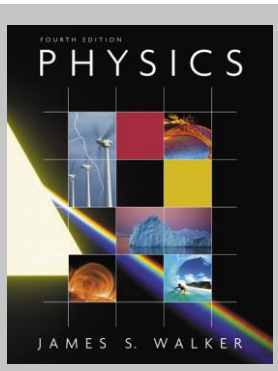



ConcepTest Clicker Questions

Chapter 11

*Physics, 4th Edition*

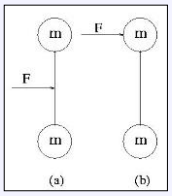
James S. Walker



## *Question 11.5a* Dumbbell I

A force is applied to a dumbbell for a certain period of time, first as in (a) and then as in (b). In which case does the dumbbell acquire the greater center-of-mass speed ?

a) case (a)
b) case (b)
c) no difference
d) it depends on the rotational inertia of the dumbbell

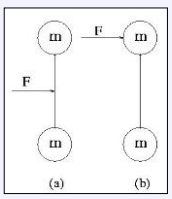



## *Question 11.5a* Dumbbell I

A force is applied to a dumbbell for a certain period of time, first as in (a) and then as in (b). In which case does the dumbbell acquire the greater center-of-mass speed ?

a) case (a)
b) case (b)
c) no difference
d) it depends on the rotational inertia of the dumbbell

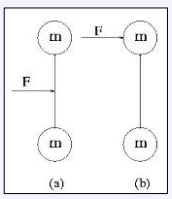
Because the same force acts for the same time interval in both cases, the change in momentum must be the same, thus the CM velocity must be the same.




## *Question 11.5b* Dumbbell II

A force is applied to a dumbbell for a certain period of time, first as in (a) and then as in (b). In which case does the dumbbell acquire the greater energy ?

a) case (a)
b) case (b)
c) no difference
d) it depends on the rotational inertia of the dumbbell

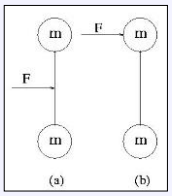



## *Question 11.5b* Dumbbell II

A force is applied to a dumbbell for a certain period of time, first as in (a) and then as in (b). In which case does the dumbbell acquire the greater energy ?

a) case (a)
b) case (b)
c) no difference
d) it depends on the rotational inertia of the dumbbell

If the CM velocities are the same, the translational kinetic energies must be the same. Because dumbbell (b) is also rotating, it has rotational kinetic energy in addition.

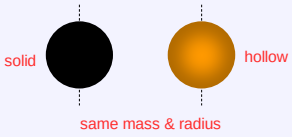



## *Question 11.6* Moment of Inertia

Two spheres have the same radius and equal masses. One is made of solid aluminum, and the other is made from a hollow shell of gold.

Which one has the bigger moment of inertia about an axis through its center?

a) solid aluminum
b) hollow gold
c) same



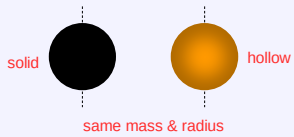
## Question 11.6 Moment of Inertia

Two spheres have the same radius and equal masses. One is made of solid aluminum, and the other is made from a hollow shell of gold.

Which one has the bigger moment of inertia about an axis through its center?

a) solid aluminum
b) hollow gold
c) same

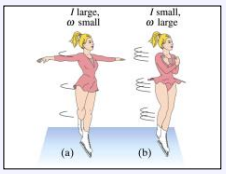
Moment of inertia depends on mass and distance from axis squared. It is bigger for the shell because its mass is located farther from the center.




## Question 11.7 Figure Skater

A figure skater spins with her arms extended. When she pulls in her arms, she reduces her rotational inertia and spins faster so that her angular momentum is conserved. Compared to her initial rotational kinetic energy, her rotational kinetic energy after she pulls in her arms must be

a) the same
b) larger because she's rotating faster
c) smaller because her rotational inertia is smaller

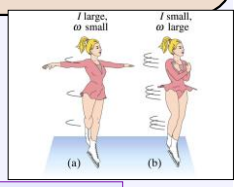



## Question 11.7 Figure Skater

A figure skater spins with her arms extended. When she pulls in her arms, she reduces her rotational inertia and spins faster so that her angular momentum is conserved. Compared to her initial rotational kinetic energy, her rotational kinetic energy after she pulls in her arms must be:

a) the same
b) larger because she's rotating faster
c) smaller because her rotational inertia is smaller

$KE_{rot} = \frac{1}{2} I \omega^2 = \frac{1}{2} L \omega$ (used $L = I\omega$). Because $L$ is conserved, larger $\omega$ means larger $KE_{rot}$. The "extra" energy comes from the work she does on her arms.



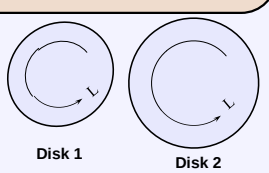

Follow-up: Where does the extra energy come from?

## Question 11.8 Two Disks

Two different spinning disks have the same angular momentum, but disk 1 has more kinetic energy than disk 2.

Which one has the bigger moment of inertia?

a) disk 1
b) disk 2
c) not enough info




## Question 11.8 Two Disks

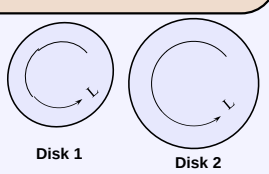
Two different spinning disks have the same angular momentum, but disk 1 has more kinetic energy than disk 2.

Which one has the bigger moment of inertia?

a) disk 1
b) disk 2
c) not enough info

$KE = \frac{1}{2} I \omega^2 = L^2 / (2 I)$ (used $L = I \omega$).

Because $L$ is the same, bigger $I$ means smaller KE.




## Question 11.9 Spinning Bicycle Wheel

You are holding a spinning bicycle wheel while standing on a stationary turntable. If you suddenly flip the wheel over so that it is spinning in the opposite direction, the turntable will:

a) remain stationary
b) start to spin in the same direction as before flipping
c) to spin in the same direction as after flipping

## Question 11.9 Spinning Bicycle Wheel

You are holding a spinning bicycle wheel while standing on a stationary turntable. If you suddenly flip the wheel over so that it is spinning in the opposite direction, the turntable will:

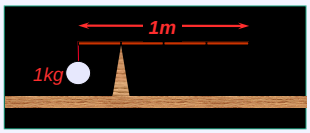
a) remain stationary
b) start to spin in the same direction as before flipping
c) start to spin in the same direction as after flipping

The total angular momentum of the system is $L$ upward, and it is conserved. So if the wheel has $-L$ downward, you and the table must have $+2L$ upward.


## Question 11.10 Balancing Rod

A 1-kg ball is hung at the end of a rod 1-m long. If the system balances at a point on the rod 0.25 m from the end holding the mass, what is the mass of the rod?

a) ¼ kg
b) ½ kg
c) 1 kg
d) 2 kg
e) 4 kg

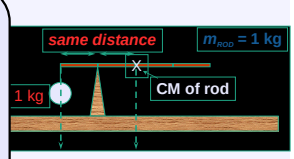



## Question 11.10 Balancing Rod

A 1-kg ball is hung at the end of a rod 1-m long. If the system balances at a point on the rod 0.25 m from the end holding the mass, what is the mass of the rod?

a) ¼ kg
b) ½ kg
c) 1 kg
d) 2 kg
e) 4 kg

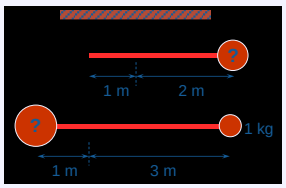
The total torque about the pivot must be zero !! The CM of the rod is at its center, 0.25 m to the right of the pivot. Because this must balance the ball, which is the same distance to the left of the pivot, the masses must be the same !!




## Question 11.11 Mobile

A (static) mobile hangs as shown below. The rods are massless and have lengths as indicated. The mass of the ball at the bottom right is 1 kg. What is the total mass of the mobile?

a) 5 kg
b) 6 kg
c) 7 kg
d) 8 kg
e) 9 kg

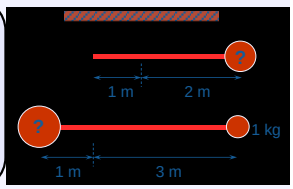



## Question 11.11 Mobile

A (static) mobile hangs as shown below. The rods are massless and have lengths as indicated. The mass of the ball at the bottom right is 1 kg. What is the total mass of the mobile?

a) 5 kg
b) 6 kg
c) 7 kg
d) 8 kg
e) 9 kg

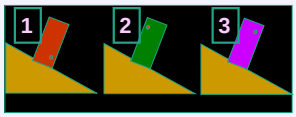
Use torques in two steps: (1) find the big mass on the bottom left (lower rod only), and (2) use the entire lower rod assembly (with two masses) to find the mass on top right. Finally, add up all the masses.




## Question 11.12a Tipping Over I

A box is placed on a ramp in the configurations shown below. Friction prevents it from sliding. The center of mass of the box is indicated by a blue dot in each case. In which case(s) does the box tip over?

a) all
b) 1 only
c) 2 only
d) 3 only
e) 2 and 3

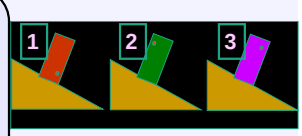


## *Question 11.12a* Tipping Over I

A box is placed on a ramp in the configurations shown below. Friction prevents it from sliding. The center of mass of the box is indicated by a blue dot in each case. In which case(s) does the box tip over?

a) all
b) 1 only
c) 2 only
d) 3 only
e) 2 and 3

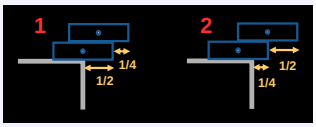
The torque due to gravity acts like all the mass of an object is concentrated at the CM. Consider the bottom right corner of the box to be a pivot point. If the box can rotate such that the CM is lowered, it will!!




## *Question 11.12b* Tipping Over II

Consider the two configurations of books shown below. Which of the following is true?

a) case 1 will tip
b) case 2 will tip
c) both will tip
d) neither will tip




## *Question 11.12b* Tipping Over II

Consider the two configurations of books shown below. Which of the following is true?

a) case 1 will tip
b) case 2 will tip
c) both will tip
d) neither will tip

The CM of the system is midway between the CM of each book. Therefore, the CM of case #1 is not over the table, so it will tip.