

3.091 Fall Term 2009  
**Homework Quiz #1A**  
solution outline

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

from the periodic table, you see that the atomic mass of Ce is 140.115, which must be the weighted sum of the isotope masses

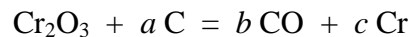
here we assume that it is necessary to consider only  $^{140}\text{Ce}$  and  $^{142}\text{Ce}$

$$\text{so, } (x \text{ mass of } ^{140}\text{Ce}) + (1-x) \text{ mass of } ^{142}\text{Ce} = 140.115$$

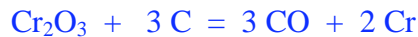
for the purposes of this decision, we can approximate the atomic masses of the isotopes as  $\sim 140$  for  $^{140}\text{Ce}$  and  $\sim 142$  for  $^{142}\text{Ce}$  and solve for  $x$

$x = 0.94$  which means that  $^{140}\text{Ce}$  is the most abundant isotope of cerium

Production of chromium in an electric arc furnace would involve the reaction of carbon with chromium sesquioxide 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 chromium (in kg) produced if the reaction consumed 333 kg C and produced the stoichiometric amount of Cr. Assume 100% efficiency.

$$333 \text{ kg C} = 333000/12.011 = 27725 \text{ moles C}$$

the stoichiometric amount of Cr is  $2/3$  amount of carbon on a molar basis

$$\therefore \text{ amount of Cr} = 27725 \times 2/3 \text{ moles of Cr} = (27725 \times 2/3) \times 51.996 = 961 \text{ kg Cr}$$