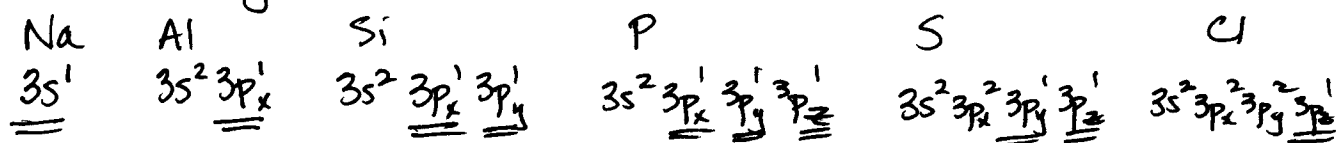


1) a) The potassium nucleus has two more protons so it will be harder to pull away an electron: K will have higher IE.

b) All of the elements in the row have unpaired electrons except for Mg and Ar.



c)

$$\lambda_{\text{He}} = \frac{h}{mv}$$

$$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$m = 4 \text{ amu} = 4 \times 1.66 \times 10^{-27} \text{ kg}$$

$$v = 0.01 c = 3 \times 10^6 \text{ m/sec}$$

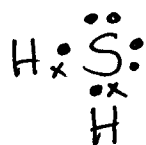
$$\lambda_{\text{He}} = 3.3 \times 10^{-14} \text{ meters}$$

d) When the wavelength of the particle is larger than or comparable to the dimensions of the system of interest, we will need to think of the particle as a wave.

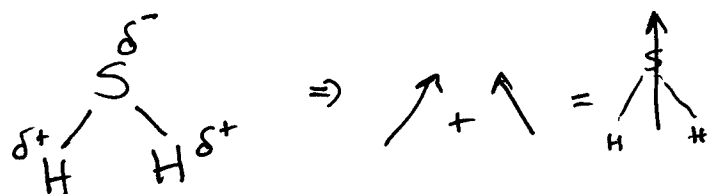
For the He atom above, it will be particle-like in almost any realistic situation except perhaps in probing nuclear structure.

e) A resonance structure occurs when there are many valid Lewis structures for a given molecule. The system will exhibit an average structure. We know because there will be a single vibrational absorption in IR spectra.

2) a)



This will have a V-shaped geometry



with dipole moment as sketched.

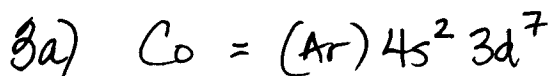
- b) Because the lone pairs in S are 3p rather than 2p, they will extend further into space and repel more. The H atoms will be closer in H_2S than H_2O :

Smaller H-S-H bond angle.

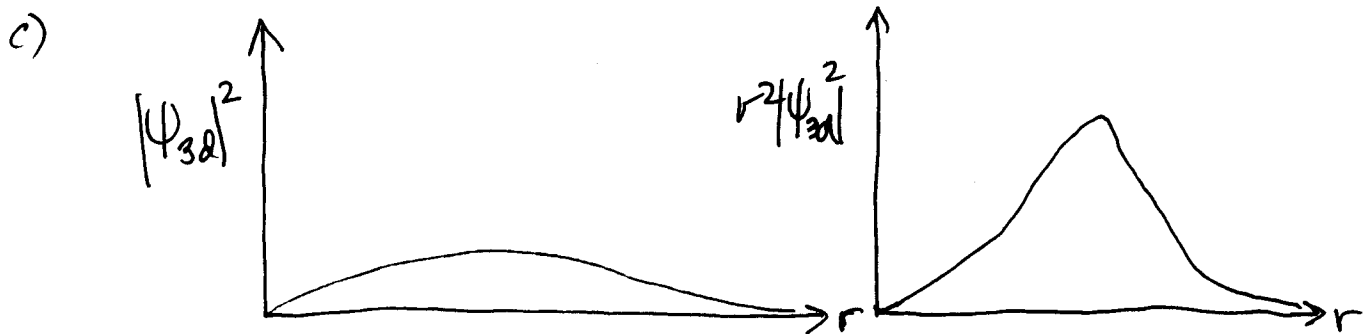
- c) The D-S-D bond angle will be the same as H-S-H. The Coulomb forces are exactly the same and the mass difference is irrelevant to the equilibrium structure.

(NOTE: It would, however, change the vibrational spectrum).

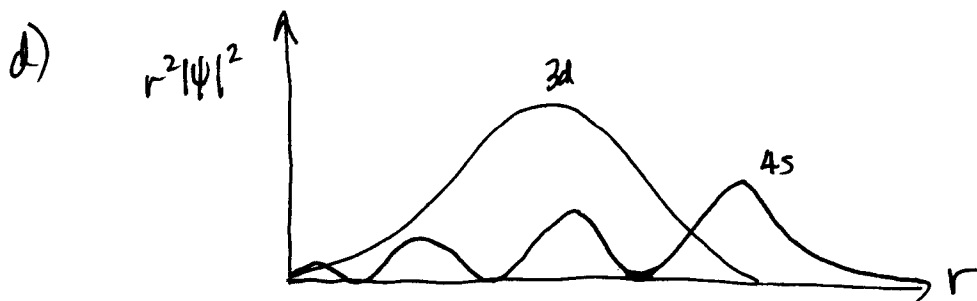
- d) H_2O has a bigger dipole moment because oxygen is more electronegative than sulfur. Large dipole moments mean large inter molecular forces (e.g. higher boiling points as in this example).



- b) All will have $n=3, l=2$.
 Any m_l from $-2, -1, 0, 1, 2$ is okay.
 Either $m_s = +1/2$ or $m_s = -1/2$ is okay.
- } e.g. $n=3$
 $l=2$
 $m_l=0$
 $m_s=1/2$



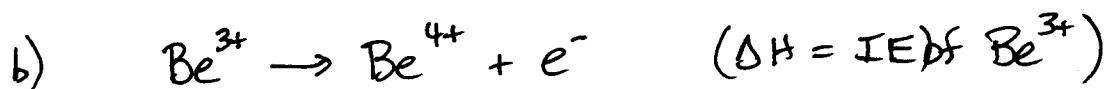
The left graph describes probability going away from the nucleus in one direction. The right graph is probability of being a distance r from the nucleus in any direction.



Even though the average distance of the 4s electron is further from the nucleus, it sometimes gets close to the nucleus which greatly lowers its energy (Coulomb pot. $\sim \frac{-Ze^2}{r}$). Hence, 4s has lower energy than 3d in multi-electron atoms.

- e) Co will have higher electronegativity than Rh. Adding a 3d electron is more energetically helpful than 4d since they are closer to the nucleus.

$$4) a) \psi_{1s}(\text{Be}^{3+}) : = \frac{1}{\sqrt{\pi}} \left(\frac{4}{a_0}\right)^{3/2} e^{-4r/a_0}$$



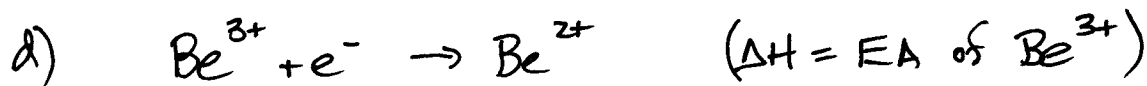
c) Yes, we can use the Bohr formula since this is a one electron atom.

$$\text{IE} = E_{\infty} - E_1 = 0 - E_1 = -E_1 = -2.178 \times 10^{-18} \left(\frac{Z^2}{1^2}\right)$$

$$\text{Here, } Z=4 \quad \text{so } \text{IE} = 3.485 \times 10^{-17} \text{ J/Be}^{3+} \text{ atom}$$

$$\text{In KJ/mol, } \text{IE} = 3.485 \times 10^{-17} \frac{\text{J}}{\text{atom}} \times \frac{1 \text{ KJ}}{1000 \text{ J}} \times \frac{6.023 \times 10^{23} \text{ atoms}}{\text{mole}}$$

$$\boxed{\text{IE} = 2.10 \times 10^4 \text{ KJ/mol}} \text{ for Be}^{3+}$$



e) Since Be^{2+} is a two electron atom, the Bohr formula will not be a good approximation for describing its energy. Therefore, we cannot accurately compute the EA of Be^{3+} .