Chapter 6 XtraWrk – Momentum and Impulse

6.1) Calculate the momentum of the following instances:

a) A helium nucleus (m = 1.67 x 10^{-27} kg) moving at 5 x 10^{6} m/s
b) A 15 g projectile moving at 300 m/s
c) A 75.0 g cross country runner moving at 10 m/s
d) The Earth (m = 5.98 x 10^{24} kg) orbiting at 2.98 x 10^{4} m/s.

6.3) A tennis player claims they can serve a 0.145 kg tennis ball with as much momentum as a 3.0 g bullet moving at 1500 m/s.

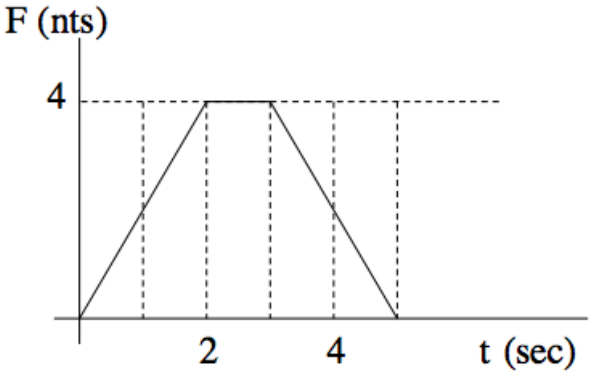
a) How fast must the tennis ball be moving for this to be true?
b) Does the tennis ball or the bullet have more kinetic energy?

6.4) A m = 1 kg ball is thrown straight up with initial speed v_0 = 15 m/s. For both parts below, derive your expression algebraically before putting in numbers!

a) Find the momentum at its maximum height
b) Find an expression for the maximum height in terms of v_0 and g, then find the max height.
c) Find the momentum halfway to its maximum height

6.16) A variable force F_x acts horizontally on a 2 kg object as shown in the graph. Using the graph, find:

a) the impulse imparted by the force
b) the final velocity of the object if it starts at rest
c) the final velocity if it is initially moving horizontally at -2 m/s.



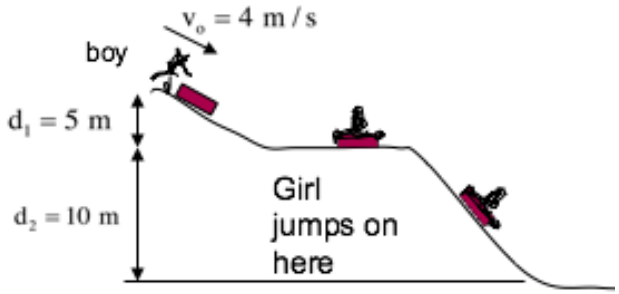
6.21) Slo-mo video shows a 200 g bocce ball moving at 55 m/s as it strikes a 0.46 g golf ball at rest. After they collide, the bocce ball continues moving in the same direction at 40 m/s. What's the speed of the golf ball just after the collision?

6.25) An astronaut doing an untethered spacewalk has a total mass of 85 kg, including her space suit and oxygen tanks. She is additionally carrying a 12 kg toolbox when her maneuvering unit runs out of fuel, so she can no longer get back to her spacecraft. She decides to throw the toolbox away from her spacecraft to propel herself towards it.

a) If she can throw the toolbox away at 8.0 m/s and it takes her 2.0 minutes to return to the spacecraft, how far away was she?

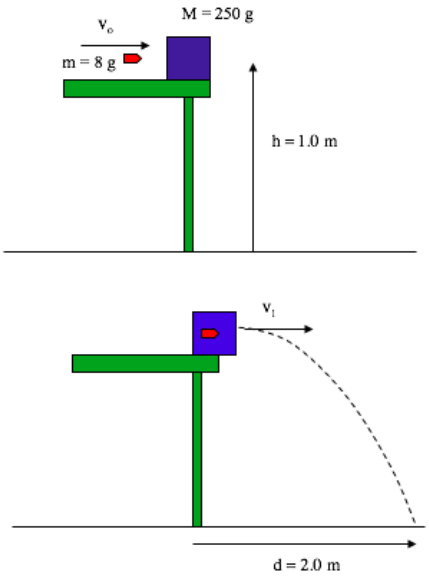
b) Explain using Newton's Laws why this would work.

6.31) A 5.00 kg sled sits at rest at the top of a frictionless, snowy hill. A 50.0 kg boy moving at 4.00 m/s runs towards the sled and jumps on it. Partway down the hill as shown, a 30.0 girl initially at rest jumps on the sled as well, and it continues to the bottom of the 15.0-m high hill. What's the final speed of the sled at the bottom of the hill?

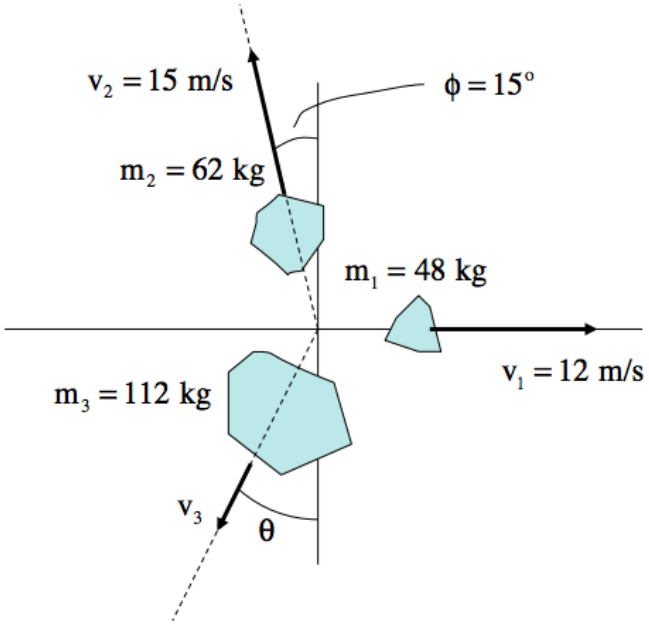


6.40) An 8 g projectile is shot at a motionless block (M = 250 g) at the edge of a 1.00-m high lab bench. The projectile sticks to the block, and the objects launch off the table and land 2.00 m away horizontally.

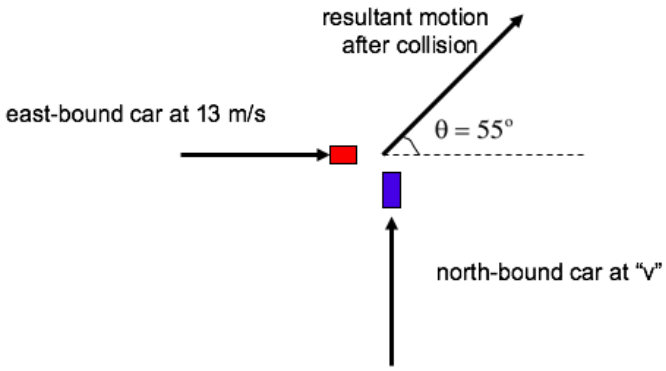
a) Where is energy conserved?
b) Where is energy not conserved?
c) Where is momentum conserved?
d) What kind of collision is this?
e) How fast was the projectile initially moving?



6.44) A firecracker initially at rest explodes into three pieces as shown. What is the unknown velocity and angle?

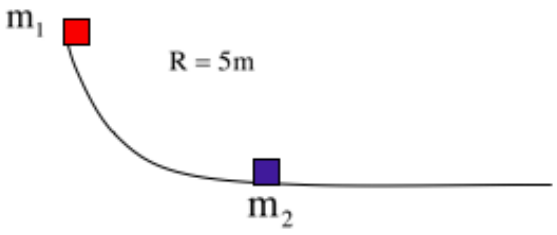


6.50) An accident investigator is at the scene where two identical cars collided in the middle of an intersection. One car was initially traveling east at 13 m/s, and the other was traveling north at an unknown velocity *v*. After the collision, the two cars slid together, leaving skid marks measured to be 55º north of east. The northbound driver claims he was driving within the 35 mph speed limit. Should the investigator believe him?

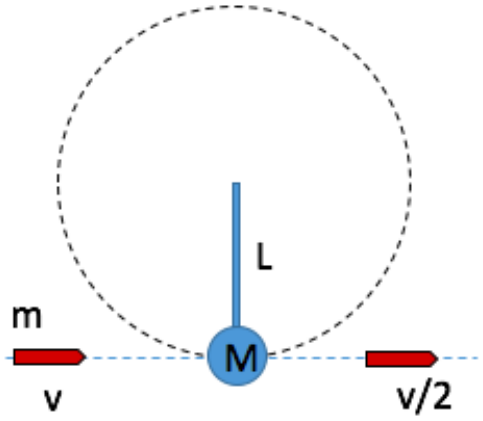


6.54) A 4-kg model car (m_1) is released down a curved, frictionless track as shown. At the bottom of the curve, the car collides elastically with a stationary 10.0-kg block (m_2).

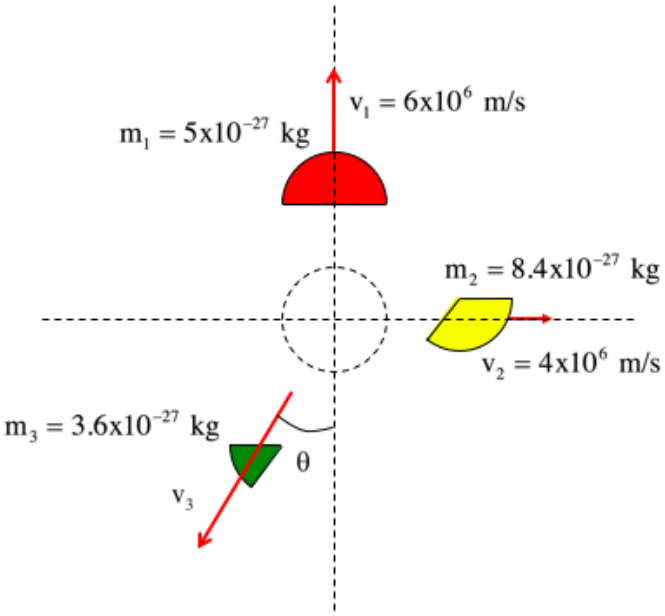
a) What is true about energy considerations here?
b) What is true about momentum considerations here?
c) How far back up the incline will the car travel before coming to rest?



6.56) A wooden ball M at the end of a rigid (essentially massless) rod of length L hangs motionless. A bullet of mass *m* traveling at speed *v* enters the wooden ball and exits with velocity *v/2*. The impact causes the ball and rod to act like a pendulum and swing upward in a circular path. If the ball barely makes it through a compete circle, what does *v* have to be?



6.60) A 1.7 x 10^{-27} kg radioactive nucleus decays ejecting three particles. Two have known mass, velocity, and direction. The third has unknown velocity and direction. Determine the unknown quantities.



6.65) A small, 0.5 kg block (m_1) starts from rest and slides down a frictionless, curved incline of mass m_2 = 3 kg. The incline is free to move on a frictionless surface. At the bottom of the incline, m_1 is moving at 4 m/s.

a) What's the velocity of the wedge when the block reaches the ground?
b) At what height did m_1 start?