

The SI System Of Measurement In Science

Assignment Description

This assignment, which was adapted by A. Russell (UCLA, CPR team) from an assignment by B. Gonzalez (CSU Fullerton), can be used either to introduce CPR to a class or to reinforce content in an introductory general science course. As a model assignment, the calibration questions demonstrate the variety of questioning strategies you can use to probe understanding of a topic and student writing skills when you begin to author assignments.

Keywords

Measurement, history of science, general science, standard unit, SI units

Level

High school, lower division

Subject

General Science

Assignment Goals

In this assignment you will

- *compare and contrast measurement systems.*
- *recognize the variability of standard measures as a function of culture.*
- *identify the advantages of the SI System for science.*
- *write an effective persuasive essay as a method of verbal communication.*

Specifically, upon completing this assignment, you will be able to

- *compare units by ratio/proportion.*
- *understand the need to express several measurements in common units for purposes of comparison.*
- *convert measured values from one SI or English unit to another, and convert measured values between the two systems.*

Source Material

This assignment assumes that you have had prior instruction on the English system of measurement, and the SI (Metric) system of measurement.

1. The Measurers

This web site is from the Museum of the History of Science in Oxford, England. You will see how important measurement was to the medieval Flemish society by exploring the painting entitled, "The Measurers." The Flemish units of measure for weight, volume, etc., are described.

2. A Dictionary of Units

This web site will guide you through the SI system and its correlation to the English system of measurement.

Source Material Resources:

[The Measurers](#) - A Web site from the Museum of the History of Science, Oxford University, UK.

URL: <http://www.mhs.ox.ac.uk/measurer/text/measures.htm#measures>

[A Dictionary of Units](#) - A Web-based reference site from the University of Oxford, UK on units of measure. The English, U.S. and SI systems are covered in detail.

URL: <http://www.ex.ac.uk/cimt/dictunit/dictunit.htm>

[HTML Tutor](#) - This page explains how to use simple HTML commands to format your essay. It includes such formatting items as subscripts and line returns.

URL: http://cpr.molsci.ucla.edu/ms/source_mat/htmlprompt.htm

Guidance for Studying the Source Material

Introduction

One of the most important activities of science is measurement. Measurement is a means of quantifying properties for identification. For example, density is the relationship between the mass and volume of a pure substance. One could determine if a piece of yellow metal is gold by determining its density. Measurement allows scientists to make comparisons. Measurement also provides a means by which scientists can judge the reproducibility of experimental procedure. However, measurement is not an activity that is restricted to scientists. Every age and every culture in the world has developed a measurement system. Measurement is as old as an ancient Egyptian using a cubit unit to measure the height of a pyramid. It is as new as a programmer using a Megabyte unit to indicate the memory capacity of computer software.

Instructions for the Explorations

Follow the link named [The Measurers](#) under "Resources" to examine a Web site from the Museum of the History of Science in Oxford, England. You will see how important measurement was to the medieval Flemish society by exploring the painting entitled, "The Measurers." As you read about the various kinds of measuring devices and methods portrayed in the painting, pay particular attention to the description of the Flemish units of measure for weight, volume, etc.

Modern science uses the *Système Internationale* (SI) as its measurement system. The Web site, [A Dictionary of Units](#), will guide you through the SI system and its correlation to the English system of measurement. Make sure that you are able to convert units within and between the SI and English measurement systems.

When you have completed the explorations and are able to answer all of the "Guiding Questions," return to this page and continue with the writing assignment.

Something to think about: The SI measurement system was officially adopted for use in the scientific community in 1960. Prior to that most measurements intended for scientific purposes were expressed in Metric units. Given the wide variety of measuring systems in the world, why did the scientific community choose SI as their preferred measurement system?

Guidance for Writing your Text

In studying the resources and writing your text consider the issues raised by the following questions:

1. Consider the English system; how are successive units of measure related? For example, look at the conversion factors for measures of length in inches, feet, and yards.
2. How are successive units of measure related in the medieval Flemish, Metric and SI systems?
3. How are new units of measure generated in each measurement system?
4. Why do national governments adopt one system of measurement, and which one is currently used by a majority of nations in the world?
5. What features of a measurement system are important for governments, business and commerce?
6. Why do scientists prefer to use only one system of measurement?
7. What features of a measurement system are important to scientists?

Writing Prompt

Write an essay of the required length that defends the use of the SI measurement system in science. The essay should integrate the issues raised by the guiding questions. Be sure to compare and contrast SI to at least one other measurement system within the body of the text. Give at least three reasons for the use of the SI system in science.

Note: Formatting from word processors is NOT preserved when you copy and paste into the text box below. Refer to the [HTML Tutor](#) in the "Source Material Resources" section to learn how to format your essay with subscripts and superscripts, as well as line returns and paragraphs.

ALWAYS check your formatting by using the "Preview Text" button below. This will show you exactly how your text will appear to reviewers.

Calibrations and Answer Keys

Average Calibration Word Count = 419

High Quality Calibration

Measurement is extremely important to both everyday human interaction and to scientific research. Measurement is used to facilitate the exchange of goods and services. Countries adopt specific measurement systems to make it easier for commercial transactions to take place between communities. Measurement is the basis of much of science, where phenomena are observed, analyzed, and described. Measurements serve as evidence to support the theories that scientists propose. Thus, a scientific system of measurement must have reproducible standards, well-defined fundamental units, a range of measurements that can span from the minute to the infinite, and a logical progression between those units of measure. Of the many measurement systems developed in the world, the scientific community has adopted the *Système Internationale* (SI). Why is this the preferred measurement system in science?

SI is based on the Metric System. The Metric System is used by a majority of the nations in the world. There are seven fundamental units that have absolute standards based upon observable physical phenomena. Each unit can be made larger or smaller by means of

prefixes that assign values based upon the decimal system. It is possible to make those units larger or smaller by using a prefix that corresponds to an appropriate power of ten. Thus, SI has reproducible standards, well-defined fundamental units, a flexible range of measurement, and a logical progression between the units of measure. For these reasons, SI is the measurement system used by the scientific community.

In the United States, an adaptation of the English measurement system is still commonly used. This system does make use of reproducible standards that are the responsibility of the federal Bureau of Weights and Measures. However, the progression between units is not predictable. For example, there are 12 inches in a foot, three feet in a yard, and 5,280 feet in a mile. The medieval Flemish system of measurement also demonstrates conversion ratio variability. The dry volume measurement of one viertel was equivalent to 4 meukens, 56 pots, 112 pintes, and 224 upers. The Flemish system had the additional disadvantage that the dry volume measurement for oats was different than that for other grains. Neither the English nor the Flemish systems of measurement meet the stringent demands for scientific measurement.

1. Does the essay have a descriptive topic sentence? (Does the first sentence of the essay accurately introduce the subject of the entire essay?)

- Yes
- No

Answer: Yes

Feedback : The first sentence is: "Measurement is extremely important to both everyday human interaction and to scientific research." This sentence introduces the idea that the topic of the essay is measurement, including the use of measurement in science.

2. Are there several reasons given to support the use of SI in the scientific community?

- None
- Some (1 or 2)
- Many (more than 2)

Answer: Many (more than 2)

Feedback : The second paragraph gives four reasons: "... reproducible standards, well-defined fundamental units, a flexible range of measurement, and a logical progression between the units of measure."

3. Does the text mention the decimal arrangement of the SI units?

- Yes
- No

Answer: Yes

Feedback : "...prefixes assign values based upon the decimal system."

4. Does the text mention the generation of new units within a measurement system?

- Yes
- No

Answer: Yes

Feedback : "It is possible to make those units larger or smaller by using a prefix that corresponds to an appropriate power of ten."

5. Is the SI or Metric System identified as the measurement system currently used by most nations?

- Yes
- No

Answer: Yes

Feedback : The essay specifically states that "The Metric System is used by a majority of nations in the world."

6. Is there a specific description of the conversion factors for a fundamental measurement in the English system?

- Yes
- No

Answer: Yes

Feedback : The conversion ratios between the units of length are discussed in the third paragraph. "...there are 12 inches in a foot, three feet in a yard, and 5,280 feet in a mile."

7. Is the need for standard measures for business and for scientific purposes mentioned?

- A. Business purposes only.**
- B. Scientific purposes only.**
- C. Both business and scientific purposes.**
- D. Neither business nor scientific purposes.**

- A
- B
- C
- D

Answer: C

Feedback : The first paragraph discusses the use of "specific measurement systems to make it easier for commercial transactions to take place..." and also describes the need within the scientific community for reproducible and well-defined measurements.

8. Are there abbreviations that are not defined?

- Yes
 No

Answer: No

Feedback : The only abbreviation present is "SI", and it is correctly identified as representing "Système Internationale" the first time it is used.

9. Does the essay contain grammatical errors such as misspellings, punctuation faults, subject-verb agreement errors, sentence fragments, or other errors?

- None
 Some (1 or 2)
 Many (more than 2)

Answer: None

Feedback : none

10. Does the essay contain one or more complete sentences copied verbatim from the source material and, therefore, not in the author's own words? If Yes explain the location of the sentence(s) in both the essay and the article and assign the essay a rating of "1." If No type "none" for your explanation. The explanation is only required when you are reviewing your peers' essays.

- Yes
 No

Answer: No

Feedback : none

11. Does the essay present persuasive contrasts to argue against the use in science of a system other than the SI system? Include an explanation of your answer when you are reviewing your peers' essays.

- Yes
 No

Answer: Yes

Feedback : The first paragraph presents the requirements science and business have for a measurement system. The second paragraph identifies those features in the SI system and the third paragraph shows the limitations of the English and Flemish systems.

12. Is there a concluding sentence?

- Yes
- No

Answer: No

Feedback : It is left to the reader to draw the conclusions based on the contrasting properties of the three systems presented in the second and third paragraphs.

13. How would you rate this text?

- 10 Highest
- 1 Lowest

Rating: 9

Feedback : The text presents a logical argument in support of the SI system of measurement for scientific use. The lack of a concluding statement detracts from an otherwise well-written coherent essay.

Mid Quality Calibration

SI is the system of measurement used by science for several reasons. SI is based upon the decimal system. Its seven fundamental units is well-defined standards. New units of measure can be created by using a prefix that goes with the right decimal place. These features of SI makes it easy to make comparisons between measures taken by different people, or to express the value of very large or very small measurements, and to convert units from one to another. The English system is not as convenient to use for science. For example, the unit of length has units of inches, feet, and miles. The conversion factors for these units don't just have different decimal places. Instead, you have to memorize that there are 12 inches in a foot, three feet in a yard, and 5,280 feet in a mile. The English system is the one used in the United States. The English system is not the only measurement system that is not ideal for scientific purposes. The medieval Flemish society had a measuring system that was even more worse than the English system. The volume measurement of one viertel was equivalent to 4 meukens, 56 pots, 112 pintes, and 224 upers. The measure of one viertel was also different based on the type of grain being measured. This is not acceptable for use in science. The SI is a much better choice.

Measurement is important to society in general. Measurement systems had to be developed because business need measurement to set prices. It is important that measures have a standard so that business can take place easily in many locations. It would be very difficult to conduct business if both sides did not have agreement on measures. Scientists require high standards of measurement because reproducibility is important to the nature of science. Scientists use a measurement system to confirm experimental results and to analyze trends. The ways in which measures are used in science set very high standards for a measuring system. Measurement systems that is acceptable for use in business may not have the right range and specificity for use in science. This is why SI is the best measurement system for science.

1. Does the essay have a descriptive topic sentence? (Does the first sentence of the essay accurately introduce the subject of the entire essay?)

- Yes
 No

Answer: Yes

Feedback : The first sentence is: "SI is the system of measurement used by science for several reasons."

2. Are there several reasons given to support the use of SI in the scientific community?

- None
 Some (1 or 2)
 Many (more than 2)

Answer: Many (more than 2)

Feedback : The first paragraph mentions that SI is preferred because it: (1)"is based upon the decimal system" (easy conversion of units) (2) has "well-defined standards" (reproducibility), and (3) can be used "to express the value of very large or very small measurements" (flexible range).

3. Does the text mention the decimal arrangement of the SI units?

- Yes
 No

Answer: Yes

Feedback : The text states that "SI is based upon the decimal system."

4. Does the text mention the generation of new units within a measurement system?

- Yes
 No

Answer: Yes

Feedback : The text states that "New units of measure can be created by using a prefix that goes with the right decimal place."

5. Is the SI or Metric System identified as the measurement system currently used by most nations?

- Yes
 No

Answer: No

Feedback : There is no mention of the widespread use of the SI or metric system worldwide, other than in the context of the scientific community.

6. Is there a specific description of the conversion factors for a fundamental measurement in the English system?

- Yes
 No

Answer: Yes

Feedback : The conversions for units of length are discussed. "Instead you have to memorize that there are 12 inches in a foot, three feet in a yard, and 5,280 feet in a mile."

7. Is the need for standard measures for business and for scientific purposes mentioned?

- A. Business purposes only.
- B. Scientific purposes only.
- C. Both business and scientific purposes.
- D. Neither business nor scientific purposes.

- A
- B
- C
- D

Answer: C

Feedback : The second paragraph contains a thorough discussion of this subject.

8. Are there abbreviations that are not defined?

- Yes
- No

Answer: Yes

Feedback : The abbreviation SI is never explained.

9. Does the essay contain grammatical errors such as misspellings, punctuation faults, subject-verb agreement errors, sentence fragments, or other errors?

- None
- Some (1 or 2)
- Many (more than 2)

Answer: Many (more than 2)

Feedback : none

10. Does the essay contain one or more complete sentences copied verbatim from the source material and, therefore, not in the author's own words? If Yes explain the location of the sentence(s) in both the essay and the article and assign the essay a rating of "1." If No type "none" for your explanation. The explanation is only required when you are reviewing your peers' essays.

- Yes
- No

Answer: No

Feedback : none

11. Does the essay present persuasive contrasts to argue against the use in science of a system other than the SI system? Include an explanation of your answer when you are reviewing your peers' essays.

- Yes
 No

Answer: Yes

Feedback : In introducing the English system with the statement, "The English system is not as conveneint to use for science" thauthor is building the contrast with the previous features identified in the SI system. A further contrast is introduced with the sentence, "The medieval Flemish society had a measuring system that was even more worse than the English system."

12. Is there a concluding sentence?

- Yes
 No

Answer: No

Feedback : The final sentence, "This is why SI is the best measurement system for science " attempts to summarize the two paragraphs.

13. How would you rate this text?

- 10 Highest
 1 Lowest

Rating: 6

Feedback : The essay's content is good. The only important point that is omitted is the fact that the metric system is used widely throughout the world. The many grammatical and spelling errors mar the otherwise good content of the essay. There are a number of verb tense errors: The phrase "...fundamental units is well-defined," should use "are." The phrase "business need measurement to set prices," should use "needs." The sentence "Measurement systems that is acceptable for use..." should use "are." Spelling errors occur that could have been detected by a spell checker: "Conveneint" should be spelled "convenient, and "diffrent" should be "different." Although they are not technically spelling errors, it is not appropriate to use contractions such as "don't" in formal writing.in addition, the sentence "...Flemish society had a measuring system that was even *more worse* than the English system" uses comparatives incorrectly. "*Worse*" should be used alone here. "Measurement systems that is [*sic*] acceptable for use *is* business..." incorrectly uses "*is*" in place of "*in*" before the word "*business*."

Low Quality Calibration

Why is SI the preferred measurement system in science? To answer this question you have to compare the SI measurement system with at least one other measurement system.

Measurement isn't just used for science. It is important for trade among people. Governments have to decide on specific measurement systems to make it easier for trading to take place. Otherwise, people would never know how much of something they were actually buying and it would be hard to know what a good price for things would be. In science, measurement is used to assign values to use in experiments. Scientists explain things with measurements to help. But scientists need to have very precise measures. In the United States, the English measurement system is still commonly used. This system is understood by shoppers, but is not accurate enough for scientists. The conversions between units are not standardized, so you have to memorize a lot of random numbers to convert back and forth. It's not easy to do, so people usually don't convert English to Metric units and vice versa.

SI is based upon the Metric system. The Metric System is used by most other countries in the world. The fundamental units of measure are standards that are related to things in the world. Like the meter. The web site we went to says that "It is the distance light travels, in a vacuum, in 1/299792458th of a second." The other standards are the kilogram (length), second (time), ampere (elec. current), kelvin (temp), mole (substance) and candela (intensity). The fundamental units are expanded to larger and smaller units by adding a prefix. The prefixes are usually based upon Greek names. Some of them are easy to remember, like "kilo-" for 1000, but some of them are weird, like "yotta-" which means 10^{24} . The prefixes makes it possible to express measures that are much larger or much smaller than you can even imagine. In science the atom is extremely tiny and the universe is too large to comprehend. Both the atom and the universe have to be measured and described and a measurement system must be good enough to give values to express these measures.

1. Does the essay have a descriptive topic sentence? (Does the first sentence of the essay accurately introduce the subject of the entire essay?)

- Yes
 No

Answer: Yes

Feedback : The first two sentences make up the topic sentence for this essay. They are: "Why is SI the preferred measurement system in science? To answer this question one must understand the importance of measurement not only in science, but society in general."

2. Are there several reasons given to support the use of SI in the scientific community?

- None
 Some (1 or 2)
 Many (more than 2)

Answer: Some (1 or 2)

Feedback : The essay does not specifically state the reasons for using SI, but two characteristics are mentioned that support its use. The text indicates that this system uses reproducible standards ("The fundamental units of measure is [*sic*] standards that are related to things in the world") and that it has a flexible range of measurement ("The prefixes makes [*sic*] it possible to express measures that are much larger or much smaller than one could even imagine").

3. Does the text mention the decimal arrangement of the SI units?

- Yes
 No

Answer: No

Feedback : There is no specific mention of the decimal nature of the SI or Metric systems.

4. Does the text mention the generation of new units within a measurement system?

- Yes
 No

Answer: Yes

Feedback : "The fundamental units is expanded to large and smaller units by adding a prefix."

5. Is the SI or Metric System identified as the measurement system currently used by most nations?

- Yes
 No

Answer: Yes

Feedback : The text states that "The Metric System is used by most other countries in the world."

6. Is there a specific description of the conversion factors for a fundamental measurement in the English system?

- Yes
- No

Answer: No

Feedback : The text states only that "The conversions between units are not standardized, so you have to memorize a lot of random numbers to convert back and forth."

7. Is the need for standard measures for business and for scientific purposes mentioned?

- A. Business purposes only.**
- B. Scientific purposes only.**
- C. Both business and scientific purposes.**
- D. Neither business nor scientific purposes.**

- A
- B
- C
- D

Answer: C

Feedback : The second paragraph states that "Measurement isn't just used for science. It is important to trade among people. Governments have to decide on specific measurement systems to make it easier for trading to take place."

8. Are there abbreviations that are not defined?

- Yes
- No

Answer: Yes

Feedback : The abbreviation "*SI*" is used and not defined or explained. Also, "*elec.*" is used as an abbreviation for "*electrical*," and "*temp.*" is used as an abbreviation for "*temperature*."

9. Does the essay contain grammatical errors such as misspellings, punctuation faults, subject-verb agreement errors, sentence fragments, or other errors?

- None
- Some (1 or 2)
- Many (more than 2)

Answer: Some (1 or 2)

Feedback : "Like the meter" is a sentence fragment.

10. Does the essay contain one or more complete sentences copied verbatim from the source material and, therefore, not in the author's own words? If Yes explain the location of the sentence(s) in both the essay and the article and assign the essay a rating of "1." If No type "none" for your explanation. The explanation is only required when you are reviewing your peers' essays.

- Yes
- No

Answer: No
Feedback : none

11. Does the essay present persuasive contrasts to argue against the use in science of a system other than the SI system? Include an explanation of your answer when you are reviewing your peers' essays.

- Yes
- No

Answer: No
Feedback : Although the English system in use in the United States is mentioned in the first paragraph, there are no contrasts developed or comparisons made that argue for why the SI system is the preferred system for science.

12. Is there a concluding sentence?

- Yes
- No

Answer: Yes
Feedback : The final sentence summarizes general concepts that are included in this non-specific essay.

13. How would you rate this text?

- 10 Highest
- 1 Lowest

Rating: 3
Feedback : The essay has a compelling style but lacks a persuasive argument. The content in the essay is also sparse. The reasons for the use of SI in science are not specifically indicated, and some of the most important reasons are not included at all, such as the decimal nature of the system. No specifics are given on conversion between units in the English or Flemish systems, as prompted in the guiding questions. Instead of focusing on these points, the essay lists all of the fundamental units of the SI system, even though this does not contribute to making a point about the usefulness of the SI system.