Self-Assessment: Structure of the Atom

Weekly Homework Quiz

Problem #1

(a) Cerium has many isotopes (8 to be exact), but only ^{140}Ce and ^{142}Ce are present in substantial amounts. Which isotope of cerium is the most abundant?

Production of chromium in an electric arc furnace would involve the reaction of carbon with chromium sesquioxide according to the following reaction:

$$Cr_2O_3 + a\ C = b\ CO + c\ Cr$$

(i) Balance the equation, i.e., specify the values of *a*, *b*, and *c*. Insert the correct values below.

(ii) Calculate the minimum amount of chromium (in kg) produced if the reaction consumed 333 kg C and produced the stoichiometric amount of Cr. Assume 100% efficiency.

Problem #2

(a) Antimony has two isotopes, ^{121}Sb and ^{123}Sb. Which isotope has the higher natural abundance?

(b) Production of hafnium by the Kroll Process would involve the reaction of magnesium with hafnium tetrachloride according to the following reaction:

$$HfCl_4 + a\,Mg = b\,MgCl_2 + c\,Hf$$

(i) Balance the equation, i.e., specify the values of *a*, *b*, and *c*. Insert the correct values below.

(ii) Calculate the minimum amount of magnesium (in kg) needed to convert 111 kg $HfCl_4$ into elemental hafnium.

Problem #3

(a) Show by means of a calculation that blue light of wavelength, $\lambda = 444$ nm, is not capable of exciting electrons in $Li^{2+}(g)$ from the state $n = 2$ to $n = 4$.

(b) Is the value of the energy of transition from the state $n = 2$ to $n = 4$ in Li^{2+}, $\Delta E_{2\rightarrow 4}$, greater than or less than the value of the energy of transition from the state $n = 1$ to $n = 2$ in Li^{2+}, $\Delta E_{1\rightarrow 2}$? Explain with the use of an energy level diagram. There is no need to calculate the values of the two quantities.

Problem #4

(a) In a gas discharge tube what is the minimum frequency (ν) of a photon capable of ionizing ground-state electrons in Li^{2+}?

(b) Explain with reference to the relevant physical forces why the value of the 1st ionization energy of Li is less than the 3rd ionization energy of Li.

3.091SC Introduction to Solid State Chemistry

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