# Modern Physics
# Problem Set 7

JC-35)  **Picking-up an Electron with Tweezers**
(10 points)  What difficulties does the uncertainty principle cause in trying to pick up an electron with a pair of tweezers?

JC-36)  **Range of the Nuclear Force**
We can make an estimate of the range of the nuclear force by considering the following process. A proton or neutron can sometimes "violate" conservation of energy by emitting and then reabsorbing a pi meson ($\pi$), which has a mass of 135 MeV/$c^2$.  This is possible as long as the pi meson is reabsorbed within a short enough time $\Delta t$ consistent with the uncertainty principle.

    a)  (10 points)  Consider p --> p + $\pi$.  By what amount $\Delta E$ is energy conservation violated?  (Ignore any kinetic energies.)
    b)  (10 points)  For how long a time $\Delta t$ can the pi meson exist?
    c)  (10 points)  Assuming the pi meson travels at very near the speed of light, how far from the proton can it go?

JC-37)  **White Dwarfs**
(10 points)  A white dwarf is a very dense star, with its ions and electrons packed extremely close together.  Each electron may be considered to be located within a region of size $\Delta x \approx 1.5 \times 10^{-12}$ m.  Use Heisenberg's Uncertainty Principle to estimate the minimum speed of the electrons.  Do you think the effects of relativity will be important for these stars?

JC-38)  **Solving the Schrödinger Wave Equation**
(20 points)  The graphs of several wave functions are shown below.  For each function, comment on whether or not the function would be an acceptable wave function in quantum mechanics.  If not, explain what is wrong with the function.
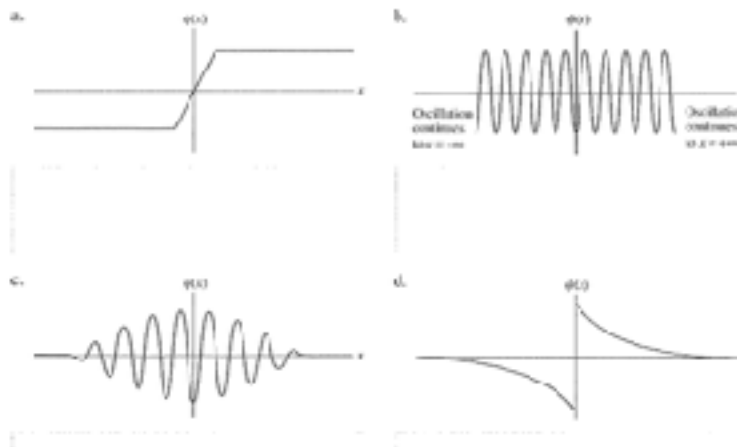
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Talk 1) **Appropriate References**
(10 points)  Rank the following sources in order of most reliable to least reliable and justify your answer.

      a)  [http://www.wikipedia.org/](http://www.wikipedia.org/)
      b)  [http://www.sciencemag.org](http://www.sciencemag.org)/
      c)  [http://scitation.aip.org/content/aip/proceeding/aipcp](http://scitation.aip.org/content/aip/proceeding/aipcp)
      d)  [http://searleffect.com/](http://searleffect.com/)
      e)  [http://arxiv.org/](http://arxiv.org/)
      f)  [http://www.popsci.com/](http://www.popsci.com/)
      g)  [http://scitation.aip.org/content/aip/magazine/physicstoday](http://scitation.aip.org/content/aip/magazine/physicstoday)

Talk 2) **Find References and Continue Research**
(10 points)  List at least three potential references for your topic.