Conservation Laws

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Opening Discussion

- http://www.youtube.com/watch?v=jx4fophzyx4
- Have you seen anything interesting in the news? What did we talk about last class?
- Minute essay responses
  - Physics background varies greatly.
  - Sorry, the bed of nails only comes to class once.
  - I have never been skydiving, but that does give you weightlessness until the air resistance gets too high. Terminal velocity.
  - Was Newton accepted in his own time?

More

- Acceleration due to gravity is the same. If you throw in other forces (air resistance, magnets, ...) things behave differently.
- What happens when an unmovable object hits an unstoppable force?
- Escape velocity of the galaxy.
- Concept of the clockwork Universe and the idea of the clockmaker.
- Chaos vs. clockwork.
- Point of the nail bed demo.
- When will you get assignment #1 back?

And More

- What happens if everyone goes to one side of the world and jumps?
- If the Universe is expanding, why is Andromeda going to hit us?
- Learning more about light and sound.

Force and Acceleration (Math)

- Let's work through a few basic problems with velocity, acceleration, and force.
  - If a car is driving 100km/h and it drives for 5 h, how far does it go?
  - If a ball is dropped for a tall building, how fast is it moving after 2s, 5s, 10s? (neglect air resistance)
  - How far will the ball have fallen in 2s, 5s, and 10s?
  - If I throw a 1kg ball and I apply a force of 100N for 0.1s, how fast will the ball be moving when it leaves my hand?

Conservation Laws

- Some of the most fundamental principles of physics are conservation laws.
- These are not only basic physics, they help make for some very nice, simple arguments about the world around us.
- The basic idea of these laws is that certain things in the Universe are neither created nor destroyed, but always conserved.

Conservation of Momentum

- Conservation of linear momentum is a side effect of Newton's laws and it is intimately woven into them.
- Remember momentum is the product of the mass and the velocity. $\mathbf{p}=m\mathbf{v}$.
- This conservation law says that momentum can be transferred from one object to another, but in a closed system, the sum of all momenta is constant.
- You often don't see this because friction lets you put momentum into the Earth.

Angular Momentum

- An object that is spinning, but not going anywhere has zero linear momentum, but it has a certain amount of angular momentum.
- $L=mvr$ for circular motion (or $\mathbf{r}\times m\mathbf{v}$ more generally)
- This value is also conserved in a closed system. This is very significant in astronomy.
- As things contract they spin faster to conserve angular momentum.

Energy

- Another significant value in physics is energy.
- Energy comes in many forms. It is movement of energy from one object to another or from one form to another that makes things happen in the Universe.
- The mks unit is the Joule. $1[J]=1[kg*m^2/s^2]=1[N*m]$
- Other units:
  - 1[cal]=4.2[J] (energy required to heat 1 gram of water 1C)
  - 1[Cal]=1[kcal]=4200[J] (dietary calorie)

Forms of Energy

- Kinetic – $e=0.5*mv^2$
  - Thermal – kinetic energy of atoms and molecules is what we call heat.
- Radiative – light carries energy
- Potential - “stored” with the potential to do something.
  - Chemical
  - Gravitational – $e=mgh$
  - Mass-energy - $e=mc^2$

Conservation of Energy

- Energy is also a conserved quantity. It is never created or destroyed, it simply moves and changes form.
- This can be very difficult to see because there are so many forms it can take.
- Again, friction on Earth makes us feel like energy is destroyed. Instead, it goes into forms we don't notice.

Minute Essay

- A normal can of coke has about 150 Calories in it. That is 630,000 Joules. How high do you have to climb to have that much potential energy? How fast do you have to be moving to have that much kinetic energy? How are those related.
- Answer one of two of those on the minute essay and thing about the others over the weekend.