Teacher Guide

Welcome to the BLOSSOMS lesson, "How Big is a Mole?" This lesson was designed with two primary goals in mind. First, this lesson seeks to provide students with an appreciation for the magnitude of the mole. It is difficult for students to fathom a number as large as 6×10^{23}, so this lesson uses macroscopic objects such as Ping-pong balls, combined with a series of exercises in estimation, to help them wrap their heads around such an enormous quantity. The second goal of this lesson is to help build students' estimation skills and number sense. Too often, students rely on the answers their calculators spit out without taking the time to check and see if these answers make sense. The estimation activities in this lesson help students let go of the need to obtain a precise numerical answer and instead encourage them to think about the relative magnitudes of different numbers.

This lesson does not require a significant body of prerequisite material, making it ideal for both first and second year chemistry students alike. This lesson can be a great way to complement students' first introduction to the concept of a mole, but it is also a great extension for those who may have already seen the concept once but perhaps did not fully understood or appreciate its many facets. Additionally, although the activities in this lesson center around estimation of different quantities, students need only a basic understanding of simple geometry to complete them and do not require an extensive math background. This lesson also requires minimal supplies, only pencil and paper and perhaps a map, so it is portable and can be carried out in almost any setting.

Each of the activities in this lesson involves estimation and are designed to be completed in groups of two or, ideally, three students. It is important to monitor students to ensure there is no "cheating" (i.e. use of calculators or measuring devices) to ensure that students are focused on developing their number sense, rather than obtaining an exact answer. The first activity will likely take the most time as students become acclimated to the art of estimation (and weaned off of their calculators). You can also add some depth to the first activity by collecting all of the students' estimates and displaying them on the board. In most cases, you will find that these estimates, when rounded to one significant figure, are usually the same. It is a great opportunity to talk with students about why, when dealing with estimates, only one or two significant figures are appropriate in your answer.

If you would like to supplement the activities presented in this lesson, we suggest assigning your students one or more of the following activities. Prior to the lesson, students can practice their estimating skills with the Fermi exercises that accompany this lesson. Following the lesson, students may enjoy showing what they have learned in the form of a poster project. The Mole Poster Project that we have included asks students to compare a mole of their favorite macroscopic item to a celestial-scale quantity. For example, if you stacked one mole of your

dog spike on top of each other, how many times could you go to the sun and back? Students enjoy the creative, visual aspects of this poster, which really helps drive home the magnitude of a mole, and the accompanying calculations help boost their experience with number sense. Finally, we have included a list of calculations that students can perform following the lesson, which will also help drive home the magnitude of a mole and may be a good choice if you are more pressed for the time or materials required for the poster project.

We hope you and your students enjoy this lesson! If you have any comments or suggestions on this lesson, we encourage you to leave that feedback at the MIT BLOSSOMS website.