Homework #2 for Physics 371

Due 4pm Friday, January 29

1) Schrödinger initially arrived at a wave equation for a particle of mass m that reads as follows in one dimension:

$$\frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2} = \frac{\partial^2\psi}{\partial x^2} - \frac{m^2c^2}{\hbar^2}\psi.$$

Show that a plane wave solution of this equation is consistent with the relativistic energy-momentum relationship. (The equation above is known as the one-dimensional Klein-Gordon equation.)

2) Show that the following function is a valid representation of the Dirac delta function:

$$\delta(x) = \lim_{\epsilon\to 0^+} \frac{\epsilon/\pi}{x^2+\epsilon^2}.$$

3) Verify the following properties of the delta function:
(a) $\delta(x) = \delta(-x)$.
(b) $x\delta(x) = 0$.
(c) $\delta'(-x) = -\delta'(x)$.
(d) $x\delta'(x) = -\delta(x)$.
(e) $c\delta(cx) = \delta(x)$, $c > 0$.

4) Problem 1.5, Griffiths.