Physics 100: Homework 5 Solutions

1) Somewhere between the Earth and the moon, the gravitational force on a space shuttle would cancel. Is this location closer to the moon or to the Earth? Explain your answer.

The gravitational force on the shuttle due to the moon is proportional to the shuttle's mass, the moon's mass, and inversely proportional to the square of the shuttle-moon distance. That due to the Earth is proportional to the shuttle's mass, the Earth's mass, and inversely proportional to the square of the shuttle-Earth distance. Since Earth mass >> moon mass, the shuttle must be much closer to the moon in order for the two attractions to cancel.

2) Which is greater, the gravitational pull of the moon on the Earth or that of the sun on the Earth? Which has a greater effect on our ocean tides, the sun or the moon? Explain your answers.

The gravitational pull of the Sun on the Earth is greater than the gravitational pull of the Moon, about 180 times as large due its much greater mass, as explained in class. The tides, however, are caused by the *differences* in gravitational forces by the Moon on opposite sides of the Earth. The *difference* in gravitational forces by the Moon on opposite sides of the Earth is greater than the corresponding difference in forces by the stronger pulling but much more distant Sun. The difference, $1/(d+D_{earth})^2 - 1/d^2$, where D_{earth} is the diameter of Earth, is greater for the moon (smaller d) than it is for the sun (larger d), which is the math-way of saying what we said in class about the inverse-law flattening out…

3 a) A particular atom contains 47 electrons, 61 neutrons, and 47 protons. What is the atomic number of this element, and what is its name?
b) If one proton is somehow added to the atom in (a), when what would its atomic number and name be? How about if an electron was instead added? And what about if instead a neutron was added?

a) The number of protons determines the atomic number, so this is 47. From the periodic table, we see the element with atomic number 47 is Silver, symbol Ag.

b) If one proton is added to Silver, we get Cadmium (atomic number 48). If instead an electron is added to Silver, we still get Silver, but it is a negatively charged Silver ion, Ag^-. (In fact, if only one proton is added to Silver and no extra electron, it is a positively charged Cadmium ion). If instead a neutron was added, we get an isotope of Silver, Ag-109.

4) Which contributes more to an atom's mass: electrons or protons? Which contributes more to an atom's size?

The protons contribute far more to an atom's mass: one proton weighs about 2000 times more than one electron and there are equal numbers of protons and electrons in any neutral atom. The electrons contribute far more to the atom's size: the diameter of the atom is about 10000 times the nuclear diameter.

5) your clicker question