Science News
EDUCATOR GUIDE

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January 14, 2023

The Metric System Has Gained New Prefixes

SOCIETY FOR SCIENCE

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About this Guide

The metric system has gotten an upgrade! In this Guide, students will learn about new measurement prefixes, work with those prefixes in metric conversions and create their own units of measure.

This Guide includes:

Article-based Comprehension Q&A — Students will answer questions about the *Science News* article "The metric system is growing. Here's what you need to know," which explores new prefixes for the metric system. A version of the article, "The metric system gains new prefixes," appears in the January 14, 2023 issue of *Science News*. Related standards include NGSS-DCI: HS-ETS1; MS-ETS1.

> **Student Comprehension Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — Students will review prefixes and their meanings, learn about the metric system's newest prefixes and apply the definitions in metric conversions. Learning Outcomes: Proportion and scale, measurement and dimensional analysis, a deeper understanding of the metric prefixes. Related standards include NGSS-DCI: HS-ETS1; MS-ETS1.

> **Student Discussion Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

Science Bite Activity — In this quick activity, students will create their own unit of length to measure something in the classroom and use principles of dimensional analysis to convert their measurement into a partner's units. Learning Outcomes: Units of measurement, unit conversion.

> **Student Activity Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

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Article-based Comprehension, Q&A

Directions for teachers: Ask students to read the online Science News article "The metric system is growing. Here's what you need to know," which explores new prefixes for the metric system. A version of the article, "The metric system gains new prefixes," appears in the January 14, 2023 issue of *Science News*.

1. What are the new metric system prefixes? How are they represented numerically compared with a base unit of measure, for example one meter?

The new metric system prefixes are ronna-, quetta-, ronto- and quecto-. One ronnameter is 1×10^{27} meters, and one quettameter is 1×10^{30} meters. One rontometer is 1×10^{-27} meters, and one quectometer is 1×10^{-30} meters.

2. When and where were the new prefixes adopted?

The new prefixes were adopted November 18 at the 27th General Conference on Weights and Measures in Versailles, France.

3. What was one sign that new prefixes were needed, according to Richard Brown?

People started coming up with their own prefixes, such as "bronto-."

4. What is the global system of measurement called? Why is it beneficial for scientists to use a shared system and set of prefixes? Explain.

The International System of Units is the world's most widely used system of measurement. If scientists agree on units and prefixes, they can communicate and understand each other with less room for confusion.

5. What are the masses of Earth and an electron using the new prefixes? Why might these prefixes be beneficial in some cases?

The mass of Earth is six ronnagrams. The mass of an electron is about one rontogram. In some cases, smaller numerical values might be easier to understand and compare.

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Student Comprehension Worksheet

Directions: Read the online Science News article "The metric system is growing. Here's what you need to know," which explores new prefixes for the metric system. A version of the article, "The metric system gains new prefixes," appears in the January 14, 2023 issue of *Science News*.

1. What are the new metric system prefixes? How are they represented numerically compared with a base unit of measure, for example one meter?

2. When and where were the new prefixes adopted?

3. What was one sign that new prefixes were needed, according to Richard Brown?

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5. What are the masses of Earth and an electron using the new prefixes? Why might these prefixes be beneficial in some cases?

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Cross-curricular Discussion, Q&A

Directions for teachers: Students should discuss answers to the first set of questions before reading the *Science News* article "The metric system is growing. Here's what you need to know" and answering the second set of questions. A version of the article, "The metric system has gained new prefixes," appears in the January 14, 2023 issue of *Science News*.

To review the purpose of units in science and the importance of using standard units versus relative values, you can pull questions from the "Why use units" discussion lesson plan.

Want to make it a virtual lesson? Post the online *Science News* article to your virtual classroom. Discuss the article and questions with your class on your virtual platform.

Prefixing the metric system

1. Give at least four examples of words with prefixes and underline each prefix. Leave the root of the word without an underline. Compare the prefixes. What is similar about them and what is different?

Student answers will vary. Examples may include unhappy, extraordinary, millimeter, kilogram, etc.

2. What does each prefix in your examples tell you about the meaning of each word? Based on your examples, how would you define a prefix?

Student answers will vary. "Un-" means not, "extra-" means beyond, "milli-" means one thousandth and "kilo-" means one thousand. A prefix is attached to the front of a root word (happy, meter, gram, etc.) to create a derivative of the root word. The meaning of the new word is typically based on a combination of the prefix's meaning with the root word's meaning.

3. Give examples of root words used in the metric system, or the International System of Units (SI). What's the purpose of these words? Give at least three examples, making sure to include their abbreviations and explain what the words mean.

The metric system's root words are units of measure for types of data. A meter (m) is a base unit of length, a gram (g) is a base unit of mass and a liter (L) is a base unit of volume.

4. What are four common metric, or SI, prefixes. What do the prefixes mean on their own and how are they abbreviated?

Milli- (m) means one thousandth, kilo- (k) means one thousand, deci- (d) means one tenth and centi- (c) means one hundredth.

5. Based on your answers to the previous questions, define the terms "kilogram" and "milliliter."

A kilogram is a measure of mass equal to one thousand grams. A milliliter is a measure of volume equal to one thousandth of a liter.

Converting units

1. The *Science News* article pairs the new metric prefixes ronna-, quetta-, ronto- and quecto- with grams, the base metric unit of mass. Is each prefixed unit (ronnagram, quettagram, rontogram and quectogram) larger or smaller than the base unit (gram)? Write a conversion factor, or unit factor, that converts each prefixed unit to the base unit.

Ronnagram and quettagram are both larger than a gram. One ronnagram is equal to 10^{27} grams, and one quettagram is equal to 10^{30} grams. Rontogram and quectogram are both smaller than a gram. One gram is equal to 10^{27} rontograms or 10^{30} quectograms.

2. According to the online *Science News* article, Earth is six ronnagrams, Jupiter is two quettagrams, an electron is about one rontogram and one bit of data on a mobile phone is roughly one quectogram. Using the conversion factors you came up with, convert each mass to grams. Show how your units cancel using dimensional analysis, or the Factor Label Method.

6 ronnagrams is 6×10^{27} grams. 2 quettagrams is equal to 2×10^{30} grams. 1 rontogram is equal to 1×10^{-27} grams. 1 quectogram is equal to 1×10^{-30} grams.

3. Why are prefixes useful for expressing measurements? Think about your answers to the previous two questions.

Prefixes are useful for scaling the base unit to easily express a measured quantity that may be very large or very small. For example, the mass of the Earth is a very large number of grams that's hard to write out and conceptually understand. It's much easier to write and understand 6 ronnagrams than it is to write and understand 6,000,000,000,000,000,000,000,000,000 grams, or even 6×10^{27} grams.

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Student Discussion Worksheet

Directions: Discuss the first set of questions as instructed by your teacher. Then read the *Science News* article "The metric system is growing. Here's what you need to know" and answer the second set of questions. A version of the article, "The metric system has gained new prefixes," appears in the January 7, 2023 issue of *Science News*.

Prefixing the metric system

1. Give at least four examples of words with prefixes and underline each prefix. Leave the root of the word without an underline. Compare the prefixes. What is similar about them and what is different?

2. What does each prefix in your examples tell you about the meaning of each word? Based on your examples, how would you define a prefix?

3. Give examples of root words used in the metric system, or the International System of Units (SI). What's the purpose of these words? Give at least three examples, making sure to include their abbreviations and explain what the words mean.

4. What are four common metric, or SI, prefixes. What do the prefixes mean on their own and how are they abbreviated?

5. Based on your answers to the previous questions, define the terms "kilogram" and "milliliter."

Converting units

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2. According to the online *Science News* article, Earth is six ronnagrams, Jupiter is two quettagrams, an electron is about one rontogram and one bit of data on a mobile phone is roughly one quectogram. Using the conversion factors you came up with, convert each mass to grams. Show how your units cancel using dimensional analysis, or the Factor Label Method.

3. Why are prefixes useful for expressing measurements? Think about your answers to the previous two questions.

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Science Bite Activity: Create Your Own Unit of Measure

Directions for teachers: Use this short activity as a warm-up or exit ticket in class. Students will create their own unit of length to measure something in class, compare their units with a partner's and use dimensional analysis to create a conversion between the units.

For good measure

1. Come up with your own unit of length and create a ruler that defines one length unit. For example, your unit of length could be your fingernail's width, and the length of the ruler you make would be equal to the width of your fingernail.

2. Use your ruler to determine the length of something in your classroom. For example, the length of your desk could be 110 fingernails. Then add the most appropriate metric prefix to scale the measurement between 1 and 10. For example, the width of the desk could be 1.1 hectofingernails. Share your unit and measurement with a partner, and check each other's work.

3. Determine a unit conversion from your length unit to your partner's. Use dimensional analysis, or the factor label method, to convert the length of your object as measured in your units into your partner's units. Check your answer by measuring the width of your object with your partner's ruler.

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Student Activity Worksheet: Create Your Own Unit of Measure

Directions: By following the prompts below, you will come up with your own unit of length and use it to measure something in class. You will then compare your unit with a partner's and use dimensional analysis to create a conversion between the units.

For good measure

1. Come up with your own unit of length and create a ruler that defines one length unit. For example, your unit of length could be your fingernail's width, and the length of the ruler you make would be equal to the width of your fingernail.

2. Use your ruler to determine the length of something in your classroom. For example, the length of your desk could be 110 fingernails. Then add the most appropriate metric prefix to scale the measurement between 1 and 10. For example, the length of the desk could be 1.1 hectofingernails. Share your unit and measurement with a partner, and check each other's work.

3. Determine a unit conversion from your length unit to your partner's. Use dimensional analysis, or the factor label method, to convert the length of your object as measured in your units into your partner's units. Check your answer by measuring the width of your object with your partner's ruler.

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