Supplementary Information

For Instructors:

This activity can be used as an inquiry based approach to learning mole-mass conversions and reviewing SI units. It is based upon the data usually obtained from the analysis of minerals in the blood. The laboratory often reports these values in mg or μg per dL.

During the activity students have access to medical data which shows normal ranges for various substances including minerals in the blood. The data in references 12-13 is helpful and can be made available to the students by having the books available in class. References 14 and 15 can be printed from the website and provide information relevant to Patient A. Specifically for this activity the normal ranges of minerals in the blood are given below in Table 1 that were retrieved from http://en.wikipedia.org/wiki/Reference_ranges_for_blood_tests and references therein *(16)*.

Table 1: Concentrations of minerals in the blood

Minerals	Concentration Range/(μg/dL)
Calcium, Ca	8.5 -10.5
Copper, Cu	100-200
Iron, Fe	50-150
Zinc, Zn	70-120

The students will need to be guided towards appropriate actions when they ask questions. Remember the idea is to help the students develop a plan to carry out calculations, to compare their values to known ranges, then to craft a plan for presenting their interpretations. The students should be able to conclude based upon their calculations that Jenny, Case A, has a concentration of iron in her blood that is out of the normal range (too high) and Ben, Case B, has too low a concentration of copper. Information in references 12, 13, and 16 can help them determine which values are out of range and may also help them match the patient's symptoms to the particular mineral which is in abundance or deficit in the patient's blood.

This activity can be completed in a 70-minute class period. If the periods are 45 minutes, then students can begin the activity and likely make it to the point that most of the calculations are finished and a comparison of data has taken place. In the next class period teams of students

can decide how to present their interpretations of the data to the class, and carry out the presentations.

The calculations are shown in Table 2 below.

Table 2: Concentrations of minerals in the blood converted from moles to μg.

Case A

Minerals	Atomic mass/ (g/mol)	Given amount/ (mol)	Calculated mass/ (g)	Calculated mass/(μg)	Normal ranges/ (μg/dL)
Calcium, Ca	40.078	2.35E-07	9.42E-06	9.42	8.5 - 10.5
Iron, Fe	55.845	6.09E-06	3.40E-04	339.98	50 - 150
Zinc, Zn	65.409	1.55E-06	1.01E-04	101.38	70 - 120

Case B

Minerals	Atomic mass/ (g/mol)	Given amount/ (mol)	Calculated mass/ (g)	Calculated mass/(μg)	Normal ranges/ (μg/dL)
Copper, Cu	63.546	7.87E-07	5.00E-05	50.00	100 - 200
Iron, Fe	55.845	2.39E-06	1.33E-04	133.47	50 - 150
Zinc, Zn	65.409	1.32E-06	8.63E-05	86.34	70 - 120

As the students present their data and interpretations teachers can ask questions of the audience to be sure that all students are engaged. A closing activity beyond learning the content can involving asking students questions such as these:

- What part of this activity was most difficult? Why?
- This activity demonstrates that chemistry is important, even to people who are not chemists in laboratories. How does this make you think about chemistry in the world?
- Are there any careers in science that interest you that may use chemistry? How?

These questions can be used as a simple survey of the activity, or can be used as team and class discussion points.

Student results from the classroom: This activity was carried out with two honors chemistry classes. All students were able to complete the calculations once they recognized how to begin. In terms of the presentations that the students used, some were very lecture oriented while one

group chose to perform a skit using the setting of a doctor's office. The students (and teacher) found the skit to be quite funny and creative while communicating the correct calculations.

For student:

Today you will work in teams to diagnose a patient. You are a medical doctor, and you see patients on a daily basis. Because you took chemistry courses in high school, college, and medical school, you now possess a very broad knowledge of chemistry! You are seeing patients today, and will be required to use your knowledge of chemistry and medicine to diagnose them.

Choose one of the patients below to study in detail, and decide how to best help your patient. Make a proposal to give to the class using chemical explanations in your proposal. The format of your proposal is up to you- skit, poster, lecture-style, etc. Make sure to explain any conclusions you make with evidence from your data and from the available resources.

Patient A is an 11-year-old female named Jenny. She comes into your office today with her mother, and is complaining of abdominal pain and has been vomiting. You ask Jenny if she takes any medications, and she tells you that she takes her mom's multivitamins every day. When you hear this, you become worried that Jenny may be suffering from an overdose from taking a vitamin made for an adult woman (Adult vitamins contain higher amounts of trace metals than vitamins for children, and children do not require as much as adults). To test this hypothesis, Jenny's blood is drawn for laboratory analysis. Below are the results you receive from the lab in units of moles per deciliter.

Table 1: Laboratory Results for Jenny

Element	Amount/mol
Ca	2.35×10^{-7}
Fe	6.09×10^{-6}
Zn	1.55×10^{-6}

Patient B is a 22-year old man named Ben. He comes to you today complaining of fatigue and lack of energy, even though he is a young man. You know as a medical doctor that one cause of fatigue may be low concentrations of trace metals in the blood. To test this hypothesis, a sample of Ben's blood is drawn and sent to the laboratory for analysis. The report from the laboratory is below in moles per deciliter.

Table 2: Laboratory Results for Ben

Element	Amount/mol
Fe	2.39×10^{-6}
Cu	7.87×10^{-7}
Zn	1.32×10^{-6}