Guided Practice - Expressing Large Numbers in Astronomy (via Scientific Notation)

Class: ASTR 1510 Principles of Astronomy
Date assigned:
Date due:
Time estimate to complete this assignment: Approximately 35 minutes

Overview/Introduction

In astronomy, it is not uncommon to deal with numbers that are much larger than everyday usage. For example, the speed of light is roughly three hundred million meters per second. Numerically, it can be expressed as 300,000,000 m/s. However, that is a lot of zeroes to keep track of, and it is very easy to make a mistake somewhere by dropping a zero or adding an extra zero, hence the use of scientific notation to simplify the process is vastly beneficial to astronomers. In its standard form, scientific notation is expressed as

$a \times 10^n$

where a is the coefficient and n is the exponent.

Learning Objectives

Basic objectives (to be completed prior to class)

1. Recognize the need for scientific notation
2. Identify scientific notation in standard and non-standard forms
3. Express large but simple numbers in standard and non-standard forms

Advanced objectives (to be completed during and after class)

1. Express large and complex numbers in standard and non-standard forms
2. Convert standard and non-standard forms to numerical values
3. Apply scientific notation in calculation problems

Preparatory Activities and Resources:

1. Read the section, "Numbers in Astronomy", in your textbook (section 1.4)
2. Read the PDF handout "Scientific Notation" on Moodle/Canvas.

Exercises: Please complete by Noon on Sunday before class.

- A short quiz (5 questions; 10 minutes; 5 pts total) will be posted on Moodle/Canvas. You will be converting a list of simple numbers to scientific notation in standard and non-standard form.

Questions?

If you are stuck, there are multiple ways of getting help. You are encouraged to utilize the discussion board on our course page on Moodle/Canvas. You can reach me through either email (hmok2@calstatela.edu) or via Moodle/Canvas message. You can also come talk to me during office hours (please check syllabus for time).

Lesson Plan

Lesson: Expressing Large Numbers in Astronomy (via Scientific Notation)

Timeframe: Approximately 50 minutes

Materials needed: Textbook (*Astronomy* by Fraknoi, Morrison, & Wolff), PDF handout* (*Scientific Notation*), copies of worksheetsm and a handheld scientific calculator. *Accessible on Moodle/Canvas

Objectives:

Basic:

1. Recognize the need for scientific notation
2. Identify scientific notation in standard and non-standard forms
3. Express simple numbers in standard and non-standard forms

Advanced:

1. Express large and complex numbers in standard and non-standard forms
2. Convert standard and non-standard forms to numerical values
3. Apply scientific notation in calculation problems

Background to the Lesson: This is an introductory course that, together with the lab, satisfy GE Block B1. As such, the student body consists mainly of students outside of the science disciplines, thus many basic but important concepts in sciences such as directions and working with large numbers, tends to lead to many confusions among the students. This lesson plan serves as a jumping point to introduce non-science majors to dealing with large numbers, especially for later topics such as wavelength and frequencies. Basic competence in arithmetic is required. A scientific calculator is, however, highly recommended to accompany this lesson.

Introduction to Lesson: To prepare for the in-class activities, students should read the relevant section of the textbook on working with large numbers that serves as an introduction to scientific notation. An accompanied handout posted on Moodle/Canvas further expands on the reasoning of using scientific notation and also describes the structure of scientific notation in its standard and non-standard forms. A five-questions quiz posted on Moodle/Canvas will be used to check for level of preparedness. While in-class, students will apply what they've learned to convert a list of large numbers to scientific notation in standard and non-standard forms. They will also perform the procedure in reverse, namely, given a number in scientific notation, in standard or non-standard form, expand it into normal form. Finally, as a post-class homework, they will apply these concepts in simple word problems (solving them with answers given in scientific notation).

Procedure [Time needed, include additional steps if needed].

Pre-Class Individual Space Activities and Resources: Outline the major steps for the preparatory activities and be sure to tie the steps to the basic learning objectives you have noted above. Note resources required for learner preparation.

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Read the relevant section (*Numbers in Astronomy*) in the required textbook	Introduce students to the concept of scientific notation	10 minutes	#1 (Basic)
Step 2: Read the PDF handout "Scientific Notation" on Canvas	Explain the different structure of scientific notation (both standard and non-standard form)	15 minutes	#2 & 3 (Basic)
Step 3: Short quiz on scientific notation in standard and non-standard form (5 questions max) for 5 pts	To check for preparedness	10 minutes	#2 & 3 (Basic)

In-Class Group Space Activities and Resources. Outline the major steps for the in-class activities and be sure to tie the steps to the advanced learning objectives you have noted above. Also note any resources needed/developed to provide effective active learning activities within class.

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Answer questions submitted on Moodle/Canvas	Review/clear up any confusion or general questions about topic	5 minutes	All basic objectives

Step 2: In small group of 3 to 4 students, convert a list of large and complex numbers to standard and non-standard form of scientific notation.	Have students apply the concept learned in individual space in group space activity	10 minutes	#1 (Advanced)
Step 3: Informal quiz related to step 2: 3 questions total, questions will be projected on screen, students will have three minutes to work on the questions *individually*; at the end of three minutes, they will have two minutes to discuss with peers	Assessment of level of understanding (for both students and instructor); spark discussion with peers	(3+2) minutes	#1 (Advanced)
Step 4: In small group of 3 to 4 students, convert a list of numbers in scientific notation (in both standard and non-standard form) back to normal decimal form.	Reinforce concept by applying them to successively more difficult cases.	10 minutes	#2 (Advanced)
Step 5: Informal quiz related to step 4: 3 questions total, questions will be projected on screen, students will have three minutes to work on the questions *individually*; at the end of three minutes, they will have two minutes to discuss with peers	Assessment of level of understanding (for both students and instructor); spark discussion with peers	(3+2) minutes	#1 (Advanced)
Step 6: Repeat step 2 and 4 with more complexity (ie. word problems)	Reinforce concept by applying them to successively more difficult cases.	10 minutes	All advanced objectives
Step 7: Closing remarks and describe the upcoming homework assignment	Review/clear up any confusion or general questions about topic	5 minutes	All basic & advanced objectives

Post-Class Individual Space Activities and Resources. Outline the major steps for the post-class activities and be sure to tie the steps to the advanced learning objectives you have noted above. Also note any resources learners will need to complete any post-class activities assigned after the group space activities.

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Complete associated homework assignment (10 word-problems)	Apply their knowledge of the topics toward increasingly difficult scenarios	30 minutes	All advanced objectives

Evaluation:

Analysis:
Considering that this is a GE course and that most, if not all, of the students taking this class have no prior scientific background (for many, this will be their only science course taken in college), it is necessary to cover the basics, hence this lesson plan. Often times, they will have no knowledge of working with large numbers, and thus not able to solve problems. Many of them dislike math and are hesitant and wary of anything math-related. The purpose of the in-class group activity is to alleviate the uneasiness of dealing with large numbers. By the time the students arrive in class, they should have a fairly clear view of what scientific notation is and isn't (if they follow the guided practice thoroughly).

Connections to Future Lessons.
The next topic is on the properties of light, specifically wavelength and frequency, both of which are commonly expressed in scientific notation. Application of this lesson will be directly applied to the calculations of many real-life examples. Similar lesson plan, with tailored individual space activities and group space activities, can be adapted to future lessons as well.