Physics 112

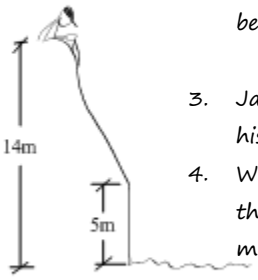
Assignment # 8 – Conservation of Mechanical Energy

Due Friday, January 12th, 2018

1. If you neglect friction, the total mechanical energy at the top of a hill is _____as the total mechanical energy at the bottom of a hill.
   a) same b) half as much c) twice as much d) none of the previous
2. A moving cart hits a large spring and is brought to a stop. Upon hitting the spring all kinetic_energy is changed to _ _____energy.
   a) gravitational potential b) elastic potential c) kinetic d) none of the previous
3. A sled sits at rest at the top of hill. If the mass of the sled is doubled the velocity at the bottom is _____ as it would have been with the initial mass. (Neglect friction)
   a) the same b) half as much c) twice as much d) none of the previous
4. A simple pendulum, consisting of a mass m, is attached to the end of a 1.5m length of string. If the mass is held out horizontally, and then released from rest, its speed at the bottom is:
   a) 4.4m/s b) 5.4m/s c) 9.8m/s d) 17m/s
5. The difference between the initial energy in a system and the final energy in a system is equal to_____? (System includes friction)
   a) potential energy b) elastic energy c) kinetic energy d) work
6. A 6kg mass is moving with a speed of 2m/s, and a 3kg mass is moving with a speed of 4m/s. Both masses are moving over a frictionless surface when they encounter the ***same horizontal force*** that acts to slow them down and are brought to rest. Which statement best describes their respective stopping distance?
   a) The 6kg mass travels twice as far b) The 3kg mass travels twice as far
   c) Both masses travel the same distance d) The 3kg mass travels more than twice as far
7. A sled sits at rest at the top of hill. If the height of the hill is doubled the velocity at the bottom is _____as it was the initial time. (Neglect friction)
   a) the same b) two times as much c) four as times as much d) none of the previous

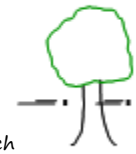
Problems (Show your work & Include sketches) Solve using Conservation of Energy principles.

1. What is the kinetic energy of an electron, mass 9.10×10^{-28} g, moving at a speed of 4.00×10^{9} cm/s?
2. A worker lifts a large bag from the ground to a second level in a storage building using a rope. The bag has a mass of 50 kg and the second level is 10.5 m high.
   a) How much work is done to lift the bag to the second level?
   b) If the rope is released when the bag is level with the second floor how fast will the bag be going when just before it hits the ground?



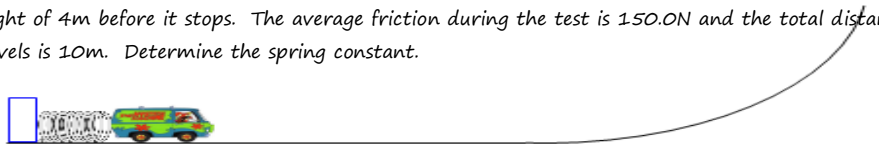
3. James is skiing. He has a mass of 80.0 kg and goes down a slope starting from rest. Ignoring friction, if his speed is 25.0 m/s at the bottom, then from what height did he start on the slope?
4. William is sliding down a bank on his backside and the work done by friction is 2400J. At the bottom of the bank he drops into a river that is 5m below. The bank is 14m high (above the water) and he has a mass of 80kg, determine his speed a) At the bottom of the sloped section b) when he hits the water.
5. Two women set out to climb the summit of a 3mile high mountain, starting from sea level. One of them sets out along a slope that averages 30.0° above the horizontal, the other along a slope that averages 40.0° above the horizontal. Each woman has a mass of 70.0 kg but the woman on the 40.0° slope carries a 10.0 kg knapsack. Find the work done by each of them.

Practice Problems



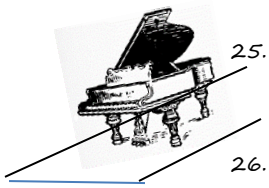
1. A car spring has a spring constant of 750 N/m. a) What weight will compress the spring 30cm? b) How much energy is stored in the spring?
2. A 45g bullet is travelling at 450m/s when it hits a tree. The bullet leaves the other side of the tree at 350m/s. How much work is done by the tree to slow the bullet down?
3. How much work is done by a boy weighing 800 N in climbing 6.0 m up a rope in the school gymnasium?**(4.8×10^3 J)**
4. A 60.0 kg boy lifts himself on a chinning bar a distance of 30.0 cm. (a) What force must he exert to lift himself? (b) How much work does he do? **(5.88×10^2 N, 1.76×10^2 J)**
5. The third floor of a house is 8.0 m above street level. How much work is required to move a 100 kg refrigerator up to third floor? **(7.8 kJ)**
6. Donella throws a 100g ball in the air with a velocity of 20 m/s from an initial height of 1m. Using conservation of energy and neglecting friction:
   a) Find the velocity of the ball when it is 8 m in the air. **(16.2m/s)**
   b) Find the maximum height of the ball. **(20.4m)**
   c) Find the velocity of the ball when it returns to her. **(20m/s)**
7. Franklin jumps off of a 5m tall building onto a trampoline that is 1.8m high. a) If the spring constant is 5000N/m determine the spring extension. b) After he bounces off the trampoline he reaches a height of 4m. How much energy is lost during the bounce? (His mass is 50kg) **(0.896m,490J)**
8. Hermie, mass of 65kg, is at the top of a 6m tall tree when he falls. If he hit the ground at 4.5m/s, how much work did the tree branches do to slow him down? **(-3163.88J)**

9. A 50 kg mass is raised by a machine to a height of 20 m. (a) Calculate the work output of the machine. (b) If the machine is only 78% efficient, calculate the work input of the machine. **(9.8kJ, 12.6 kJ)**
10. How much work does a 400 watt motor do in 5.0 min? **(1.2×10^5 J)**
11. A pump raises 30 liters of water per minute from a depth of 100 m. What is the power of the pump? (1 liter mass is 1 kg) **(4.9×10^2 W)**
12. A horizontal force of 800 N is needed to drag a crate across a horizontal floor. (a)How much work is done in dragging the crate 22 m? (b) If the job is done in 8.0 sec., what is the power? **(1.8×10^4 J, 2.2kW)**
13. A boats engine propels it through water at a steady rate of 15 m/s. The force of friction the boat must overcome to maintain this speed is 6000 N. a) What is the power of the engine in kilowatts? b) Horsepower? **(90 kW, 120hp)**
14. A gardener pushes a lawnmower 40.0m across a level lawn with a horizontal force of 100 N. How much work is done in moving the lawnmower?**(4kJ)**
15. A gardener pushes a lawnmower across a level lawn with a horizontal force of 120 N. If the width of the lawnmower is 60 cm and the dimensions of the lawn are 10.0 m by 15.0 m, how much work does the gardener do? **(30 kJ)**
16. How long would it take a 500 watt motor to raise the 1000 N hammer of a pile driver 20 m?**(40 s)**
17. A 2000kg car moves up a hill at 12 m/s. The hill is 400 m long and 25 m high. (a) What work does the car's engine do in getting the car up the hill? (b) How long does it take? (c) What power does the engine use?**(4.9×10^5 J,32sec,1.5×10^4 W)**
18. Shaggy and Velma are doing some experimenting with the Mystery Machine. They have built a scale model that has a mass of 200kg and have set up a system as shown below. The Mystery Machine is set up against the spring when it is compressed 60cm. Once the spring is released the Mystery Machine travels along the flat part and goes up the ramp to a maximum height of 4m before it stops. The average friction during the test is 150.0N and the total distance the Mystery Machine travels is 10m. Determine the spring constant.



19. A 1500kg car accelerates from 72km/h to 90km/h in 2.5 seconds. What is the car's power? **(6.8×10^1kW)**
20. Sylvia's car's engine can supply a force of 2500N while accelerating. If she accelerated for 50m and the car has a mass of 1500kg what is her velocity going to be if she starts accelerating from 36km/h? From what height would you have to drop a compact car to have the same energy as it would have travelling at 100km/h? **(31.89)**
21. A car spring has a spring constant of 750 N/m. What weight will compress the spring 30cm? **(225N)**
22. How much energy is stored in the spring in question 16? **(10.13J)**
23. An 100.0 kg man skis down a slope starting from rest. Ignoring friction, if the speed of the man is 25.0 m/s then from what height did the man start on the slope? **(31.89m)**
24. A bumper car with a mass of 200 kg runs into the wall at 10m/s. a) If the rubber bumper compresses 10 cm what is the spring constant of the bumper. Neglect frictional forces. b) How fast will the bumper car be travelling when it bounces off the wall? **(1MN/m, 10m/s)**

25. Brett is on his GT snowracer at the top of a hill that is 5m tall. He has a weight of 140lbs and travels down the hill. You can assume that the hill is essentially frictionless. Once he hits the bottom he is crossing a road that is 6m wide. The coefficient of friction is 0.4 a) Determine his velocity at the bottom of the hill. b) Determine his velocity on the other side of the road. **(9.9 m/s, 7.27m/s)**
26. Sally's car's engine can supply a force of 2100N while accelerating. If she accelerated for 50m and the car has a mass of 1200kg what is her velocity going to be if she starts accelerating from 50km/h? **(69km/h)**
27. Donella throws a 100g ball in the air with a velocity of 20 m/s from an initial height of 1m. Neglecting friction:
    a. Find the velocity of the ball when it is 8 m in the air.
    b. Find the maximum height of the ball.
    c. Find the velocity of the ball when it returns to her.



25. A piano weighing 1500 N is pushed up a ramp that has an angle of 30° and is 4m long. (a) What is the work output? (b) Assuming that the efficiency of the plane is 70%, what would the work input be?

26. Calculate the hp of a motor that does 11250 J of work in 25 seconds. What is the work input if the efficiency is 60%?