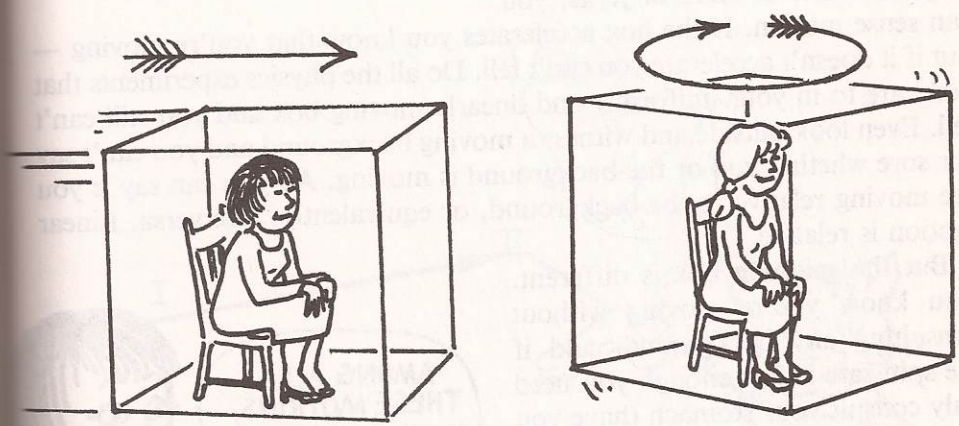
## ABSOLUTE MOTION

tist is completely isolated inside a smoothly-
x that travels a straight-line path through space,
er scientist is completely isolated in another box

A scientist is completely isolated ... moving box that travels a straight-line path through space, and another scientist is completely isolated in another box that is spinning smoothly in space. Each scientist may have all the scientific goodies she likes in her box for the purpose of detecting her motion in space. The scientist in the

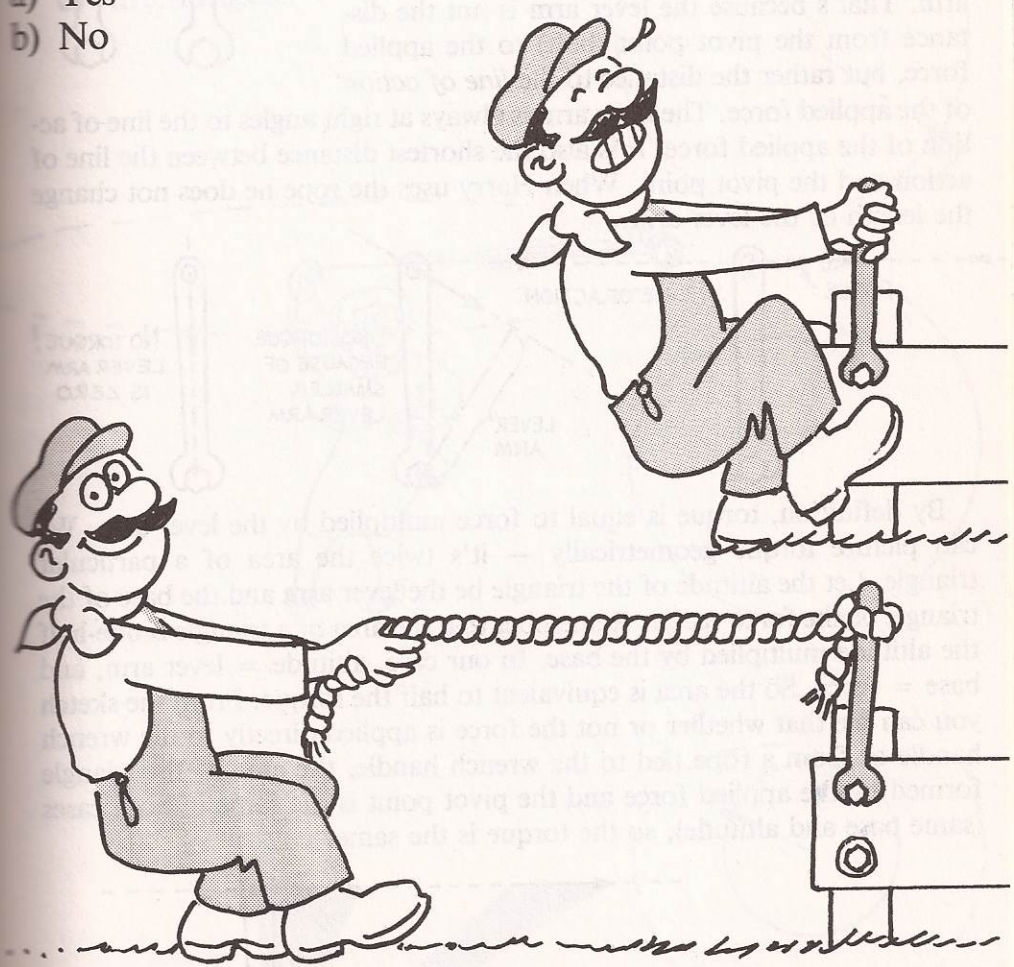


a) traveling box can detect her motion.
b) spinning box can detect her motion.
c) . . . both can detect their motions.
d) . . . neither can detect their motions.

## TORQUE

Harry is finding it very difficult to muster enough torque to twist the stubborn bolt with a wrench and he wishes he had a length of pipe to place over the wrench handle to increase his leverage. He has no pipe, but he does have some rope. Will torque be increased if he pulls just as hard on a length of rope tied to the wrench handle?

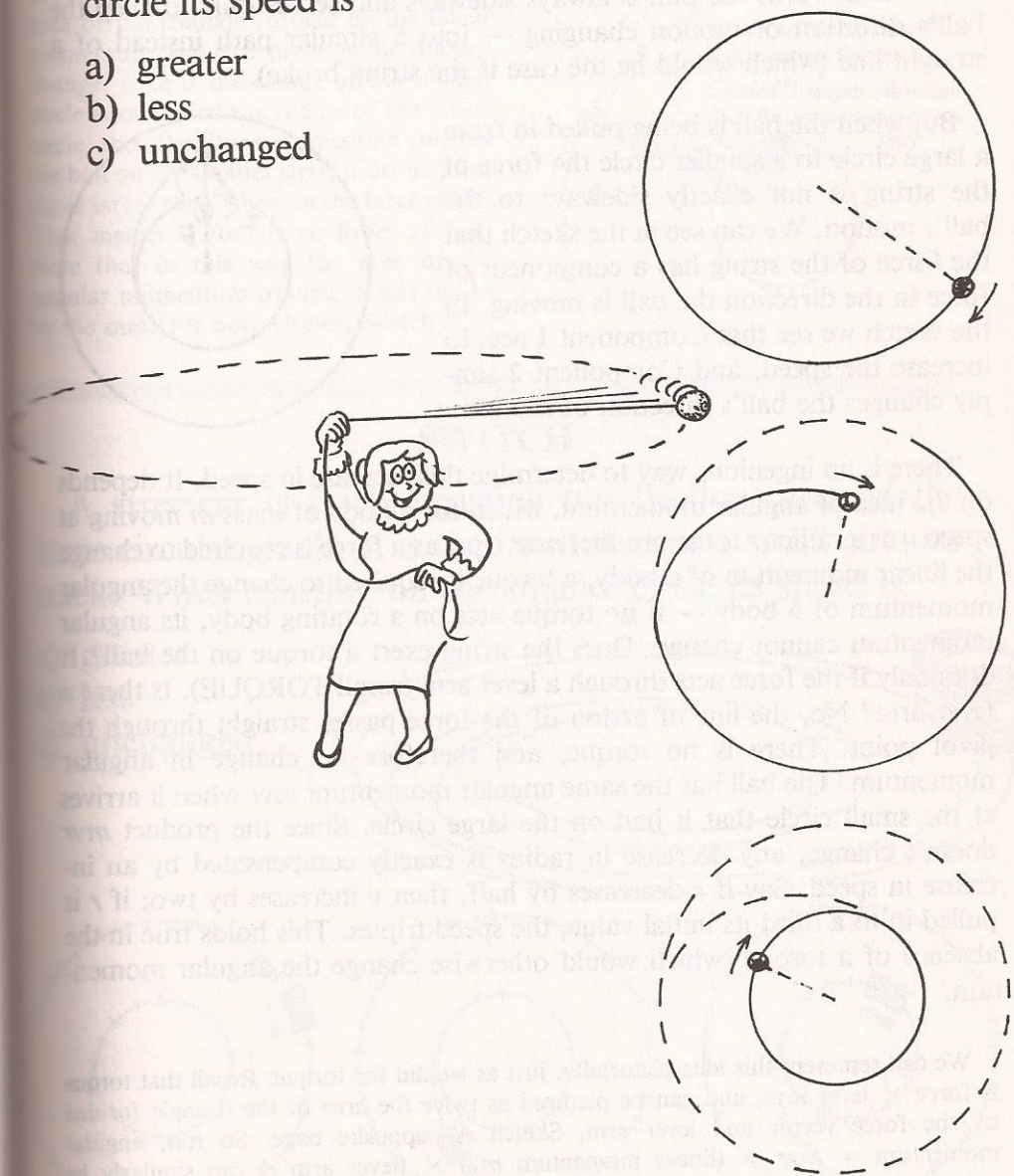
a) Yes
b) No



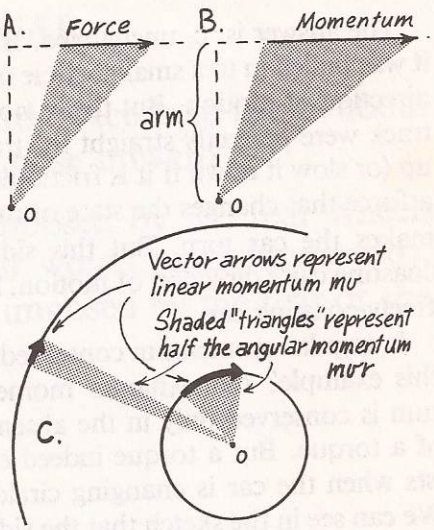
## BALL ON A STRING

A ball held by a string is coasting around in a large horizontal circle. The string is then pulled in so the ball coasts in a smaller circle. When it is coasting in the smaller circle its speed is

a) greater
b) less
c) unchanged



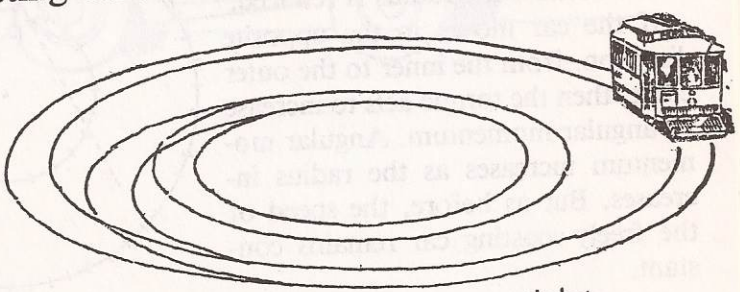
represented by twice the area of the triangle formed by the linear-momentum vector and the lever arm, Sketch *B*. If no torque acts on any rotating system, its angular momentum will not change. In the case of our circling ball, the angular momentum is the same on the outer circle as it is on the inner circle. That means the area of the triangle formed by the linear momentum and the pivot point doesn't change. Like if the radius of the smaller circle is one third the radius of the larger circle, then the linear momentum ($mv$) of the ball on the smaller circle must be three times larger than when on the large circle. That means it goes three times as fast. Note that in this way the area of the angular momentum triangle comes out to be the same for both circles, Sketch *C*.

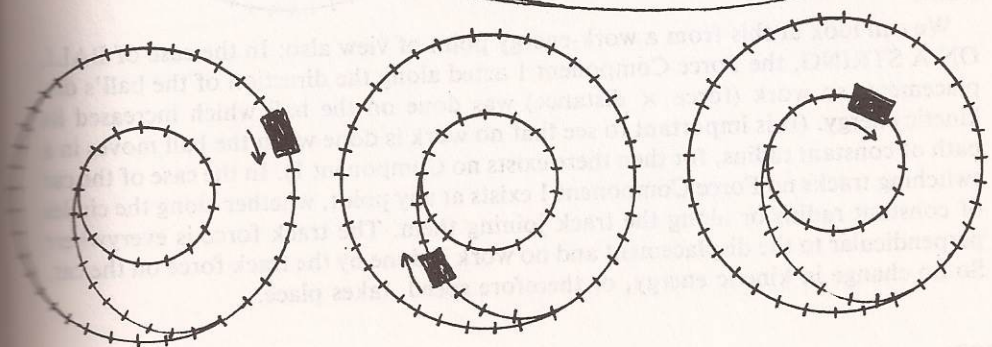



## SWITCH

A streetcar is freely coasting (no friction) around the large circular track. It is then switched to a small circular track. When coasting on the smaller circle its speed is

a) greater
b) less
c) unchanged

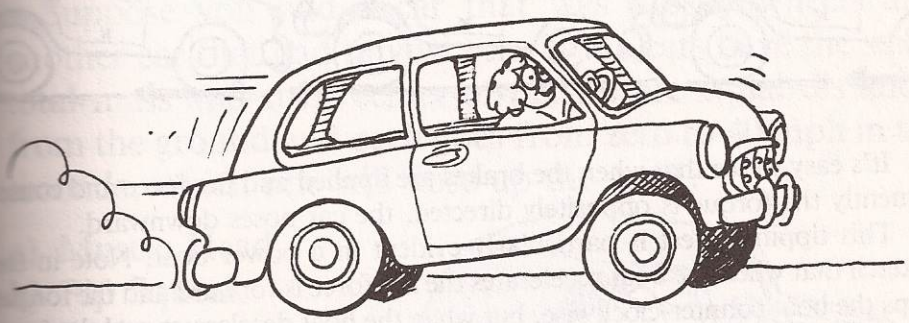




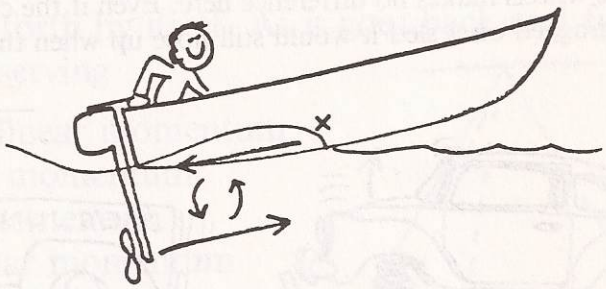
## NOSING CAR

When a car accelerates forward, it tends to rotate about its center of mass. The car will nose upward

a) when the driving force is imposed by the rear wheels (for front-wheel drive the car would nose downward).
b) whether the driving force is imposed by the rear or the front wheels



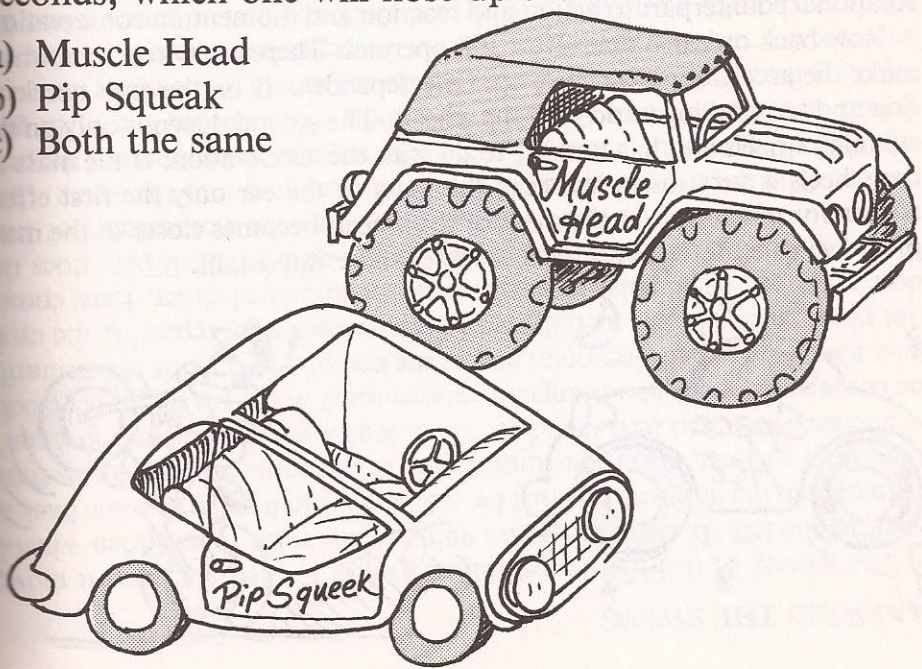
on the prop, but the prop is deeper in the drink and is farther than the hull bottom from the boat's center of mass. So the bottom friction and prop act together to produce a turning couple or torque.



## MUSCLE HEAD & PIP SQUEAK

Suppose you had a car that was mostly wheels and another car that had tiny wheels. If the cars have the same total mass and their center-of-masses are equal distances from the ground and each goes from zero to 40 mph in ten seconds, which one will nose up the most?

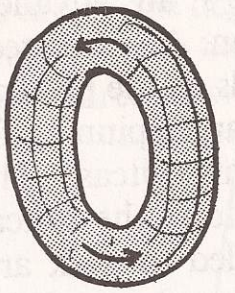
a) Muscle Head
b) Pip Squeak
c) Both the same

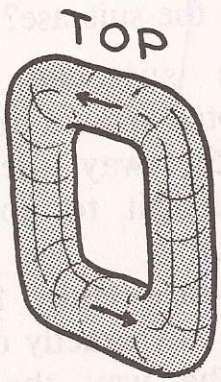


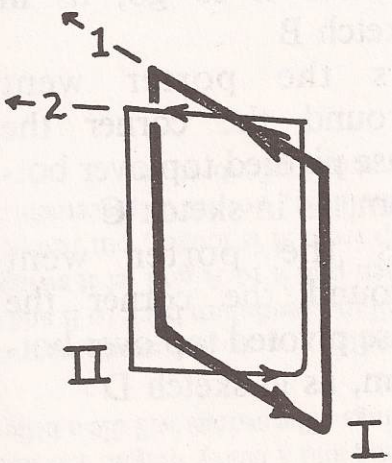
## YRO PRANK

r is: d. Gyroscopic mo-
omplicated, but we can
we picture the spinning
round pipe or tire or
which some heavy liquid
. Next, picture the ring
square ring. The liquid
flowing up one side,
tally over the top, then
wn the other side and
tally back on the bot-

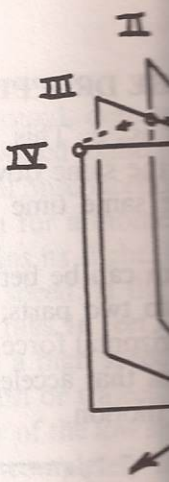
ture the "square" fly-
ng from position I to
s the porter goes around
The part of the liquid
and down in the vertical
pipe does not change its
f flow as the square
loop pivots from position
vertical sides remain ver-
he liquid flowing in the
rns does change its direc-
. For example, the liquid
might begin flowing in
and finish in direction 2.
sketch shows how a por-
id flowing in the top pipe
pipe is actually forced to
curve as the porter turns
Now, when a thing goes
ipe which is turning it ex-
e on the side of the pipe.
r CAROUSEL.) Why? Be-
hing tends to go straight,
ed to turn. The arrows in
ketch show the direction
e on the sides of the pipe.
on the top and bottom are
nd so the direction of the





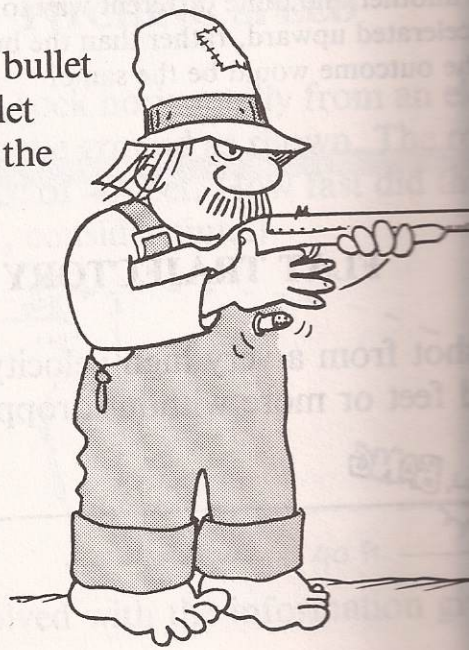

force on the top and bottom are opposite. The force on the pipe is the same as the force on the flywheel and that force is communicated to the suitcase. The top tilts to the right and the bottom to the left — as in sketch "D."



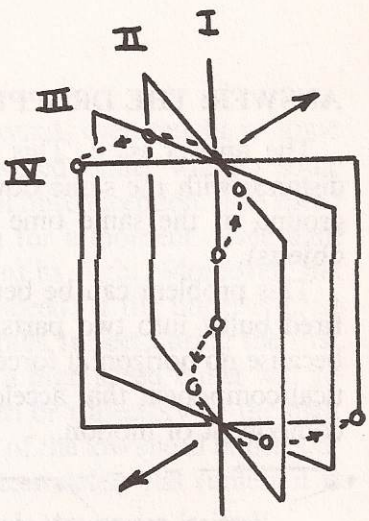

## THE DROPPING BULLET

At the same time that a high-speed bu
horizontally from a rifle, another bullet is sim
from the same height. Which bullet strikes
first?

a) The dropped bullet
b) The fired bullet
c) Both stike at the same time



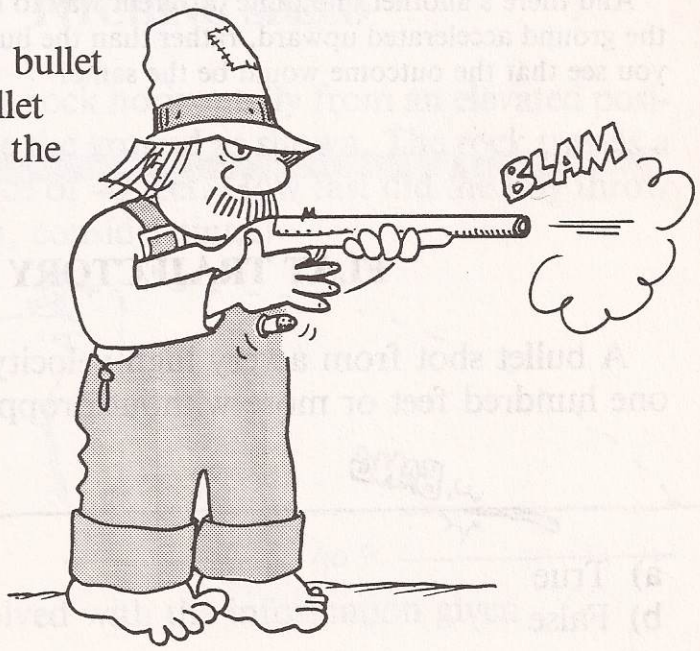
force on the top and bottom are opposite. The force on the pipe is the same as the force on the flywheel and that force is communicated to the suitcase. The top tilts to the right and the bottom to the left — as in sketch "D."




## THE DROPPING BULLET

At the same time that a high-speed bullet is fired horizontally from a rifle, another bullet is simply dropped from the same height. Which bullet strikes the ground first?

a) The dropped bullet
b) The fired bullet
c) Both stike at the same time



Answers:

Absolute Motion: b
Torque: a
Ball on string: a
Switch: c
nosing car: b
muscle head & pip squeak: a (due to the larger moment of inertia of muscle-heads wheels)

The last 2 pages show the diagram for the suitcase trick done in class.

These questions were taken from:

http://www.amazon.com/Thinking-Physics-Understandable-Practical-Reality/dp/0935218084

Another great book for conceptual understanding is

http://www.amazon.com/Flying-Circus-Physics-Jearl-Walker/dp/0471762733