same amount of gravitational potential energy as Bangles did before he jumped, assuming both potential energies are measured from the ground. If Bangle's mass is 86 kg, what is Juggle's mass?
8) A bicyclist rides 5.0 km due east, while the resistive force from the air has a magnitude of 3.0 N and points due west. The rider then turns around and rides 5.0 km due west, back to her starting point. The resistive force from the air on the return trip has a magnitude of 3.0 N and points due east.
    a. Find the work done by the resistive force during the round trip.
    b. Based on your answer to (a), is the resistive force a conservative force? Explain.

9) A shot-putter puts a shot (weight = 71.1 N) that leaves his hand at a distance of 1.52 m above the ground.
    a. Find the work done by the gravitational force when the shot has risen to a height of 2.13 m above the ground (watch your sign!).
    b. Determine the change in the gravitational potential energy of the shot.
10) A 0.60 kg basketball is dropped out of a window that is 6.1 m above the ground. The ball is caught by someone whose hands are 1.5 m above the ground.
    a. How much work is done on the ball by its weight?

    What is the gravitational potential energy of the basketball, relative to the ground, when it is
    b. released, and
    c. caught?
    d. How is the change in the ball's gravitational energy related to the work done by its weight?
11) A 55.0 kg skateboarder starts out with a speed of 1.80 m/s. He does +80 J of work on himself by pushing with his feet against the ground. In addition, friction does -265 J of work on him. In both cases, the forces doing the work are nonconservative. The final speed of the skateboarder is 6.00 m/s.
    a. Calculate the change in the gravitational potential energy.
    b. How much has the vertical height of the skater changed (skater above or below the starting point)?
12) A 35 kg girl is bouncing on a trampoline. During a certain interval after she leaves the surface of the trampoline, her kinetic energy decreases to 210 J from 440 J. Neglecting air resistance, how high does she rise during this interval?
13) A slingshot fires a pebble from the top of a building at a speed of 14.0 m/s. The building is 31.0 m tall. Ignoring air resistance, find the speed with which the pebble strikes the ground when the pebble is fired
    a. horizontally.
    b. vertically, straight up, and
    c. vertically, straight down.
14) The drawing shows a person who, starting from rest at the top of a cliff, swings down at the end of a rope, releases, and then falls into the water. There are two paths by which a person can enter the water. Suppose he enters the water at a speed of 13.0 m/s via Path 1. How fast would he be moving on Path 2 where he would release the rope at a height of 5.20 m above the water? You may ignore air resistance.



15) The drawing shows a skateboarder moving at 5.4 m/s along a horizontal section of a track that is slanted upward by 48° above the ground at the end, which is h = 0.40 m high. When she leaves the track, she follows characteristic projectile motion. Ignoring friction and air resistance, find the maximum height H to which she rises above the end of the track.



16) A surfer is "catching a wave!" Suppose he starts at the top of the wave with a speed of 1.4 m/s and moves down the wave until his speed increases to 9.5 m/s. The drop in his vertical height is 2.7 m. If his mass is 59 kg, how much work is done by the (nonconservative) force of the wave?

17) A student, starting from rest, slides down a water slide. On the way down, the kinetic frictional force acts on her. The student has a mass of 83.0 kg, and the height of the water slide is 11.8 m. If the kinetic frictional force that is acting on her does -6.50×10^3 J of work, how fast is she going at the bottom of the slide?

18) A 63 kg skier coasts up a snow-covered hill that makes an angle of 25° with the horizontal. The initial speed of the skier is 6.6 m/s. After coasting 1.9 m up the slope, the skier has a speed of 4.4 m/s.
    a. Find the work done by the kinetic frictional force that acts on the skis.
    b. What is the magnitude of the kinetic frictional force?

19) A pitcher throws a 0.140 kg baseball, and it approaches the bat at a speed of 40.0 m/s. The bat does W_{nc} = 70.0 J of work on the ball in hitting it. Ignoring air resistance, determine the speed of the ball after the ball leaves the bat and is 25.0 m above the point of impact.