

**Unit 5: Naming, Moles & Math****Free Response Review #1**

**Directions:** The suggested time is about 15 minutes for answering the constructed response section of the chemistry test. The parts within a question may not have equal weight. For calculations, show all your work in the spaces provided after each part. Pay particular attention to the proper use of units. Be sure your final answer is rounded to the correct number of significant figures. Make sure your work is legible. Illegible work will receive a grade of zero.

**Question 1 [8 POINTS]**

Aspartame is an artificial sweetener: one molecule of aspartame is 160 times sweeter than a molecule of sucrose (table sugar,  $C_{12}H_{22}O_{11}$ ) when dissolved in water. It is marketed as NutraSweet. The molecular formula for aspartame is  $C_{14}H_{18}N_2O_5$ .

The molar mass of aspartame,  $C_{14}H_{18}N_2O_5$ , is 294.3 grams/mol.

The molar mass of sucrose,  $C_{12}H_{22}O_{11}$ , is 342.3 grams/mol.

**A.** One packet of aspartame contains 35.0 mg of  $C_{14}H_{18}N_2O_5$ .

**i.** Show a numerical setup using dimensional analysis and determine how many moles of aspartame are present in each packet. **[2 POINTS]**

$$35.0 \text{ mg} \times \frac{10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mol}}{294.3 \text{ g}} = 1.19 \times 10^{-4} \text{ mol } C_{14}H_{18}N_2O_5$$

**ii.** Show a numerical setup using dimensional analysis and determine how many molecules of aspartame are present in each packet. **[1 POINT]**

$$1.19 \text{ E-}4 \text{ mol} \times \frac{6.022 \text{ E}23 \text{ molec.}}{1 \text{ mol}} = 7.17 \times 10^{19} \text{ molec. } C_{14}H_{18}N_2O_5$$

**iii.** Show a numerical setup using dimensional analysis and determine how many atoms of nitrogen are present in each packet. **[1 POINT]**

$$1.19 \text{ E-}4 \text{ mol } C_{14}H_{18}N_2O_5 \times \frac{2 \text{ mol N}}{1 \text{ mol } C_{14}H_{18}N_2O_5} \times \frac{6.022 \text{ E}23 \text{ atoms N}}{1 \text{ mol N}} = 1.43 \times 10^{20} \text{ atoms N}$$

B. What is the percent by mass of carbon in:

i. aspartame? [1 POINT]

$$\% C = \frac{14 \times 12.01}{294.3} \times 100 = \boxed{57.13\% C}$$

ii. sucrose? [1 POINT]

$$\% C = \frac{12 \times 12.01}{342.3} \times 100 = \boxed{42.10\%}$$

C. One morning, a chemistry teacher uses one packet of aspartame in her morning coffee. The next morning, she uses 3.90 g of sucrose instead. Is the number of molecules of sucrose used greater than, equal to, or less than the number of molecules of aspartame used? Show a numerical setup using dimensional analysis to justify your response. [2 POINTS]

$$3.90 \text{ g} \times \frac{1 \text{ mol}}{342.3 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ molec.}}{1 \text{ mol}} = 6.86 \times 10^{21} \text{ molec. } C_{12}H_{22}O_{11}$$

6.86 E 21 molec. > 7.17 E 19 molec.  
 Sucrose                      aspartame

↑  
 (from part A, ii → don't  
 need to redo calculation!)