663, Homework II, (2 problems)

Problem 1
Consider electron muon scattering due to the electromagnetic interaction:
\[ e^- + \mu^- \rightarrow e^- + \mu^- \] (0.1)

a) Compute the unpolarized differential cross section and total cross section.

b) Consider now the non-relativistic limit and study the polarized differential cross section for given initial spins. What are the spins of the outgoing particles?

c) Consider now the ultra-relativistic limit and study the polarized differential cross section for given initial helicities. What are the helicities of the outgoing particles?

Problem 2
Assume that the value of \((g - 2)/2\) is accounted by known corrections to precision of \(10^{-10}\). Consider now a scalar particle of mass \(M\) and compute the correction to \((g - 2)/2\) from an interaction
\[ V = \int d^3x \frac{\lambda}{\sqrt{2}} \phi \bar{\psi} \psi \] (0.2)

Since this correction is not seen, what constraints do you get on the values of \(M\) and \(\lambda\)? Repeat the same for a pseudo-scalar particle \(\phi\) that couples as
\[ V = \int d^3x \frac{i\lambda}{\sqrt{2}} \phi \bar{\psi} \gamma^5 \psi \] (0.3)