1. a) (6 pts) Consider the process $e + \mu^+ \rightarrow e + \mu^+$. Considering only the electromagnetic interaction, write down the expression for $\langle |M|^2 \rangle$ to lowest order in terms of momentum dot products. You do not need to show your work, but can instead adapt expressions from your HW as needed.

b) (4 pts) Do the same for $\mu + e^+ \rightarrow \mu + e^+$. 

\[ M = \frac{-i e \gamma^\mu \bar{u}(\mu) i \gamma^\nu u(e) \gamma^\nu}{(p_4 - p_1)^2} \]

\[ \langle |M|^2 \rangle = \frac{8 g e^4}{(p_4 - p_1)^4} \left[ (p_3 \cdot p_2)(p_1 \cdot p_4) + (p_3 \cdot p_1)(p_2 \cdot p_4) - (p_3 \cdot p_1) h_\mu^1 c - (p_2 \cdot p_1) h_\mu^1 c \right. \\
\left. + 2 h_\mu^2 h_\mu^2 c \right] \]

b) For $e^+ + n \rightarrow e^+ + n$, $\langle |M|^2 \rangle$ will be the same as above by $C$-conjugate symmetry.
2) Evaluate $p_1^\alpha p_2^\beta p_3^\gamma p_4^\delta \eta_{\alpha \delta} \eta_{\rho \kappa} \eta_{\lambda \xi} \eta_{\mu \nu} \eta_{\tau \nu} \eta_{\xi \rho}$ in terms of dot products such that there are no more metric factors in the expression.

\[ p_1^\alpha p_1^\delta \eta_{\alpha \delta} = p_1 \cdot p_1 \]
\[ p_2^\delta p_3^\delta \eta_{\delta \kappa} \eta_{\lambda \xi} = p_2^\delta p_3^\delta \delta_\kappa^\lambda \eta_{\xi} = p_2^\delta p_3^\delta \eta_{\lambda \xi} = p_2 \cdot p_3 \]
\[ \eta_{\lambda \nu} \eta_{\nu \xi} \eta_{\xi} = \delta_\lambda^\nu \delta_\nu^\xi = \delta_\nu^\nu = \eta \]

\[ A(\gamma_1 \beta_1 \kappa_1 \xi_1) = \left( \eta \cdot p_1 \right) \left( \eta \cdot p_2 \right) \]