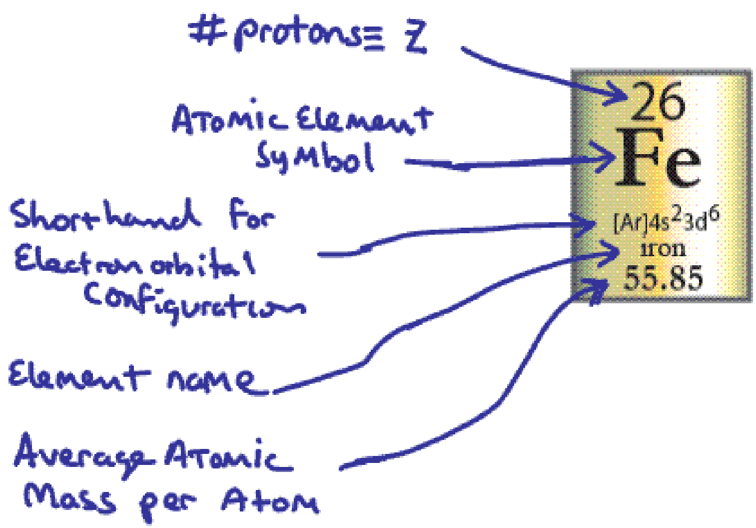
Physics 100 – Spring 2007 – Recitation 7

① Review how lasers work.

Suppose you have a laser that is optically "pumped". How does the frequency of the pumping light compare to the frequency of the light emitted by the laser? Why?

(2)



In a typical entry for each element of a periodic chart, you will see the various components above. Make sure you understand each of these things... except for the electron configuration shorthand.

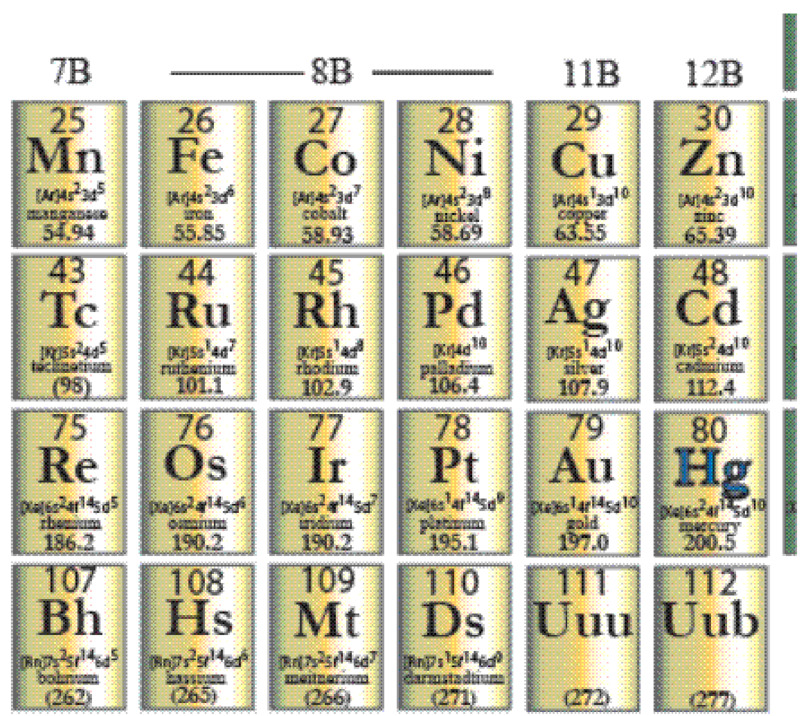
If the atomic mass is given in AMU (atomic mass units) and each nucleus is made of protons and neutrons (each of which add 1 AMU to the mass of the nucleus), how is it that iron can have the mass of 55.85 as shown above?

③ ^{56}Fe has how many protons and how many neutrons?

④ How about ^{57}Fe?

⑤ An energetic beam of electrons strikes a gold (Au) target and a silver (Ag) target ...

which target will emit characteristic x-rays with the highest frequency? Why?



In quantum mechanics we usually cannot predict the outcome of a single measurement, but we can often predict the correct average of many measurements.

(6)

Quantum Dice 1 :

Do in groups of 2 to 4

One person (The experimentalist) should Toss a single die 48 times keeping track of the values on top face of the die for each toss.

A different person (the oracle) should move where they cannot see the die being thrown and they should predict the value seen for each of the 48 throws and record their predictions

How often does the oracle correctly predict what the experimentalist measures?

How often would you expect the oracle to get it right just due to random luck?

How much variation is there among all the oracles in your section in terms of the number of correct predictions they make?

What is the average value of all the measurements made by the experimentalist?

What would you expect to find for the average value of all 48 measurements?

(7) Quantum Dice 2:

Do in groups of 2 to 4

Throw two Dice sequentially 50 times. When the 1st Die comes up as a one or a two, record the value of the second die.

Compare the distribution and average values of your measurements with what you observed in the Quantum Dice 1 exercise. What do you see from this comparison?

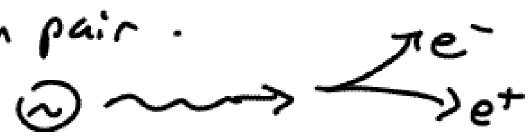
Now repeat the exercise ... but instead of throwing the second die take as your measured value the number on the bottom face of the first die (remember ... only take those where the 1st die comes up one or two). Compare the distribution and average of your measurements with what you saw earlier.

Can you explain the difference you see?

How might this situation be similar to what is meant by "quantum entanglement"?

Radiation such as α, β and γ rays are potentially harmful to living things because the $\alpha/\beta/\gamma$ particles can ionize (rip apart) the molecules in human tissue, killing cells and causing long-term DNA damage. If the radiation dose is high enough the cell damage can kill the living thing. If the damage is not that severe, the DNA damage can lead to cancer and/or birth defects many years later.

Only particles that are charged can cause ionizing damage as they pass through tissue. The larger the electrical charge of the ionizing radiation, the heavier is the ionizing damage and the shorter the range of the radiation in the material. γ-rays pass harmlessly through materials except when they pair-produce into an electron-positron pair.



This is what happens to γ-rays when they eventually interact with matter.

α particles can be stopped by a sheet of paper.

β particles are stopped by the outer layers of skin.

γ-rays can pass through living tissue and other materials. Typically they are stopped by a thick layer of lead.

(8) If I told you that you had to spend the night sleeping in a bed laced with an α source, a β source or a γ source ... which would you choose? Why? (Assume similar activities for the sources)

(9) Suppose you had 3 stupid friends...

friend 1 drinks a glass of water laced with an α source.

friend 2 " " " " " " β source.

friend 3 " " " " " " γ source.

Assume similar activities for the materials in the drinks.

Which friend should you be most worried about? Why?