The following ***"research literature-based assessment"*** is based on the publication: **Naviglio et al., Nutrients (2018) 10, 1647.** *Please note that the set of questions below does **not** investigate all of the experimental methods in this article.* The questions rather focus on the techniques that relate to the first few chapters of the general chemistry curriculum, such as *stoichiometry, reaction balancing, combustion reactions, chemical reactions in solution, percent composition of compounds, molecular & empirical formula, mole and density calculations*. First five pages of the article is especially useful for answering the questions in this exam.

1. Authors of this research paper are trying to synthesize an iron supplement for the medical iron deficiency. Article talks about several *causes* of iron deficiency. Give three examples of the conditions that may cause an individual to be iron deficient which would require the careful use of the iron supplements.

2. What is the chemical difference between ferric iron vs. ferrous iron? In order to explain, you may want to look up their symbols in a textbook and write down. Which one is preferred when taken as supplement? Why?

3. Article talks about an ancient practice of preparing an iron-tainted apple. This method relies on the organic acids of the apple reacting with metallic iron. How do organic acids help absorb the metallic iron to the apple's flesh?

4. Reaction (1) in page 4 shows the net chemical transformation between metallic iron and the citric acid.

a. This net reaction only shows the ***molecular formula*** of the reactants and the products. Please re-write the reaction by using the ***structural formula*** of each molecule. You may want to use the index of your textbook to look up the **structure of the citric acid**, then read the paragraph above reaction 1 to carefully place & coordinate the iron atom correctly.

b. Can the ***molecular formula*** of the reactants and products of the reaction (1) in page 4 could further be simplified into ***empirical formula***? If yes, show the empirical formula. If not, explain why.

5. Equations (2) and (4) calculate the % composition of Fe and C in $FeC_6H_6O_7$, but not the other components. Below, please calculate the % composition for H and O in $FeC_6H_6O_7$.

6. Equations (3) and (5) calculate the % composition of Fe and C in the hydrated form of $FeC_6H_6O_7$, which is shown as $FeC_6H_6O_7 \bullet H_2O$. Below, please calculate the % composition for H and O in $FeC_6H_6O_7 \bullet H_2O$.

7. Which form of iron-citrate compound, normal $FeC_6H_6O_7$ or the hydrated form $FeC_6H_6O_7 \bullet H_2O$ is the main product of the synthesis of this research? How do authors know and explain this in the light of % composition analysis?

8. Figure 1 shows the graph from the Thermogravimetric Analysis (TGA) of the product. In this technique, a known mass of a compound is gradually heated to higher temperatures until it decomposes, and all of its organic matter combusts. Percent weight loss (Delta Y) is then recorded as shown in the graph.

a. A TGA graph also gives us the temperature under which the compound is stable. At what approximate temperature does the synthesized complex *start to* decompose? Pay attention to the graph and to the first signs of weight loss. Explain your reasoning of how you determined this.

b. At what approximate temperature does the compound completely stop decomposing? How do you know?

c. In this research study, TGA method did not involve any ***external oxygen*** to combust the product. Where do you think the oxygen come from to combust the organic part of the product?

9. After TGA, only leftover compound is Fe_2O_3. Write the net reaction that took place during this complete decomposition. Start from the compounds below, **write ALL the products** of the reaction, and balance the stoichiometries of each component. Note that this is not explicitly done in the article so we need your chemistry knowledge and skills to get it right. *(Remember that this is a decomposition reaction, not a full combustion with excess oxygen. Products would be a mix of semi reacted gases.)*

a. $FeC_6H_6O_7 \xrightarrow{heat}$

b. $FeC_6H_6O_7 \bullet H_2O \xrightarrow{heat}$

10. Figure 1 shows 69.653% drop in weight after TGA.

a. Is the 69.653% drop by weight consistent with the reaction in 9(a) or 9(b)? Explain.

b. Does the 69.653% drop in weight in figure 1 support the answer you gave in Q7? Show your work/calculations to rationalize your response.

11. Many commercial iron supplements use the formulation from this research paper. Remember that you also found and analyzed this formula in question 7.

a. You read the label on one of these iron remedy products and see that each tablet in the supplement bottle promises to provide 25 mg of iron. How many moles of iron does each tablet contain?

b. Approximately, how many individual atoms of iron are there each tablet ?

c. If each tablet contains the 25 mg of iron, then how many milligrams of iron citrate compound does each tablet contain?

d. Let's say you are a *compounding pharmacist (it is a cool job, check it out)* and trying to fit in the entire amount of the iron citrate mass in (c) into a perfectly spherical pill with a diameter of 6mm, like the one on the right. Assuming there are no other fillers in this pill and *it consists of only the iron citrate compound,* what will be the density of it?

– END OF THE EXAM –