Solution to HW 6
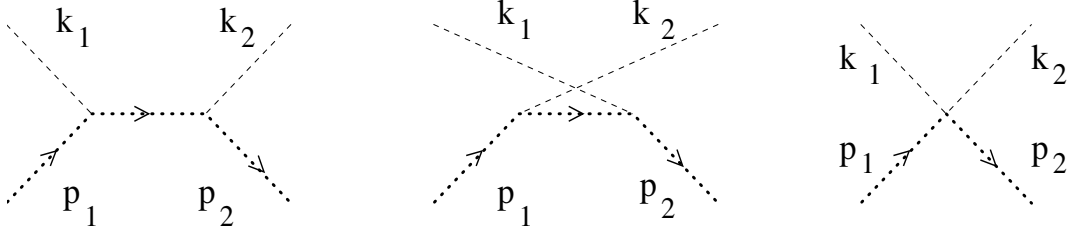
The differential cross section for Compton scattering is calculated in Appendix A

$$\left(\frac{d\sigma}{d\Omega}\right)^{\text{Compton}}_{\text{lab}} = \frac{|T|^2}{64\pi^2} \frac{1}{[m + k_1(1 - \cos\theta)]^2} \tag{0.1}$$
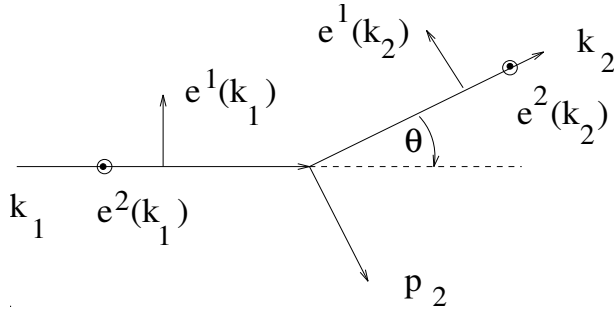
The diagrams are shown in Fig. 66 from the lecture notes:

and the transition matrix is given by Eq. (5.95)

$$T^{\lambda_1\lambda_2}(p_2, k_2; p_1, k_1) =$$
$$e^2 \left(\frac{4(e^{\lambda_1}(k_1)\cdot p_1)(e^{\lambda_2}(k_2)\cdot p_2)}{m^2 - s - i\epsilon} + \frac{4(e^{\lambda_2}(k_2)\cdot p_1)(e^{\lambda_1}(k_1)\cdot p_2)}{m^2 - u^2 - i\epsilon} + 2e^{\lambda_2}(k_2)\cdot e^{\lambda_1}(k_1) \right) \tag{0.2}$$

If we choose the polarizations as shown in Fig. 90 of the lecture notes we have the

property

$$e^{(2)}(k_i)\cdot p_j = 0, \quad e^{(1)}(k_i)\cdot p_1 = 0 \tag{0.3}$$

(and of course $e^{(i)}(k_1)\cdot k_1 = e^{(i)}(k_2)\cdot k_2 = 0$). Thus, the only non-zero term in the r.h.s. of Eq. (??) is the last one and we get

$$T^{11} = -2e^2\cos\theta, \quad T^{12} = T^{21} = 0, \quad T^{22} = -2e^2$$
$$\Rightarrow T^{++} = T^{--} = -e^2(1 + \cos\theta), \quad T^{-+} = T^{+-} = e^2(1 - \cos\theta) \tag{0.4}$$

The differential cross sections are

$$\left(\frac{d\sigma}{d\Omega}\right)_{++} = \left(\frac{d\sigma}{d\Omega}\right)_{--} = \frac{e^4(1 + \cos\theta)^2}{64\pi^2} \frac{1}{[m + k_1(1 - \cos\theta)]^2},$$
$$\left(\frac{d\sigma}{d\Omega}\right)_{+-} = \left(\frac{d\sigma}{d\Omega}\right)_{-+} = \frac{e^4(1 - \cos\theta)^2}{64\pi^2} \frac{1}{[m + k_1(1 - \cos\theta)]^2} \tag{0.5}$$

which coincides with Eq. (5.120) from the lecture notes.

1