Physics 100: Homework Solutions #8

Chapter 20: *due Nov 13*

1) What two physics mistakes occur in a science fiction movie that shows a distant explosion in outer space where you see and hear the explosion at the same time?

   To travel to us from outer space, the wave must be able to travel through regions of space which are essentially vacuum (nothing there). Sound cannot do this, as it requires a medium to propagate in, so we would not be able to hear the explosion. This is one mistake. The second mistake is that sound and light travel at very different speeds – light travels about a million times faster than sound, so the explosion could not be seen and heard at the same time (even if it could be heard), it would be heard later.

2) Explain why if you pluck the A-string of a one-eighth size child's violin equally hard as pluck the A-string on a regularly-sized violin, why the sound is softer in the first case.

   The sound from the plucking of the string gets amplified by the wood of the violin in the same way that the sound from banging a tuning fork is much larger when we put it on the table, as in class. This is because the vibrating string forces vibrations of the wood, which is in contact with a lot more air molecules than the string alone is, forcing in turn vibrations of those air molecules that then propagate through the air to your ear. The bigger the surface (sounding board), the bigger the sound.

3) Consider two charged particles somehow held a certain distance apart, e.g. two electrons.
   a) What is likely to be larger, the gravitational or the electrical force between them?
   b) How would the electrical force between them change if they are brought to twice the original separation? What about the gravitational force?

a) It is likely that the electrical force is larger, c.f. example of the hydrogen atom in class, kq_eq_e is much larger than Gm_em_e

b) Both the electrical force and the gravitational force will go down by a factor of 4, since both follow the inverse-square law for distance-dependence ~ $1/d^2$. So if d was doubled, then d^2 is quadrupled, and $1/d^2$ is ¼ x as much, i.e. the electrical force becomes 4 times smaller (quartered).

4) In a thunderstorm, why should you not stand under a tree? Also, why you should not stand with your legs far apart? Nor lie down? (Note that charges flow when there is an electric potential difference between two points as we discussed in class, more in Ch. 23; so think of the electrical potential difference at different points on the ground if there wa a lightning strike localized at one spot on the ground).

The tree is likely to be hit because it provides a path of less resistance between the cloud overhead and the ground. The tree and the ground near it are then raised to a high potential relative to the ground farther away. If you stand with your legs far apart, one leg on a higher-potential part of the ground than the other, or if you lie down with a significant potential difference between your head and your feet, you may find yourself a conducting path. That, you want to avoid!

5) Your own clicker question.