

3.091 Fall Term 2009

Homework Quiz #1B

solution outline

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

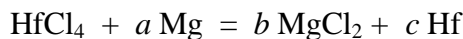
from the periodic table, you see that the atomic mass of Sb is 121.757, which must be the weighted sum of the isotope masses

$$\text{so, } (x \text{ mass of } ^{121}\text{Sb}) + (1-x) \text{ mass of } ^{123}\text{Sb} = 121.757$$

for the purposes of this decision, we can approximate the atomic masses of the isotopes as ~ 121 for ^{121}Sb and ~ 123 for ^{123}Sb and solve for x

$x = 0.62$ which means that ^{121}Sb is the more abundant isotope of antimony

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



- (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.

$$111 \text{ kg HfCl}_4 = 111000/[178.49 + (4 \times 35.45)] = 347 \text{ moles HfCl}_4$$

the stoichiometric amount of Mg is twice the amount of HfCl_4 on a molar basis

$$\therefore \text{ amount of Mg} = 347 \times 2 \text{ moles of Mg} = (347 \times 2) \times 24.305 = 16.9 \text{ kg Mg}$$