The Compton scattering equation (4.25)

The directions follow the derivation as outlined in the text so you should be looking at that section of the text when you do this work. As you derive each equation you must label the equation with the number in the text in parenthesis or with the number I have specified. Show all algebraic steps in the process outlined below.

1. Draw Figure 4.12 complete with all labels and be sure to indicate that the momenta are vectors.

2. Write equation 4.18 for conservation of energy. Don’t forget to label the equation - after this I won’t continue to remind you.

3. Write equation 4.19 for conservation of momentum. Indicate that the momenta are vectors.

4. Write equation 4.20 by simply rearranging equation 4.18.

5. Write equation 4.15 and write this again with m = 0 for a photon to produce equation 4.16.

6. Use equation 4.16 to rewrite the initial photon energy $E_o$ and the final photon energy $E$. Then put these expressions into equation 4.20 and label the result 4.20 a.

7. Use equation 4.15 to express the energy $E_e$ of the electron in terms of the momentum $p_e$ and the mass $m$ of the electron. Label this result 4.20 b.

8. Now put the expression for $E_e$ from 4.20 b into 4.20 a to produce equation 4.21.

9. Divide both sides of 4.21 by $c$ and label the result 4.21 a.

10. Put brackets around $(p_o - p)$ on the right side. Square both sides of equation 4.21 and label this result 4.21 b.

11. Write equation 4.19 as $p_e = p_o - p$ and then square both sides to produce equation 4.22. You square vectors by forming the dot product of the vector with itself so be sure to show this process in full detail retaining the various dot products until they are completed and your result is the scalar equation 4.22.

12. Put equation 4.22 into equation 4.21 b and you will find that some of the terms on one side also appear on the other side of the equation and thus cancel. When the dust settles, you should have produced equation 4.23.

13. Produce equation 4.24 from equation 4.23.

14. Use $E = pc$ and $E = hf$ for photons to write $p = hf/c$. Then use $c = f\lambda$ to change this to $p = h/\lambda$.

15. Now put this into 4.24 to produce equation 4.25. This is the way the Compton scattering equation is usually written.