1. The Higgs boson has $m_H c^2 \approx 120 \text{GeV}$. Suppose that the $H$ particle is at rest and that it decays into two photons, $H \rightarrow \gamma + \gamma$. Find the magnitude of the spatial momentum of the two photons, $|c \vec{p}_1|$ and $|c \vec{p}_2|$.

2. Suppose that the Higgs boson, with $m_H c^2 \approx 120 \text{GeV}$, is traveling along the $x$-axis with $v/c = 4/5$, and then decays $H \rightarrow \gamma + \gamma$. Find the momentum magnitude, $|c \vec{p}_1|$ and $|c \vec{p}_2|$ of the two photons if they are also traveling only along the $x$-axis.


4. Thomson 17.4.

5. Verify that $\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} - j^\mu A_\mu$ is invariant under the gauge transformation. This is similar to exercise 17.3 in Thomson, but I'd like you to include the $j^\mu A_\mu$ term and verify that both that and the other term are separately gauge invariant; the gauge invariance of the $j^\mu A_\mu$ term uses the fact that $\partial_\mu j^\mu = 0$.

6. Thomson 17.7.

7. Verify that $\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} - j^\mu A_\mu + \frac{1}{2} m_\gamma^2 A_\mu A^\mu$ violates gauge invariance if $m_\gamma \neq 0$. (Moral: gauge invariance forbids a photon mass. Caveat: there is a way to get around this with a bose condensate. This is what happens in the Higgs mechanism, for the Weak forces. And it is what happens in a superconductor for E and M.)