

10/30 In Class –Momentum, Energy, Work, Practice Problems**Summary of momentum so far...**

Momentum is mass times velocity. It is a vector. It has no special units—usually it is measure in kg m /s

$$\vec{p} \equiv m\vec{v}$$

The second Law is more correctly written:

$$\Sigma \vec{F} = \frac{d\vec{p}}{dt}$$

If there is no net force on the system (choose your system so this is true!), then momentum of the system is constant (conserved.)

$$\text{total } \vec{p}_{before} = \text{total } \vec{p}_{after}$$

$$\vec{p}_{1b} + \vec{p}_{2b} = \vec{p}_{1a} + \vec{p}_{2a}$$

where b and a can stand for points a and b or before and after the collision, and 1 and 2 stand for the two particles involved in the system.

Conservation of momentum is used most often for collision problems where you can isolate all the objects involved in the collision and consider that your system.

Energy, or Kinetic Energy, may or may not be conserved in a collision.

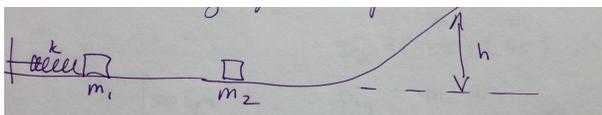
1. Elastic Collisions: conserve KE. (Think steel balls colliding—no deformation)
2. Inelastic Collisions: do not conserve KE
 - (a) Stick together: if any of the objects involved in the collision stick together, it is inelastic
 - (b) Explode: if any object breaks apart or explodes it is also inelastic
 - (c) Any other case where an object involved in collision deforms (gets squished or crumpled.)

Practice Problems

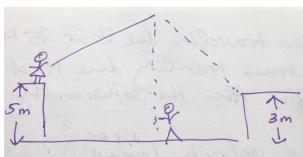
(This begins with what was problem 4 on the last in class worksheet.)

1. A 0.5 kg mass is launched horizontally across a smooth table. It is launched from a spring of constant $k = 450\text{N/m}$ that is compressed 10cm. The mass then collides and sticks to another block of mass 1 kg. They both then slide up a ramp.

- (a) What is the speed of the first mass as it leaves the spring? Could you use conservation of momentum for this part? Why or why not?
- (b) What is the speed of both blocks immediately after the collision (before they slide up)? Could you use conservation of energy for this part? Why or why not?
- (c) How high will they go? Could you use conservation of momentum for this part? Why or why not?



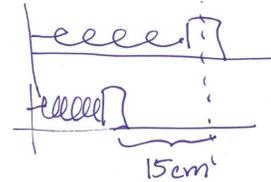
2. A particle of mass $6m$ is at rest in the lab. It decays into particles of mass m , $2m$, and $3m$. Immediately after the decay (a collision of sorts), the first mass, m , travels in the positive y -direction at a speed of $6m/s$. The second particle, mass $2m$, travels at a speed of $4m/s$ in the positive x -direction.
 - (a) What is the velocity of the third fragment?
 - (b) Draw vectors to represent graphical addition of momentum for this case. (Remember vectors add tail-to-tip.)
3. Jane swings on a vine to rescue Tarzan from a ferocious beast. Jane has a mass of 60 kg and starts from a height of 5m above the ground. At the bottom of her swing, she grabs Tarzan (mass 75 kg standing on the ground) and they swing up together. She is aiming for a branch that is 3m above the ground. Will they make it? Show all the work you do to answer this question.



An energy problem:

4. (This problem was on the Cons of Energy worksheet.) A spring of constant 25N/m is compressed horizontally a distance of 15cm from equilibrium. A mass of 200g is pushed against the end of the spring and the spring is released.

- (a) What is the potential energy of the spring when it is compressed 15cm?
- (b) If the surface between the table and the mass is frictionless, how fast will the block be traveling when it leaves the spring? How far will it go?
- (c) If the coefficient of kinetic friction between the block and the table is 0.3, how fast will the mass be traveling when it leaves the spring?
- (d) In the case with friction, how far will the mass travel before coming to rest?



New: Rotational motion

5. A DVD player spins a DVD at a rate of 1000 rpm. (rpm = revolutions per minute) What is its angular speed?
6. If a DVD spins up from rest to 1200 rpm in 1.5 seconds, what is its angular acceleration?
7. A speck of dust is 2.5cm from the center of a DVD that is rotating at a rate of 1000 rpm. What is the translational speed of the speck of dust?