Linear and Angular Motion

9-16-2005

Opening Discussion

- Hand in assignment #2.
- Have you seen anything interesting in the news?
- What are the 4 phases of matter? Why to materials go from one phase to another? Why are different materials in different phases in the same environment?
- Why do you get a burn from something really cold?
- I have said that energy is conserved. What happens when I bounce a ball?

Electron Energy States

- The electrons in an atom can't take on any energy level they want. Instead, they can only be a certain fixed energy levels.
- This fact is the fundamental aspect of quantum mechanics. It plays a huge role in astronomy as we will see in a few chapters when we talk about light.
- It happens that the energy levels in basically all bound systems are quantized. This includes the energies of the motions of atoms in molecules.
- In the hydrogen atom the energy levels are easily calculated by $-13.6*(1-n^2)$ eV.

Momentum and Conservation

- We have already talked about energy. Another critical value in physics is momentum. The momentum of an object is given by p=mv (mass * velocity). Here we care about the direction in velocity.
- The reason this value is important is because it is conserved and it doesn't change forms so it is easy to track.
- If momentum is conserved, then any time you start walking, something else has to move in the opposite direction. What moves and why don't you notice it?

Newton's First Law

- Isaac Newton redefined the way people viewed the Universe when he published the Principia in 1687. Part of this work included three laws.
- The first law was a stronger statement of something that Galileo had already observed.
- On object will maintain its velocity unless acted upon by an outside net force.
- You don't start moving unless something pushes on you and you won't stop moving unless something pushes you in the direction opposite your motion.

Newton's Second Law

- This law gives a precise relationship to how motion is impacted by force. It can be stated in two ways.
- force=change in momentum ($f=d(mv)/dt$)
- force=mass*acceleration ($f=ma$)
- Notice that for the same force, how much acceleration you get is inversely proportional to the mass.
- Velocity, acceleration, and force are vector quantities here. Direction matters. The mks unit of force is a Newton.

Newton's Third Law

- For every force there is an equal and opposite reaction force.
- This is often the hardest one for people to grasp, but given what has already been said, it has to be true.
- Consider the first statement of the second law that a force causes a change in momentum. We have already said that momentum is conserved so something else must have an equal and opposite change in momentum.
- This is also how rockets work.

Angular Momentum

- When something is spinning it has angular momentum. The angular momentum of an object is given by $L=mvr$ for circular motion. (For those who care $L=r\times p$, where p is the linear momentum.)
- Like linear momentum, angular momentum is conserved.
- You also have laws very similar to Newton's laws, but force is replaced with torque. A torque is a force at a distance.
- We will talk more about this next class.

Minute Essay

- In what type of situation might you really notice the fact the way you normally transfer momentum to the Earth?
- Quiz #2 will be at the beginning of next class.