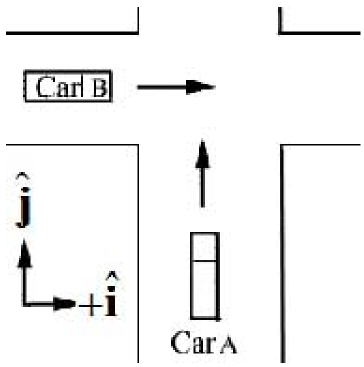
In-Class Problem 7: Law of Addition of Velocities

Suppose two cars, Car A, and Car B, are traveled along roads that are perpendicular to each other. An observer is at rest with respect to the ground. A second observer is in Car A. According to the observer on the ground, Car A is moving with a velocity $\vec{\mathbf{v}}_A = v_A\,\hat{\mathbf{j}}$, and Car B is moving with a magnitude of velocity $\vec{\mathbf{v}}_B = v_B\,\hat{\mathbf{i}}$ . .

What is the velocity of Car B according to the observer in Car A? Express your answer both as components of the velocity vector, and direction and magnitude of the velocity vector.



Problem 1:

Suppose you are sitting in a soundproof, windowless room aboard a hovercraft moving over flat terrain. The following motions occur on your trip.

A. rotation
B. deviation from the horizontal orientation
C. motion at a steady speed
D. acceleration
E. state of rest with respect to ground

Which of these can you detect from inside the room?

1. all of them
2. A, B, D
3. C, E
4. B, D
5. A, B, D, E
6. A, D
7. A
8. D

Problem 2:

Consider a person standing in an elevator that is accelerating upward. The upward normal force *N* exerted by the elevator floor on the person is

1. larger than
2. identical to
3. smaller than

the downward force of gravity on the person.

Problem 3:

An object is held in place by friction on an inclined surface. The angle of inclination is increased until the object starts moving. If the surface is kept at this angle, the object

1. slows down.
2. moves at uniform speed.
3. speeds up.
4. none of the above

Problem 4:

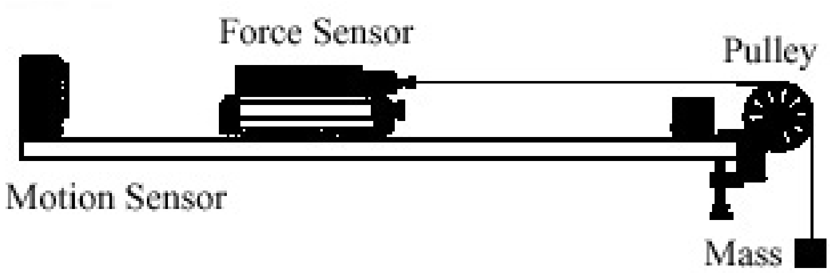
A massive rope pulls a block with friction between the block and the table. Is the tension in the rope

1) greater than the pulling force?

2) equal to the pulling force?

3) less than the pulling force?

Problem 5:



A force sensor on a cart is attached via a string to a hanging weight. The cart is initially held. When the cart is allowed to move does the tension in the string

1. increase?
2. stay the same?
3. decrease?
4. cannot determine. Need more information about friction acting on the system.

Problem 6:

In the 17th century, Otto von Güricke, a physicist in Magdeburg, fitted two hollow bronze hemispheres together and removed the air from the resulting sphere with a pump. Two eight-horse teams could not pull the halves apart even though the hemispheres fell apart when air was readmitted. Suppose von Güricke had tied both teams of horses to one side and bolted the other side to a heavy tree trunk. In this case, the tension on the hemispheres would be

1. twice
2. exactly the same as
3. half

what it was before.

Problem 8

You’re playing with a yo-yo (a vertically oriented top surrounded by a coiled string, in case you’ve never used one). The action of the yo-yo is produced by several forces, most notably tension in the string and gravity acting on the top. Which statement is true for the top just after it is released?

1) The tension in the string is greater than the force of gravity.

2) The tension is equal to the force of gravity.

3) The tension is less than the force of gravity.

Problem 9

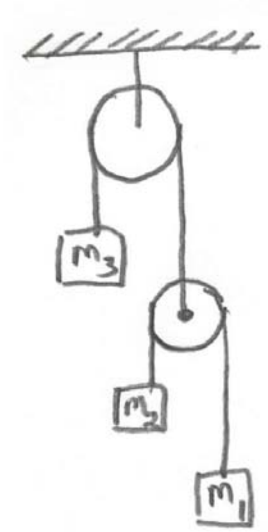
You're still playing with the yo-yo; now, you wait until the top has hit the bottom of its run and returns upward to your hand. Which statement is true for the top when it hits bottom and returns upward?

1) The tension in the string is greater than the force of gravity.

2) The tension is equal to the force of gravity.

3) The tension is less than the force of gravity.

Problem 10



A set of objects are connected via strings to pulleys and released from rest. Assume

$m_3 > m_2 + m_1 + m_p$ and $m_2 > m_1 > m_p > 0$.

Choose positive acceleration pointing down. Which describes the nature of the acceleration of object 3?

1) Equal in magnitude, but points in the opposite direction, to the acceleration of object 1

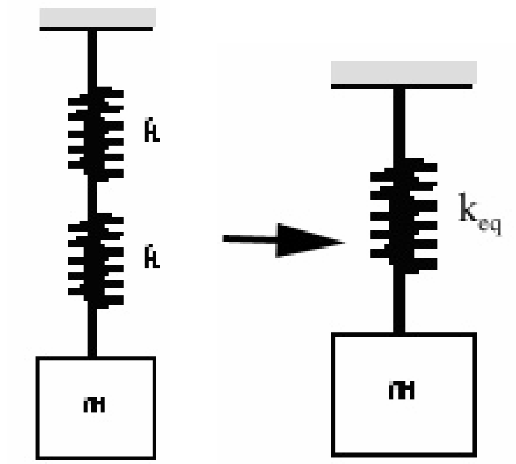
2) Less in magnitude, but points in the opposite direction, to the acceleration of object 1

3) Greater in magnitude but points in the opposite direction to the acceleration of object 1

4) Not enough information to determine the relation, but it points in opposite direction

Problem 11:

Two identical springs with spring constant k are attached to each and a mass is suspended from the lower spring. If you suspended the same mass by a single spring with a new spring constant k_{eq}



the new spring constant is related to the old spring constant by

1) $k_{eq} = k$

2) $k_{eq} = 2k$

3) $k_{eq} = \frac{1}{2}k$

4) an unknown relation; there is not enough information.