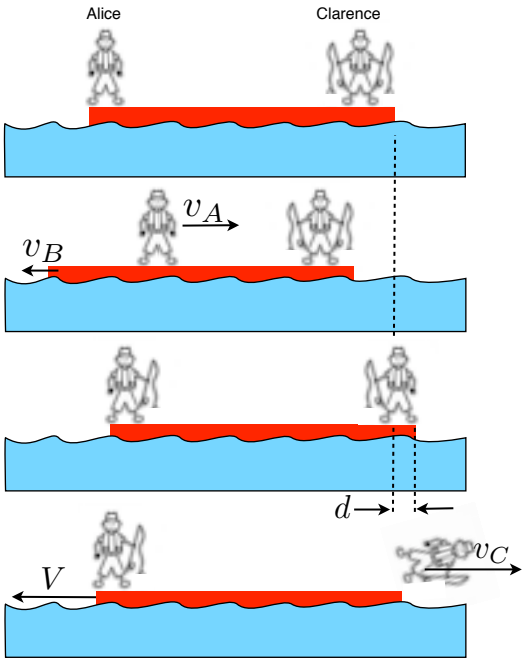
Exam #2 Physics 1501Q, Fall 2012 **BOX YOUR ANSWERS!**
You may attach extra paper - raise your hand if you need it

1. Two friends, Alice (m_A=50kg) and Clarence (m_C=70kg), go on a fishing expedition in Coventry Lake. The boat begins at rest with Clarence on the right end of the m_b=10kg boat, holding 2 fishing rods of equal mass (m_r=1kg each). Alice is on the left end, 5m from Clarence.

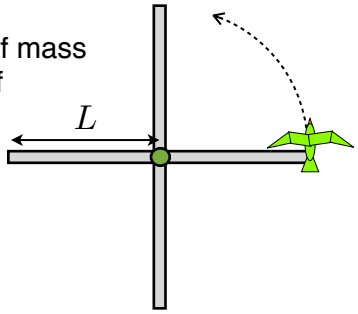


(a) Alice walks from the left end towards Clarence at speed v_A=1m/s with respect to the lake. Find the speed v_B of the moving boat.

(b) Alice takes a fishing rod from Clarence and walks to the left end of the boat. What is the net displacement d of the boat after her round trip?

(c) A fish bites Clarence's line and pulls to the right with a constant force of 100N. After 100ms, the line breaks, Clarence loses balance and he and his rod are sent overboard with a speed v_C=1m/s to the right (relative to the lake). Find the speed V that Alice, her rod, and the boat move to the left.

2. A ceiling fan, initially at rest, as shown from above, consists of four rods of mass M=100g and length L=1m. The moment of inertia of a rod about its center of mass is 1/12 ML^2. A parakeet (small bird) of mass m=40g sits on the end of the blade to the right.



(a) What is the moment of inertia of one blade around the fan axis? What is the moment of inertia of the entire fan (no parakeet) about its axis?

(b) What is the moment of inertia of the parakeet about the center of the fan?

(c) The parakeet smoothly takes off, and glides along a uniform, circular, counterclockwise trajectory with constant speed v=1m/s as shown. Find the angular speed of the fan.

(d) The parakeet lands on the next blade it encounters and the fan stops rotating. By what angle has the blade rotated during this entire process?

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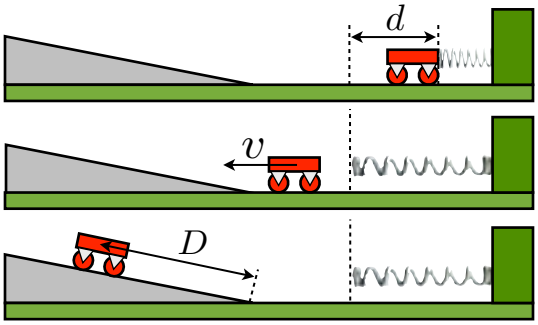
3. A M=10kg cart has four cylindrical wheels of mass m=2kg each. A spring with a constant k=100N/m is used to launch the cart up a ramp as shown. The spring is compressed by d=1m and released. The cart rolls without slipping, $I_{cyl}=1/2mr^2$, and g=9.81m/s^2.



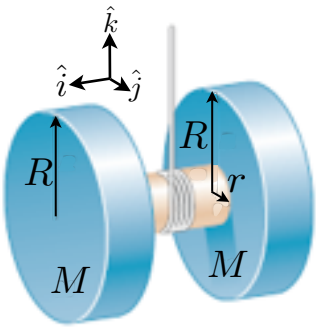
(a) How much work was done to compress the spring?

(b) Find the speed v just after the spring loses contact.

(c) The ramp has an incline of 10 degrees. Find the distance D that the cart travels up the ramp.

4. A yo-yo consists of two uniform cylindrical disks of radius R=3cm and mass M=50g (each) connected by a uniform cylindrical axle of radius r=1cm and mass m=5g as shown. When let go, the yo-yo moves in a purely vertical ($\hat{k}$) direction, g=9.81m/s^2, and I_{cyl}=1/2 *mass radius* ^{2}.

(a) What is the total moment of inertia of the yo-yo about its axis?



(b) Using the coordinate system shown, find the direction of the torque and angular acceleration vectors about the cylindrical axis.

(c) How is the linear acceleration along $\hat{k}$ related to the angular acceleration?

(d) Draw the free-body diagram for the yo-yo, find the total force and total torque, and solve for the acceleration of the yo-yo after it is let go.