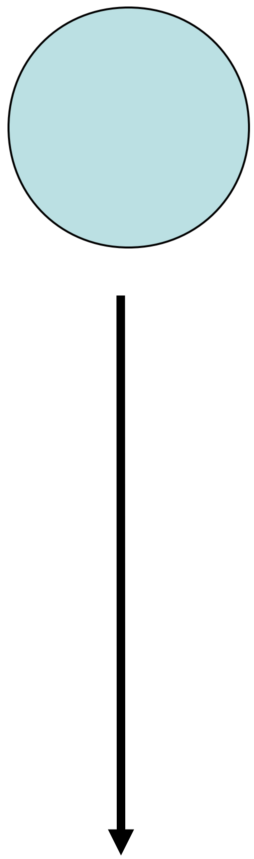
8.012 Concept Questions

Compiled by Adam Burgasser

Notes

- Questions are rated by:
  - **Easy** - >75% poll correctly on first poll
  - **Ideal** - <75% poll correctly on first attempt, but peer instruction results in majority correct in subsequent polls
  - **Challenge** - < 75% poll correctly after multiple polls
- Questions for which a demo is associated are indicated by **demo**



Ball falling close to Earth’s surface

What is the best coordinate system to use?

(1) 1D

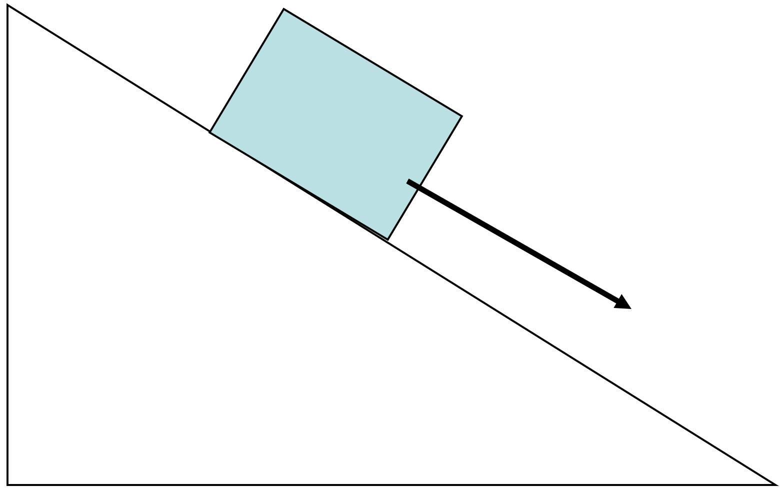
(2) 2D rectangular

(3) 2D polar

(4) 3D cylindrical

(5) 3D spherical

easy



Block sliding down an inclined plane

What is the best coordinate system to use?

(1) 1D

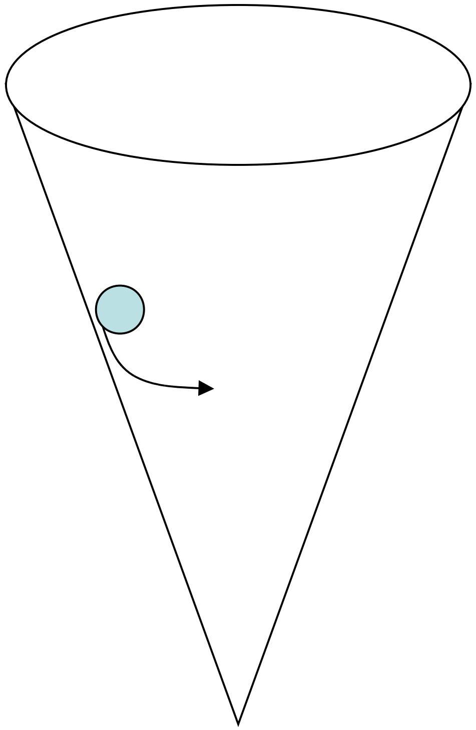
(2) 2D rectangular

(3) 2D polar

(4) 3D cylindrical

(5) 3D spherical

easy



Ball rolling on inside surface of a cone

What is the best coordinate system to use?

(1) 1D

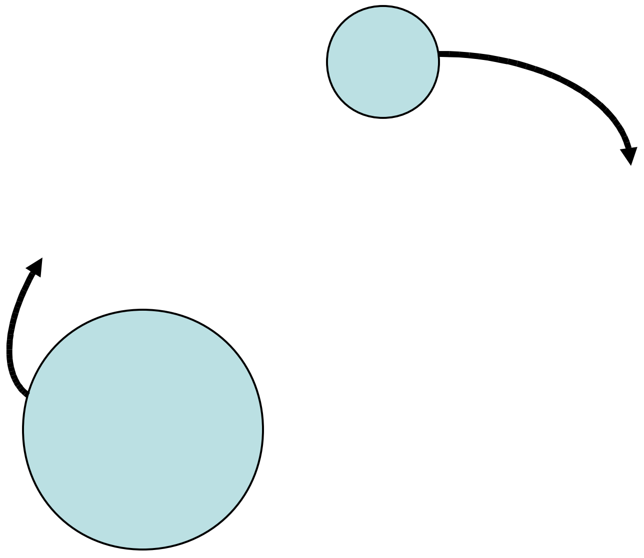
(2) 2D rectangular

(3) 2D polar

(4) 3D cylindrical

(5) 3D spherical

easy



Two planets in orbit around each other

What is the best coordinate system to use?

(1) 1D

(2) 2D rectangular

(3) 2D polar

(4) 3D cylindrical

(5) 3D spherical

ideal

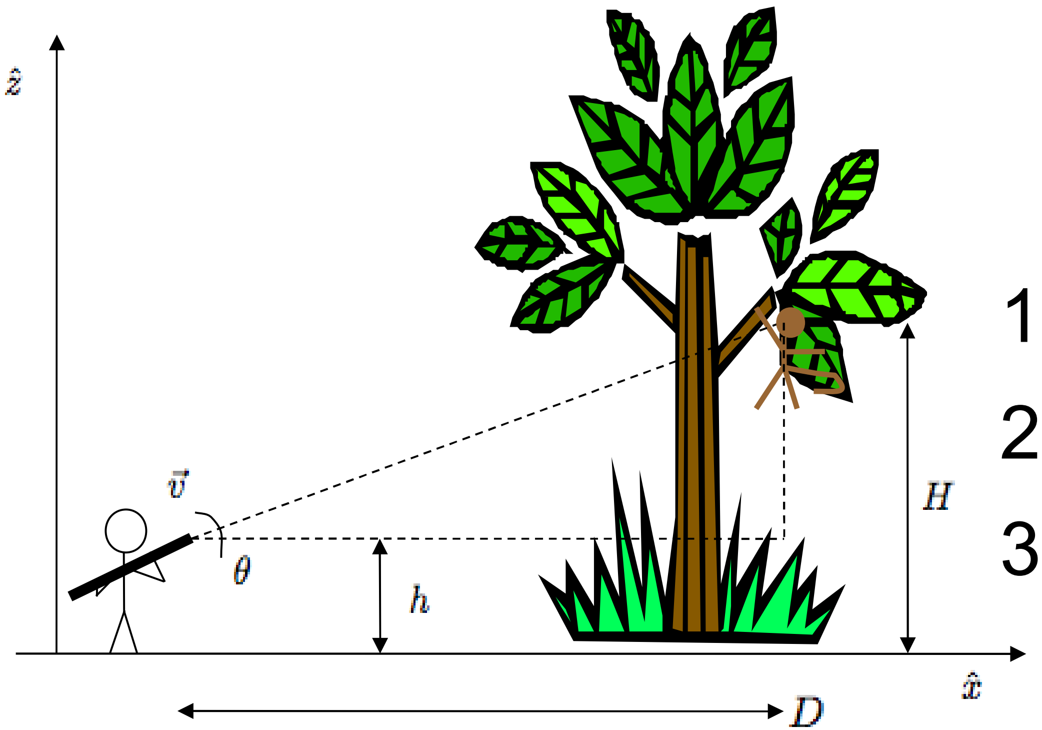
Photo by Philippe Halsman

Salvador Dali jumps from the ground into the air. At the very top of his jump, what is true about his velocity and acceleration? Assume only gravity acts on Dali.

1. His velocity and acceleration are nonzero
2. His velocity is zero but acceleration is nonzero
3. His velocity is nonzero but acceleration is zero
4. His velocity and acceleration are zero

easy

Where do we aim to hit the monkey?



1. Above the monkey
2. At the monkey
3. Below the monkey

demo

ideal

Astronauts are seen to move heavy objects in the space station almost effortlessly. Why is this?

1. Because inertial mass is decreased in space.
2. Because astronauts are stronger in space.
3. Because friction forces are reduced in space.
4. Because gravitational force is reduced in space.
5. None of these reasons.

ideal

Which of the following is a valid force law?

1. $\vec{F} = mr^2\hat{r}$
2. $\vec{F} = 3av^2$ where *a* has units of kg/m
3. $\vec{F} = b\dot{\theta}^2\hat{\theta}$ where *b* has units of kg-m
4. $\vec{F} = c\frac{m_1 m_2^2}{r^3}\hat{r}$ where *c* has units of m^4/s^2-kg^2
5. None of the above

challenge

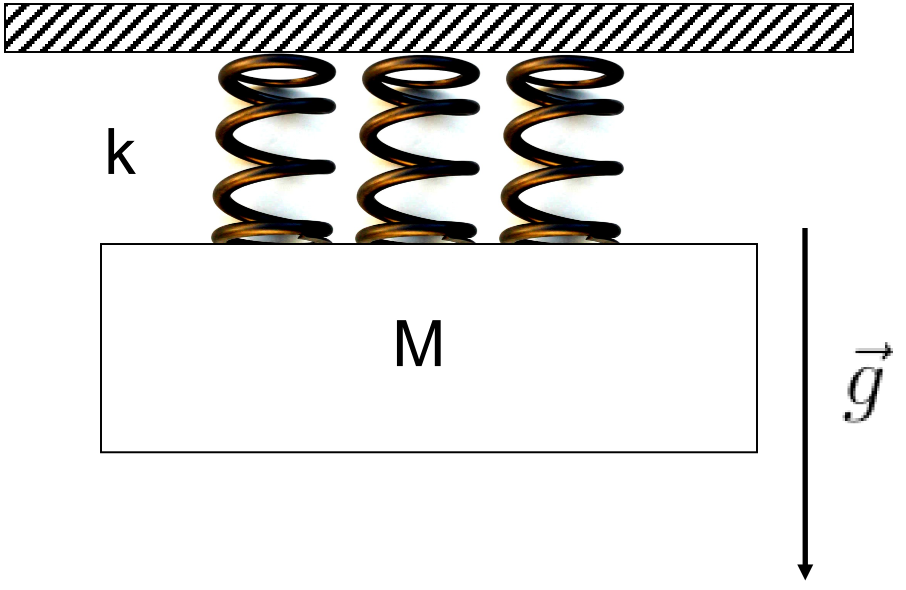
Consider the swinging rope problem we just solved. If the rope was suddenly severed, what would be the tension as a function of length? Ignore air resistance.

1. The same as before the rope was severed.
2. Constant and equal to the weight of the rope plus mass.
3. Constant and equal to the weight of the mass.
4. The tension would be zero.
5. It is not possible to constrain the problem.

ideal

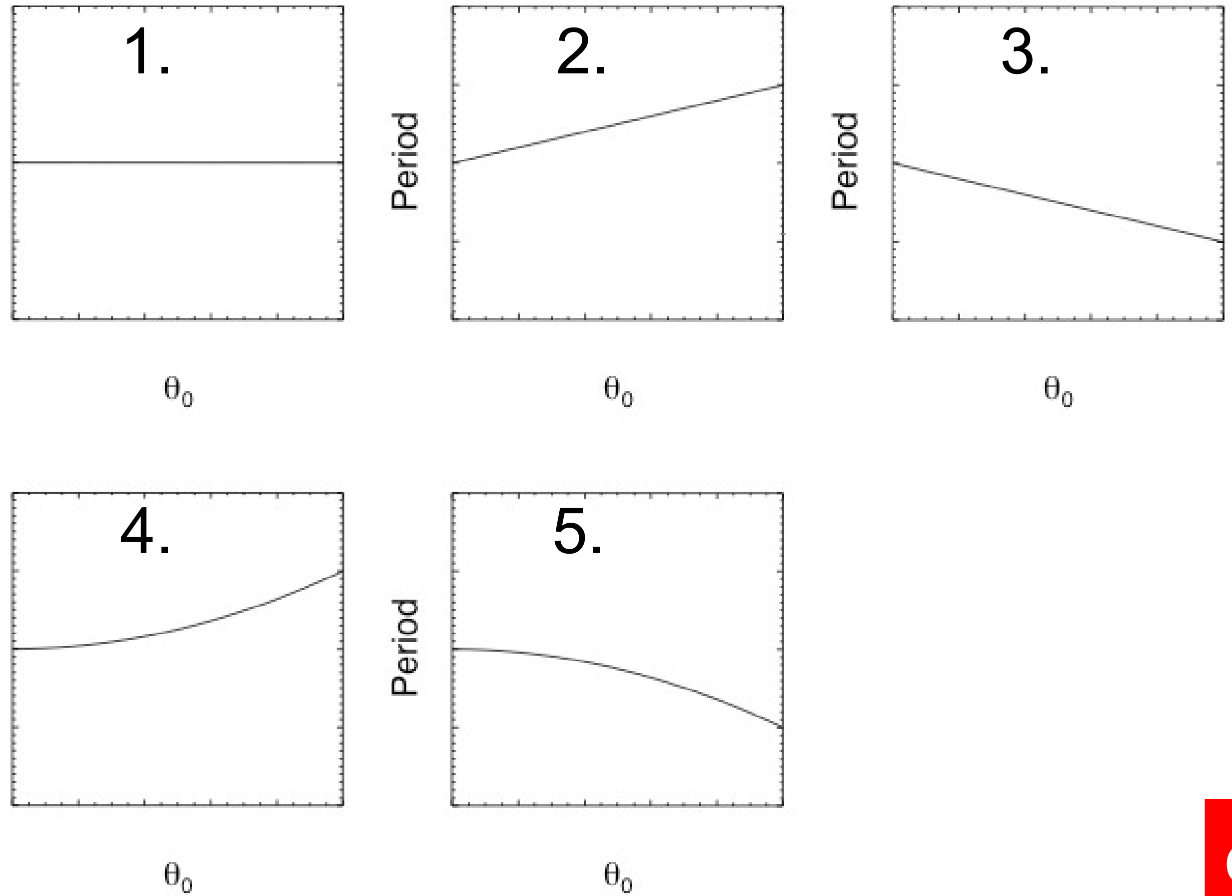
A mass M is supported by three springs each with spring constant k to a rigid mount. How does the <u>oscillation period</u> compare to the case where there is only one spring?

1. $P_3 = 3P_1$
2. $P_3 = \sqrt{3}P_1$
3. $P_3 = P_1$
4. $P_3 = \frac{1}{\sqrt{3}}P_1$
5. $P_3 = \frac{1}{3}P_1$



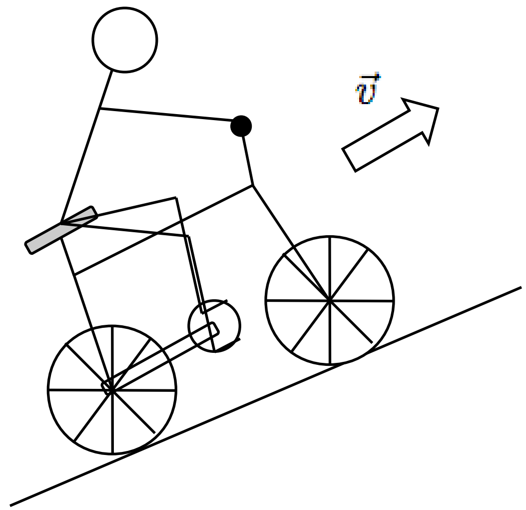
easy

Consider a pendulum comprised of a rigid rod and mass released from an initial angle θ_0 . How does the oscillation period vary with θ_0?



challenge

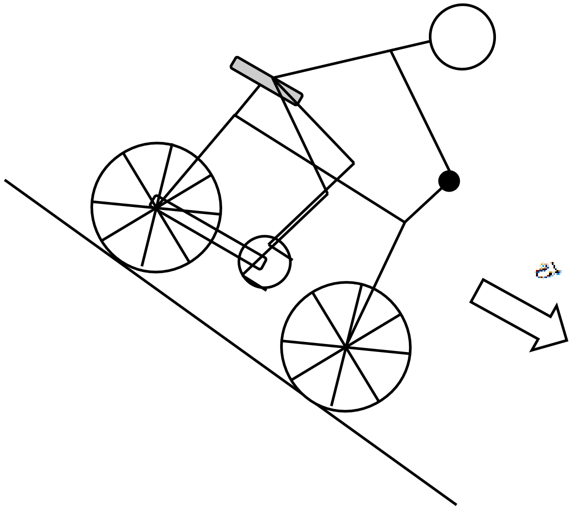
For a biker riding up a hill at constant velocity, in which direction does friction act on the biker?



1. Up the hill.
2. Down the hill.
3. Normal to the hill.
4. For a constant velocity, there is no friction force acting.

ideal

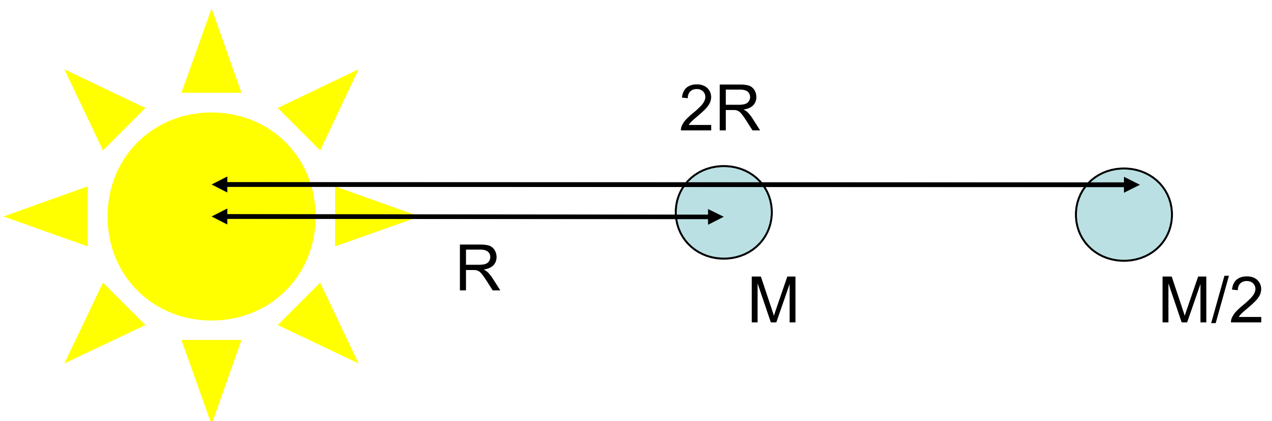
For a biker riding down a hill at constant velocity, which direction does friction act?



1. Up the hill.
2. Down the hill.
3. Normal to the hill.
4. For a constant velocity, there is no friction force acting.

ideal

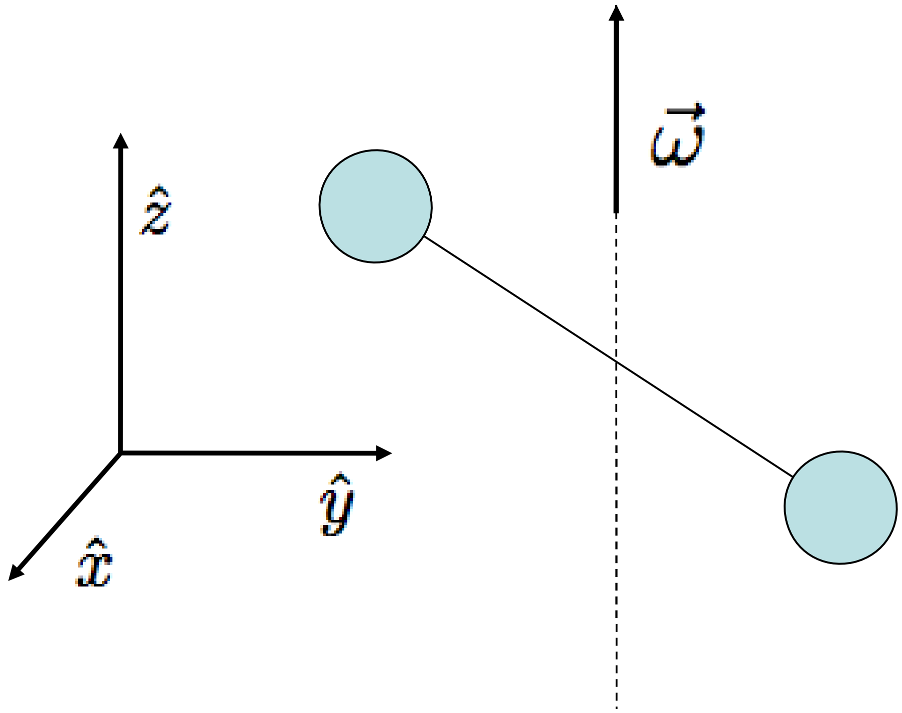
Two planets are in orbit around a star. The closer planet has mass M and the more distant planet (twice as far from the star) has mass M/2. Which planet has the most orbital angular momentum?



1. The closer planet
2. The more distant planet
3. They have the same angular momenta

ideal

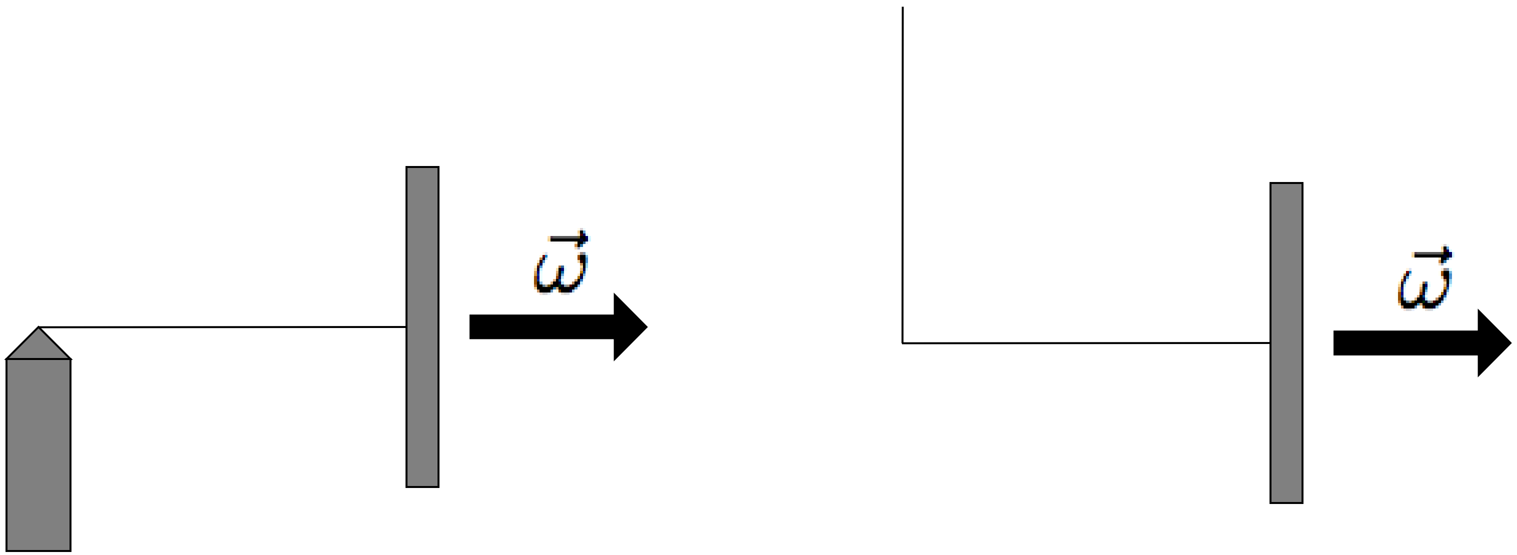
In which direction must a force be applied to top mass in order to keep the skew rod skewed at a constant rotation rate?



1. $+\hat{x}$
2. $+\hat{y}$
3. $+\hat{z}$
4. No force is necessary

ideal

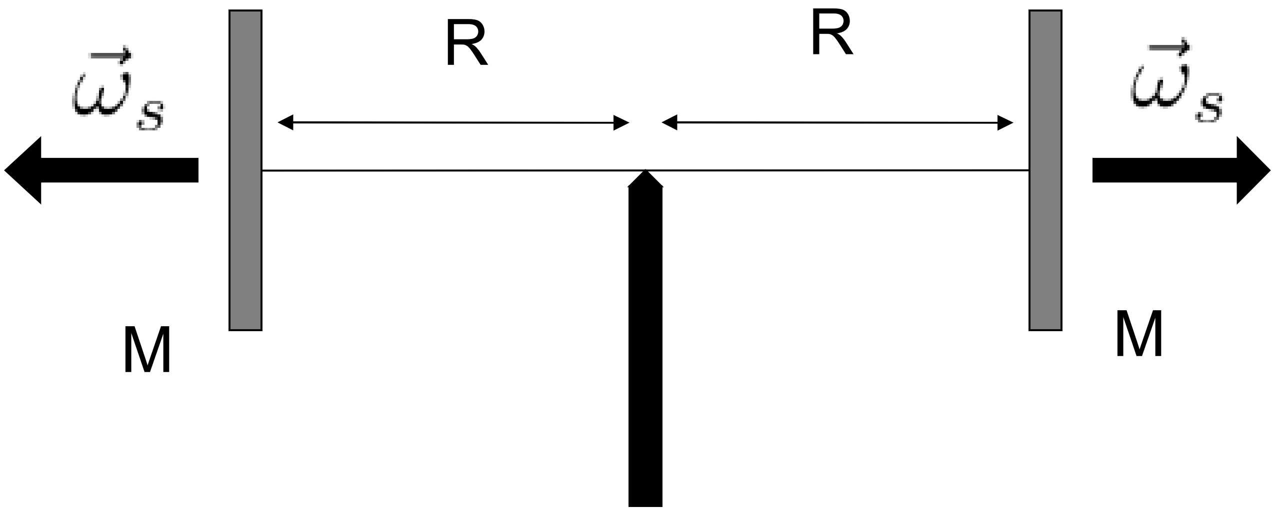
Does a gyroscope precess in the same direction if it is suspended rather than supported on a post?



1. Yes
2. No

ideal

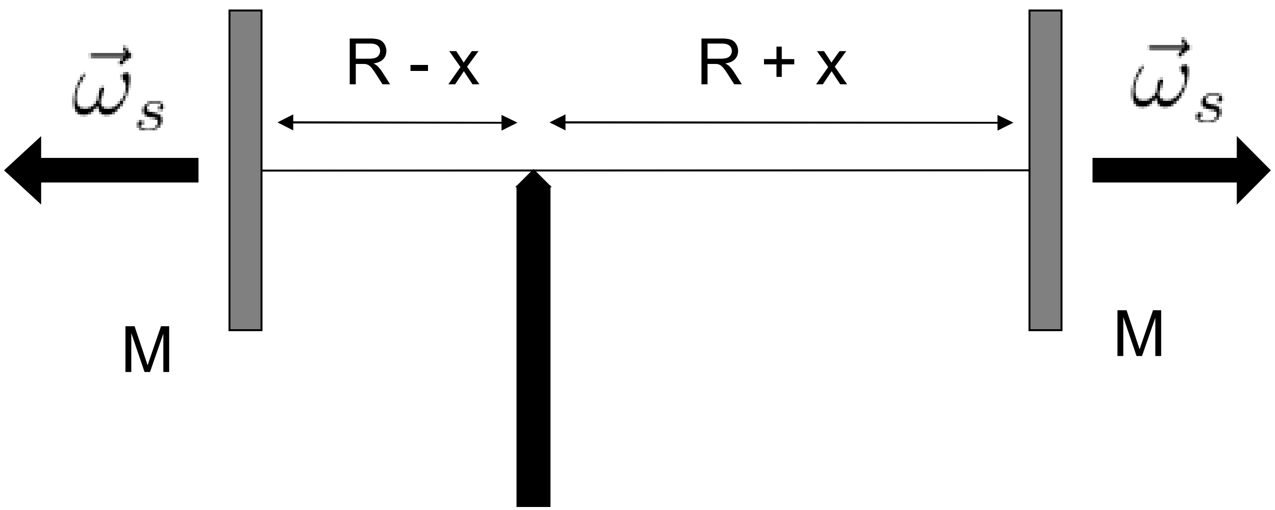
In what direction will the precession angular velocity vector point for this compound gyroscope?



1. Up (counterclockwise from above)
2. Down (clockwise from above)
3. No precession

challenge

In what direction will the precession angular velocity vector point for this compound gyroscope?



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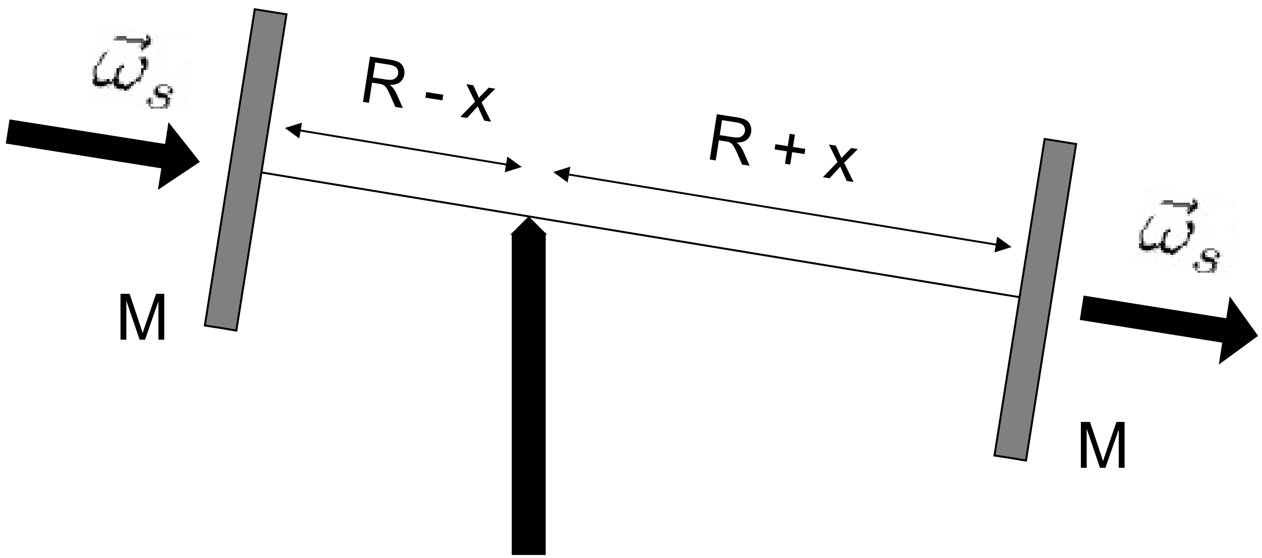
challenge

In what direction will the precession angular velocity vector point for this compound gyroscope?



1. Up (counterclockwise from above)
2. Down (clockwise from above)
3. No precession

challenge

Can fictitious forces cause an object to spin?

1. Yes
2. No

easy

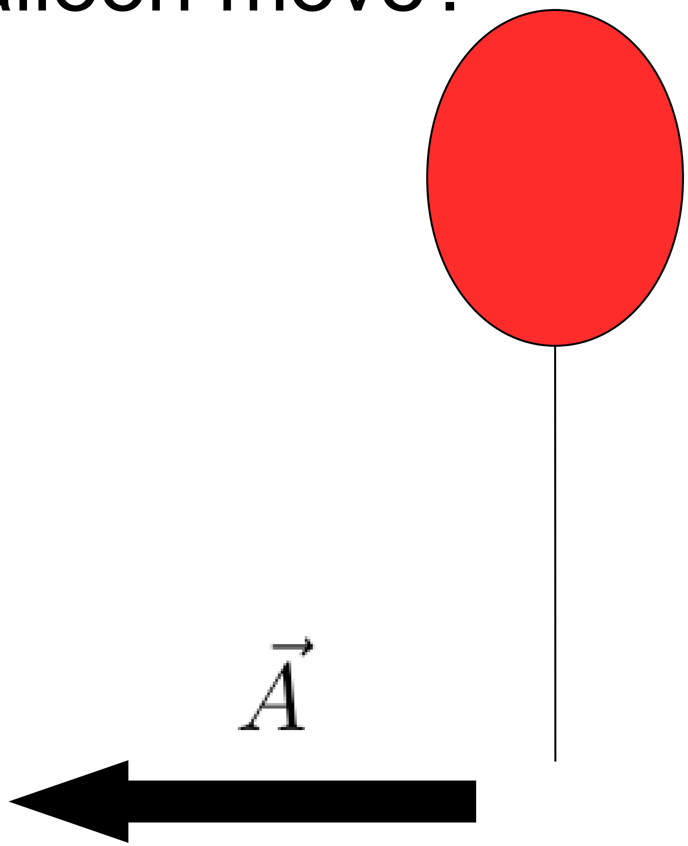
Can fictitious forces do work?

1. Yes
2. No

challenge

A ballon filled with helium is held by a hand that is suddenly accelerated to the left. Which way will the balloon move?

1. Left
2. Right
3. It won’t move

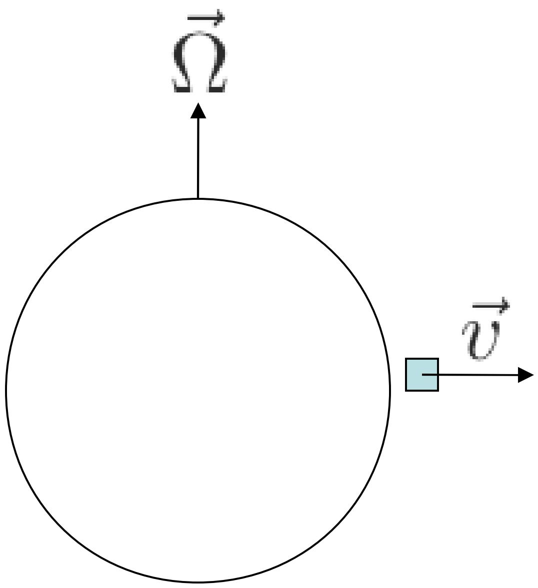


demo

easy

A student throws an object straight up at the equator on the (spinning) Earth. Neglecting air drag, in which direction will the object be displaced when it lands?

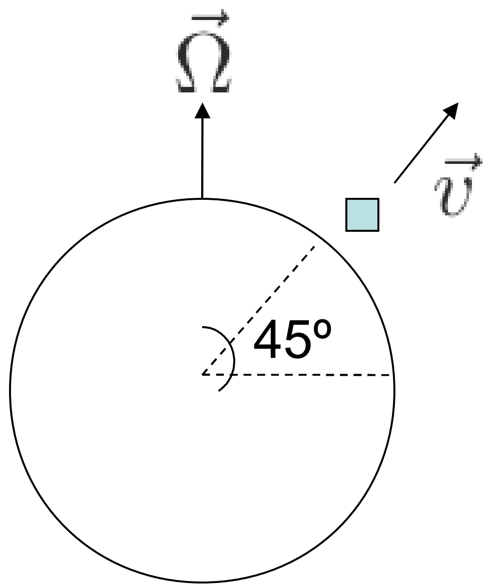
1. North
2. South
3. East
4. West
5. No displacement



challenge

A student throws an object straight up at 45ºN latitude on the (spinning) Earth. Neglecting air drag, in which direction will the object be displaced when it lands?

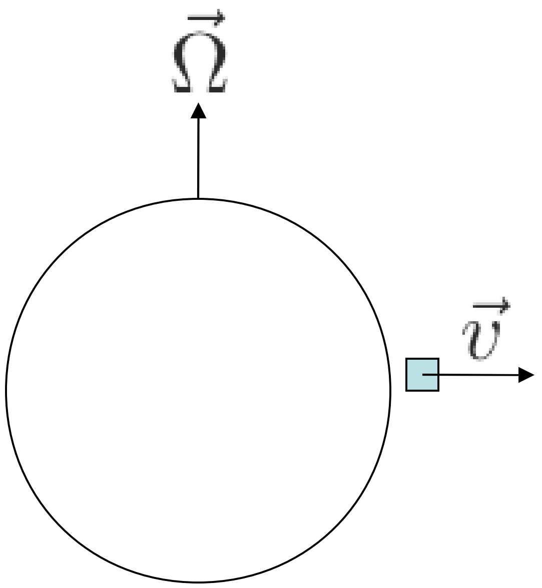
1. North
2. South
3. East
4. West
5. No displacement



challenge

A student throws an object straight up at the equator on the (spinning) Earth. Including air drag, in which direction will the object be displaced when it lands?

1. North
2. South
3. East
4. West
5. No displacement



challenge