Problem set II

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Problem 1: In the $\lambda\phi^4$ theory, the interaction term is given by:

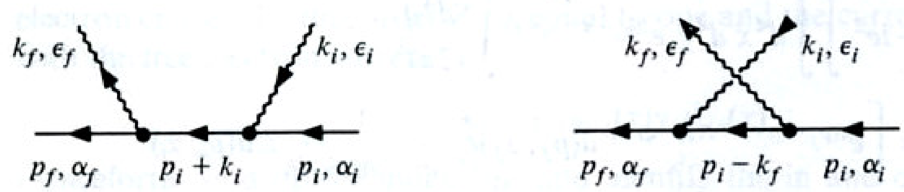
$$H_I = \frac{1}{4!}\lambda\phi^4$$

Show that, to the lowest order in λ, the differential cross-section for two particle elastic scattering in the centre-of-mass frame is given by

$$\frac{d\sigma}{d\Omega} = \frac{\lambda^2}{128\pi^2 s}$$

where $s=(p_1+p_2)^2$ and p_1, p_2 are the 4-momenta of the incoming particles.

Problem 2: Calculate the Compton scattering cross section which includes the two Feynman diagrams:



Show that the result is the Klein Nishina (1929) formula :

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4m^2}\left(\frac{k_f}{k_i}\right)^2\left[\frac{k_f}{k_i} + \frac{k_i}{k_f} + 4(\varepsilon_f \cdot \varepsilon_i)^2 - 2\right]$$

Which at the low energy limit reduces to the Thomson cross section:

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{m^2}(\varepsilon_f \cdot \varepsilon_i)^2 \qquad \frac{\alpha}{m} = r_0 = 2.8 \times 10^{-13}\text{ cm}$$