Lecture Notes B: Stoichiometry

1) Determining the density of a substance

Concept
There was probably some air trapped in the bag, and this may introduce some error into our measurement. What is the nature of this error?

a) The density we calculated is probably a bit larger than the actual density
b) The density we calculated is probably a bit smaller than the actual density
c) The direction of the error is not predictable.
2) Molarity

Problem
PCR (Polymerase Chain Reaction) is used to amplify DNA for techniques such as DNA fingerprinting. In the PCR process, everytime the solution is heated and cooled, the number of DNA molecules is doubled (see animation on http://www.people.virginia.edu/~rjh9u/pcranim.html). In principle, this technique can be used to amplify a single DNA molecule up to a detectable concentration (say 1 µM).

Consider a 1ml solution containing 1 DNA molecule. How many cycles are needed to make this into a 1 µM solution of DNA?
3) **Empirical formula**

**Problem**
The pre-hormone androstenedione (*commonly called andro*) has been in the sports news in recent years owing to its arguable contribution to the breaking of the homerun record. The product has a composition that is 79.68% carbon (C), 9.15% hydrogen (H), and 11.17% oxygen by weight. What is the empirical formula for this compound?

at. wts.: \( C \) 12.011 \( H \) 1.0079 \( O \) 15.999
4) **Combustion reactions (balancing chemical equations)**

\[
\text{A hydrocarbon } + \ O_2 \rightarrow \ CO_2 + H_2O
\]

**Problem**

100.0 grams of *andro* are burned in excess oxygen. How many grams of O\(_2\) are consumed, and how many grams of CO\(_2\) and H\(_2\)O are produced?

MW \(\text{O}_2 = 2 \times 15.999 = 31.998\) \(\text{CO}_2 = 12.011 + 2 \times 15.999 = 44.009\)

\(\text{H}_2\text{O} = 2(1.0079) + 15.999 = 18.0148\)

**Concept**

If the empirical formula for *andro* was C\(_{19}\)H\(_{26}\)O\(_4\) (instead of C\(_{19}\)H\(_{26}\)O\(_2\)), what would change about the above reaction?

- a) More CO\(_2\) would be produced
- b) Less CO\(_2\) would be produced
- c) More O\(_2\) would be consumed
- d) Less O\(_2\) would be produced
5) Combustion of methane vs propane
6) **Limiting Reagents**

In a reaction, a limiting reagent is the reagent that runs out first, it *limits* the amount of the products that are produced.

\[ A + B \rightarrow C + D \]

**Problem**

I’m trying to make tomato sandwiches. I like 3 slices of tomatoes per sandwich on two slices of bread. If I have 20 slices of bread and 24 slices of tomatoes, how many sandwiches can I make? What do I have left over, if anything?
**Problem**
Consider the reaction of ammonia (NH₃) and carbon dioxide (CO₂) to form (NH₂)₂CO and water (H₂O). 2.54g of ammonia is reacted with 3.61g of CO₂. The reaction goes to completion. What is present at the end of the reaction.