Estimating with Scientific Notation

Let's multiply and divide with scientific notation to answer questions about animals and planets.

12.1 Scientific Notation and Technology

Diego and Priya were calculating $(5 \times 10^{13}) \cdot (8 \times 10^{25})$.

- Diego used a calculator and his display read $4\text{E}39$.
- Priya used her knowledge of exponent rules and got 40×10^{38}.
- Clare used an online calculator and the screen showed $4e + 39$.

What do you think these different results mean?

12.2 Biomass

Use the table to answer questions about different creatures on the planet. Be prepared to explain your reasoning.

creature	number on planet	mass of one individual (kg)
humans	7.5×10^9	6.2×10^1
cows	1.3×10^9	4×10^2
sheep	1.75×10^9	6×10^1
chickens	2.4×10^{10}	2×10^0
ants	5×10^{16}	3×10^{-6}
blue whales	4.7×10^3	1.9×10^5
Antarctic krill	7.8×10^{14}	4.86×10^{-4}
zooplankton	1×10^{20}	5×10^{-8}
bacteria	5×10^{30}	1×10^{-12}

1. Which creature is least numerous? Estimate how many times more ants there are than this creature.

2. Which creature is the least massive? Estimate how many times more massive a human is than this creature.

3. Which is more massive, the total mass of all the humans or the total mass of all the ants? About how many times more massive is it?

4. Which is more massive, the total mass of all the krill or the total mass of all the blue whales? About how many times more massive is it?

12.3 Info Gap: Distances in the Solar System

Your teacher will give you either a problem card or a data card. Do not show or read your card to your partner.

If your teacher gives you the *problem card*:

1. Silently read your card, and think about what information you need to answer the question.
2. Ask your partner for the specific information that you need. "Can you tell me ________?"
3. Explain to your partner how you are using the information to solve the problem. "I need to know ________ because . . . ."

   Continue to ask questions until you have enough information to solve the problem.
4. Once you have enough information, share the problem card with your partner, and solve the problem independently.
5. Read the data card, and discuss your reasoning.

If your teacher gives you the *data card*:

1. Silently read your card. Wait for your partner to ask for information.
2. Before telling your partner any information, ask, "Why do you need to know ________?"
3. Listen to your partner's reasoning and ask clarifying questions. Only give information that is on your card. Do not figure out anything for your partner!

   These steps may be repeated.
4. Once your partner says they have enough information to solve the problem, read the problem card, and solve the problem independently.
5. Share the data card, and discuss your reasoning.

Are you ready for more?

Choose two celestial objects and create a scale drawing of them.

object	diameter (km)
Sun	1.392×10^6
Mercury	4.878×10^3
Venus	1.21×10^4
Earth	1.28×10^4
Mars	6.785×10^3
Jupiter	1.428×10^5
Saturn	1.199×10^5
Uranus	5.149×10^4
Neptune	4.949×10^4

Lesson 12 Summary

Multiplying numbers in scientific notation extends what we do when we multiply regular decimal numbers. For example, one way to find $(80)(60)$ is to view 80 as 8 tens and to view 60 as 6 tens. The product $(80)(60)$ is 48 hundreds or 4,800. Using scientific notation, we can write this calculation as

$$(8 \times 10^1)(6 \times 10^1) = 48 \times 10^2$$

To express the product in scientific notation, we would rewrite it as 4.8×10^3.

Calculating using scientific notation is especially useful when dealing with very large or very small numbers. For example, there are about 39 million, or 3.9×10^7 residents in California. The state has a water consumption goal of 42 gallons of water per person each day. To find how many gallons of water California would need each day if they met their goal, we can find the product $(42)(3.9 \times 10^7) = 163.8 \times 10^7$, which is equal to 1.638×10^9. That's more than 1 billion gallons of water each day.

Comparing very large or very small numbers by estimation also becomes easier with scientific notation. For example, how many ants are there for every human? There are 5×10^{16} ants and 8×10^9 humans. To find the number of ants per human, look at $\frac{5 \times 10^{16}}{8 \times 10^9}$. Rewriting the numerator to have the number 50 instead of 5, we get $\frac{50 \times 10^{15}}{8 \times 10^9}$. This gives us $\frac{50}{8} \times 10^6$. Since $\frac{50}{8}$ is roughly equal to 6, there are about 6×10^6 or 6 million ants per person!

