Introduction to Scientific Notation

Definition of Scientific Notation:

In scientific notation all numbers are written in the form of $a \times 10^b$ where the exponent b is an integer, and the coefficient a is any real number (however, see normalized notation below), called the *significand* or *mantissa*.

Any given number can be written in the form of $a \times 10^b$ in many ways; for example, 350 can be written as 3.5×10^2 or 35×10^1 or 350×10^0.

In *normalized* scientific notation, the exponent b is chosen so that the absolute value of a remains at least one but less than ten ($1 \le |a| < 10$). Following these rules, 350 would ***always*** be written as 3.5×10^2.

1. Fill out the missing entries in the table below:

Standard decimal notation	Normalized scientific notation	Written English
	2×10^0	
300		Three hundred.
4,321.768		
	-5.3×10^4	
6,720,000,000		
0.2		Two tenths.
	7.51×10^{-9}	Seven hundred and fifty one - one billionths
-0.0006071		

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2. The names of certain powers of ten are as follows:

units; 1	quadrillion; 10^{15}
tens; $10=10^1$	quintillion; 10^{18}
hundreds; 10^2	sextillion; 10^{21}
thousands; 10^3	septillion; 10^{24}
millions; 10^6	octillion; 10^{27}
billions; 10^9	nonillion; 10^{30}
trillions; 10^{12}	decillion; 10^{33}

For this exercise, we will first rewrite numbers in scientific notation, and then use scientific notation to write as a number using the names above.

a. There are about 7,031,000,000 people in the world. Rewrite this in normalized scientific notation, and then in words as an amount in billions.

b. A mole is a unit of atoms, where the number of atoms is called Avogadro's number, which equals 602214000000000000000000 atoms. Write this in normalized scientific notation, and then in words as an amount in sextillions.

c. The amoeba, *Amoeba proteus,* may reach 0.0008 meters (800 μm) in length. Write this in in normalized scientific notation, and then in words.

Scientific Notation Practice:

Simplify and perform the following operations:

a. $\frac{5.06 \times 10^{2}}{1.5 \times 10^{-3}} \times \frac{1.607 \times 10^{-10}}{7.0003 \times 10^{-16}} \times 3.06 \times 10^{-2}$

a. $6.03 \times 10^{6} \times \frac{-1.5 \times 10^{5}}{8.07 \times 10^{7}} \times \frac{2.05 \times 10^{3}}{4.6 \times 10^{-6}}$

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Island Conversions

A certain island has no currency but instead it has the following exchange rate:

5 bananas = 2 coconuts

10 coconuts = 3 seashells

5 bananas = 4 mangos

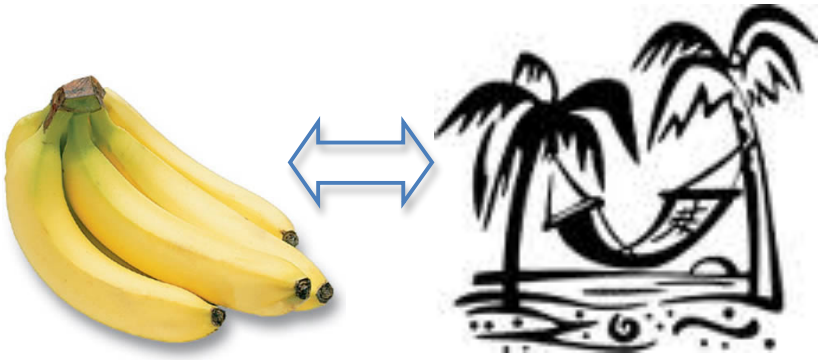
2 mangos= 1 coconut

5 coconuts = 2 fish

15 seashells = 2 snake skins

100 fish = 1 hammock

10 snake skins = 1 hammock



1. If you want 27 seashells, how many coconuts do you need? *Show your units in making this calculation.*

2. If you want 3 hammocks how many snake skins do you need? *Show your units in making this calculation.*

3. (i) How many bananas does it take to trade for a hammock? *Show your units in making this calculation.*

(ii) Suppose it costs 1 banana for each conversion. How much would the conversions cost? How many bananas total would the hammock cost in that case?

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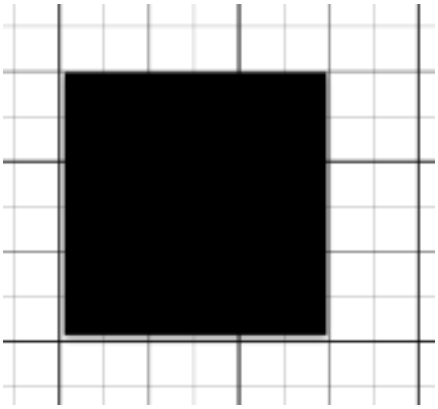
(1) **AREA**

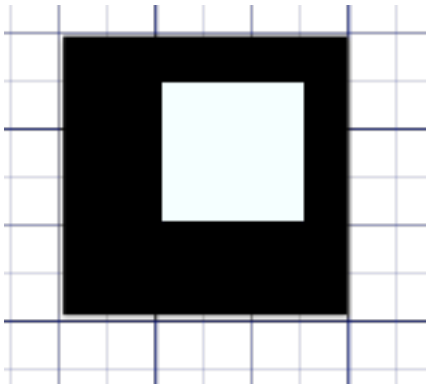
a. As a reminder, we define area as:

b. What is the area that is shaded in the following enclosed shapes?

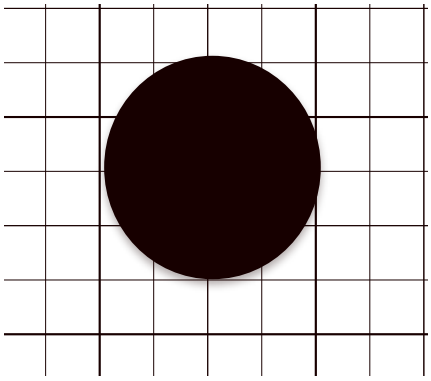
(i) $AREA_{square}$:_____



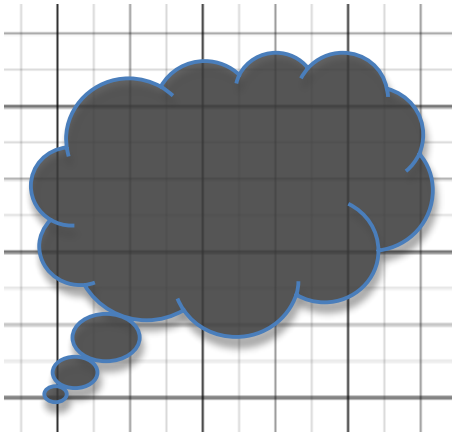
(ii) $AREA_{square\_hole}$: _____



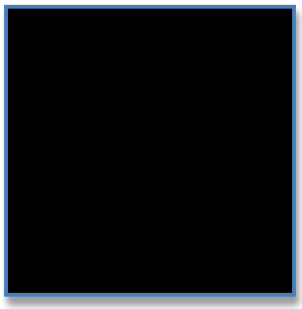
(iii) $AREA_{circle}$: _____



(iv) $AREA_{crazy\_shape}$: _____



c. Given a square with 1inch side lengths …



- What is the area in inches squared (in^2) ?

- What is the area in centimeters squared (cm^2)?
  Recall: **1in = 2.54 cm.**

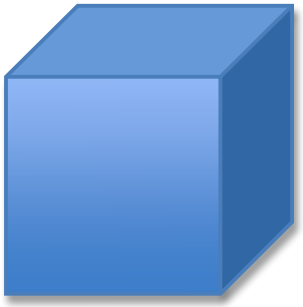
(2) **VOLUME**

a. As a reminder, we define volume as:

b. If the Square (i) on the previous page is the base of rectangular box that is 5 boxes tall, what is the volume of the resulting box? Draw a picture and solve**.**

c. If the Circle (iii) on the previous page is the shadow of sphere, what is the volume of the resulting sphere?

d. Given a cube with side lengths of 1 inch….



- What is the volume in inches cubed (in^3)?

- What is the volume in centimeters cubed (cm^3)?

e. Suppose you have a cylinder and you know two of the following three measures: the volume, the height, and the area of the base. Can you find the missing measure? Make a drawing and write any relevant formulas.

EXTRA Unit Conversiion PROBLEMS

- 1.2 in^2=_____cm^2

- 5.06 x 10^5 in^3=_____cm^3

- A cube with volume 4.5 x10^5 cm^3 has side lengths of _____ inches?

- 500 acres =_____mi^2

- **APPLIED PROBLEM**

You fill up your morning quart-size glass of milk, just to the top. While you are putting the rest of the milk into the fridge your cat jumps on the table and knocks over the glass. This covers your 1 meter x 1 meter table with a layer of milk. There is a 1 mm (millimeter) lip around the edge of your table, will the milk spill on the ground or is the lip enough to stop the milk?

What question are we attempting to answer?

What do we know? (Don't forget to draw a picture)

Solve the question:

Question to Consider: How can you check your solution?

Crazy Calculations!

1. Sea Otters have about 1 million hairs per square inch on their body. How many hairs do they have per square centimeter?

2. ***Estimate*** the total number of sheets of 8.5 x 11 inch paper used by all the students at Stanford in one semester.

3. If you laid out a single layer of hydrogen atoms, how many would it take to cover the continental US?

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a. Guess your answer (with units):

b. What answer is going to be too big?

c. What answer is going to be too small?

d. Calculate the answer:

4. How many drops of waters are there in all of the Great Lakes?

a. Guess your answer (with units):

b. What answer is going to be too big?

c. What answer is going to be too small?

d. Calculate the answer:

BONUS QUESTIONS:

5. If you make $100,000 annually, how many years would it take for you to make $182M? How about to make $2.7B? $100B?

6. If you are six feet tall, how many lengths of you would be equal to the height of a stack of $182M in dollar bills? (A stack of 50 bills is 0.215 inches.)

7. How many miles is a $2.7 billion stack of one-dollar bills if you stack them side-by-side?

8. If you can run 10 minutes per mile, how long would it take for you to run the miles from #7 in days?

The DBD Oil Spill

Ten days ago, a big underwater oil well from DBD Petroleum Company ruptured near the coast of Paradise Island. DBD sent a robot to take pictures of the damaged pipes, and using these images they reported to the public an estimate of 8000 barrels per day being discharged into the ocean.

The government of Paradise Island has contracted your team to evaluate the DBD estimate of oil discharge. It is important to have a reasonable estimate in order to assess the magnitude of the problem and prepare the national response to the spill.

Your Team Task:

Prepare a report for the Paradise Island officials. It should contain:

1. An estimate the oil discharge of the DBD oil well into the ocean, in units of barrels of oil per day.

2. An explanation of the calculations and information that leads to your estimate.

3. An evaluation of the DBD estimate. Is it reasonably close to your estimate? Is it too low? Too high?

Note. The Exxon Valdez disaster of 1989 discharged 250,000 barrels of oil into the ocean (10.5 million gallons).

To complete this task your team will be provided the following (see page 2):

- The DBD estimate of the spill
- Satellite pictures of the oil spill on Day 2 and Day 7 after the incident.
- Information about the appearance of the oil.
- Information about the science of past oil spills (depth estimates, other volume estimation information).

Note: This activity is based on the article "Deepwater disaster: how the oil spill estimates got it wrong", by Ian MacDonald, in the December 2010 issue of Significance, journal of the Royal Statistical Society.

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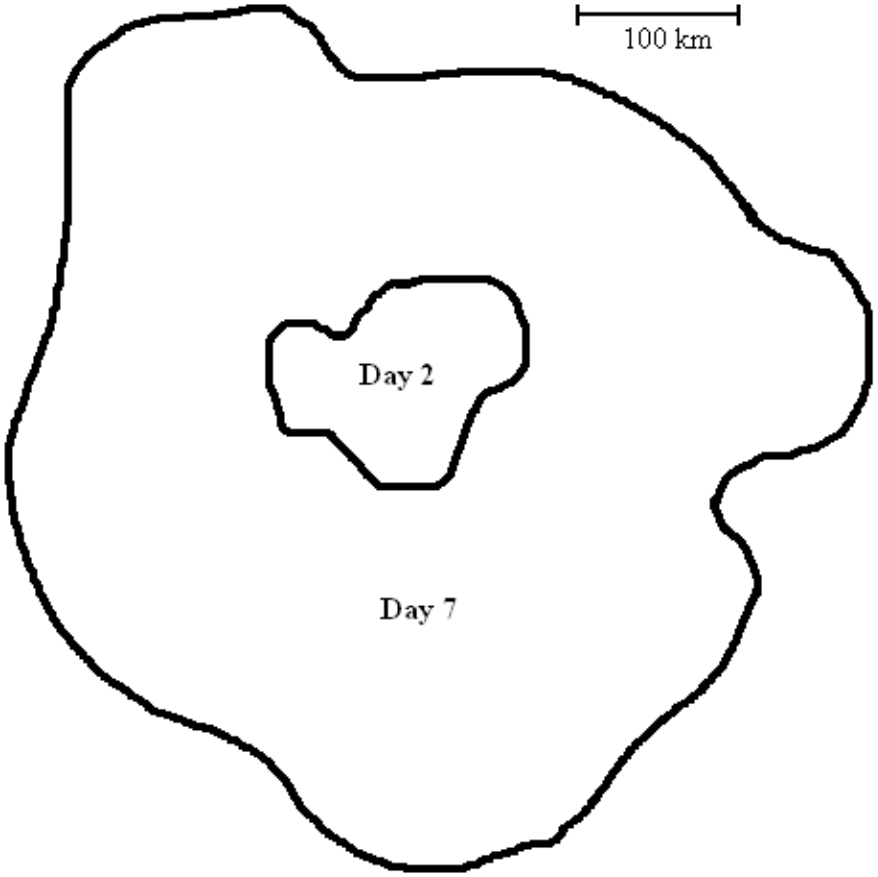
Satellite Pictures of the Oil Spill on Day 2 and Day 7

Your team does not have access to the DBD data on the accident but you have satellite pictures of the oil spill taken on Day 2 and Day 7 after the incident:



In addition to sharing the satellite pictures the Paradise Island officials have told you that the appearance of the oil spill on the surface of the water gives it a bright color.

Information from Past Oil Spills

The following table, gathered from several studies of earlier oil disasters, describes the thickness of the oil layer according to its appearance:

Oil appearance	Thickness (μm)
Barely visible	0.04
Silvery	0.08
Slight color	0.15
Bright color	0.3
Dull	1.0
Dark	2.0

Recall that 1 μm = 10^{-6} m. A human hair has an approximate diameter of 100 μm.

One last factor, oil spill research has shown that the visible spillage, as seen on the surface of the ocean, accounts for only two-thirds of the total discharge because of evaporation, sinkage, and other processes.

What question is your team attempting to answer?

What does your team know?

Solving the question:

Question to Consider: How can you check your solution?