

HW 8 Key

1. a)  $n=2, l=2, m=1, m_s=1/2$  : not allowed,  $l = 0, 1, \dots, n-1$
- b)  $n=3, l=1, m=1, m_s=-1/2$  : allowed
- c)  $n=1, l=2, m=0, m_s=1/2$  : not allowed,  $l = 0, 1, \dots, n-1$
- d)  $n=4, l=-1, m=0, m_s=-1/2$  : not allowed  $l \neq 0$
- e)  $n=3, l=2, m=0, m_s=-1/2$  : allowed
- f)  $n=3, l=-3, m=0, m_s=-1/2$  : not allowed,  $l \neq 0$

2. a)  $n=2, l=0$  : 2s
- b)  $n=4, l=2$  : 4d
- c)  $n=6, l=3$  : 6f
- d)  $n=3, l=1$  : 3p

3. # angular nodes =  $l$   
 # radial nodes =  $n - l - 1$   
 total # of nodes =  $n - 1$

1b) angular nodes = 1  
 radial nodes = 1  
 total nodes = 2

2a) angular nodes = 0  
 radial nodes = 1  
 total nodes = 1  
 c) AN = 3  
 RN = 2  
 Tot = 5

1c) angular nodes = 2  
 radial nodes = 0  
 total nodes = 2

b) angular nodes = 2  
 radial nodes = 1  
 total nodes = 3  
 d) AN = 1  
 RN = 1  
 Tot = 2

(2)

$$4. \psi_{2p_z} : \psi(r, \theta, \phi) = R(r) Y(\theta, \phi)$$

$$R(r)_{2p_z} = \frac{1}{2\sqrt{6}} \left(\frac{z}{a_0}\right)^{3/2} \sigma e^{-\sigma/2}$$

$$Y(\theta, \phi)_{2p_z} = \left(\frac{3}{4\pi}\right)^{1/2} \cos \theta$$

$$\psi(r, \theta, \phi) = \frac{1}{2\sqrt{6}} \left(\frac{z}{a_0}\right)^{3/2} \sigma e^{-\sigma/2} \left(\frac{3}{4\pi}\right)^{1/2} \cos \theta$$

$$\sigma = \frac{zr}{a_0}$$

$$\psi(r, \theta, \phi) = \underbrace{\frac{1}{2\sqrt{6}} \left(\frac{z}{a_0}\right)^{3/2}}_{\text{constant}} \underbrace{\left(\frac{zr}{a_0}\right)}_{\text{const.} \times r} e^{-2r/2a_0} \underbrace{\left(\frac{3}{4\pi}\right)^{1/2}}_{\text{const.}} \cos \theta$$

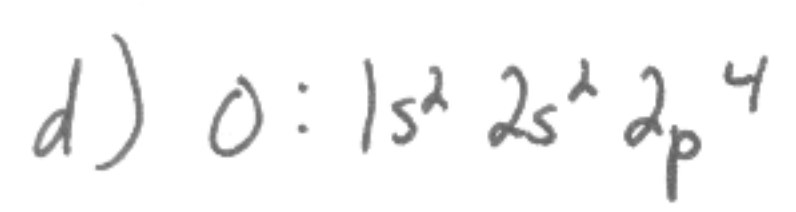
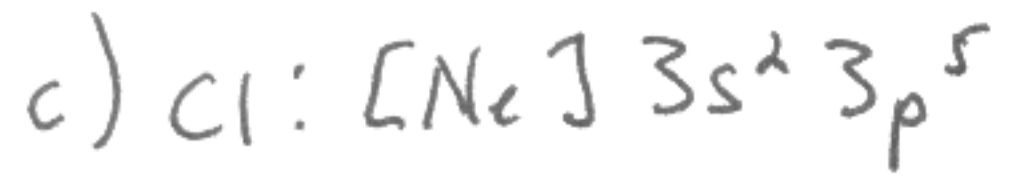
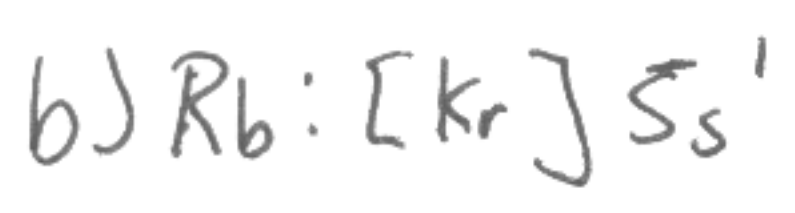
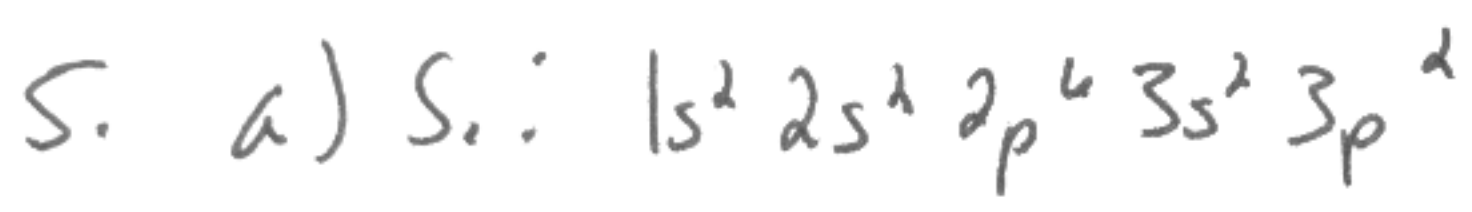
reduces to:  $\psi(r, \theta, \phi) = C r e^{-2r/2a_0} \cos \theta$

where I have ~~reduced~~ <sup>combined</sup> all the constants to the constant C

$$P = \psi^2(r, \theta, \phi) = C^2 r^2 e^{-2r/a_0} \cos^2 \theta$$

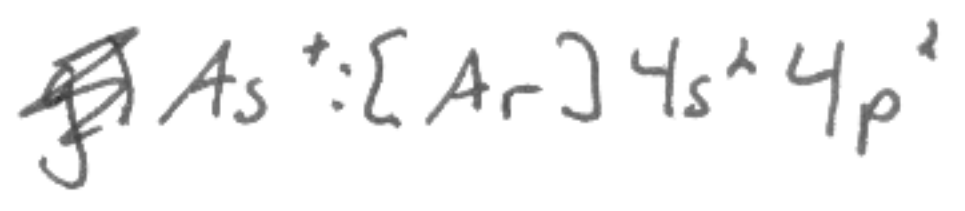
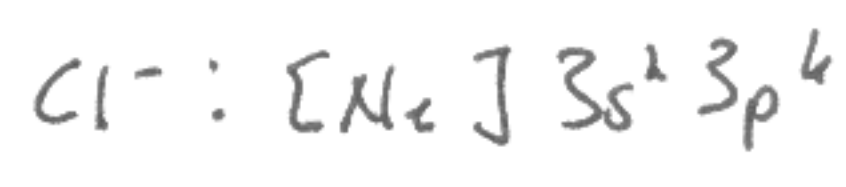
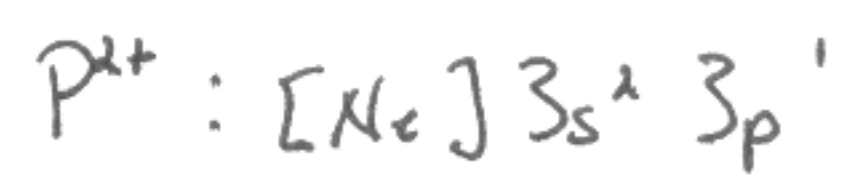
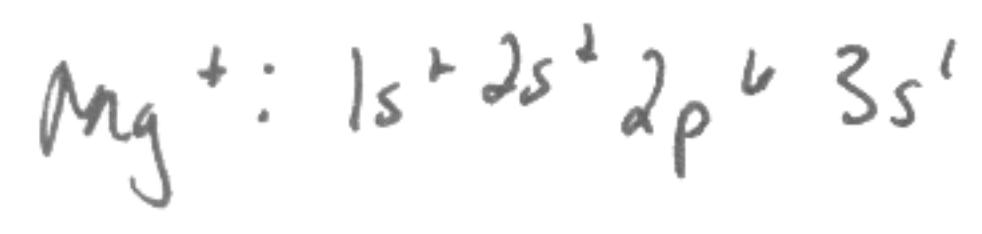
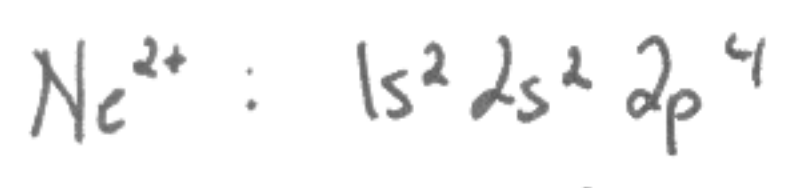
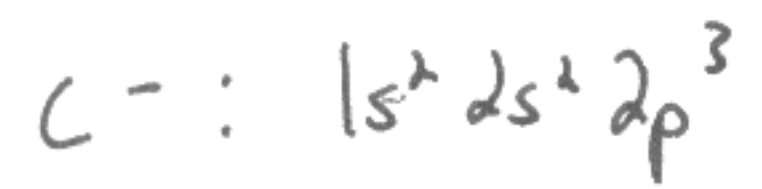
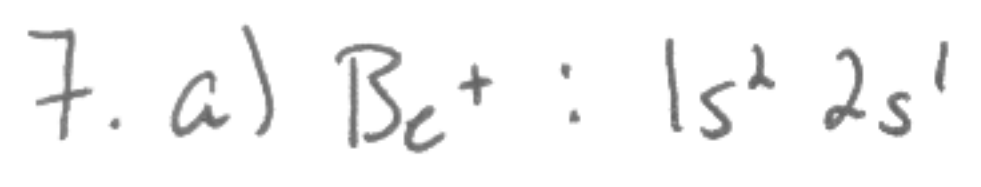
- Where will this equal 0? at  $r=0$  and at  $\theta = \frac{\pi}{2}, \frac{3\pi}{2}$

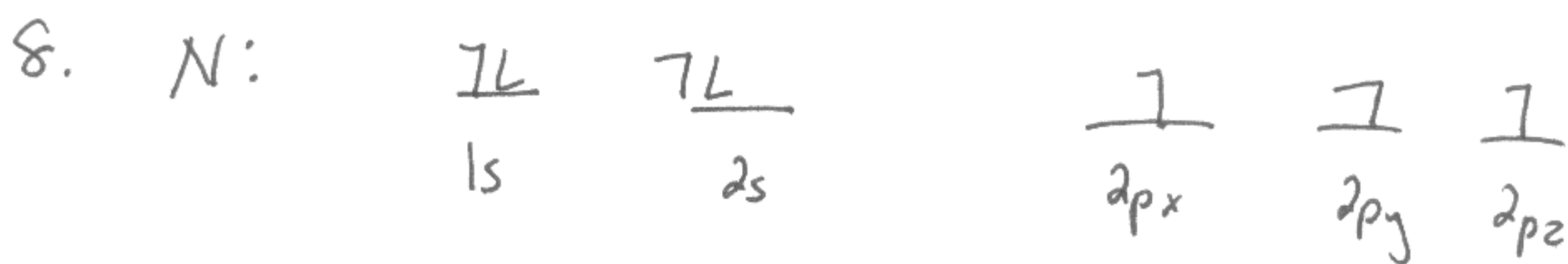
- Based on our definition of spherical polar coordinates,  $\theta$  is the angle off the z-axis. Therefore  $\theta = \frac{\pi}{2}$  or  $\frac{3\pi}{2}$  by definition places us in the x-y plane.



6. period 2 valence e:

	1s	2s	2p <sub>x</sub>	2p <sub>y</sub>	2p <sub>z</sub>	
Li:	<u>↑↓</u>	<u>↑</u>	—	—	—	paramagnetic
Be:	↑↓	↑↓	—	—	—	not
B:	↑↓	↑↓	↑	—	—	paramagnetic
C:	↑↓	↑↓	↑	↑	—	paramagnetic
N:	↑↓	↑↓	↑	↑	↑	paramagnetic
O:	↑↓	↑↓	↑↓	↑	↑	paramagnetic
F:	↑↓	↑↓	↑↓	↑↓	↑	paramagnetic
Ne:	↑↓	↑↓	↑↓	↑↓	↑↓	not.





The  $2p$  orbital is half full in the most favorable configuration of unpaired electrons (according to Hund's rules) - all unpaired and of the same spin. Data on IE and EA show us that it is harder to ionize N than C or O, and that it is very difficult to add an extra  $e^-$  to N (EA not recorded). Taking all that information, it seems like this electron configuration gives N a special stability.