9-Series Problem

9.1) A mass *m* has momentum *p*.

a.) Generate an expression for the mass's kinetic energy KE in terms of its momentum.

b.) Write out the mass's momentum in terms of its kinetic energy KE.

9.4) A 145 gram baseball is in contact with a bat for 2.00 ms. During that time, the ball changes its velocity from 45.0 m/s in the horizontal to 55.0 m/s going straight upward. As a vector, how big a force, on average, does the bat exert on the ball during the hit?

9.5) A 40.0 kg girl standing stationary on roller skates pushes a 65.0 kg boy standing stationary on roller skates motivating him to move with velocity 2.90 m/s in the *–x direction*. Ignoring friction:

a.) Describe the girl's resulting motion.

b.) The girl's muscles burn chemical energy generating mechanical energy for the boy/girl system. How much energy did she generate with the push?

c.) During the push, is momentum conserved in the boy/girl system?

d.) Explain how the momentum in the system can be conserved even though the forces in play are large.

e.) Explain how the momentum in the system can be conserved if there is no motion before the shove but a lot of motion after the shove?

9.6) A 150 kg plank sits stationary on a frictionless, perfectly horizontal ice pond. A 45.0 kg girl stands stationary on the plank. If the girl begins to walk with velocity magnitude 1.50 m/s, relative to the plank:

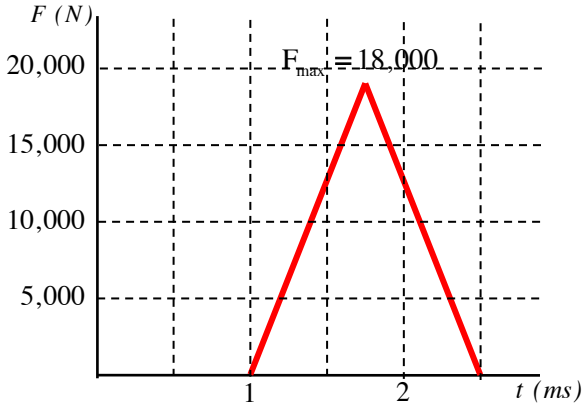
a.) What is the girl's velocity relative to the pond?

b.) What is the plank's velocity relative to the pond?

9.11) A bat strikes a ball. A somewhat unrealistic graph of the *force versus time* for the impact is shown.

a.) What is the impulse magnitude delivered to the ball by the bat?

b.) What is the average force magnitude delivered to the ball by the bat?

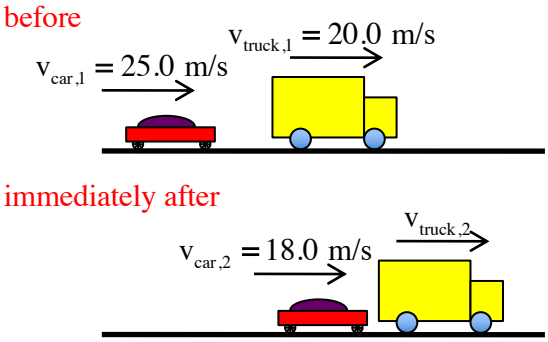


9.18) A 1200 kg car runs into the back of a 9000 kg truck. All of the pertinent information is shown in the sketch.

a.) Assuming the two vehicles don't stick together as a consequence of the crash, what is the velocity of the truck just after the collision?

b.) How much *mechanical energy* is lost during the collision?

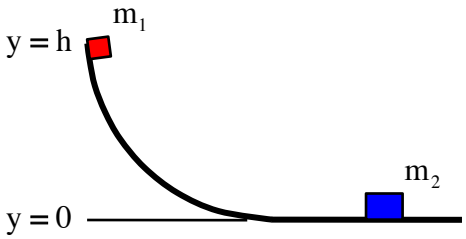
c.) Explain where all that *mechanical energy* went?



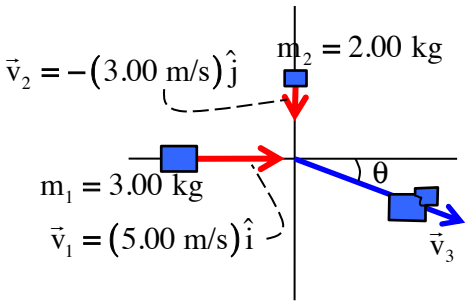
9.19) A 5.00 kg block of wood sits stationary on a frictionless surface. Just after a .010 kg slug is fired horizontally into the block, the block and slug are observed to be moving with velocity magnitude 0.600 m/s. How fast was the slug moving just before it struck the block?

9.23) A 100 gram block of wood sits stationary on a horizontal surface whose coefficient of kinetic friction is 0.650. A 12.0 gram wad of wet clay is thrown against the block in the horizontal, sticking to it. If the block and clay are observed to move together a distance 7.50 meters before coming to rest, what must the velocity of the wad have been just before the impact?

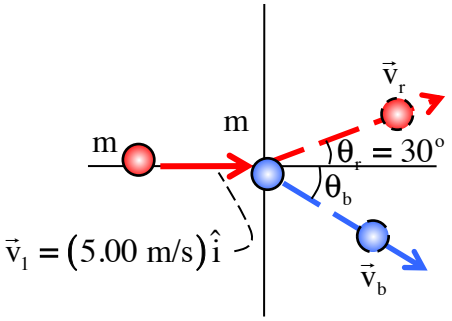
9.27) Elastic collisions are often approximated using magnetics whose like-poles are juxtaposed against one another. Assume the two masses shown on the curved incline to the right have magnets so positioned. If $m_1 = 5$ kg is released from rest a distance h = 5.00 meters above the flat part of the incline, how far vertically back up the incline will m_1 travel after its elastic collision due to magnetic repulsion with $m_2 = 10.0$ kg (initially at rest).



9.29) A perfectly inelastic collision between two mass is shown in the sketch to the right. What is the final velocity *as a vector* of the two masses after the collision?

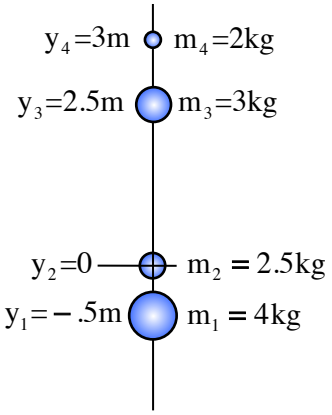


9.33) A stationary billiard ball is struck a glancing blow, assumed to be elastic, by a second ball moving at 5.00 m/s. If the attacking ball leaves with a velocity of $v_r = (4.33 \text{ m/s}) \measuredangle 30^\circ$ with respect to its original motion, what must the struck ball's "final" velocity be?

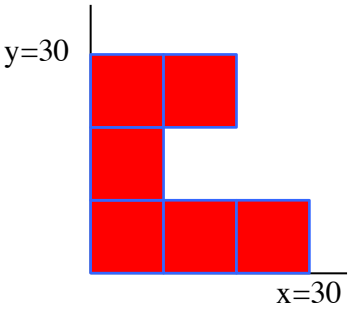


9.36) The distance between the center of mass of the earth (mass $5.97\text{x}10^{24}$ kg) and the moon (mass $7.35\text{x}10^{22}$ kg) is $3.84\text{x}10^{8}$ meters. Relative to the center of the earth, where is the *center of mass* of the earth/moon system?

9.37) For the masses shown in the sketch to the right, where is the *y-coordinate* of their *center of mass*?



9.38) A flat, homogeneous piece of material is shown in the sketch. What are its *x* and *y center of mass coordinates*?



9.40) An inhomogeneous rod (not the same density everywhere) has a linear density function of $\lambda = 50.0 + 20.0x$ (grams/meter), where x, in meters, is measured from the left end of the rod. If the rod's length is 30 centimeters:

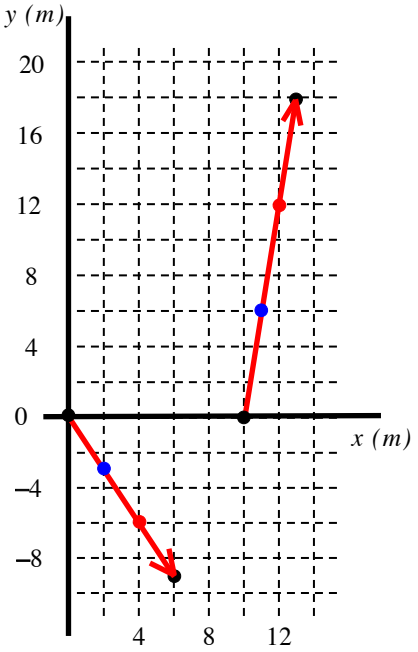
a.) What is the rod's total mass?

b.) Relative to the left end, where is the rod's center of mass?

9.41) A two-body system consists of a 2.00 kg mass moving at $\left(2.00\hat{i} - 3.00\hat{j}\right)$ m/s and a 3.00 kg mass moving at $\left(1.00\hat{i} + 6.00\hat{j}\right)$ m/s. At a particular point in time, the 2.00 kg body is found at the origin of a coordinate axis while the 3.00 kg body is found at (10 m, 0). The motion of the two masses over the next 3 seconds is shown on the graph to the right.

a.) Derive an expression for the velocity, as a vector, of the system's *center of mass*.

b.) Determine the total momentum of the system (again, as a vector).



9.43) Romeo and Juliet decide to take a moonlit row on the lake. They get out in the middle of the lake and come to a stop with Romeo's end of the boat facing away from the shore. Impulsively, Juliet decides to place a smacker (1950's language for a kiss) on Romeo's cheek, so she gets up and walks the 2.70 meters to where Romeo is sitting. Assuming his mass is 77.0 kg, her mass is 55.0 kg and the boat's mass is 80.0 kg, how much closer will Juliet's original end of the boat be to shore by the time she gets to Romeo? (Hint: You might want to draw a sketch for the original situation, identifying the center of mass of the entire system (Romeo, Juliet and the boat) in that circumstance, then draw a second sketch for the kiss and think about what has happened as a consequence of her move.)