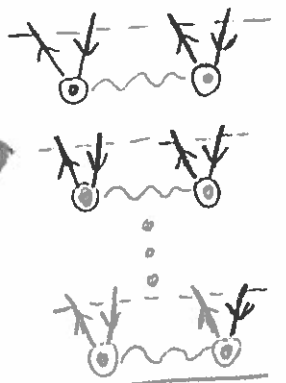
#1) Explain why the max excitation level of the wavefunction increases by 1 with each order in perturbation theory.

$$\Psi = \Psi^{(0)} + \Psi^{(1)} + \Psi^{(2)} + \dots$$

$$= C_0\Phi + [R_0 V_0 \Phi + \text{Bracketings}] + [(R_0V_0)^2\Phi + \text{Bracketings}] + \dots$$

$$\Psi^{(m)} = \underbrace{(R_0V_0)^m \Phi}_{\text{where this term is always going to contain the highest excitation level.}} + \text{Bracketings}$$

Now if we want to find the term of $(R_0V_0)^m\Phi$ that has the highest excitation level, it will be the one with all creation operators:




each of these contributes excitation level 2

$\Longrightarrow$ max excitation level $2m$

So if we're considering going from $m \to m+1$, the excitation levels will go from

$$2m \longrightarrow 2(m+1) = \underbrace{2m+2}_{\text{increases by 2}}$$