HW 2

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E45

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Problem 2.9. A copper penny has a mass of 2.60 g. Assuming pure copper, how much of this mass is contributed by **(a)** the neutrons in the copper nuclei and **(b)** electrons?

(a) Cu-63 has 29 protons and 34 neutrons. The mass of a copper atom is,

$$\frac{63.546\,g}{1\,mole} = \frac{63.546\,g}{6.022\times10^{23}\,atoms} = \frac{1.055\times10^{-22}\,g}{Cu\ atom}$$

Now find the mass percent of neutrons in a copper atom

$\frac{34\,\text{neutrons}*1.6749\times10^{-24}g}{1\,neutron} = 5.695\times10^{-23}\,g \Rightarrow \frac{5.695\times10^{-23}\,g/\text{Cu}}{1.055\times10^{-22}\,g/\text{Cu}} = 53.98\%$ neutron mass in Cu

Finally, $2.60\,g * 0.5398 = 1.40\,g$ of neutrons.

(b) Same idea fo electrons. Find the mass of 29 electrons and compare to Cu atom mass.

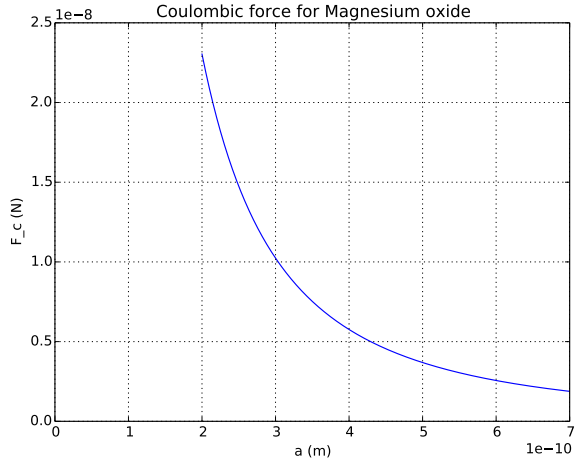
$$29\,\text{electrons} * \frac{9.11\times10^{-28}\,g}{1\,\text{electron}} = 2.64\times10^{-26}\,g$$

$$\frac{2.64\times10^{-26}\,g/Cu}{1.055\times10^{-22}\,g/Cu} = 2.50\times10^{-4}\,\%\text{electron mass in Cu}$$

Finally, $2.60\,g * 2.50\times10^{-4} = 6.51\times10^{-4}\,g$ of electrons.

Problem 2.13. Make an accurate plot of F_c versus a (comparable to that shown in Figure 2.6) for an $Mg^{2+} - O^{2-}$ pair. Consider the range of a from 0.2 to 0.7 nm.

Using the equation $F_c = \frac{-K}{a^2}$ where $K = k_0 Z_1 Z_2 q^2$ and $Z_1 = +2, Z_2 = -2$.

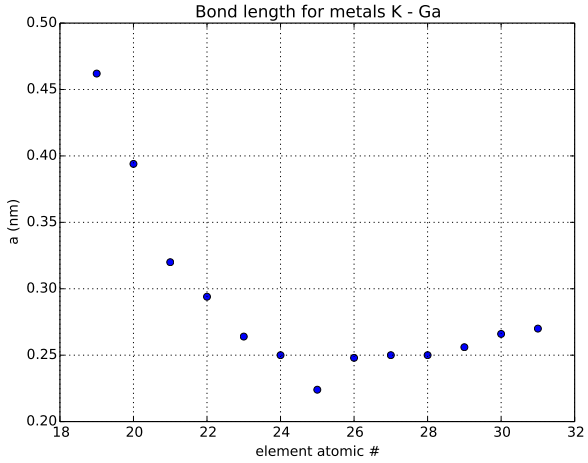


Problem 2.33. The first step in the formation of phenolformaldehyde, a common phenolic polymer, is shown in Figure 12.6. Calculate the net reaction energy (per mole) for this step in the overal polymerization reaction.

initially the $C = O$ bond is broken and two $C - H$ bonds are formed.

$$C = C \rightarrow 2\,C - H$$
$$535\text{kj/mole} \rightarrow 2(435\text{kJ/mole})$$
$$(870 - 535)\text{kJ/mole} = 335\text{kJ/mole}$$

Problem 2.46. Plot the bond length of the metals in the long row of metallic elements (K to Ga).



Problem 2.52. Due to its large atomic diameter, neon has a higher heat of solution in vitreous silica than helium. If the heat of solution of neon in vitreous silica is -6.70 kJ/mol and the solubility at 25°C is 9.07×10^{23} atoms/(m^3*atm), calculate the solubility at 200°C. (See problem 2.51.)

Let $T_1 = 298.15\,K, T_2 = 473.15\,K$ and $S_1 =$ solubility at $298.15\,K, S_2 =$ solubility at $473.15\,K$.

$$\frac{S_0}{S_1} = e^{\frac{\Delta H_s}{RT_1}}, \quad \frac{S_0}{S_2} = e^{\frac{\Delta H_s}{RT_2}}$$

divide the two equations with each other,

$$\frac{S_2}{S_1} = \frac{e^{\frac{\Delta H_s}{RT_1}}}{e^{\frac{\Delta H_s}{RT_2}}}$$

$$S_2 = S_1 e^{\frac{\Delta H_s}{R}(\frac{1}{T_1} - \frac{1}{T_2})}$$

$S_1 = 9.07 \times 10^{23}\text{atoms}/(m^3\text{atm}), \Delta H_s = -6700\text{J/mol}, R = 8.315\text{J}/(\text{mol k})$

after plugging in numbers and solving,

$$S_2 = 0.368 S_1$$

$$S_2 = 3.34 \times 10^{23}\text{atoms}/(m^3\ \text{atm})$$