Name: _____ period _____

CONTENT 1.1

1.1 SI Units

READ

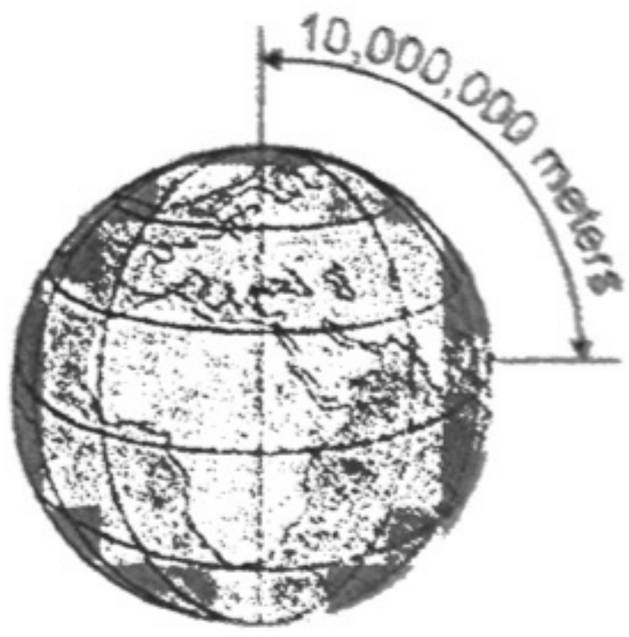
In the late 1700's, as scientists began to develop the ideas of physics and chemistry, they needed better units of measurement to communicate scientific data. Scientists needed to prove their ideas with data based on measurements that other scientists could reproduce. A decimal system of units based on the meter as a standard length, the kilogram as a standard mass, and the liter as a standard volume was developed by the French. Today this system is known as the SI system, or metric system.
The equations below show how the meter is related to other units in this system of measurements.

1 meter = 100 centimeters

1 cubic centimeter = 1 cm^3 = 1 milliliter

1000 milliliters = 1 liter

The SI system is easy to use because all the units are based on factors of 10. In the English system, there are 12 inches in a foot, 3 feet in a yard, and 5,280 feet in a mile. In the SI system, there are 10 millimeters in a centimeter, 100 centimeters in a meter, and 1,000 meters in a kilometer.



Question: Using the graphic at right, state how many kilometers it is from the North Pole to the equator.

Answer: You need to convert 10,000,000 meters to kilometers.

Since 1 meter = 0.001 kilometers, 0.001 is the multiplication factor. To solve, multiply 10,000,000 0.001 km = 10,000 km. So, it is 10,000 kilometers from the North Pole to the equator.

These are the standard units of measurement that you will use in your scientific studies. The prefixes on the following page are used with the base units when measuring very large or very small quantities.

When you are measuring:	Use this standard unit:	Symbol of unit
mass	kilogram	kg
length	meter	m
volume	liter	l
force	newton	N
temperature	degree Celsius	°C
time	second	s

You may wonder why the kilogram, rather than the gram, is called the standard unit for mass. This is because the mass of an object is based on how much matter it contains as compared to the standard kilogram made from platinum and iridium and kept in Paris. The gram is such a small amount of matter that if it had been used as a standard, small errors in reproducing that standard would be multiplied into very large errors when large quantities of mass were measured.

CONT.

1.1

The following prefixes in the SI system indicate the multiplication factor to be used with the basic unit. For example, the prefix kilo- is a factor of 1,000. A kilometer is equal to 1,000 meters, and a kilogram is equal to 1,000 grams.

Prefix	kilo-	hecto-	deka-	Basic unit (no prefix)	deci-	centi-	milli-
Symbol	k	h	da	m, l, g	d	c	m
Multiplication Factor or Place-Value	1,000	100	10	1	0.1	0.01	0.001

EXAMPLES

1. How many centigrams are there in 24 grams?

   a. Restate the question: 24 grams = _____centigrams

   b. Use the place value chart to determine the multiplication factor, and solve:

kilo	hecto	deka	meter, liter, or gram	deci	centi	milli
thousands	hundreds	tens	ones	tenths	hundredths	thousandths

Since we want to convert grams (ones place) to centigrams (hundredths place), count the number of places on the chart it takes to move from the ones place to get to the hundredths place. Since it takes 2 moves to the right, the multiplication factor is 100.

$24.00 \times 100 = 24.0.0. = 2{,}400$

move decimal two places to the right

Solution: multiply $24 \times 100 = 2{,}400$.

Answer: There are 2,400 centigrams in 24 grams.

2. How many liters are there in 5,000 deciliters?

   a. Restate the question: 5,000 deciliters (dl) = _____ liters (l)?

   b. Use the place value chart to determine the multiplication factor, and solve:

Since we want to convert deciliters (tenths place) to liters (ones place), count the number of places on the chart it takes to move from the ones place to get to the hundredths place. Since it takes 1 move to the left, the multiplication factor is 0.1.

$5{,}000 \times 0.1 = 500.0. = 500$

move decimal one place to the left

Solution: multiply $5{,}000 \times 0.1 = 500$.

Answer: There are 500 liters in 5,000 deciliters.

3. How many decimeters are in a dekameter?

   a. Restate the question: 1 dam =_____dm.

   b. Use the place value chart to determine the multiplication factor, and solve:

Since we want to convert dekameters to decimeters, count the number of places on the chart it takes to move from the tens place (deka) to the tenths place (deci). It takes 2 moves to the right, so the multiplication factor is 100.

$$1.00 \times 100 = 1.\underset{\curvearrowright\curvearrowright}{0.0.} = 100$$

move decimal two places to the right

Solution: multiply $1 \times 100 = 100$.

Answer: There are 100 decimeters in one dekameter.

4. How many kilograms are equivalent to 520,000 centigrams?

(1) Restate the question: 520,000 centigrams = _____ kilograms.

(2) Determine the multiplication factor, and solve:

Moving from the hundredths place (centi) to the thousands place (kilo) requires moving 5 places to the left, so the multiplication factor is 0.00001.

$$520{,}000 \times 0.00001 = 5.\underset{\curvearrowleft\curvearrowleft\curvearrowleft\curvearrowleft\curvearrowleft}{2.0.0.0.0.} = 5.2$$

move decimal five places to the left

Solution: Multiply $520{,}000 \times 0.00001 = 5.2$

Answer: 5.2 kilograms are equivalent to 520,000 centigrams.

PRACTICE

1. How many grams are in a dekagram?
2. How many millimeters are there in one meter?
3. How many millimeters are in 6 decimeters?
4. Convert 4,200 decigrams to grams.
5. How many liters are equivalent to 500 centiliters?
6. Convert 100 millimeters to meters.
7. How many milligrams are equivalent to 150 dekagrams?
8. How many liters are equivalent to 0.3 kiloliters?
9. How many centimeters are in 65 kilometers?
10. Twelve dekagrams are equivalent to how many milligrams?
11. Seven hundred twenty centiliters is how many liters?
12. A fountain can hold 53,000 deciliters of water. How many kiloliters is this?
13. What is the name of a length that is 100 times larger than a millimeter?
14. How many times larger than a centigram is a dekagram?
15. Name the distance that is 10 times smaller than a centimeter.

Name: _____ Date: _____

1.1 Scientific Notation

A number like 43,200,000,000,000,000,000 (43 quintillion, 200 quadrillion) can take a long time to write, and an even longer time to read. Because scientists frequently encounter very large numbers like this (and also very small numbers, such as 0.000000012, or twelve trillionths), they developed a shorthand method for writing these types of numbers. This method is called scientific notation. A number is written in scientific notation when it is written as the product of two factors, where the first factor is a number that is greater than or equal to 1, but less than 10, and the second factor is an integer power of 10. Some examples of numbers written in scientific notation are given in the table below:

Scientific Notation	Standard Form
4.32×10^{19}	43,200,000,000,000,000,000
1.2×10^{-8}	0.000000012
5.2777×10^{7}	52,777,000
$6.99\ \ 10^{-5}$	0.0000699

EXAMPLES

Rewrite numbers given in scientific notation in standard form.

- Express 4.25×10^{6} in standard form: $4.25 \times 10^{6} = 4{,}250{,}000$
  Move the decimal point (in 4.25) six places to the right. The exponent of the "10" is 6, giving us the nun. of places to move the decimal. We know to move it to the right since the exponent is a positive number.

$$4.25 \times 10^{6} = 4.250000 = 4{,}250{,}000$$

move decimal six places to the right

- Express 4.033×10^{-3} in standard form: $4.033 \times 10^{-3} = 0.004033$
  Move the decimal point (in 4.033) three places to the left. The exponent of the "10" is negative 3, giving the number of places to move the decimal. We know to move it to the left since the exponent is negative.

$$4.033 \times 10^{-3} = 0.004.033 = 0.004033$$

move decimal three places to the left

Rewrite numbers given in standard form in scientific notation.

- Express 26,040,000,000 in scientific notation: $26{,}040{,}000{,}000 = 2.604 \times 10^{10}$
  Place the decimal point in 2 6 0 4 so that the number is greater than or equal to one (but less than ten). This gives the first factor (2.604). To get from 2.604 to 26,040,000,000 the decimal point has to move 10 places to the right, so the power of ten is positive 10.
- Express 0.0001009 in scientific notation: $0.0001009 = 1.009 \times 10^{-4}$
  Place the decimal point in 1 0 0 9 so that the number is greater than or equal to one (but less than ten). gives the first factor (1.009). To get from 1.009 to 0.0001009 the decimal point has to move four places to the left, so the power of ten is negative 4.

PRACTICE

Fill in the missing numbers. Some will require converting scientific notation to standard form, while others will require converting standard form to scientific notation.

	Scientific Notation	Standard Form
a.	6.03×10^{-2}	
b.	9.11×10^{5}	
c.	5.570×10^{-7}	
d.		999.0
e.		264,000
f.		761,000,000
g.	7.13×10^{7}	
h.		0.00320
i.		0.000040
j.	1.2×10^{-12}	
k.		42,000,000,000,000
l.		12,004,000,000
m.	9.906×10^{-2}	

2. Explain why the numbers below are not written in scientific notation, then give the correct way to write the number in scientific notation.

Example: 0.06×10^{5} is not written in scientific notation because the first factor (0.06) is not greater than or equal to 1. The correct way to write this number in scientific notation is 6.0×10^{3}.

a. 2.004×1^{11}

b. 56×10^{-4}

c. 2×100^{2}

d. 10×10^{-6}

3. Write the numbers in the following statements in scientific notation:
   a. The national debt in 2005 was about $7,935,000,000,000.
   b. In 2005, the U.S. population was about 297,000,000
   c. Earth's crust contains approximately 120 trillion (120,000,000,000,000) metric tons of gold.
   d. The mass of an electron is 0.000 000 000 000 000 000 000 000 000 000 91 kilograms.
   e. The usual growth of hair is 0.00033 meters per day.
   f. The population of Iraq in 2005 was approximately 26,000,000.
   g. The population of California in 2005 was approximately 33,900,000.
   h. The approximate area of California is 164,000 square miles.
   i. The approximate area of Iraq in 2005 was 169,000 square miles.
   j. In 2005, one right-fielder made a salary of $12,500,000 playing professional baseball.