2. A)

a) The electron-electron elastic scattering process may proceed by single photon exchange. Explain why this process requires that the exchanged photon is *virtual*. What limits on time and energy are placed on the exchanged photon? Comment on the overall conservation of energy. **{10}**

b) Which of the following annihilation processes are possible:

$$e^+e^- \rightarrow n\gamma \quad ; \quad n = 1, 2, 3, 4.$$

For any invalid process, give a reason why this is so. For each valid process, draw at least one Feynman diagram to illustrate it. At a given interaction energy, how would you expect the annihilation rates to compare for the different valid processes? Give reasons. **{10}**

c) Show that a photon cannot decay via pair production $(\gamma \rightarrow e^+e^-)$ in vacuum even if its energy exceeds 1 MeV. **{4}**