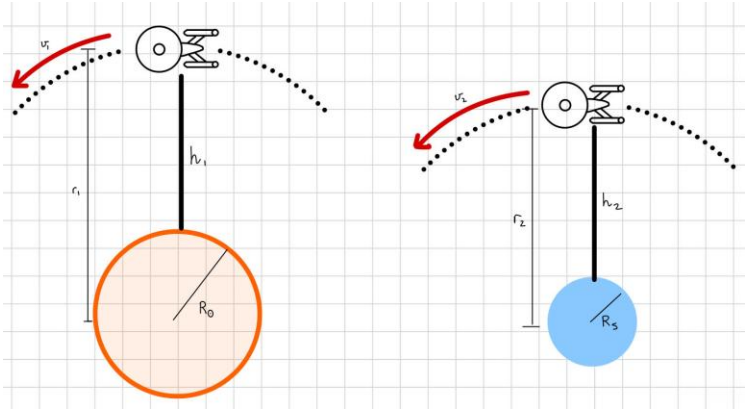
Name: _____

HW 5: Chapter 5

1. The Neutron Star vs. Jean Luc Picard

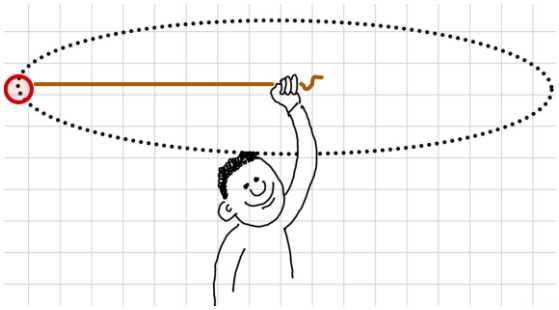
The starship Enterprise, under the command of Jean Luc Picard, orbits the Sun at $r_1 = 1.50 \times 10^{11}\ m$ with an orbital speed $v_1 = 29{,}800\ m/s$. Suddenly a Borg ship arrives and tests a new weapon on the Sun, turning it into a neutron star with the same mass. The Enterprise is forced into a new circular orbit just $30\ km$ from the neutron star's center.



Find the new orbital speed v_2, and determine how many times faster it is than the original v_1.

2. Gus and Goliath

Gus mistakes a tree that is 35 m away for a Giant and decides to use his sling to save his neighborhood. The sling is $0.80\ m$ long and just before release the rock is moving with a



constant angular speed of $50\ rad/s$. The rock is released $2\ m$ above the ground and its initial velocity is completely horizontal.

(a). Find the angular speed of the rock before it is released.

(b). What is the centripetal acceleration of the rock before it is released?

(c). How long does it take for the rock to hit the ground after it is released?

(d). Does the rock hit the tree?

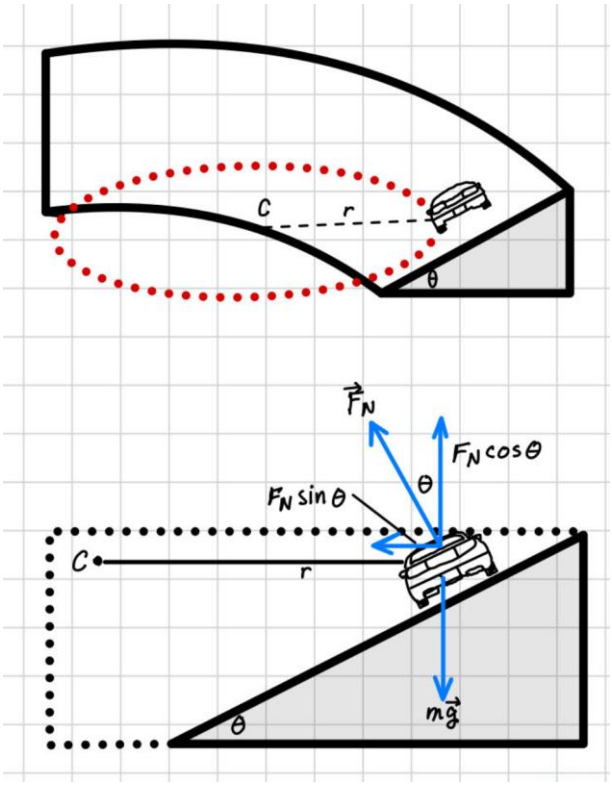
3. Safety is Priority #1

A highway engineer is designing a frictionless banked curve for a high-speed exit ramp. The curve has a radius of $r = 120\ m$, and cars are expected to travel safely through it at $v = 28\ m/s$ without relying on friction.

(a). What should the angle θ of the road be so that a car can make the turn in uniform circular motion without sliding?

(b). What would happen if the car tried to go around this same banked curve:

- $v < 28\ m/s$
- $v > 28\ m/s$



4. The Amazing Gunjito

The Amazing Gunjito is an Orangutan in Borneo who frequently swings from a rope near popular tourist paths with his hand outstretched, demanding peanuts. Gunjito has a mass of 75 kg and swings from a rope that is 7m long. He passes through the lowest point at 3.0 m/s.

(a) Draw a free body diagram, assume uniform circular motion, and find the tension in the rope when Gunjito is at the lowest point.

(b) In part (a) you calculated the tension in the rope at the bottom of Gunjito's swing. Suppose we now want to calculate the tension at a different point in the swing, such as when the rope makes a 45-degree angle with the vertical. Would the same approach from part (a) still apply? Why or why not?