Fall 2015 Physics 7A Lec 002 (Yildiz) Midterm I

(Note: Take Earth's gravitational acceleration g = 10 m/s^2 when you need to make numerical calculations).

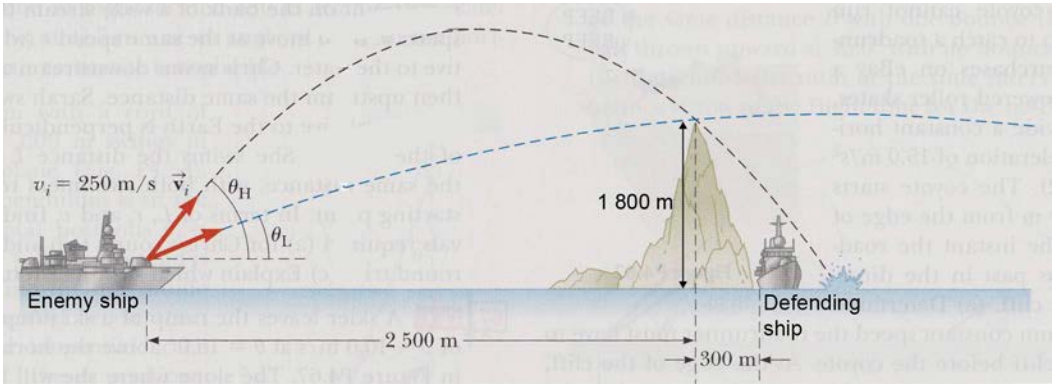
1. (15 points) An astronaut on PLANET OSKI is standing on a cliff of unknown height *H*. The astronaut would like to ascertain the gravitational acceleration g_o of PLANET OSKI. In order to determine *H* and g_o, the astronaut performs two experiments:

   (i) First she leans over the edge of the cliff and drops a rock. She notes that it takes approximately T_1 = 2.0 s for the rock to land on the surface below.

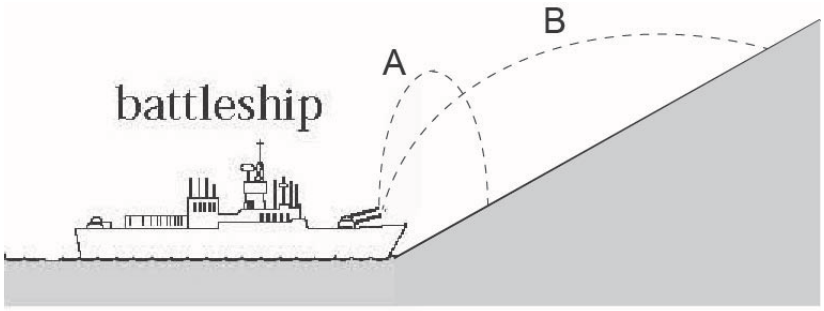
   (ii) Next she leans over the edge of the cliff and tosses a second rock straight upwards. The rock rises for approximately h = 1.0 m, then falls to the ground below. A time T_2 = 2.4 s elapses between the moment the rock leaves her hand and the moment the rock strikes the ground.

   Find *H* and g_o. (Assume that air resistance is negligible.)

2. (15 points) A defending ship is on the east side of the mountain island as shown in the figure below. The enemy ship has maneuvered to within 2,500 m of the 1,800 m high mountain peak and can shoot the projectiles with an initial speed of 250 m/s. If the eastern shoreline is horizontally 300 m from the peak, what are the distances from the eastern shore at which the defending ship can be safe from the bombardment of the enemy ship.

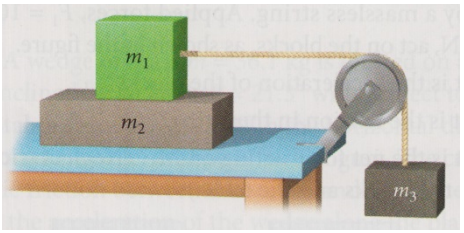


3. (10 points) A battleship simultaneously fires two shells to a rising hill. The hill height is a simple linear function of the distance from its base. If the shells follow the parabolic trajectories shown (the diagram is drawn accurately with respect to the heights/initial angle of the trajectories) which shell hits the ground first? Explain your reasoning.



4. (20 points) Three objects with masses m_1 = 40 kg, m_2 20 kg and m_3 12 kg are hanging from ropes that run over the pulleys. What is the acceleration of m_1.

5. (20 points) As shown in the figure, two masses, m_1 = 4 kg and m_2 = 6 kg, are on a frictionless tabletop and mass m_3 = 8 kg is hanging from m_1. The coefficients of static and kinetic friction between m_1 and m_2 are 0.6 and 0.5, respectively.
   a) What are the accelerations of m_1 and m_2?
   b) What is the tension on the string between m_1 and m_3?



6. (20 points) A car of weight W = 10,000 N makes a turn on a track that is banked at an angle of θ = 30˚. Inside the car, hanging from a short string tied to the rear-view mirror, is an ornament. As the car turns, the ornament swings out at an angle of φ = 45˚. What is the force of static friction between the car and the road?