

Total: 45 points

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## Homework Assignment I

Problem 1: Consider the Dirac Lagrangian:

$$\mathcal{L}_D = \frac{i}{2} [\bar{\psi} \overleftrightarrow{\not{\partial}} \psi - \psi \overleftrightarrow{\not{\partial}} \bar{\psi}] - m \bar{\psi} \psi$$

(2)

- 1) Show that this Lagrangian leads to the Dirac Equation which can be written as:

$$(i \overleftrightarrow{\not{\partial}} - m) \psi = 0$$
$$\bar{\psi} (i \overleftrightarrow{\not{\partial}} + m) = 0$$

(2)

- 2) Show that following Lagrangian describes the same Physics (corresponds to the same action):

$$\mathcal{L} = i \bar{\psi} \not{\partial} \psi - m \bar{\psi} \psi$$

(2)

- 3) Demand that the Lagrangian in (2) is invariant under local U(1) gauge transformations by introducing photons into the theory and derive that gauge transformation for the photon Field.

(2)

- 4) Write the full gauged Lagrangian including the spinor and vector parts.