Avogadro’s number = $6.022 \times 10^{23}$

1. (4 pts) Explain what Avogadro’s number represents (Hint: What units would you give Avogadro’s number?), and explain when you would use it in a calculation.

2. (4 pts) Why is it important for chemists to use a concept like the “mole”?

3. (8 pts) How many moles of water is in 1.00 gallon of water? 1 gal = 3.785 L; the density of water is 0.997 g/mL at room temperature.

4. (2 pts) How many water molecules are in 1.00 gallon of water? (You can use your answer to #3 above).

5. (6 pts) How many molecules of CO$_2$ is in a 5.00 lb chunk of dry ice (CO$_2$)? 1 lb = 453.6 g
6. Penicillin F (one kind of penicillin used as an antibiotic) has the formula $C_{14}H_{20}N_{2}SO_{4}$.

a. (4 pts) How many moles of carbon is in exactly one mole of Penicillin F? ___________ (Include units)

b. (4 pts) How many grams of carbon is in one mole of Penicillin F? ___________ (Include units)

c. (4 pts) What is the molar mass of Penicillin F? ___________ (Include units)

d. (4 pts) What is the % of carbon in Penicillin F? ___________ (Include units)

7. a. (4 pts) Ever get heartburn? Mylanta contains magnesium hydroxide and is used as an antacid. Aqueous magnesium hydroxide reacts with the aqueous hydrochloric acid in your stomach to produce aqueous magnesium chloride and liquid water. Write a balanced, chemical equation for this reaction.

b. (4 pts) Another antacid that is used is Tums, which are tablets that contain calcium carbonate. The reaction of this antacid in your stomach is below:

$$\text{CaCO}_3 (s) + \text{HCl} (aq) \rightarrow \text{CaCl}_2 (aq) + \text{H}_2\text{O} (l) + \text{CO}_2 (g)$$

Balance the reaction above.

c. (10 pts) Using the reaction in Part B, calculate how much hydrochloric acid (in grams) reacts with two Tums tablets (which together contain a total of 1500 mg of calcium carbonate).
8. Urine contains a compound called urea (CN₂H₄O). Urea can be made in the laboratory from ammonia and carbon dioxide:

\[
2 \text{NH}_3 (g) + \text{CO}_2 (g) \rightarrow \text{CN}_2\text{H}_4\text{O} (s) + \text{H}_2\text{O} (l)
\]

Molar masses:
- \(\text{NH}_3 = 17.04 \text{ g/mol}\)
- \(\text{CO}_2 = 44.01 \text{ g/mol}\)
- \(\text{CN}_2\text{H}_4\text{O} = 60.07 \text{ g/mol}\)
- \(\text{H}_2\text{O} = 18.02 \text{ g/mol}\)

The reaction is balanced and the molar masses are provided to save you time (you're welcome!)

a. (8 pts) How much urea will be formed (in grams) if you do this reaction starting with 100. g of ammonia and 100. g of carbon dioxide? Show your work.

b. (2 pts) If you did this reaction and obtained 99.5 grams of urea, what is your % yield for the reaction? % yield = (obtained yield / theoretical yield) x 100%

c. (2 pts) What are the two reactants in this reaction? ________________________________

d. (2 pts) Which reactant is the limiting reactant? __________________________

e. (2 pts) Which reactant is in excess? ________________________________

f. (6 pts) For the reactant that is in excess, calculate the amount of that reactant left over. [Hint: Start by calculating how much of the excess reactant was actually used.]