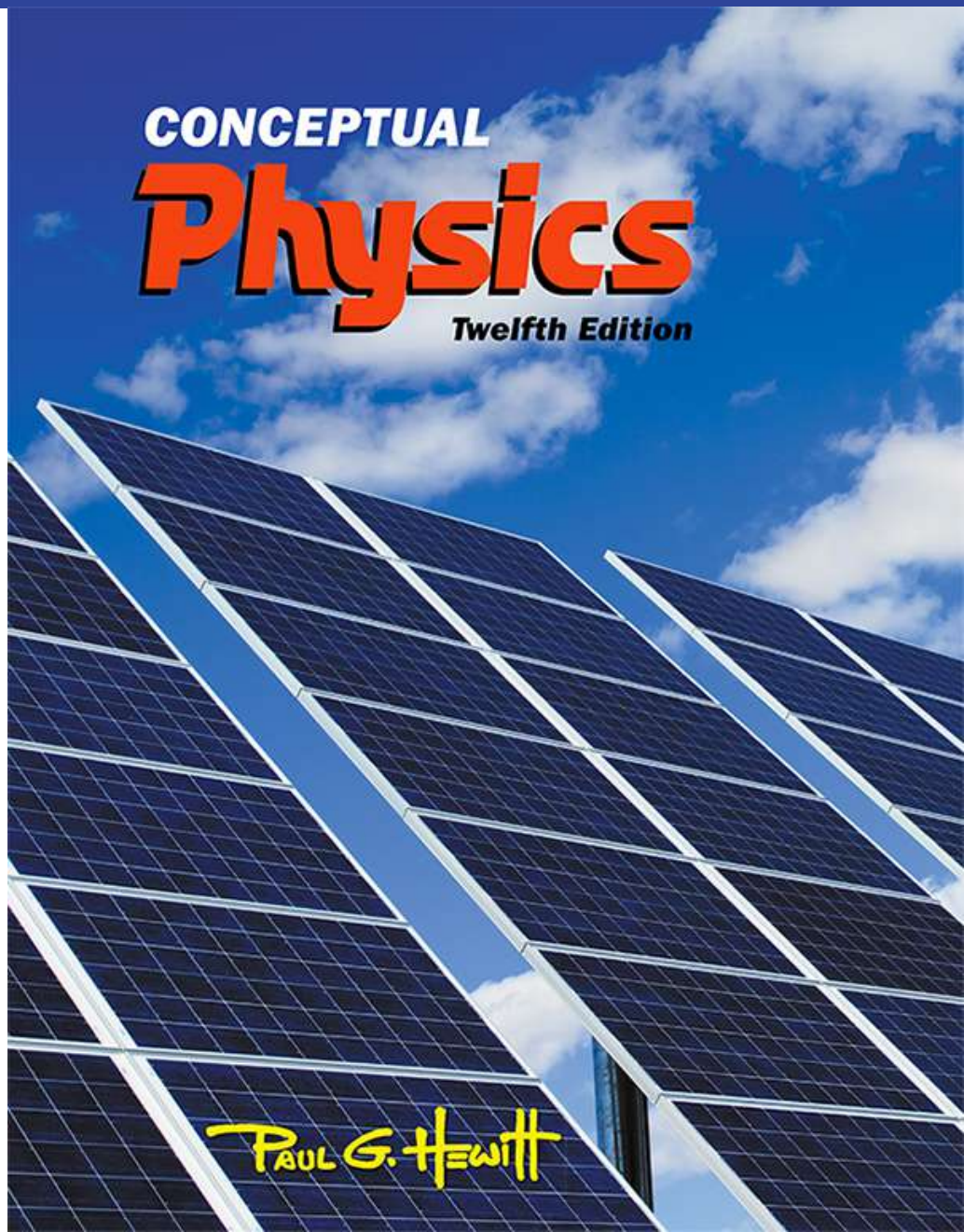
Lecture Outline

Chapter 8: Rotational Motion

Rotational Inertia



Rotational Inertia

- You will learn:

- Why you choke up on a bat.
- Why you curl your arms when you run.
- Why flywheels are used.
- Why you extend your arms for balance.
- How to balance a hammer.

Review: Inertia for straight line motion:

1) *Inertia*: Property of an object it has that resists *changes* in its motion.

2) More mass → More inertia

3) The more inertia (or mass) you have, the harder it is to *change* your motion.

→It is harder to get started; and,

→it is harder to stop.

4) Newton's 1st Law (Law of inertia):

→An object at rest tends to stay at rest.

→An object in motion tends to stay in motion.

Example:

Force and Motion

Girl pulls table cloth quickly but dishes remain on the table – a lot of physics is happening here

What force keeps the dishes in place? No force. It is inertia.

- Newton's *Law of Inertia* for rotating objects:

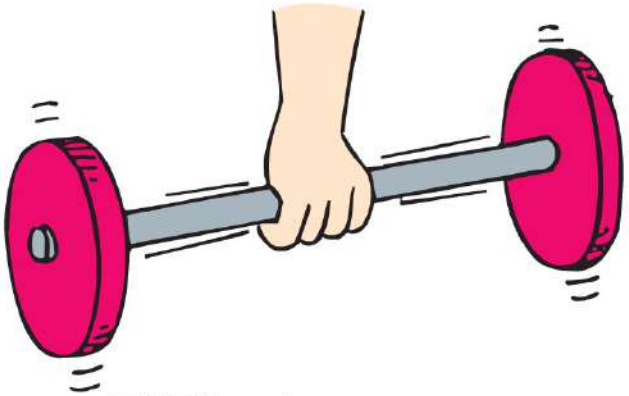
An object rotating about an axis tends to remain rotating about the same axis at the same rotational speed unless interfered with by some external influence.

- Think: wheel.
- Now think: really big wheel.
- Which is harder to start or stop? big wheel
- The property of an object to resist changes in its rotational state of motion is called **rotational inertia (symbol *I*).**

Rotational Inertia, Continued

- Depends upon
  - mass of object.
  - distribution of mass around axis of rotation.
    - The greater the distance between an object's mass concentration and the axis, the greater the rotational inertia.

Easy to rotate



Difficult to rotate

Which has more normal inertia?

neither…same mass

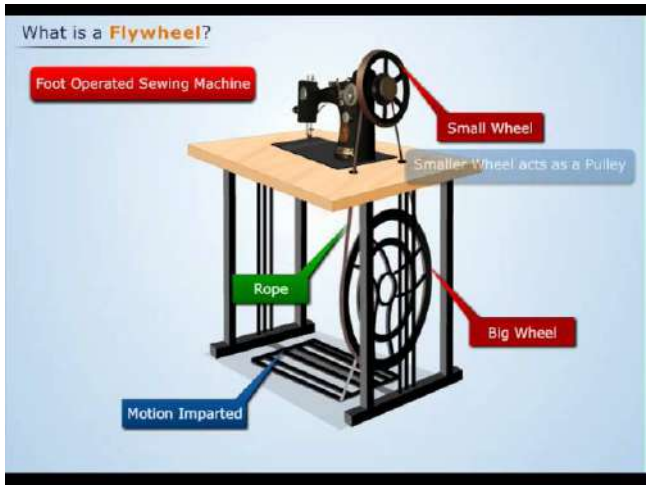
Which has more rotational inertia?

one with masses at end

Ex. Flywheels are used to stored *kinetic* (motion) energy. Once rotating, they tend to keep rotating:

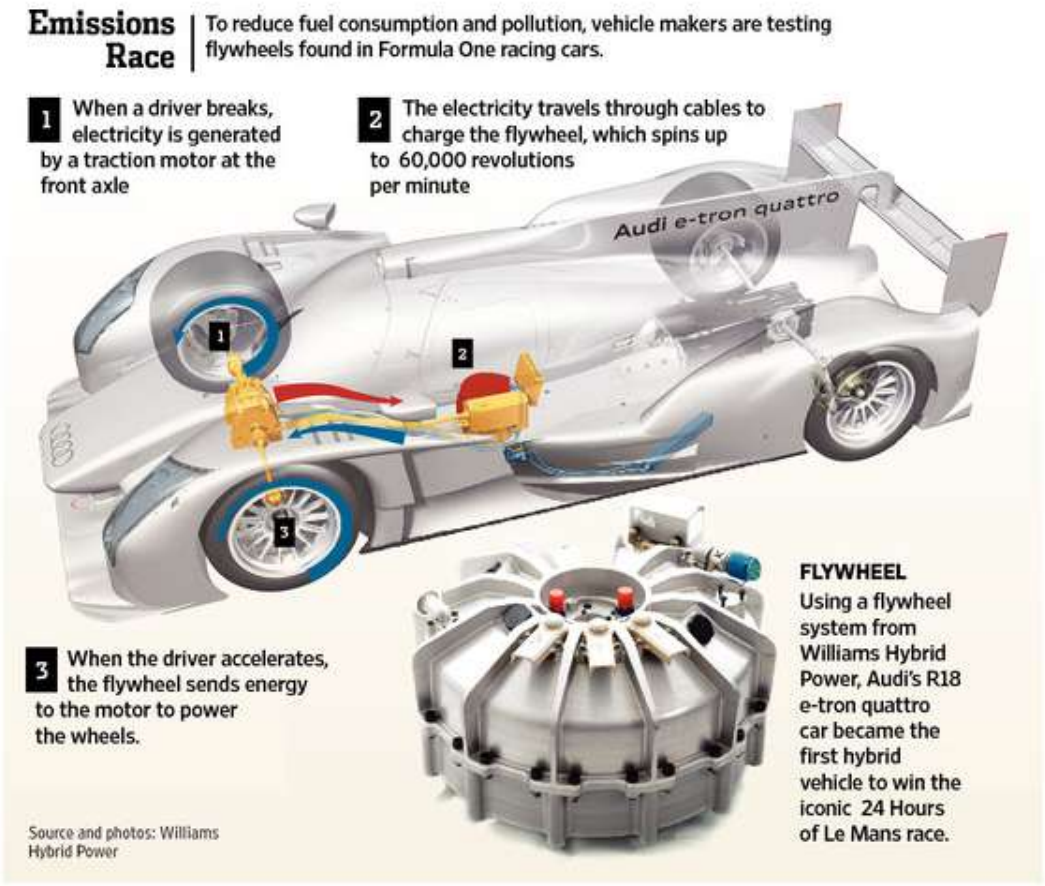
train

sewing machine



car

Hybrid car use flywheels help store KE

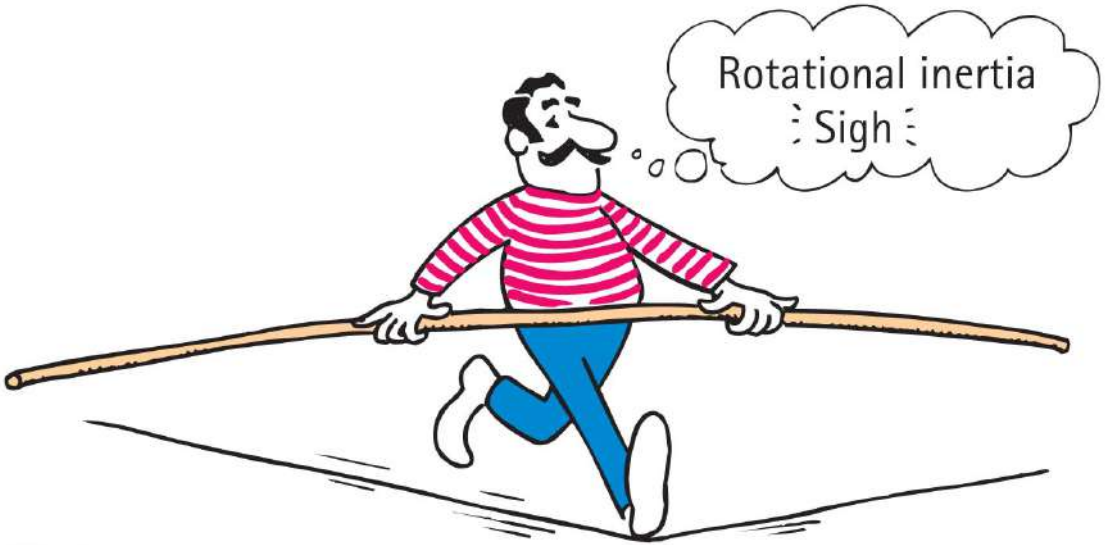


Why let all that KE go into friction, which heats things up and cannot be easily reused?

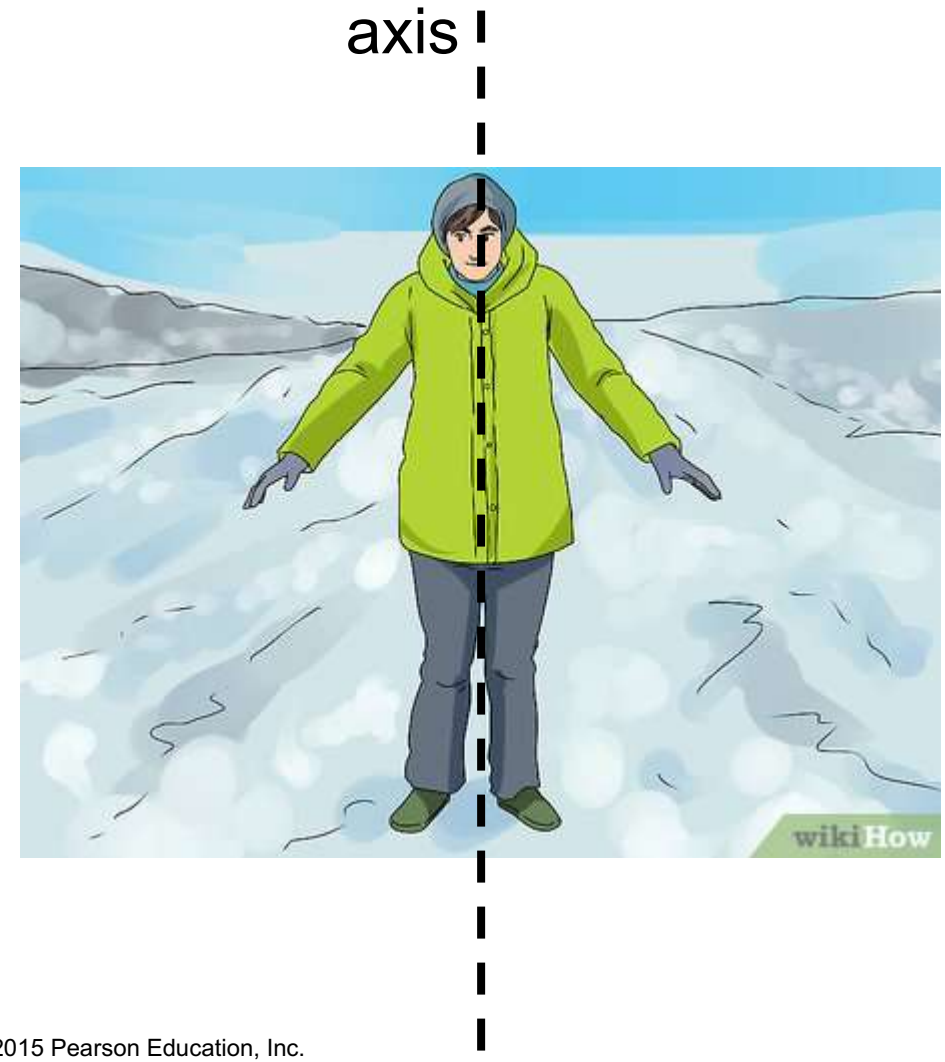
that can be used when they accelerate.

Rotational Inertia, Continued-1

- The greater the rotational inertia, the harder it is to change its rotational state.
- Why does a tightrope walker carries a long pole?
- It has a high rotational inertia, so it does not easily rotate.
- It keeps the tightrope walker stable.



Ex. Walking on ice



Why do you put your hands out to help you balance?

It puts mass further from your axis of rotation.

This increases your rotational inertia.

This resists changes in your motion

Rotational Inertia…depends on the axis around which it rotates:

1) Which axis has the pencil mass closest to it? A

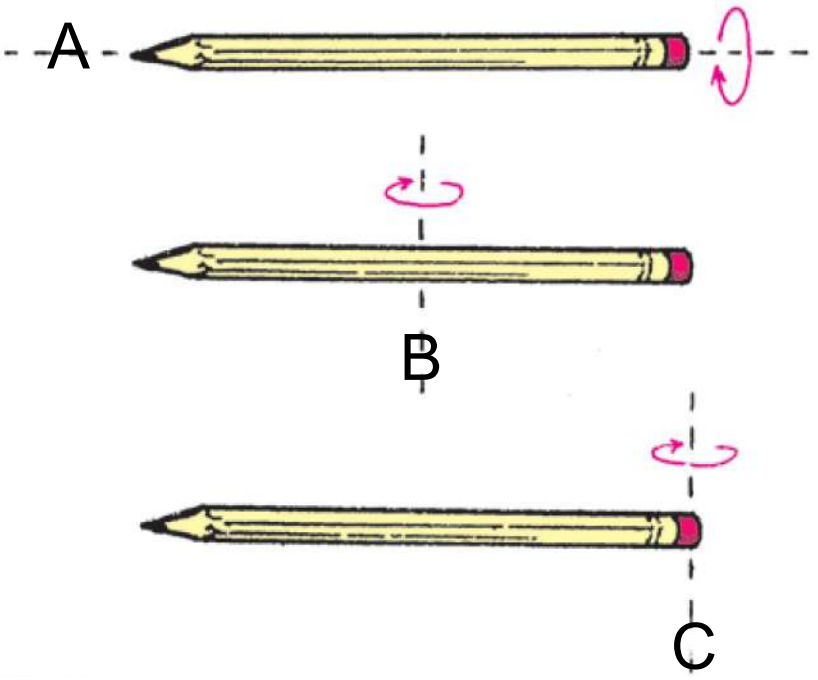
Which axis has the pencil mass furthest from it? C

2) Which axis has the most rotational inertia? C

Which has the least? A

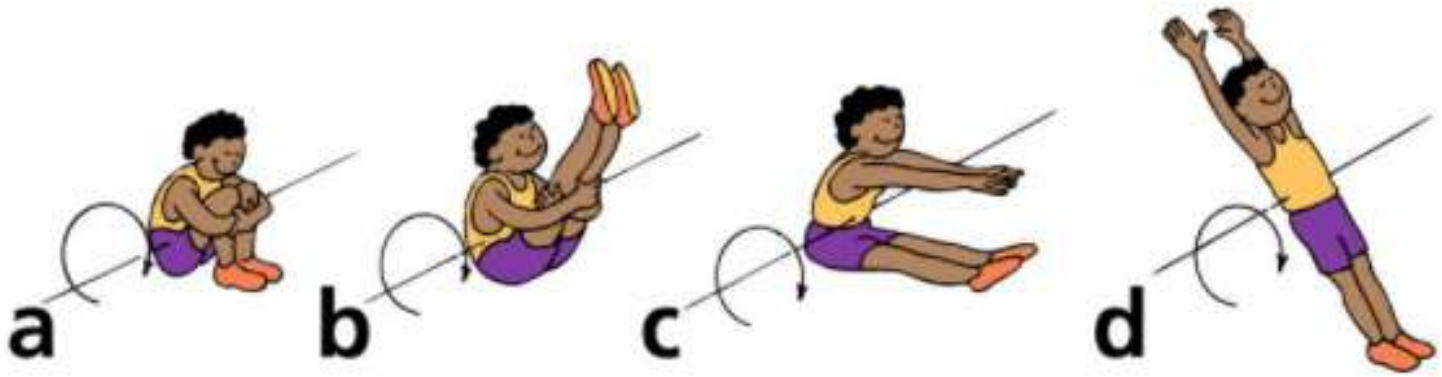
3) Which is easiest to rotate? A

Which is most difficult to rotate? C



Gymnasts change their rotational inertia:

Where is the rotational inertia the greatest? d



Where is the rotational inertia the least? a

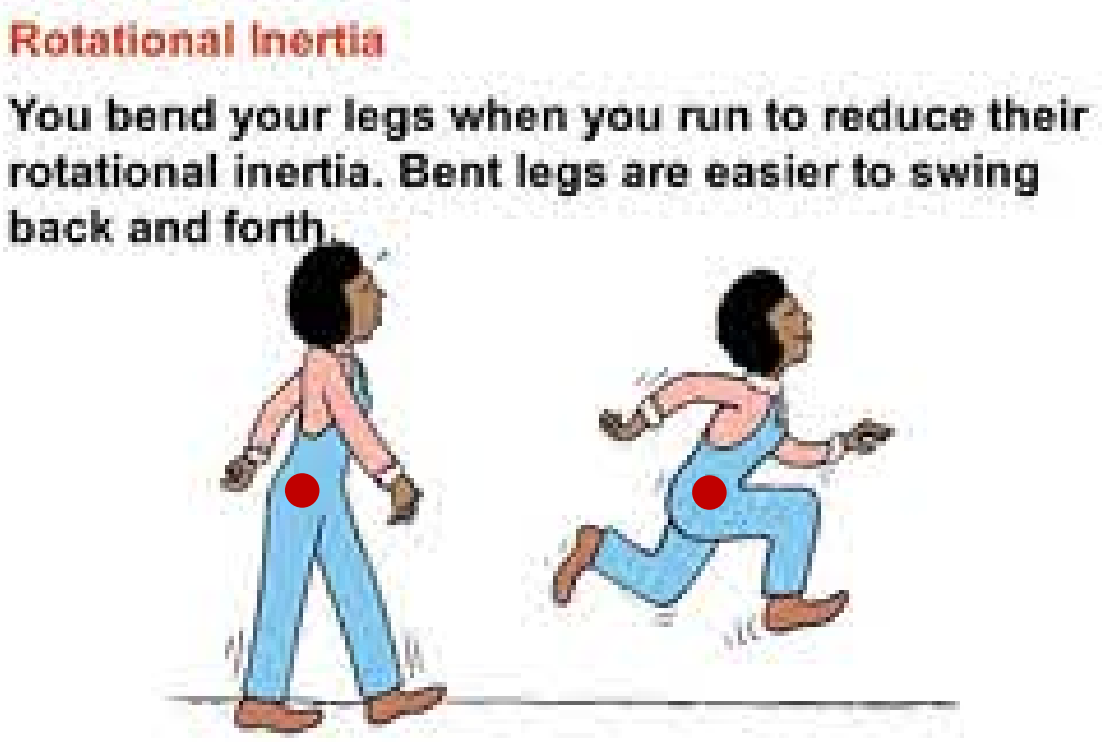
Ex. Running

Where is the axis of rotation for her legs?

hips

When you bend your legs to run, are your legs closer to or further from your hips?

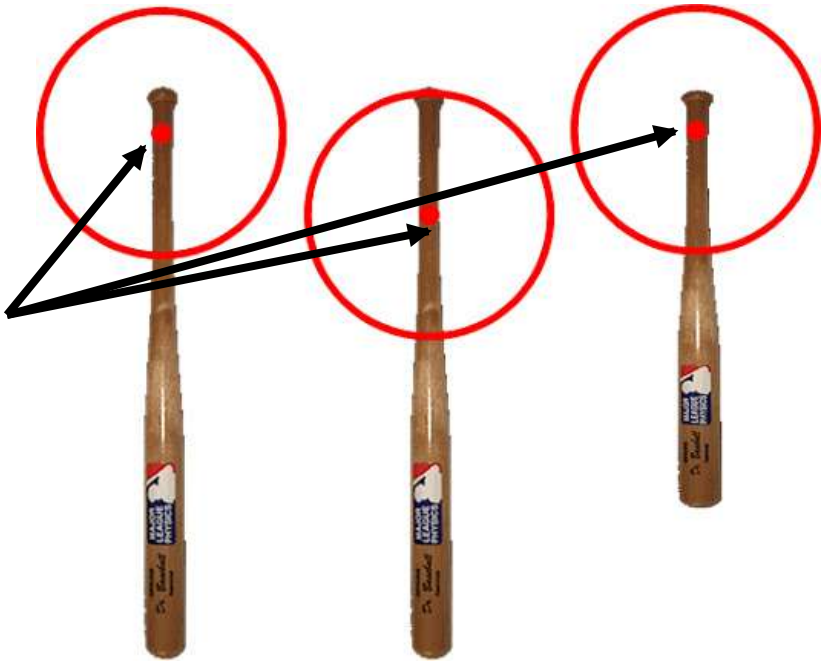
closer



Why is it easier to run when you bend your legs?

less rotational inertia…so easier to start and stop them

Ex. Choking up on a bat



Choking up means you swing the bat around different axes of rotation. It allows you to:

…bring the bat to speed in less time,

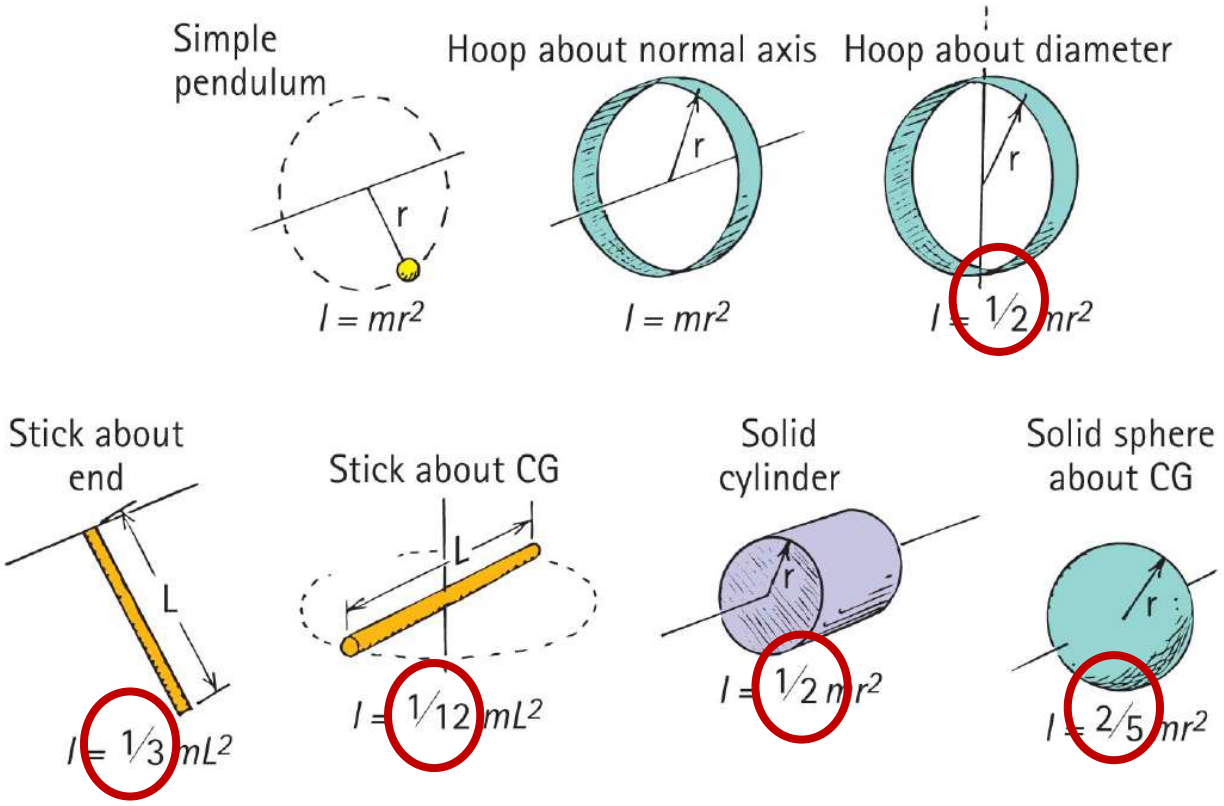
…so you can wait to see the pitch,

…and also give a greater bat velocity.

Plus, you don't have to call time out to switch bats.

Rotational Inertia of simple objects

- The rotational inertia depends upon the shape of the object and its rotational axis.
- The basic equation is: $I = mr^2$

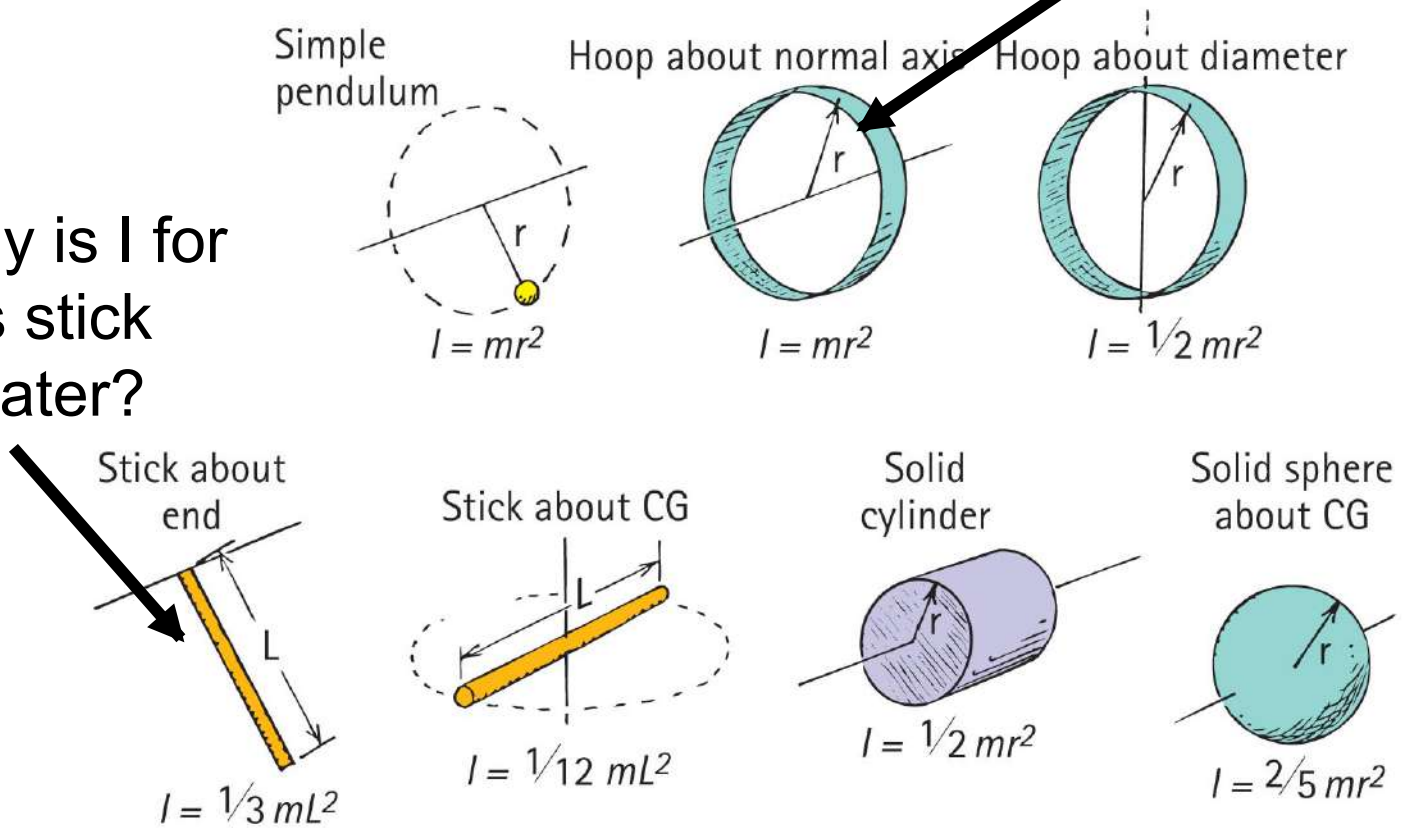


- Notice that the equations all are different fractions in front of the same ***mr²***

Details:

Why is I for this hoop greater?

Why is I for this stick greater?



I is greater when mass if further from the axis.

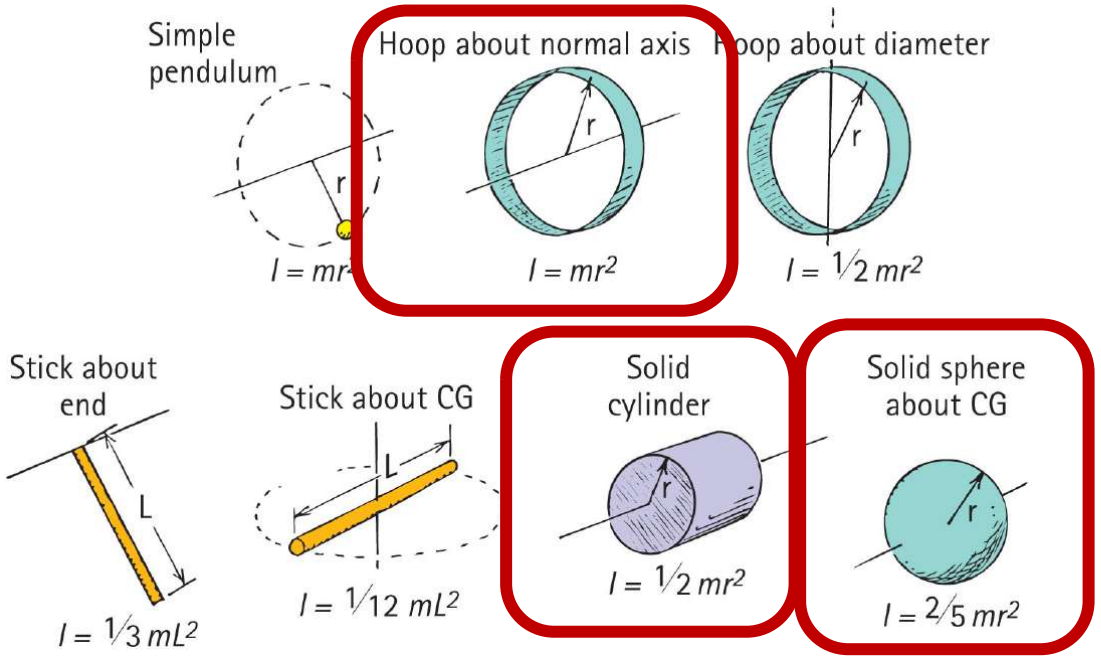
Contest: Roll a hoop (normal axis), a solid cylinder and a sphere down a ramp.

Which gets to bottom first?

sphere

Why?

smallest I

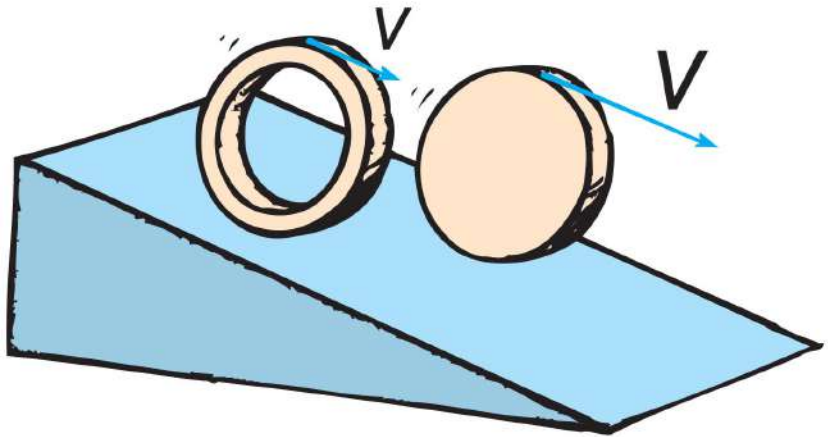


Which gets to bottom last? hoop

Why? biggest I

Rotational Inertia
CHECK YOUR NEIGHBOR

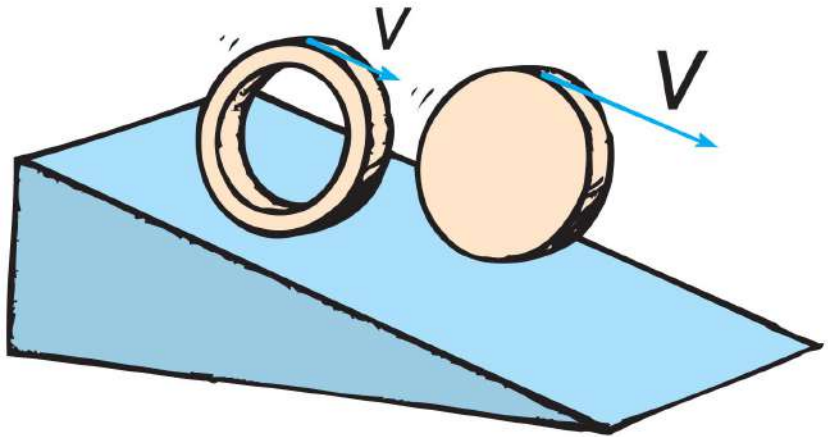
A hoop and a disk are released from the top of an incline at the same time. Which one will reach the bottom first?



A. Hoop
B. Disk
C. Both together
D. Not enough information

Rotational Inertia
CHECK YOUR ANSWER

A hoop and a disk are released from the top of an incline at the same time. Which one will reach the bottom first?

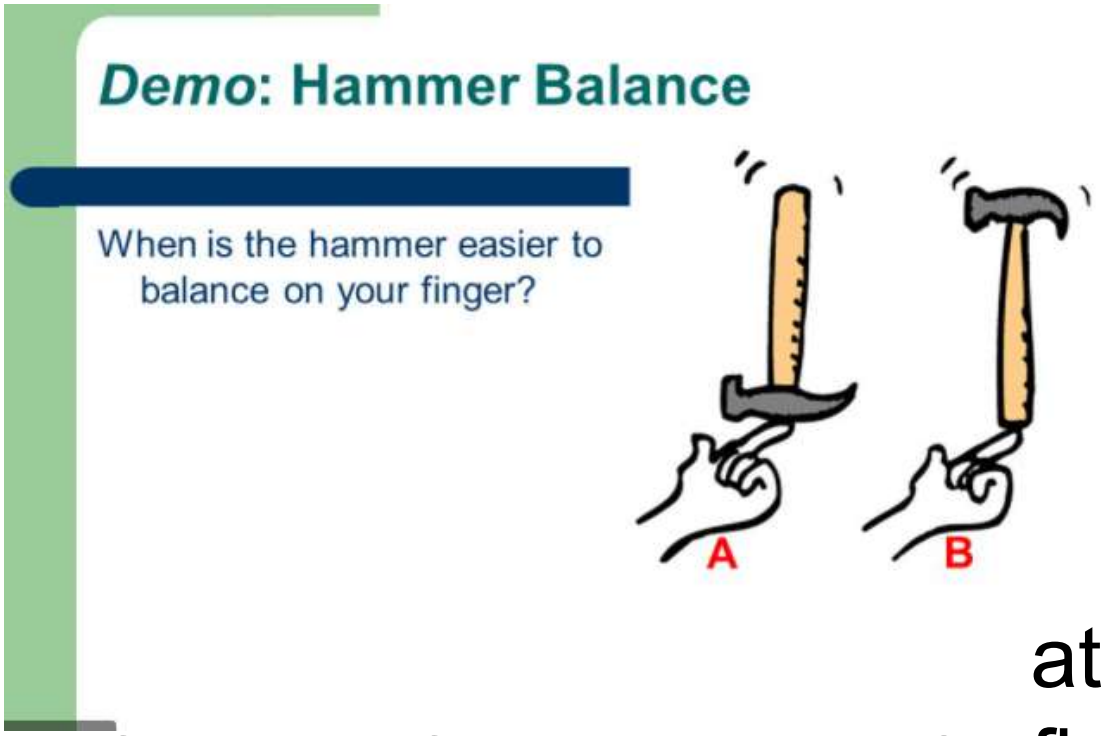


B. Disk

Explanation:

Hoop has larger rotational inertia, so it will be slower in gaining speed.

Ex. Hammer balance



Where is the axis of rotation for the hammer? at the finger

Which situation has more rotational inertia? B

Why? most mass is far from axis

Which is easier to balance? B

Homework: due Wednesday @ 7 pm

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