**CHM1311 B: Principles of Chemistry**

**Prof. N. Goto**
**Assignment #1**
**Due Sept 26th, at the beginning of class**

Assignments can be submitted individually, or by groups of up to 4 students.

**1) Name:** _____ **Student ID:** _____

**2) Name:** _____ **Student ID:** _____

**3) Name:** _____ **Student ID:** _____

**4) Name:** _____ **Student ID:** _____

Solutions must be written legibly, in the space provided. Adequate detail to the calculation (including units, appropriate sig figs) must be provided to make it possible for other students to understand how you arrived at the final solution. If more space is needed, use the back of the page. Do not add extra pages, as they will not be marked. Assignment pages must be stapled together.

**NOTE:** For each question an on-line resource in WileyPLUS is given in brackets that can walk you through a similar type of problem. (ILW = Interactive Learning Ware.)

**Question 1. (ILW 1.21) (**5 marks)
Use the data in the following table to calculate the elemental molar mass of naturally occurring cesium:

| Isotope | Isotopic Molar Mass (g/mol) | Abundance (%) |
|---|---|---|
| $^{136}$Ce | 135.9071 | 0.185 |
| $^{138}$Ce | 137.9060 | 0.251 |
| $^{140}$Ce | 139.9054 | 88.450 |
| $^{142}$Ce | 141.9092 | 11.114 |

**Question 2. (ILW 39 and FAQ: How do I write an equation to describe the dissociation of an ionic compound?)**

Solution A is prepared by dissolving 83.9 g of $K_3PO_4$ in enough water to make 1.50 L of solution.
Solution B is 2.5 L of 0.684 M KCl.

a) What is the molar concentration of $K_3PO_4$ in Solution A? (3 marks)

b) What volume of Solution A will give 2.50 g of $K_3PO_4$? (2 marks)

c) If 25.0 mL of Solution B is mixed with 35.00 mL of Solution A, what is the concentration of $K^+$ ions in the final solution? (4 marks)

**Question 3. (ILW 1.35)**

One dose of an antibiotic was found to contain 53.6 mg penicillin G ($C_{16}H_{18}N_2O_4S$) in one pill.

a) How many carbon atoms are in a 53.6 mg sample of penicillin G? (3 marks)

b) What mass of carbon is this? (2 marks)

**Question 4. (ILW 1.61)**

Ammonia gas undergoes oxidation to produce liquid water and molecular nitrogen.

a) Write the balanced chemical equation for this reaction. Be sure to include the phases. (2 marks)

b) What is the mass of ammonia gas that is required to completely react with 780 kg of molecular oxygen? (3 marks)

**Question 5. (Office hours video, 1.93)**

Hydrogen fluoride gas is produced industrially by the action of concentrated sulphuric acid on solid $CaF_2$. Suppose 312 kg of $CaF_2$ is treated with an excess of sulphuric acid and 106 kg of HF is produced. What is the percent yield of HF? (6 marks)

**Question 6. (Video for 1.75)**

The following unbalanced reaction is called the thermite reaction. It releases tremendous amounts of energy and is sometimes used to generate heat for welding.

$$Al\ (s) + Fe_3O_4\ (s) \rightarrow Fe\ (s) + Al_2O_3\ (s)$$

a) Write the balanced chemical equation for this reaction. (1 mark)

b) Determine the masses of all the substances present after the reaction if 120. g of Al and 711 g of $Fe_3O_4$ react to completion. Enter your final answers in the table below. (10 marks)

| | Al (s) | $Fe_3O_4$(s) | Fe (s) | $Al_2O_3$ (s) |
|---|---|---|---|---|
| Mass (in g) | | | | |

**Question 7. (Office hours video, 21.3)**

a) What is Z, A and N for the nuclide of the actinide thorium with a neutron:proton ratio of 1.5? (2 marks)

b) What is the nuclear symbol for the lead isotope that contains 128 neutrons? (2 marks)

**Question 8. (Student's solution manual for problem 1.65)**

Nitric acid is produced by a three-step synthesis called the Ostwald process:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

$$2NO + O_2 \rightarrow 2NO_2$$

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

The NO is recycled so that every mole of ammonia theoretically yields one mole of nitric acid. Starting with 626 kg of ammonia, what mass of nitric acid can be produced if each step is 94.5 % efficient? (5 marks)

**Question 9. (Additional Interactive LearningWare Problem 10)**

A 31.15 g sample of an unknown organic compound is subjected to combustion analysis. The sample gives 51.07 g of $CO_2$ and 20.91 g of $H_2O$. When this sample is analyzed for sulfur content, it is found to be 23.9% by mass. What is the empirical formula of the compound? (8 marks)