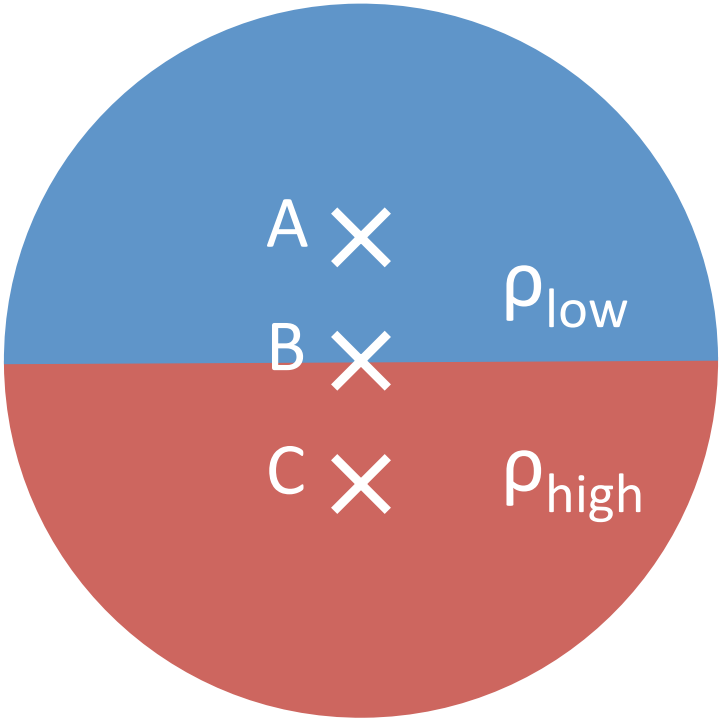
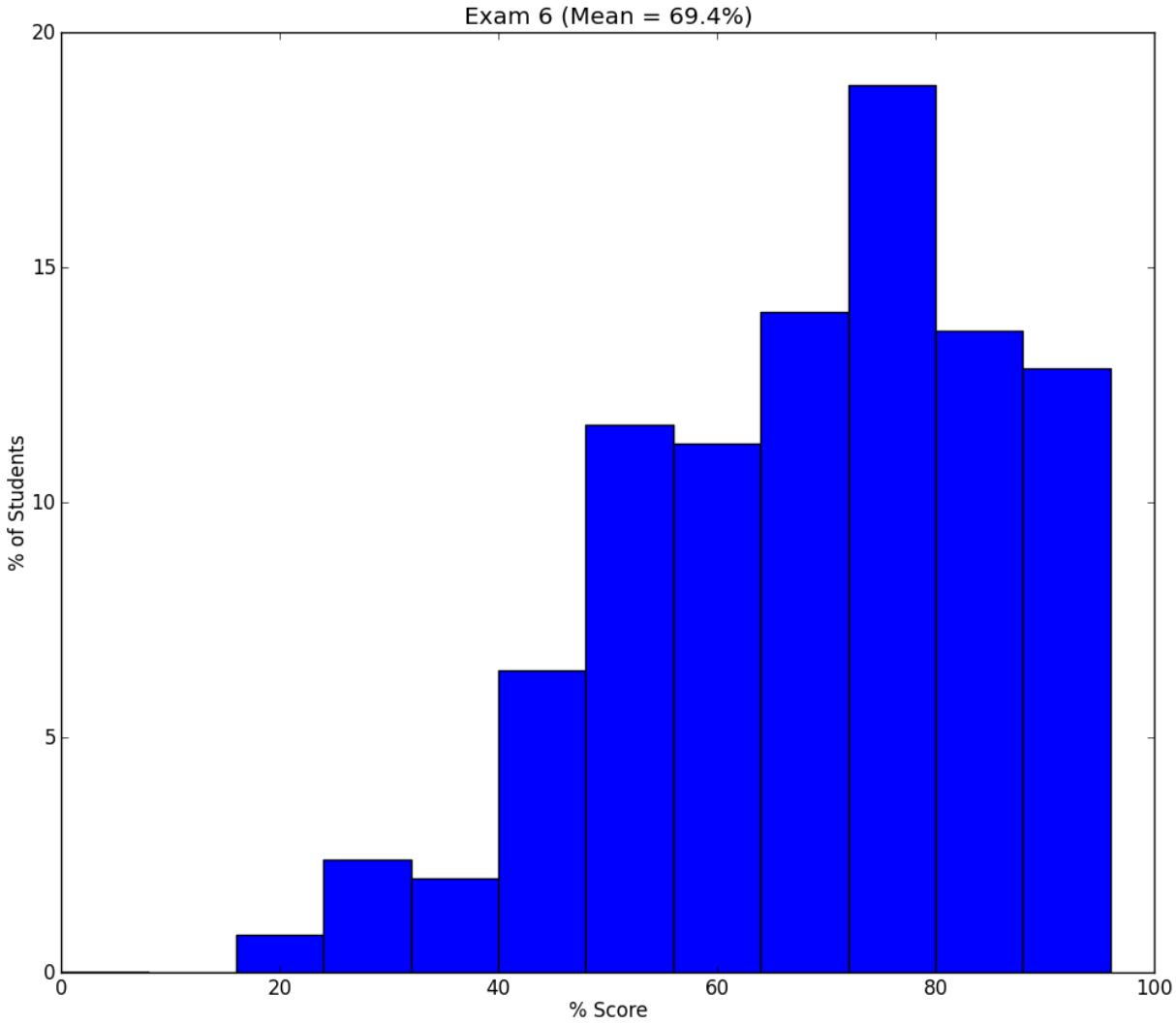
8-1) The object below is made of two half-circles. The lower half-circle is more dense than the upper one. Which location best illustrates the center of mass of this object?



D) Some other location

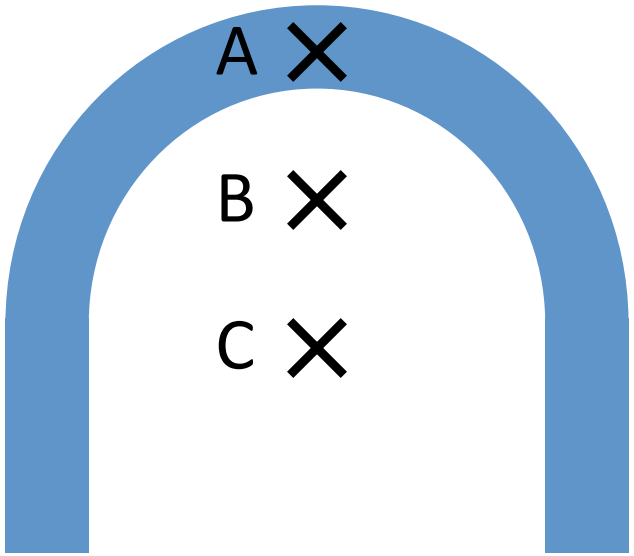


I will send out progress reports (projected grades) later tonight.

8-2) The center of mass of a rigid object in any arbitrary shape:

A) is always in inside the object.
B) can lie outside of the object.
C) depends on the motion of the object.
D) None of these are true.

8-3) What about this object? The density is uniform. Which location best illustrates the center of mass of this object?

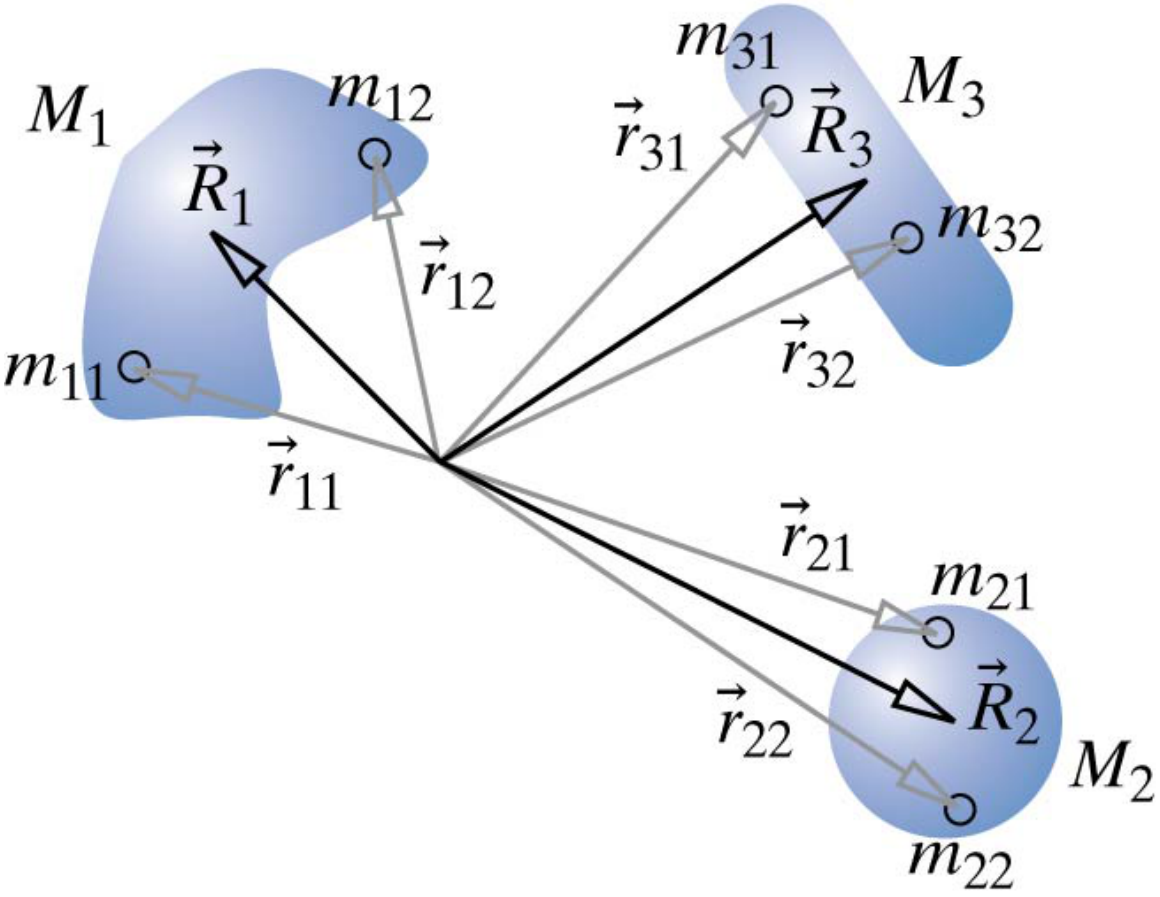


D) Some other location

8-2) The center of mass of a rigid object in any arbitrary shape:

A) is always in inside the object.
B) can lie outside of the object.
C) depends on the motion of the object.
D) None of these are true.

Center of Mass



8-4) Two pucks (M=10kg and m=1kg) are 5 meters apart. The center of mass of this two puck system is _____ of the separation distance (as measured from the larger mass).

A) 1/11
B) 1/10
C) 9/10
D) 10/11
E) Depends on the coordinate system

8-5) Three tiny equal-mass pucks are placed on a horizontal frictionless surface at the corners of an equilateral triangle (all sides 2 m and all angles 60^0). What are the x and y coordinates of the center of mass?

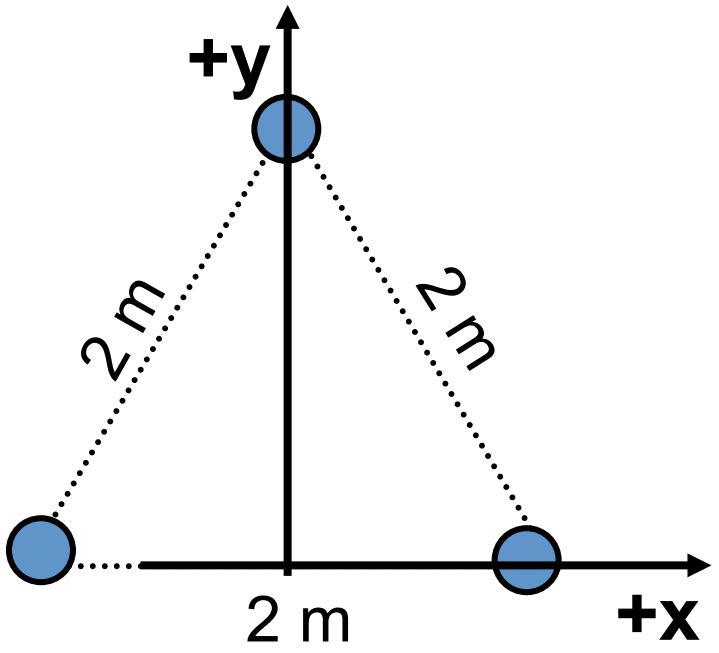
A) <0,0> m

B) <0,1> m

C) <0,.58> m

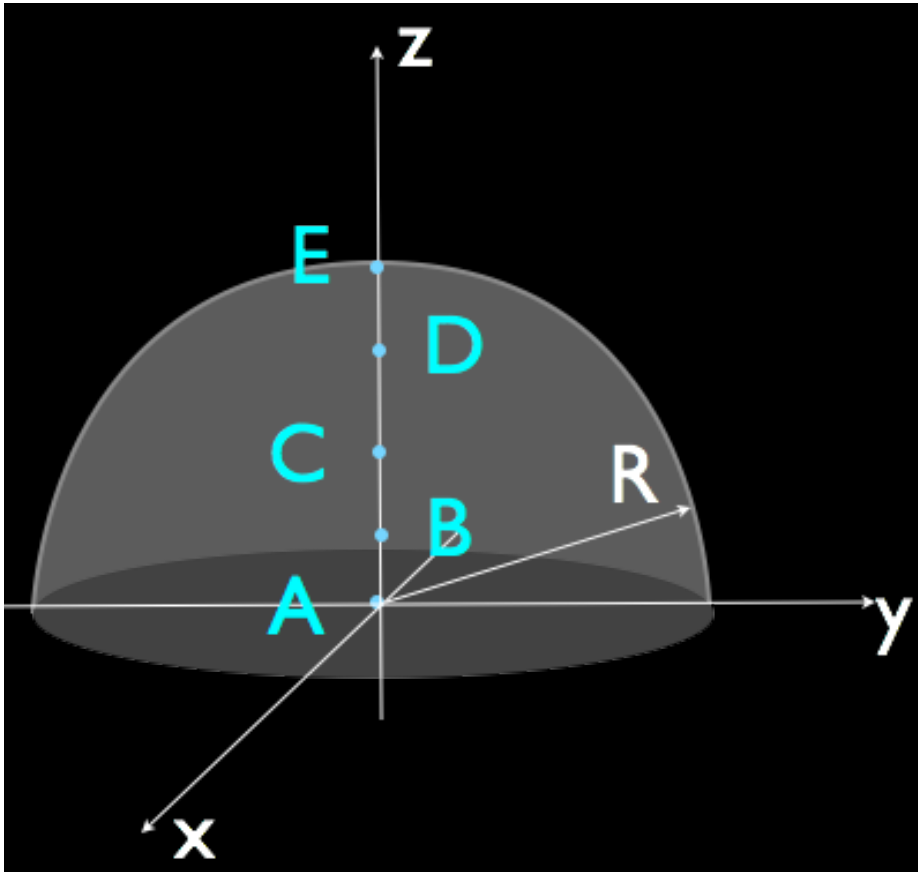
D) <0,.87> m

E) <0,.67> m

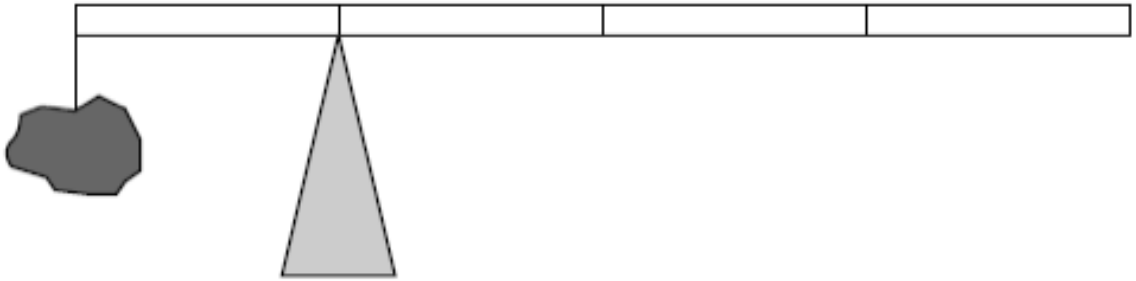


8-6) Consider a solid hemisphere of uniform density with a radius R.
Where is the center of mass?

A) z=0
B) 0<z<R/2
C) z=R/2
D) R/2<z<R
E) z=R



8-7) A 1-kg rock is suspended by a massless string from one end of a 1-m measuring stick. What is the mass of the measuring stick if it is balanced by a support force at the 0.25-m mark?



A) 0.25 kg

B) 0.5 kg

C) 1 kg

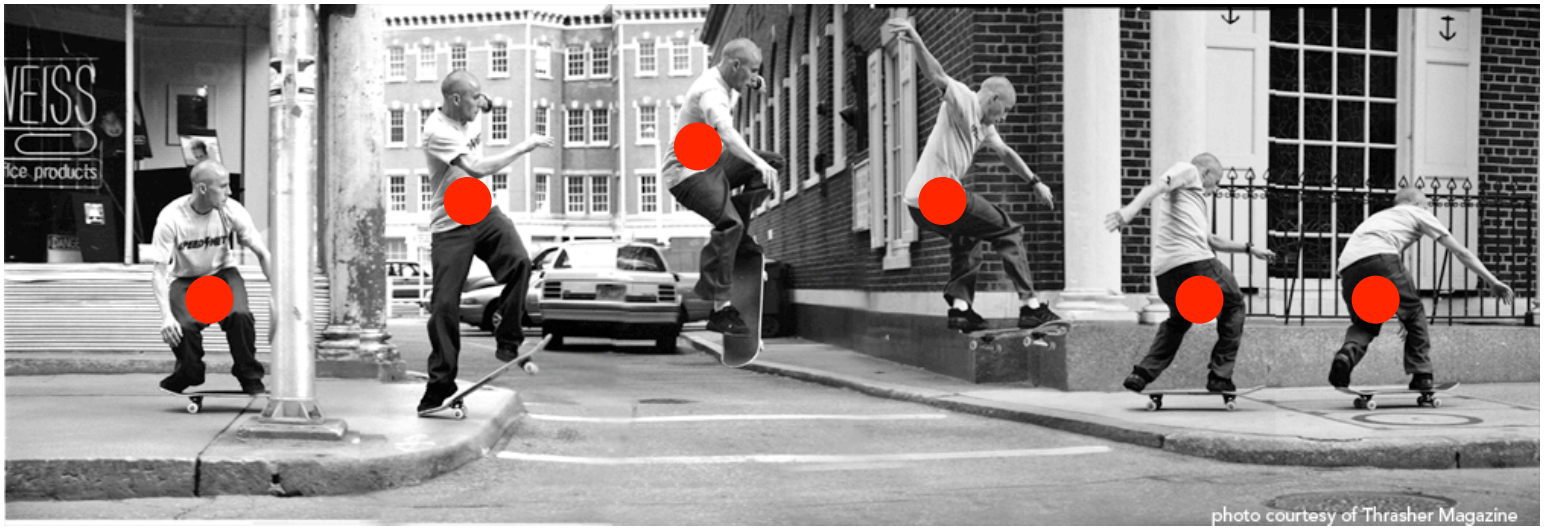
D) 2 kg

E) Impossible to determine

8-8a) Two equal mass pucks move on a frictionless horizontal surface. They collide elastically (in 2D) as shown below. Which describes the motion of the center of mass of the two-puck system?

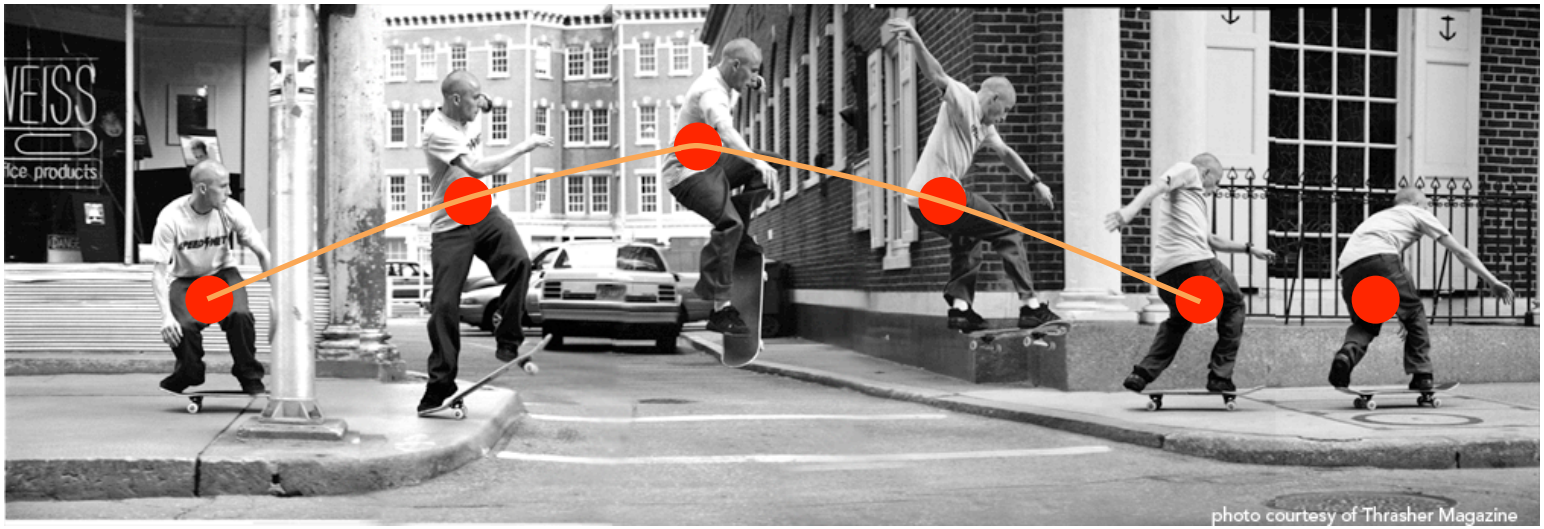
A) It doesn't move.
B) It moves with constant speed.
C) It moves with constant velocity.
D) It moves, but there's no way to tell how.

Motion of the Center of Mass



http://www.exploratorium.edu/skateboarding/

Motion of the Center of Mass



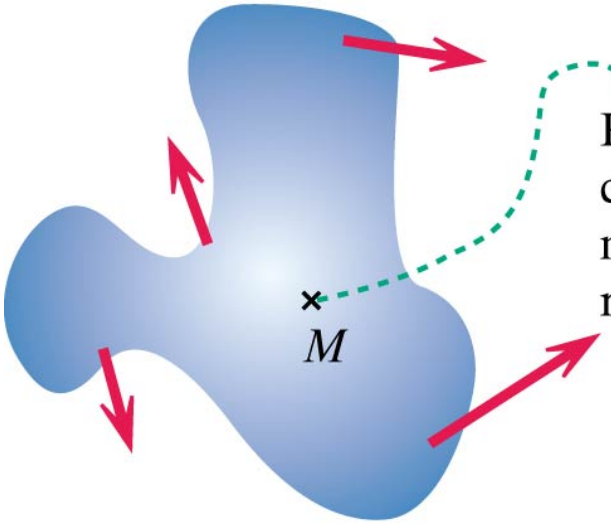
http://www.exploratorium.edu/skateboarding/

Can Skateboarding Save Our Schools?

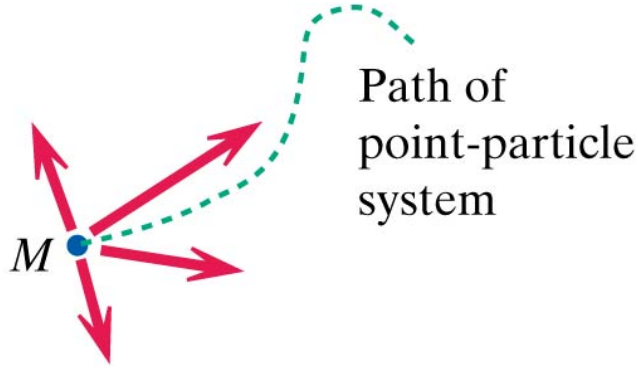
http://www.youtube.com/watch?v=lHfo17ikSpY
http://drtae.org/

Are you interested in teaching science? Talk to me.

Real system:
Forces act at different locations



Path of
center of
mass of
real system



Path of
point-particle
system

Point-particle system:
All forces act at the same location

8-8b) Two equal mass pucks move on a frictionless horizontal surface. They collide elastically (in 2D) as shown below. Which describes the motion of the center of mass of the two-puck system?

A) It doesn't move.
B) It moves with constant speed.
C) It moves with constant velocity.
D) It moves, but there's no way to tell how.

Chain Drop

8-12) Which hits the ground first?

A) The free-weight
B) The chained weight
C) Both at the same time

Example: Walking in a boat

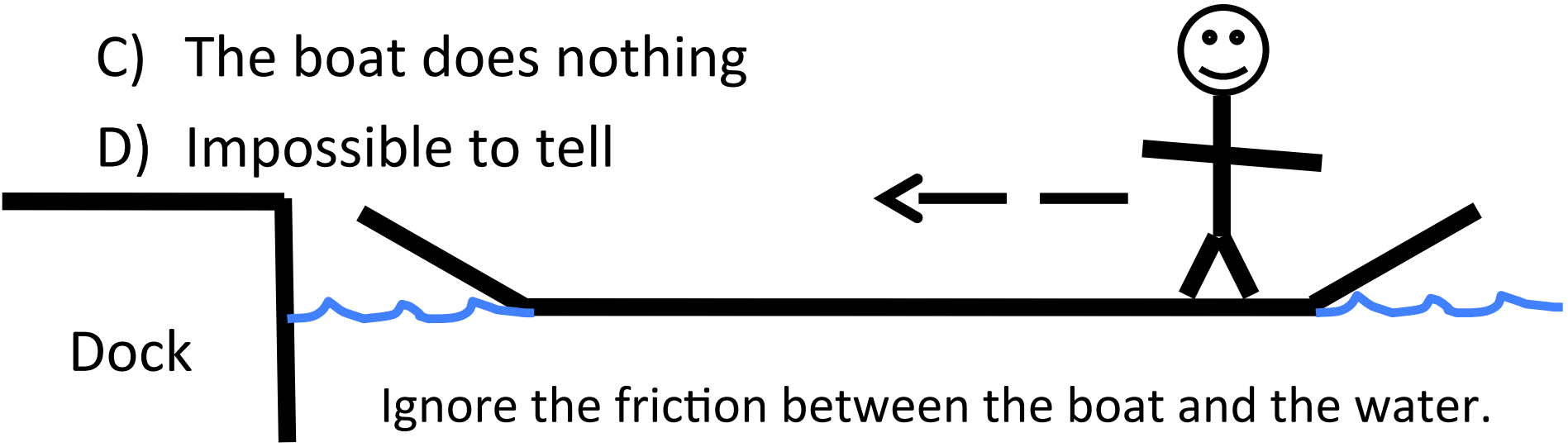
8-9a) You are standing in at one end of a boat and walk to the other end. What happens to the boat?

A) The boat moves left

B) The boat moves right

C) The boat does nothing

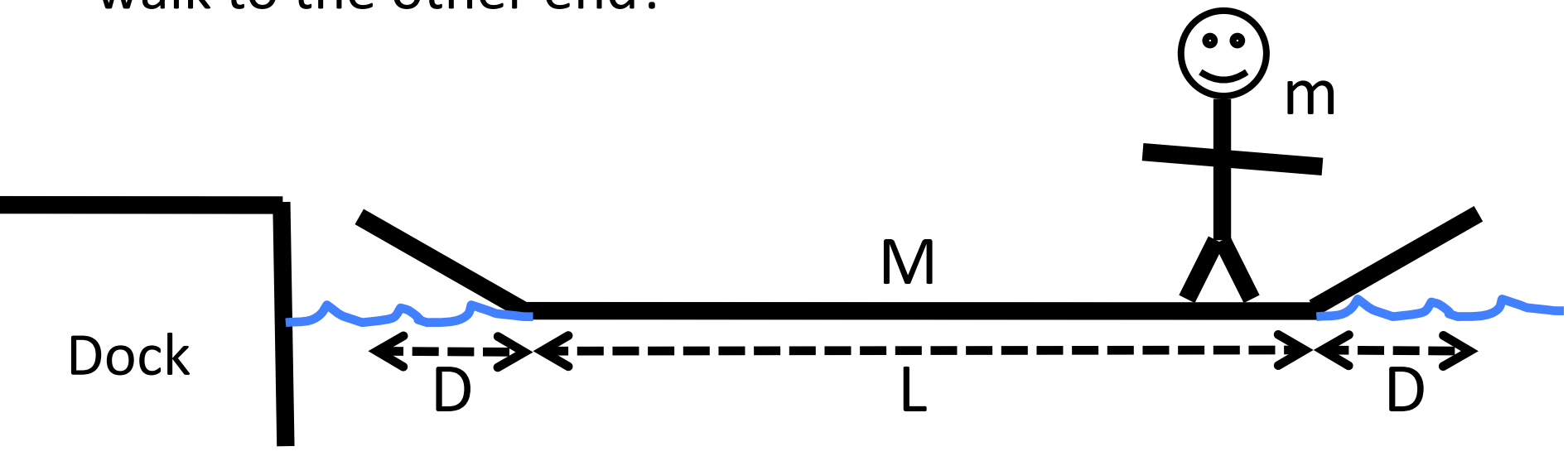
D) Impossible to tell



Ignore the friction between the boat and the water.

Example: Walking in a boat

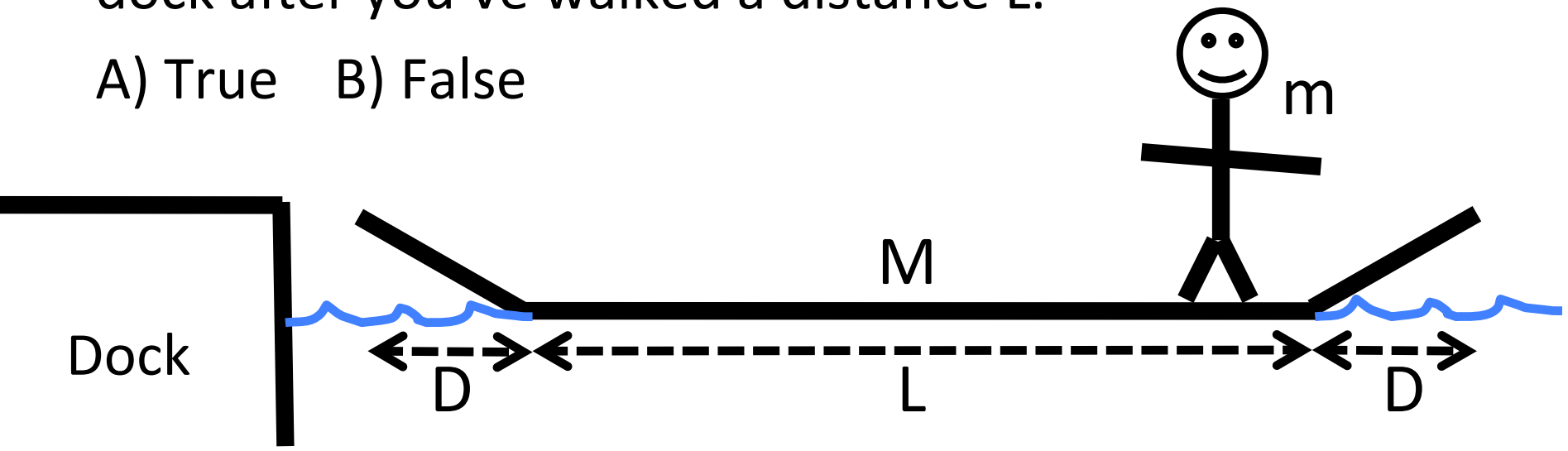
Ok, so how far from the dock is the boat when you walk to the other end?



Example: Walking in a boat

8-9b) True or False: The boat is a distance L from the dock after you've walked a distance L.

A) True B) False



Example: Walking in a boat

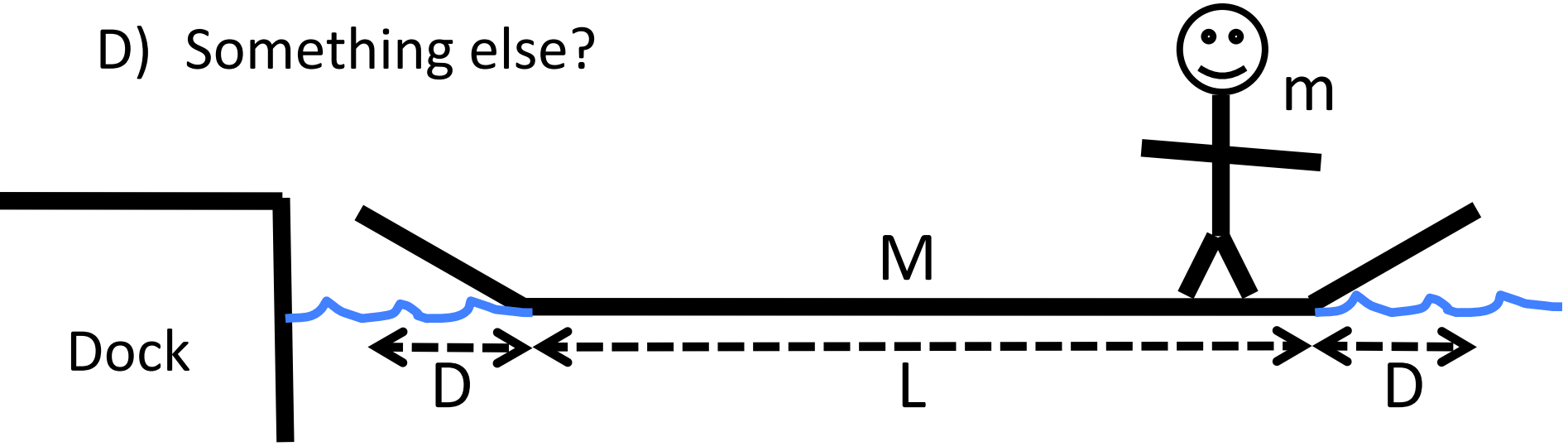
8-9c) How do we start this problem?

A) Conservation of linear momentum

B) Conservation of energy

C) Kinematics

D) Something else?



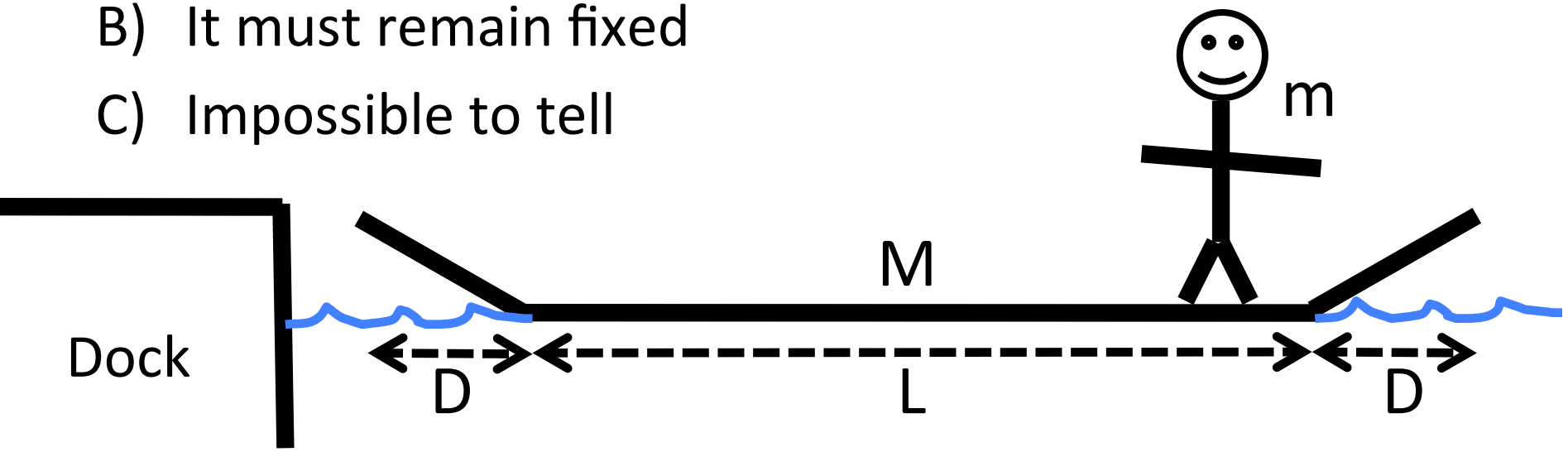
Example: Walking in a boat

8-9d) What does momentum conservation (in this problem, $\mathbf{p}_i = \mathbf{p}_f = \mathbf{0}$) tell you about the motion of the center of mass of the system?

A) It moves with constant velocity

B) It must remain fixed

C) Impossible to tell

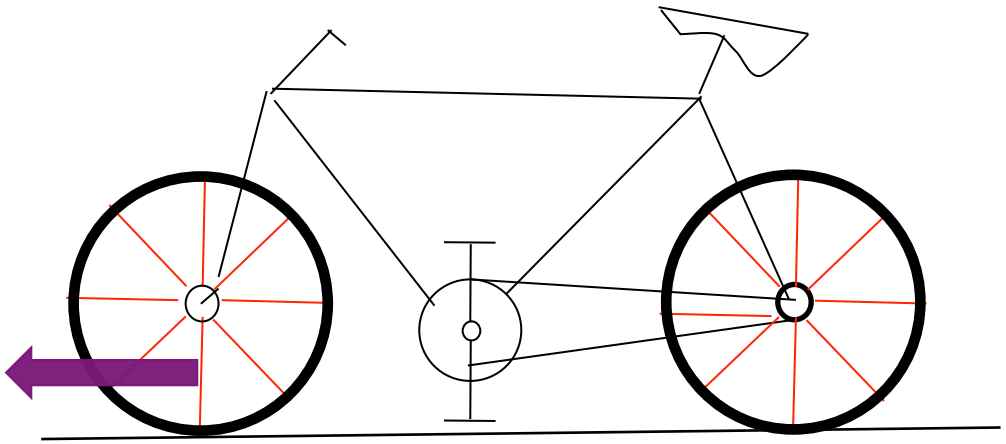


8-10) Frustrated by her adult captors, an angry two-year old kicks a basket of toys into the air. As the basket flies into the air, the toys spill out of it, moving in all directions. Which best describes the motion of the center of mass of this system?

A) It will remain at rest
B) It will move in a straight line at constant speed
C) It will more on a parabola
D) It's impossible to tell

8-11) If you push forwards on a lower spoke as shown, the bike moves

A) left B) right C) no motion D) ??



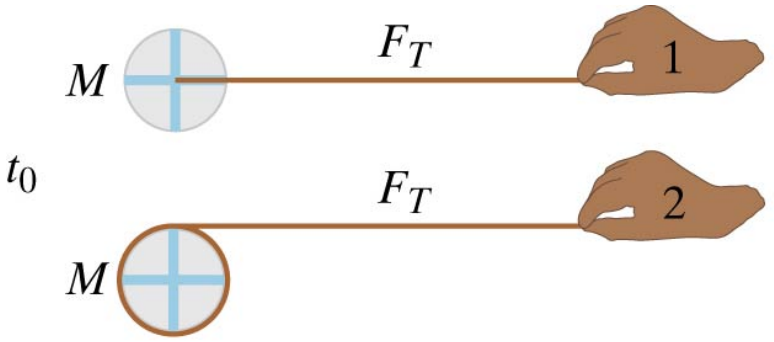
Chain Drop

8-12) Which hits the ground first?

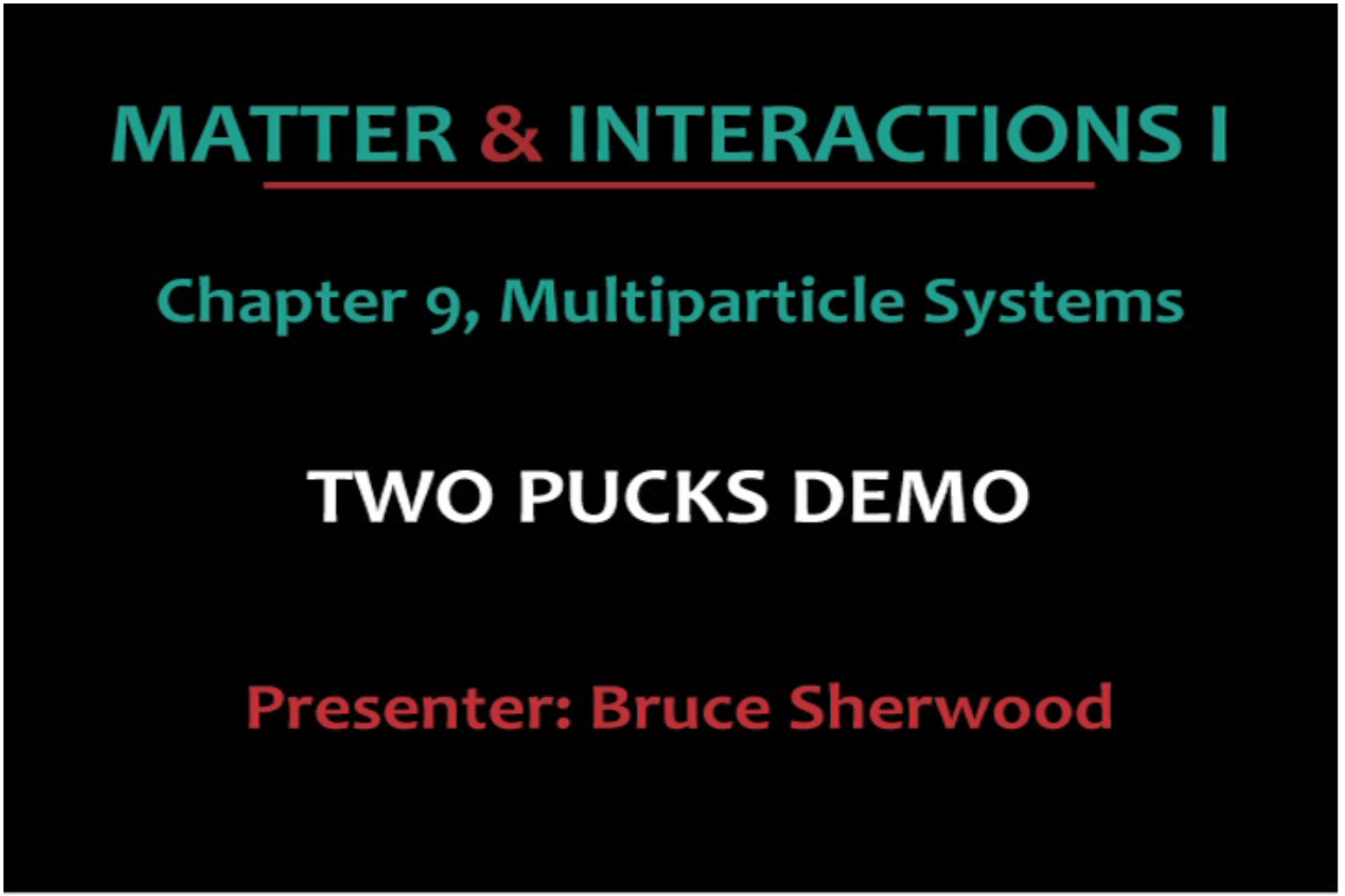
A) The free-weight
B) The chained weight
C) Both at the same time

8-13) Two pucks lie on ice and slide with no friction. A string is attached to each puck and the string is pulled with a constant force F_T. The string is wound around the outer edge of puck 2 but attached to the center of puck 1. They both start from rest. What do you think will happen in the next 3 seconds?

A) 1 will move farther than 2
B) 2 will move farther than 1
C) They move the same distance
D) Not enough information



Motion of the center of mass

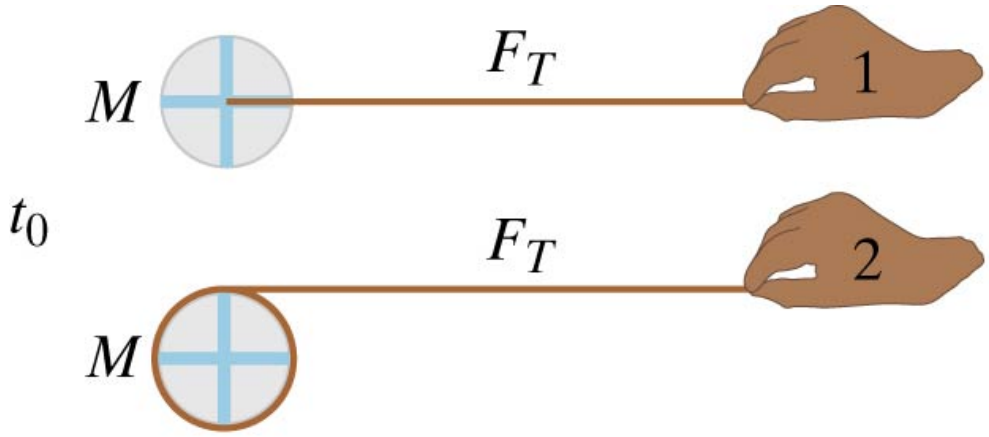


Example: Pulling two disks

You pull on a rope with the force F_T. In one situation, the rope is attached to the center of the disk. In the second, the rope is wound around the edge of the disk.

When you pull you observe both disks move the same distance in the same amount of time.

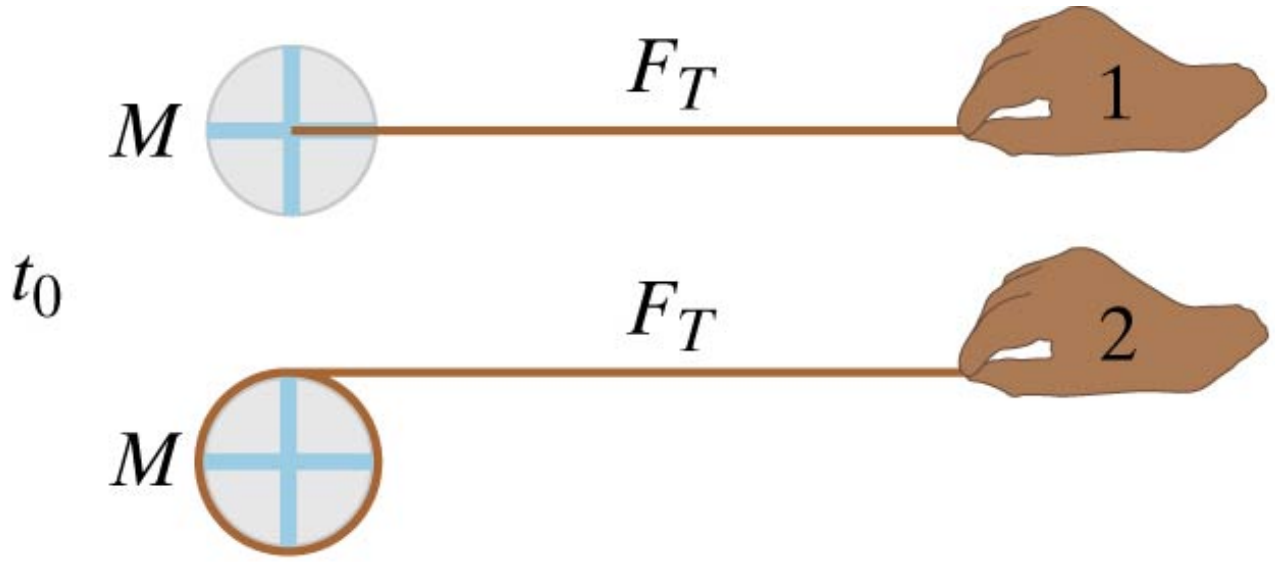
How can this be? The disk in situation two rotates! Where's the "extra energy"?



Example: Pulling two disks

8-14a) Let's say the disks move a distance *d* in the time that you pull on the rope. In that case, the work done in the center of mass system is $F_T d$. Is this also the **total** change in kinetic energy in situation 1 (rope tied to center of mass)?

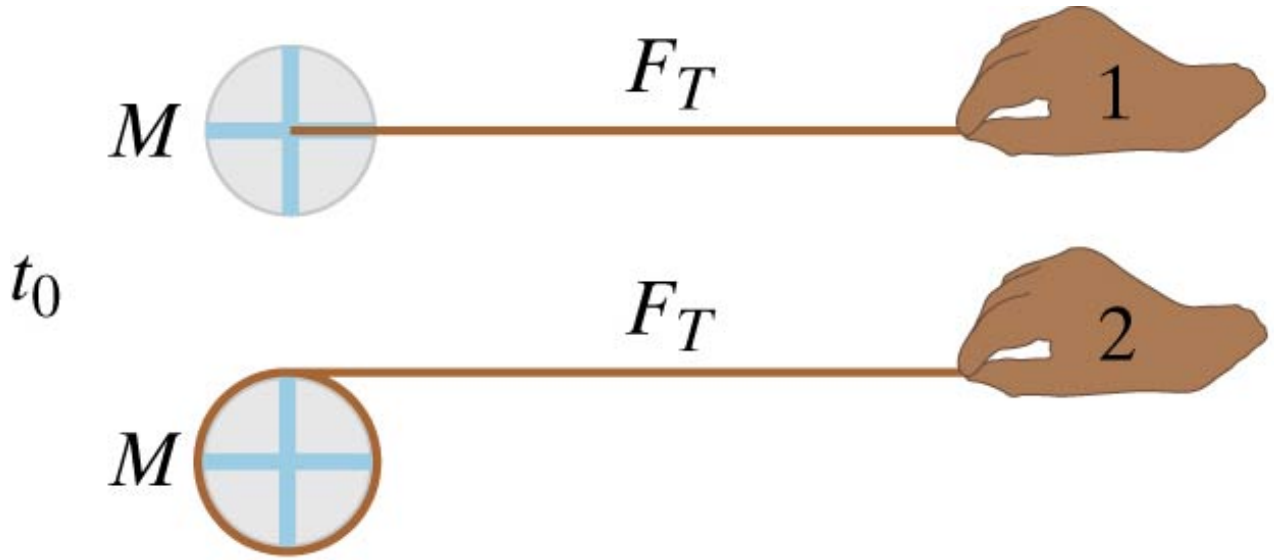
A) Yes
B) No



Example: Pulling two disks

8-14b) Is $F_T d$ also the **total** change in kinetic energy in situation 2 (rope wound around the edge)?

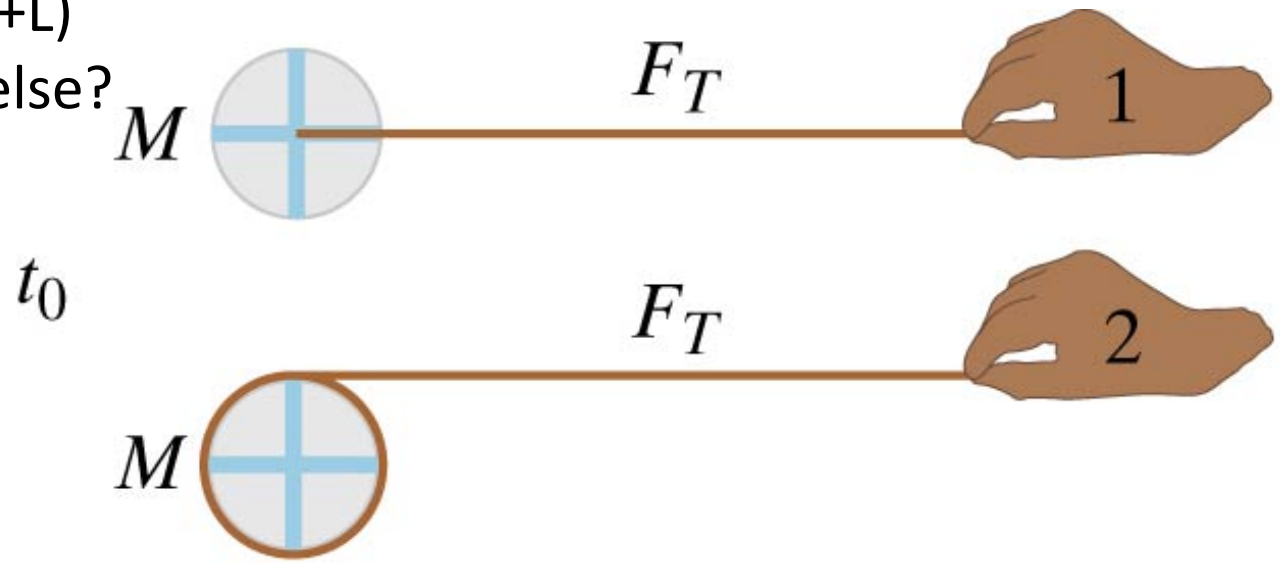
A) Yes
B) No



Example: Pulling two disks

8-14c) In situation 2, the disk moves a distance d. The string unwinds an amount L in that time. So in the **real physical** system, what is the work done by the force applied by the hand?

A) $W_{hand} = F_T d$
B) $F_T d < W_{hand} < F_T(d+L)$
C) $W_{hand} = F_T(d+L)$
D) Something else?



Chain Drop

8-12) Which hits the ground first?

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Chain Drop Answer