Exercise sheet 1

Griffiths.
Read the chapter “Historical introduction” in Griffiths (or similar stuff in other books).

Feynman diagrams.
Draw Feynman diagrams for the following interaction processes (if the process is possible) at “tree-level”, i.e. without loops, including both photons and weak gauge bosons.

a.) $e^- + \mu^- \rightarrow e^- + \mu^-$
b.) $e^- + \mu^+ \rightarrow e^- + \mu^+$
c.) $e^- + \mu^+ \rightarrow e^- + \mu^-$
d.) $e^- + e^+ \rightarrow \mu^+ + \mu^-$
e.) $e^- + e^+ \rightarrow e^- + e^+$
f.) $e^- + \nu_\mu \rightarrow e^- + \nu_\mu$
g.) $e^- + \nu_\mu \rightarrow \mu^- + \nu_e$
h.) $e^- + \nu_e \rightarrow e^- + \nu_e$
i.) $\tau^- \rightarrow \mu^- + X + Y$ (choose a suitable pair of particles)
j.) $\mu^- \rightarrow \tau^- + X + Y$
k.) $\nu_e + \nu_\mu \rightarrow \nu_e + \nu_\mu$.

Questionnaire
Indicate, if the following formulae look very familiar (left box), familiar (middle), unknown (right box), and give it next week back. (You may also add comments.)

- Lagrange function $L(q, \dot{q}, t) = T - V = \frac{1}{2}mq^2 - V(q, \dot{q}, t)$
  - $\square$ $\square$ $\square$

- conserved current $0 = \vec{\nabla} \cdot \vec{j} + \frac{\partial \rho}{\partial t}$
  $\equiv \partial_{\mu} j^\mu = 0$
  - $\square$ $\square$ $\square$

- Fermi’s golden rule $\Gamma_{fi} = 2\pi|T_{fi}|^2\rho(E_f)$
  - $\square$ $\square$ $\square$

- Angular momentum $[J_i, J_j] = i\epsilon_{ijk}J_k$
  - $\square$ $\square$ $\square$

- Lorentz transformations $ct = \gamma(ct - \beta x)$
  - $\square$ $\square$ $\square$

- $x^\mu = N^\mu_{\nu}x^\nu$
  - $\square$ $\square$ $\square$

- Electrodynamics $\vec{E} = -\vec{\nabla}\phi - \frac{1}{c}\frac{\partial \vec{A}}{\partial t}$
  - $\square$ $\square$ $\square$

- $F_{\mu\nu} = \partial_{\mu} A_{\nu} - \partial_{\nu} A_{\mu}$
  - $\square$ $\square$ $\square$

- $A^\mu = (\phi, \vec{A})$
  - $\square$ $\square$ $\square$

- $\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu}$
  - $\square$ $\square$ $\square$

Solutions are discussed Friday, 31.08.18