Problems

(1) The cross-section for the $gg \to H$ production at the TeVatron and LHC are:
$\sigma(p\bar{p}, \sqrt{s} = 1.96\ TeV) = 0.29\ pb$
$\sigma(pp, \sqrt{s} = 10\ TeV) = 17.22\ pb$,

and the instantaneous luminosities are expected to be $2 \times 10^{32}\ cm^{-2}sec^{-1}$ and $10^{34}\ cm^{-2}sec^{-1}$ for the TeVatron and LHC respectively. Compute the number of W-pairs per week produced at both colliders.

(2) Elastic scattering of elementary particles preserves their identities, and proceeds via exchange of neutral gauge bosons. Estimate the maximal range over which such exchange can take place, if the exchanged boson is: (a) photon, $m_\gamma = 0$ GeV/c^2, (b) Z boson, $m_Z = 91.19$ GeV/c^2, (c) hypothetical Higgs boson, $m_H = 135$ GeV/c^2. Use $h/2\pi = 6.582 \times 10^{-22} MeV\ sec$ and $c = 2.998 \times 10^8 m/s$.

(3) Higgs and photon boson do not couple directly, nevertheless the decay $H \to \gamma\gamma$ is possible. Draw the Feynman diagramns giving such final state.

(4) Study of some Higgs boson decay channels: (a) imagine that $m_\tau = m_b$, which channel would dominate?; (b) why $BR(H \to gg)$ is so small?; (c) why $BR(H \to gg)$ is larger than $BR(H \to \gamma\gamma$; (d) how can we have $H \to VV$ ($V = W/Z$) decays below their mass threshold?; (e) why $H \to VV$ dominates over $H \to t\bar{t}$?.