Set 8 – due 17 March

1) [20 points] Compute the lifetime for the spin flip decay of any of the 2S states of H (to the 1S state).

2) [20 points] Make a rough calculation of the lifetime of the 2S state of H assuming it decays by two-photon emission. Note that it is necessary to combine the second order matrix element of $H_1 \simeq \vec{A}\cdot\vec{p}$ with the first order matrix element of $H_2 \simeq A^2$. Do not try to do the problem exactly but get an approximate number. Intermediate steps/hints:

$$\frac{1}{\tau} = \sum_{\epsilon_1}\sum_{\epsilon_2}\frac{2\pi}{\hbar}\int |\langle f|T|i\rangle|^2\delta(E_{2S} - E_{1S} - \hbar ck_1 - \hbar ck_2)V^2\frac{d^3k_1}{(2\pi)^3}\frac{d^3k_2}{(2\pi)^3} \quad (1)$$

You can show

$$T = \frac{e^2}{2mc^2}(\frac{2\pi\hbar c^2}{V})\frac{1}{c\sqrt{k_1k_2}}T' \quad (2)$$

where T' is dimensionless. (What is it?) For an order of magnitude estimate, set

$$\sum_{\epsilon_1,\epsilon_2}|T'|^2 = 1 \quad (3)$$

and evaluate everything else. Compare your result to the one you got in problem 1.

3) [10 points] Compute the differential cross section in Born approximation for scattering from a "spherical square well:" $V(r) = -V_0$ for $r < a$ and $V(r) = 0$, $r > a$.