1. a) One decay mode of the Z^0 is $Z^0 \rightarrow \tau^+\tau^-$.

The τ subsequently decays. Draw Feynman diagrams for the following τ decay modes:

i) $\tau^- \rightarrow e^-\nu_\tau\bar{\nu}_e$

ii) $\tau^- \rightarrow \mu^-\nu_\tau\bar{\nu}_\mu$

iii) $\tau^- \rightarrow \pi^-\nu_\tau$ **{3}**

Suppose both taus decay to electrons; under what kinematic conditions might this decay be mistaken for $Z^0 \rightarrow e^-e^+$? **{2}**

Draw a Feynman diagram for the transition $D^0 \rightarrow \overline{D}^0$. **{3}**

b) Define *four-momentum transfer.*

An electron of initial energy E scatters from a proton and emerges with energy E' at an angle θ to its incident direction. When the mass of the electron can be ignored in comparison to its energy, derive an expression for the four-momentum transfer in terms of E, E' and θ. Evaluate this four-momentum transfer for an electron with incident energy of 150 GeV, which is observed to leave the scattering process with an energy of 135 GeV at an angle of 1^o to its incident direction. Identify the possible constituent parts of the proton from which the electron may have scattered. **{8}**