98/100

Name Jacob Kaufman ID # _____ Dis 1F

1.

a) Give the ground state electron configuration for Mg, P, Sc

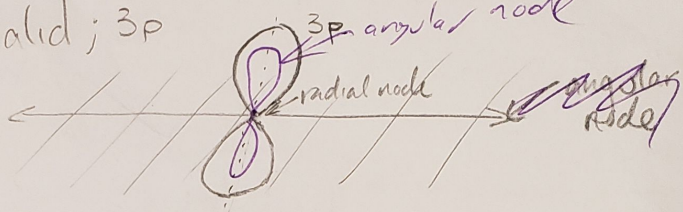
Mg: $[Ne]3s^2$ ✓

P: $[Ne]3s^2 3p^3$ ✓

Sc: $[Ar]4s^2 3d^1$ ✓

b) For each of the following sets of quantum numbers, identify which are valid and invalid. If valid, draw and label the corresponding orbital (ex. 2p, 1s) including angular and radial nodes. If invalid, indicate why.

(3, 1, -1, +½): valid; 3p



(2, 2, 0, -½): invalid because in this case $\ell > n-1$, and ℓ is always restricted to $\{0, 1, 2..., n-1\}$ ✓

(1, 0, 0, +1): Invalid because an electron cannot have spin +1; it can only have spin $\pm\frac{1}{2}$ ✓

2. Sodium has a first ionization energy of 495.8 kJ/mol

a. Write an equation showing the ionization of one sodium atom

$IE = h\upsilon - \frac{1}{2} M_e V_e^2$ OK

ionization energy of atom — Energy of light — Kinetic energy of ejected electron

b. What is the longest wavelength of light that can ionize sodium one time?

$IE = (495.8 \frac{kJ}{mol})(\frac{1000 J}{kJ})(\frac{mol}{6.022 \times 10^{23}}) = 8.233 \times 10^{-19} J$

$E = \frac{hc}{\lambda}$

$\frac{1}{E} = \frac{\lambda}{hc} \Rightarrow \lambda = \frac{hc}{E}$

$\lambda = \frac{(6.626 \times 10^{-34})(3 \times 10^8)}{(8.233 \times 10^{-19})} = \boxed{2.41 \times 10^{-7} M}$ ✓

c. What frequency of light is necessary to ionize sodium and produce an electron with a velocity of 1.5×10^7 m/s?

$IE = h\upsilon - K_e$

$(8.233 \times 10^{-19}) = (6.626 \times 10^{-34})(\upsilon) - \frac{1}{2} M_e V_e^2$

$(8.233 \times 10^{-19}) = (6.626 \times 10^{-34})(\upsilon) - \frac{1}{2}(9.11 \times 10^{-31})(1.5 \times 10^7)^2$

$\upsilon = 1.559 \times 10^{17} s^{-1}$

$\upsilon = \boxed{1.6 \times 10^{17} s^{-1}}$ ✓