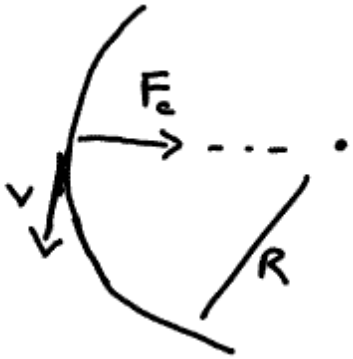
Physics 102 – Spring 2011 – Recitation module 5

Your TA will supply you with a length of string. Tie the cap of a pen to one end of the string. Have one student go across the room from all the other students and twirl it the pen cap around their head in a horizontal circle. After the pen is moving in a stable circle the person twirling the string should let go of the string. What is the motion of the cap before and after the string is released. Explain that motion using Newton's laws.

For an object to move on a circle, there must be a net force toward the center of the circle, $F_c=mv^2/R$, where Fc is the force toward the center (called the centripetal force), m is the mass of the object, v is the speed tangent to the circle, and R is the radius of the circle.



What supplies the centripetal force for a speedskater going around a curve?

For a given set of road conditions, what happens if you take a curve too fast? If you take too sharp a curve? Why?

For the space shuttle in orbit, what force acts as the centripetal force?

Briefly defend or refute the statement, "astronauts in the space station are in a weightless environment."

If you were the commander of the space shuttle, how would you point your rocket nozzle to move to a higher orbit if asked to do so by NASA?

In the Bohr model of the atom, what is the force that acts as the centripetal force?

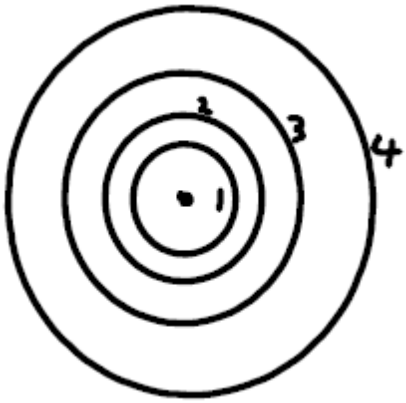
In the Bohr model of the atom, what happens to the elecron when the atom absorbs a photon? What happens to the electron when the atom emits a photon?

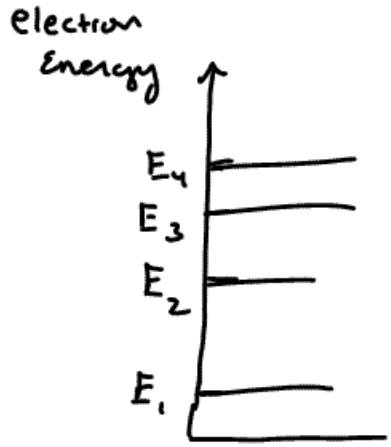
Below is a schematic diagram of an atom which four different states (or orbits) in which the electron could exist. Next to it is a graphical representation of the electron energy in each possible state … E1<E2<E3<E4.

Let E1=-13.6eV, E2=-3.4 eV, E3=-1.5 eV, and E4=-0.85 eV.

The negative signs mean that the electron is bound in the atom. It takes 13.6 eV in energy to free an electron in orbit 1, for example.

Planck's constant, h= 4.1×10^{-21} eV-seconds.



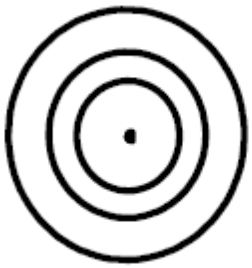


What is the highest frequency light emitted by the atom?

What is the lowest frequency light emitted by the atom?

What part of the electromagnetic spectrum will these "spectral lines" be found? (See Hobson, p. 202 for a useful table.)

An atom has three possible energy states in which the electron could exist. How many spectral lines could be emitted by this atom?



Which has a lower energy: a photon of red light or a photon of blue light? Why?

How does the speed of an x-ray compare to the speed of blue light?

If a proton microscope were devised, how would you expect its wavelength to compare with the wavelength of an electron microscope (qualitatively)? (The electron has a mass of 0.511 MeV/c^2 and the proton has a mass of approximately 1 GeV/c^2.)

Briefly make the case as to why Max Planck could be considered the father of quantum mechanics.

Briefly make the case as to why Albert Einstein could be considered the father of quantum mechanics.

Briefly make the case as to why Louis de Broglie could be considered to be father of quantum mechanics.