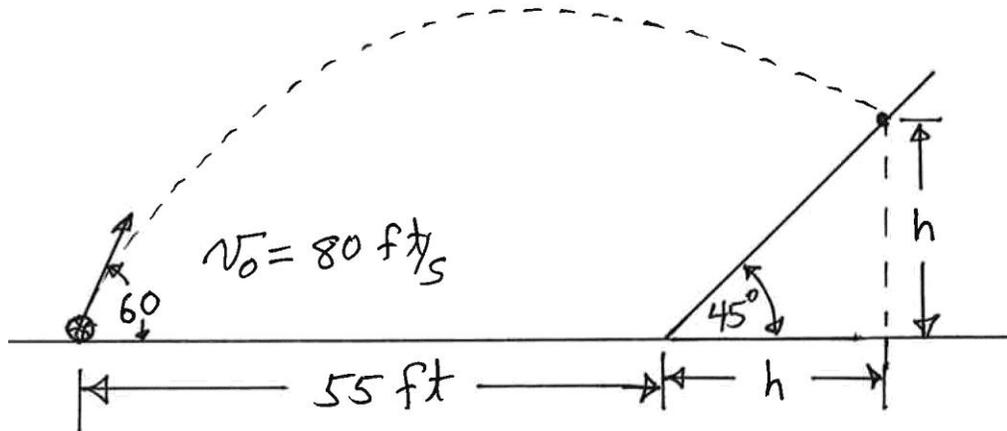


## 2.003SC Engineering Dynamics

### Problem Set 1 Concept Question Solutions

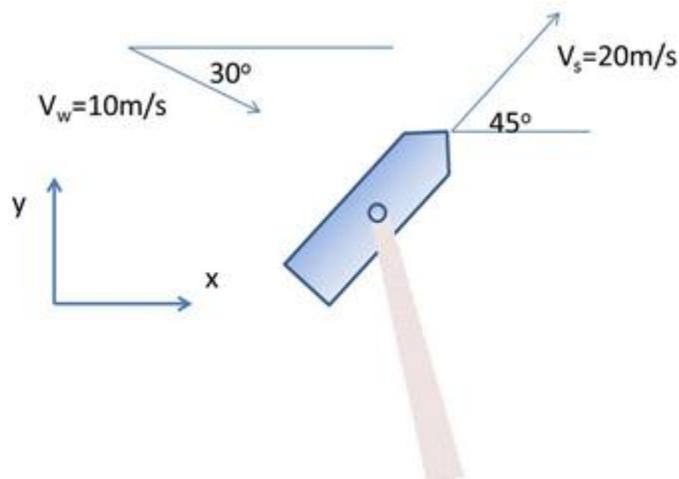
*Concept Question 1:* What is the magnitude of the horizontal component of football's velocity at the top of the arc? A. 80 ft/s; B. 40 ft/s; C.  $40\sqrt{3}$  ft/s.



*Answer:* The correct answer is 40 ft/s. Assuming no drag, the football maintains its initial momentum and therefore velocity in the horizontal direction.

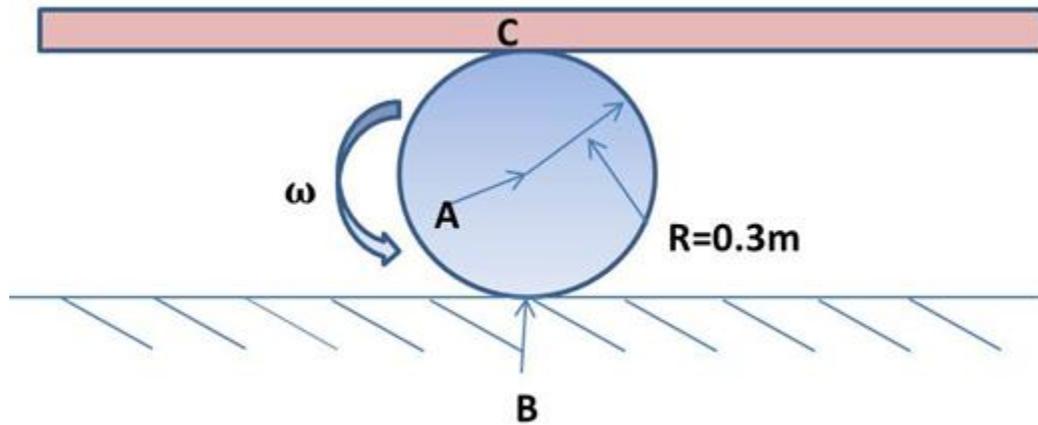
*Concept Question 2:* For the conditions described in this problem, is the reference frame of the ship an inertial frame.

A. Yes; B. No; C. Do not know.



*Answer:* Yes—the ship is an inertial frame. It is traveling at constant speed and is neither accelerating nor rotating.

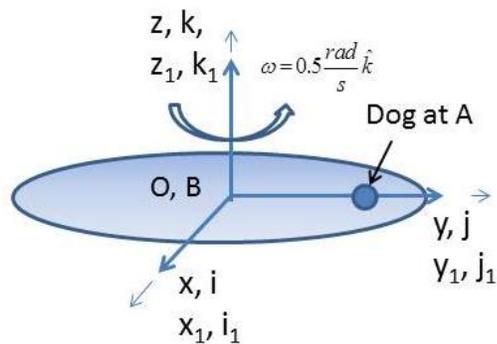
*Concept Question 3:* Where is the instantaneous center of rotation of the roller in this problem?



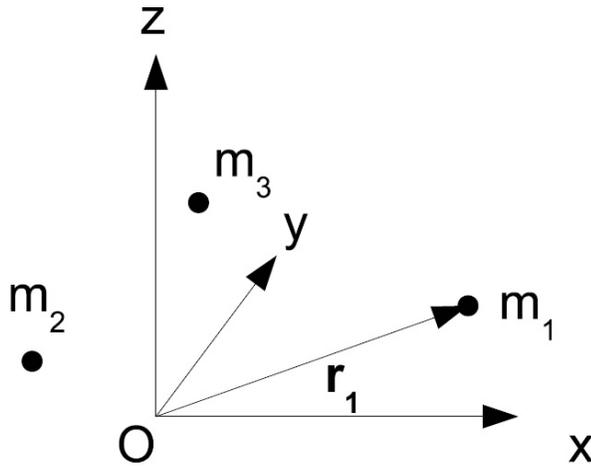
*Answer:* The answer is Point B, the point of contact with the non-moving ground. See [http://en.wikipedia.org/wiki/Instant\\_centre\\_of\\_rotation](http://en.wikipedia.org/wiki/Instant_centre_of_rotation)

*Concept Question 4:* Is the vector velocity of the dog on the platform, as observed from a fixed point in a reference frame attached to the ground, a function of the location of the fixed reference point.

- A. Yes,
- B. No,
- C. Do not know.



*Answer:* Although the position vector to the dog from an arbitrary point is dependent on the location of the reference point, the velocity is not dependent on the location of the reference point. It is only dependent on the frame of reference.



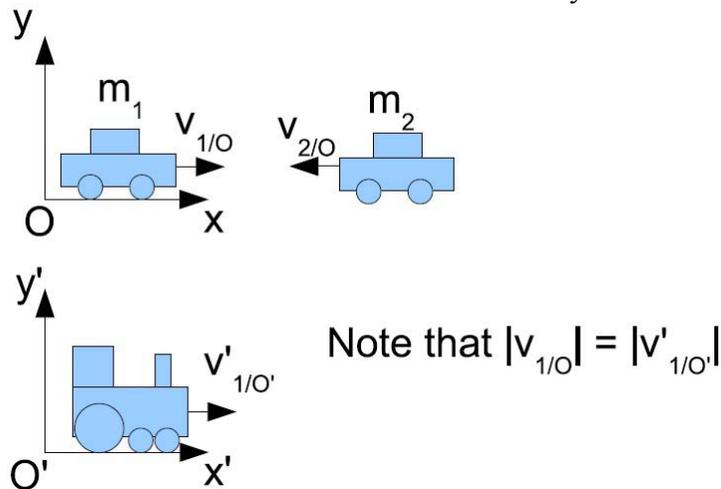
*Concept Question 5:* If you computed the total kinetic energy of the system using the total mass of the particles and the velocity of the center of mass, would the answer be:

- A. less than,
- B. greater than, or
- C. equal to the sum of the kinetic energies of the particles taken individually as in part 'd' above?

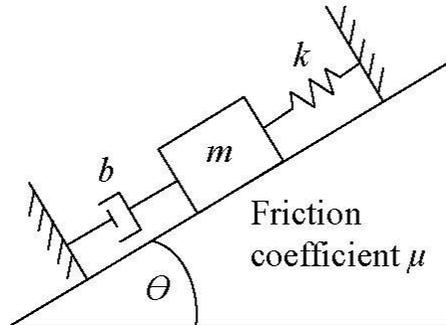
*Answer:* The sum of the individual energies is GREATER THAN the 'energy' computed using the velocity of the center of mass. Consider the example of two cars of equal mass driving in opposite directions at equal speeds. The center of mass is fixed, so the 'energy' computed using the center of mass is zero. However, the sum of the energies of the two cars is nonzero. When the group of particles form a rigid body, then the energy computed using the velocity of the center of mass has meaning. Even then, one must separately account for the kinetic energy due to rotation in addition to the kinetic energy due to translation of the center of mass.

*Concept Question 6:* Do you expect the change in total momentum and total kinetic energy to be the same or different when viewed from two inertial frames traveling at different velocities?

*Answer:* The collision results in a change in the total kinetic energy of the system. When that change is computed from the point of view of any inertial frame of reference the computed change in kinetic energy in the collision will be the same. This is true of a fixed inertial frame of reference with zero velocity or a moving inertial frame of reference with a constant velocity. The change in momentum is also the same when viewed from any inertial frame.



*Concept Question 7:* Do you expect the undamped natural frequency of the system to be dependent on the angle of the incline?



*Answer:* The undamped natural frequency is not dependent on the slope of the incline. It depends only on the mass and the spring constant of the spring.

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