Both red ($\lambda = 632.8$ nm) and green ($\lambda = 543.4$ nm) Helium-Neon lasers can be purchased. In both of these cases an electron in Ne is excited to a particular energy level by a collision with excited He. In falling to lower levels it may take several paths, the larger of two possible jumps producing the green light.

Ne in its ground state has completely filled orbitals ($1s^2 2s^2 2p^6$) so in exciting a $2p$ electron a 'hole' will be left in the $2p$ orbital and the excited electron will be alone in a new orbital. In denoting these stationary states we display the configuration of the hole (e.g., $1s^2 2s^2 2p^5 (^2P_{\frac{3}{2}})$), the location of the excited electron (e.g., $3p$), the angular momentum obtained by combining the hole's total angular momentum (e.g., $\frac{3}{2}$) with the orbital angular momentum of the excited electron (e.g., if the excited electron is in p options range from $\left[\frac{5}{2}\right]$ to $\left[\frac{1}{2}\right]$), (of course the spin of this lone excited electron makes it a doublet, $^2\left[\frac{5}{2}\right]$), and finally the total of the lone electron spin angular momentum and the previous total of hole total+lone electron orbital, J, is displayed as a subscript:
$1s^2 2s^2 2p^5 (^2P_{\frac{3}{2}}) 3p \quad ^2\left[\frac{5}{2}\right]_2$.

The below table shows the initial energy level of the electron, and various lower energy states that are available. Find the transitions that produce the red and green HeNe laser lines. Report a possible transition that is not 'allowed'. Note: a spreadsheet with the full precision values is available on the class web site (in the `data` folder).

Configuration	Term	J	Energy (eV)
$1s^2 2s^2 2p^5 (^2P_{\frac{1}{2}}) 5s$	$^2\left[\frac{1}{2}\right]$	1	20.66
$1s^2 2s^2 2p^5 (^2P_{\frac{3}{2}}) 3p$	$^2\left[\frac{1}{2}\right]$	1	18.38
same		0	18.71
$1s^2 2s^2 2p^5 (^2P_{\frac{3}{2}}) 3p$	$^2\left[\frac{5}{2}\right]$	3	18.56
same		2	18.58
$1s^2 2s^2 2p^5 (^2P_{\frac{3}{2}}) 3p$	$^2\left[\frac{3}{2}\right]$	1	18.61
same		2	18.64
$1s^2 2s^2 2p^5 (^2P_{\frac{1}{2}}) 3p$	$^2\left[\frac{3}{2}\right]$	1	18.69
same		2	18.70
$1s^2 2s^2 2p^5 (^2P_{\frac{1}{2}}) 3p$	$^2\left[\frac{1}{2}\right]$	1	18.73
same		0	18.97

Note: The listed energies are the (positive) values relative to the ground state rather than (negative) values relative to the separated (ionized) state.