# 5.111 REVIEW PROBLEMS

1. (Significant Figures Review) Report the value of x with the correct number of significant figures in the following problems.
    (a) $x = (4.1031 \times 10^{-7}) + (1.47 \times 10^{-8})$
    (b) $x = (4.0 \times 10^{-4}\,g)(1.11 \times 10^{-5}\,mol/g) - [(4.020 \times 10^{-11}\,mol) / 2.00)]$

2. (Fundamentals Sections E and F) Lithium diisopropylamide (LDA) is a strong base used in organic synthesis. LDA has a molecular formula of $C_6H_{14}LiN$ and it is a liquid at room temperature (density $= 0.79$ g/mL).
    (a) How many molecules of LDA are present in 6.1 mmol?
    (b) Convert 65 mmol of LDA into grams.
    (c) Calculate the volume of 65 mmol of LDA.
    (d) While pure LDA can spontaneously ignite, LDA in solution is not pyrophoric. Calculate the volume of a 2.0 M solution required to get 350 mmol of LDA.

3. (Fundamentals Sections L and M) Under appropriate conditions, hydrogen (H_2) and nitrogen (N_2) react to produce ammonia, NH_3. Identify the limiting reactant and determine the maximum quantity of ammonia that can be produced in each case below.
    (a) 75 mmol of H_2 and 35 mmol of N_2 (in mmol NH_3).
    (b) 1.1 g of H_2 and 0.25 mol of N_2 (in mol of ammonia);

4. (Fundamentals Sections L and M) Molecule **1** ($C_7H_{10}O$) is a precursor for the synthesis of huperzine A, a naturally occurring neuroprotective molecule with potential for the treatment of Alzheimer's disease. A three-step synthesis to generate molecule **1** was published in 2012:
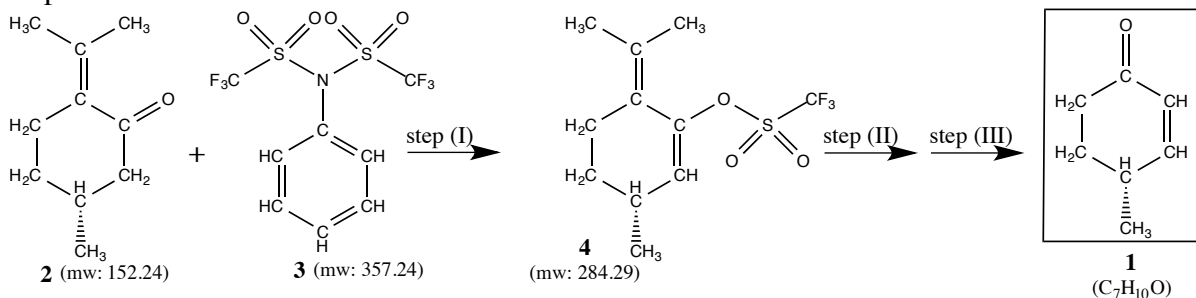
    In step (I), 6.85 g of **2** reacted with 47.0 mL of a 1.00 M solution of **3** to produce molecule **4**.

    (a) Determine the limiting reagent.
    (b) If 10.5 g of **4** were produced, calculate the percent yield for step (I).
    If step (II) and step (III) had percent yields of 59% and 91%, respectively,
    (c) determine the overall percent yield for the three-step synthesis of **1**.
    (d) How many grams of **1** would be produced from 5.0 g of molecule **2** (assuming **2** is the limiting reagent in this case).
    (e) Imagine that you come up with an alternative synthesis for **1**. Your synthesis is seven steps with a 93% yield per step. What is the overall percent yield?
    (f) Now calculate the overall yield if one of the steps is 40.% and the other six are 95%.
    (ref: *J. Org. Chem.* 2012, 77, 9422-9425.)

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5. (Fundamentals Section F) Novartis Pharmaceuticals, which has a research site a short walk from the MIT student center, has several programs that target orphan diseases, which are diseases that are either rare worldwide or uncommon in developed countries. One resulting drug has a formula of $C_{58}H_{66}N_{10}O_9$. Calculate the mass percentage composition of carbon, hydrogen, and nitrogen for this drug. Report each % to one decimal place (ie. 44.3%).

6. (Fundamentals Section G) Describe how you would prepare 2.00 L of each solution listed:
    (a) 0.250 M NaOH from solid NaOH
    (b) 0.250 M NaOH from a 1.00 M stock solution of NaOH
    (c) 0.50 M HCl from "concentrated" (12 M) HCl

5.111 Principles of Chemical Science
Fall 2014