# PHYS-4303 Homework 6 Due 7 Nov 2023

This homework is due to `https://uwcloud.uwinnipeg.ca/s/dcYrc2Yys2jsSrz` by 10:59PM on the due date. Your file(s) must be in PDF format; they may be black-and-white scans or photographs of hardcopies (all converted to PDF), PDF prepared by LaTeX, or PDF prepared with a word processor *using an equation editor*.

1. **Compton Effect** *Griffiths 3.27 and common physics*

   Consider a photon (massless) of energy $E$ that scatters from an electron (of mass $m$) at rest. Relativistically, the photon changes energy due to the electron's recoil.

   (a) If the photon's final trajectory makes angle $\theta$ with its original trajectory (ie, the scattering angle is $\theta$), show that the photon's final energy $E'$ satisfies $m(E - E') = EE'(1 - \cos\theta)$. *Hint:* this was an example in lecture for PHYS-3203.

   (b) The energy of a photon is related to its wavelength $\lambda$ by $E = 1/\lambda$. Using the result of the previous part, find $\lambda' - \lambda$. The change in wavelength is known as the *Compton effect*.

2. **Energy and Momentum in CM Frame**

   Particles $A$ and $B$ with masses $m_A$, $m_B$ collide. If their total CM frame energy is $E_{CM}$, what is the energy of the $A$ particle in the CM frame? *Hint:* Call the 4-momenta $p_A^\mu$ and $p_B^\mu$, write $p_B^\mu = (p_A + p_B)^\mu - p_A^\mu$, and square both sides. Remember that the components of the total momentum are $(p_A + p_B)^0 = E_{CM}$ and $(p_A + p_B)^i = 0$ in CM frame.

3. **One Gamma Identity**

   Show that $p_\mu p_\nu \gamma^\mu \gamma^\nu = p^2$, where $p^\mu$ is any 4-vector and $\gamma^\mu$ are the Dirac gamma matrices. *Hint:* write the sum as two terms with renamed indices and use symmetry of $p_\mu p_\nu$.