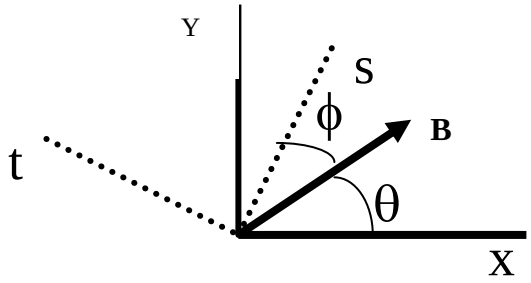
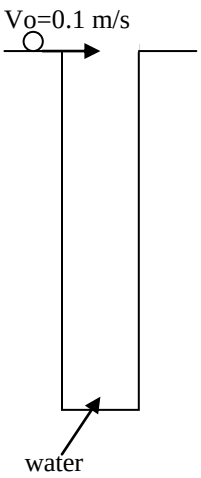
Physics 113 - Fall 2013 - workshop module 2
Vectors and multidimensional kinematics

1. Consider the vector B, drawn below on two different sets of coordinates. Find the x and y components of B in terms of theta. Find the s and t components of B in terms of phi. How many ways can you express B in terms of unit vectors?



2. A player kicks a football at an angle of 40 degrees above the horizontal with an initial speed of 14 m/s. Air resistance may be ignored. A second player standing at a distance of 26 m from the first (in the direction of the kick) starts running to meet the ball at the instant it is kicked. How fast must the second player run in order to catch the ball just before it hits the ground? How would this answer change if the football game took place on the moon? (Assume "g" on the moon is 1/6 that on the surface of the earth. Can you calculate that on your own?)

3. In a fit of frustration Eggburt Lowder decided that his newly developed skill at beer pong was not going to help him solve projectile problems. So, he prayed for a while and then walked to a nearby wishing well. Eggburt dropped several coins down the well and wished to do well on his physics exams. Suddenly, in a fit of physics euphoria he decided to use his physics knowledge to determine the depth of the well.



Eggburt dropped a coin into the well and determined the depth of the well from the time between the release of the coin and hearing the splash of the coin in the water at the bottom. (Here "depth" is defined as the distance from the lip of the well to the top of the water surface at the bottom of the well.) He measures a time difference of 2.5 s.

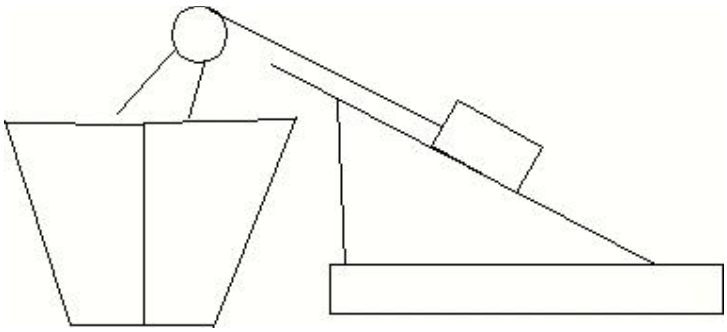
What is the depth of the well? (Assume the speed of sound in air is a constant 340 m/s.)

Next Eggburt slides the coin off the side of the well with a horizontal velocity of 0.1 m/s. In this case, what time difference does he measure between the release of the coin and hearing the sound of the splash at the bottom of the well? Assume the well is wide enough that the coin does not hit the side of the well as it descends.

4. A dog musher asks his dogs to pull the sled. The dogs refuse, referring to Newton's 3rd Law in their defense. They feel that since the sled will pull on them with the same force that they exert on it, they won't be able to go anywhere. They say, "If we can never exert a forward force on the sled which is greater than the backward force it exerts on us, how can we ever get the sled moving?" Discuss the validity of this defense with your group, and construct a counter-argument using Newton's Laws.

5. If a mosquito hits your windshield, which is greater, the force of your car on the mosquito, or the force of the mosquito on your car? Which accelerates more during the collision, the car or the mosquito? Justify your answers carefully!

6. A heavy lifting crane is being used to stack cargo containers on the deck of a ship. The heaviest container weighs 10 tons (= 20,000 pounds = 89,000 Newtons). How much force should the crane's cable support if it lifts this container (straight up) with an upward acceleration of 1 m/s^2? How would this answer change if the crane were sliding the heaviest container up an inclined plane (frictionless) making an angle of 30 degrees with the horizontal. Please assume the crate lies flat on the plane and that the cable pulling it is parallel to the surface of the plane.



7. Two identical twins of mass 30 kg have identical ropes. One twin ties his rope to the branch of a tree and hangs (without swinging) from the end of the rope. The other twin ties his rope tightly between two trees and hangs (without swinging) from the rope in the center (such that the two sides of the rope each make a 10 degree angle with the horizontal). Which rope is more likely to break? Explain your answer. What is the tension in each rope?