This problem will be collected in class on Nov. 23.

Suppose we choose to describe an atom in lowest order using a potential $U(r)$ other than the HF potential.

1. Show that the correction to the first-order energy from the single-particle part of the potential ($V_1$) for a one electron atom in a state $v$ is

$$E_v^{(1)} = \Delta_{vv},$$

where $\Delta = V_{HF} - U$.

2. Show that the following additional terms appear in the second-order valence energy:

$$E_v^{(2)} = -\sum_{na} \frac{\Delta_{na} \tilde{g}_{avnv} + \tilde{g}_{avnv} \Delta_{an}}{\epsilon_n - \epsilon_a} - \sum_{i \neq v} \frac{\Delta_{vi} \Delta_{iv}}{\epsilon_i - \epsilon_v}.$$ 

Here, $i$ runs over $a$ and $n$. 