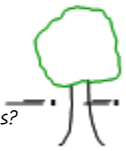
Physics 111

Assignment # 8 – Work, Energy, Power and Efficiency
Due Friday, January 12th, 2018

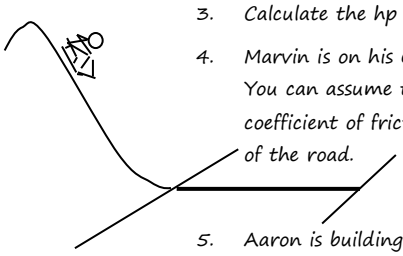
Multiple Choice

1. 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
2. If you neglect friction, the energy at the top of a hill is _____as the energy at the bottom of a hill.
   a) same b) half as much c) twice as much d) none of the previous
3. 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
4. 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
5. 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 surface with friction and are brought to a stop by the friction. 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
6. A sled sits at rest at the top of hill. If the mass of the sled is doubled the velocity at the bottom is _____. times as much. (Neglect friction)
   a) same b) half as much c) twice as much d) none of the previous
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 _____. times as much. (Neglect friction)
   a) same b) two c) four d) none of the previous
8. The kinetic energy of an electron, mass 9.10×10^{-28} g, moving at a speed of 4.00×10^{9} cm/s is:
   a) 7.28×10^{-13}J b) 7.28×10^{-16}J c) 1.82×10^{-20}J d) 1.82×10^{-23}J
9. 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

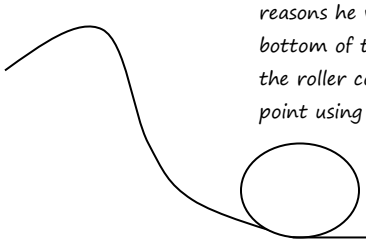
Problems (Show your work, no marks will be given for the answer only)(Include sketches)



1. A 45g bullet is travelling at 250m/s when it hits a tree. The bullet leaves the other side of the tree at 150m/s. How much work is done by the tree to slow the bullet down? What is the force of friction if the tree has a radius of 8 inches?
2. Two men 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 man has a mass of 100.0 kg and carries a 10.0 kg knapsack. Find the work done by each of them.
3. Calculate the hp of a motor that does 11250 J of work in 25 seconds.



4. Marvin is on his GT Snowracer at the top of a hill that is 5m tall. He has a weight of 132lbs 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 0.3 a) Determine his velocity at the bottom of the hill. b) Determine his velocity on the other side of the road.
5. Aaron is building a roller coaster for his amusement (park) on the **Moon**. His roller coaster cars have a total mass of *M* metric and they will start off at a yet to be determined height. He wants to design it with a complete loop. For safety reasons he wants the velocity at the top of the loop to be at least *v*. The radius of the hoop is designed to be *r* with the bottom of the hoop at ground level. He has determined that the average force of friction is *F* and the length of track the roller coaster covers from the start to the top of the loop is *l*. Create and expression for the height of the starting point using the variables provided.



Practice Problems

1. 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)**

2. 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)**

3. A piano weighing 1500 N is pushed up an incline plane 3.00 m long and 1.20 m high. (a) What is the work output? (b) Assuming that the efficiency of the plane is 70%, what would the work input be?

4. 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)**

4. 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)**

5. 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)**

6. How much work does a 400 watt motor do in 5.0 min? **(1.2×10^5 J)**

7. 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)**

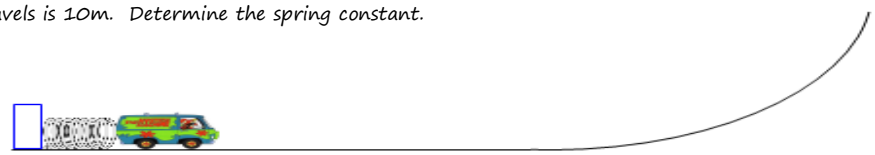
8. A horizontal force of 800 N is needed to drag a crate across a horizontal floor. (a)How much work is done in dragging the crate 22 m? (b) If the job is done in 8.0 sec., what is the power? **(1.8×10^4 J, 2.2kW)**

9. 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)**

10. 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)**

11. 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)**

12. 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.



13. How long would it take a 500 watt motor to raise the 1000 N hammer of a pile driver 20 m?**(40 s)**

14. 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)**

15. A 1500kg car accelerates from 72km/h to 90km/h in 2.5 seconds. What is the car's power? **(6.8×10^1kW)**
16. 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)**

17. A car spring has a spring constant of 750 N/m. What weight will compress the spring 30cm? **(225N)**
18. How much energy is stored in the spring in question 17? **(10.13J)**
19. 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)**
20. 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)**
21. 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)**
22. 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)**
23. 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)**
24. 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. **(9.9m/s, 7.27m/s)**
25. American Federal Statute requires a car's bumper be designed to withstand a 2.50mph collision with an immovable object without damage to the body of the car. The bumper cushions the shock by absorbing the force over a distance. Calculate the average force on a bumper that collapses 0.20m while bringing a 900kg car to rest from an initial speed of 2.50mph. **(2.82×10^3N)**
26. William is sliding down a bank on his backside. At the bottom of the bank he drops into a river that is 5m below. The bank is 14m high and he has a mass of 120kg. If the work done by friction is 3000J, determine his speed when he hits the water.