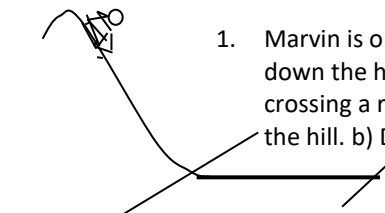


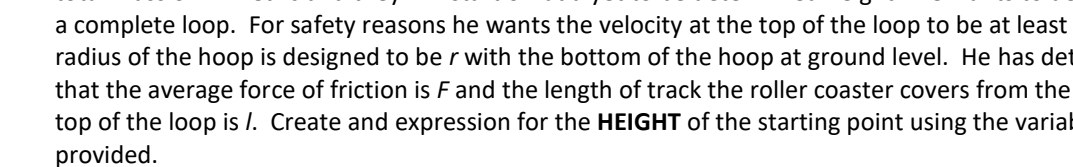
## Physics 111

Assignment # 4 – Work, Energy, Power and Efficiency

Due Friday, May 10<sup>th</sup>, 2019

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

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1. 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.

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2. 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 an expression for the **HEIGHT** of the starting point using the variables provided.

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. A pump raises 30 liters of water per minute from a depth of 100 m. What is the power of the pump in hp? If its efficiency is 50% what is the electrical energy that is used by the pump? (1 liter mass is 1 kg) (**4.9 x 10<sup>2</sup> W**)
5. Phineas is conducting some home experimentation. He is dropping large 10kg balls onto a trampoline that is 1m tall and has a spring constant of 2kN/m. How far does the trampoline stretch if he drops it from a height of 5m?
6. 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.

Multiple Choice (Do the questions online)

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?



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?( **$4.9 \times 10^5 \text{ J}, 32 \text{ sec}, 1.5 \times 10^4 \text{ W}$** )
15. A 1500kg car accelerates from 72km/h to 90km/h in 2.5 seconds. What is the car's power? ( **$6.8 \times 10^1 \text{ kW}$** )
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. ( **$2.82 \times 10^3 \text{ N}$** )
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.

