EXAM 1

Print your name and section clearly on all five pages. (If you do not know your section number, write your TA's name.) Show all work in the space immediately below each problem. **Your final answer must be placed in the box provided**. Problems will be graded on reasoning and intermediate steps as well as on the final answer. Be sure to include units wherever necessary, and the direction of vectors. **Each problem is worth 25 points**. In doing the problems, try to be neat. Check your answers to see that they have the correct dimensions (units) and are the right order of magnitudes. You are allowed one 5" x 8" note card and no other references. The exam lasts exactly one hour.

(Do not write below)

SCORE:

Problem 1: _____

Problem 2: _____

Problem 3: _____

Problem 4: _____

TOTAL: _____

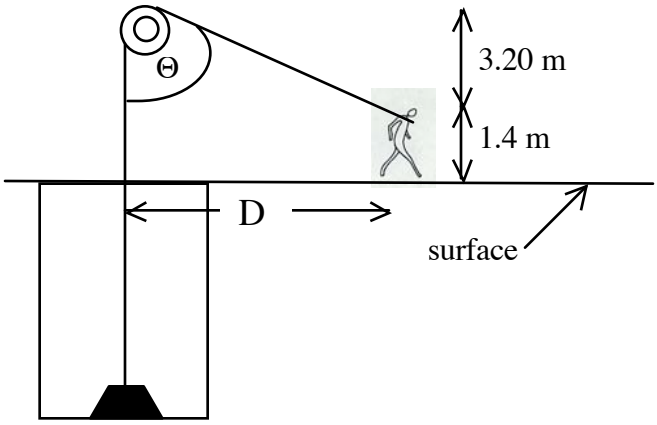
Possibly useful information:

Acceleration due to gravity at the earth's surface: $g = 9.80$ m/s^2

If $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

PROBLEM 1

A person of height 1.4 m pulls on a massless rope of fixed length that rises to a frictionless pulley at an angle of Θ from vertical and then drops vertically to a mass M=5.55 kg that is in a hole, as shown. The pulley is 3.20 m above the height at which the person is holding the rope. At time t=0 the mass is 10.0 m below the surface and the angle Θ=51.4°.



a. a. What is D, the horizontal distance between the person and the vertical part of the rope, at time t=0? *(5 pts.)*

b. The person now walks away so that the mass rises at a constant speed of v=2.3 m/s. Find the tension in the rope just after the person starts walking. *(5 pts.)*

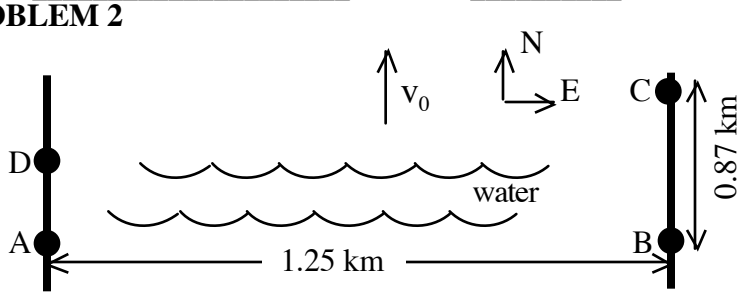
c. The person stops walking when the mass is at ground level. Find the horizontal component of the distance from the mass to the person at this point. *(5 pts.)*

d. After stopping, the person lets go of the rope and the mass drops 10.0 m down to the bottom of the hole. How long does it take for the mass to fall to the bottom of the hole? *(5 pts.)*

e. After stopping, the person lets go of the rope and the mass drops 10.0 m down to the bottom of the hole. What is the speed at which the mass hits the bottom ? *(5 pts.)*

PROBLEM 2

A swimmer who swims at a speed of 0.75 km/hr in still water swims in a river that is 1.25 km across with a current with velocity v_0=0.33km/hr pointing north.



a. What direction should the swimmer point in order to start out at point A and end up directly across the river at point B? Please express your answer in degrees N,S,E or W of N,S,E or W. *(5 pts.)*

b. How long, in hours, does it take for the swimmer to get from point A to point B? *(5 pts.)*

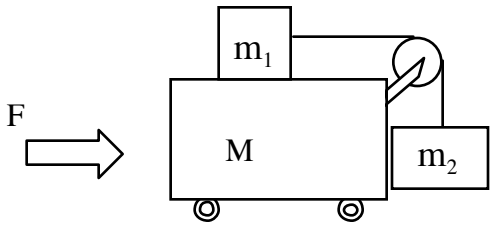
c. The swimmer walks along the shore 0.87 km at 5.28 km/hr north along the shore to point C, and then swims back to the west shore at point D by pointing at an angle Φ =36° south of west. What is the distance from point D to point A? *(5 pts.)*

d. The swimmer then walks along the shore from point D to point A at a speed of 5.28 km/hr. How far did the swimmer travel altogether (both in the water and on shore)? *(5 pts.)*

e. What is the swimmer's average speed for the entire trip, in the frame of an observer on shore? *(5 pts.)*

PROBLEM 3

A cart of mass M=2.5 kg with frictionless wheels has a frictionless pulley mounted on it, as shown. There are two blocks with masses m_1=0.53 kg and m_2= 1.44 kg connected by a rope, as shown. The coefficient of friction of block m_1 with the cart is μ_1=0.33, while the coefficient of friction of block m_2 with the cart is zero. In parts d and e, a horizontal force F is applied to the cart.



a. Find the magnitude and direction (left or right) of the friction force on block m_1 when the cart is stationary. *(5 pts.)*

b. What is the tension in the string when the cart is stationary (F=0)? *(5 pts.)*

c. What is the acceleration of block m_1 when F=0? *(5 pts.)*

d. What is the vertical component of the acceleration of m_2 when the acceleration of the cart is 6.2 m/s^2? *(5 pts.)*

e. Now suppose the coefficient of friction μ=0, and a force F is applied as shown that causes the cart to accelerate at 1.83 m/s^2. What is the vertical component of the acceleration of m_2? *(5 pts.)*

PROBLEM 4

To prepare with his battle with Goliath, David is preparing a sling shot. He finds that the fastest that he can revolve a particular stone in a circular horizontal orbit of radius 1.34 m is 5.33 revolutions per second. Assume that the speed along the orbit is uniform.

a. What is the speed of the stone in this circular orbit? *(5 pts.)*

b. Find the magnitude of the acceleration of the stone in the circular orbit. *(5 pts.)*

c. The stone of parts a and b comes out of the sling moving horizontally when it is 0.984 m above the ground. Find the time elapsed between when the stone comes out of the sling and when the stone hits the ground. (The ground is flat, and air resistance can be neglected.) *(5 pts.)*

d. Find the speed at which the stone in part c hits the ground. *(5 pts.)*

e. Find the horizontal distance between the point where the stone comes out of the sling and the point where it hits the ground. *(5 pts.)*