Tiny Culprits Worksheet

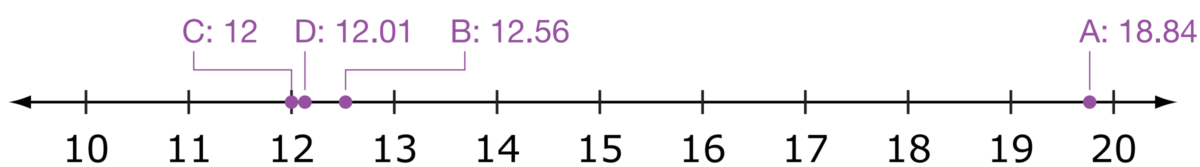
At the cellular level, you observe that two bacteria (A and B) are spherical, or cocci, and two bacteria (C and D) are rod-shaped, or bacilli. The perimeters of cell cross-sections for the four bacteria are listed in the table below and measured in micrometers.

Bacteria	Perimeter (micrometers)
Bacteria A	6π
Bacteria B	4π
Bacteria C	12
Bacteria D	12.01

1. Are the numbers representing each of the four perimeters rational or irrational? Why or why not? Explain your reasoning.

The perimeters of Bacteria C and Bacteria D are rational; the numbers terminate. The perimeters of Bacteria A and Bacteria B are irrational; the numbers do not terminate or repeat.

2. On the number line, plot the perimeter for each bacterium listed in the table above. Use a rational number approximation for those bacteria with perimeters that are irrational numbers.



3. Write a statement using inequality signs to show the comparison, from least to greatest, of the perimeters of the bacteria.

Bacteria C < Bacteria D < Bacteria B < Bacteria A

4. Which cell has a perimeter closest to $\sqrt[3]{27}$? Explain or show you found the answer.

$\sqrt[3]{27} = 3$, Bacteria C is the smallest of the bacteria measured, although it has a perimeter much larger than 3, it's perimeter is the closest to 3.

5. Would it be reasonable for a different cell to have a perimeter of $\sqrt{2}$? Explain why or why not.

No, $\sqrt{2}$ is an irrational number. It never terminates or repeats, therefore you could not measure a perimeter to have a length of $\sqrt{2}$.

6. You were able to estimate the mass of an individual cell from each of the strains. The following tables show the mass, in grams, of each cell. Complete the tables by writing the mass of each cell in both scientific notation and standard form.

Strain A Cells	Mass of Cells (grams)	
	Scientific Notation	Standard Form
1	4.32×10^{-12}	0.00000000000432
2	7.12×10^{-11}	0.0000000000712
3	1.8×10^{-10}	0.00000000018
4	4.3×10^{-8}	0.000000043

Strain B Cells	Mass of Cells (grams)	
	Scientific Notation	Standard Form
1	2.3×10^{-8}	0.000000023
2	4.56×10^{-9}	0.00000000456
3	1.67×10^{-7}	0.000000167
4	4.7×10^{-9}	0.0000000047

Strain C Cells	Mass of Cells (grams)	
	Scientific Notation	Standard Form
1	3.4×10^{-8}	0.000000034
2	5.2×10^{-7}	0.00000052
3	8.91×10^{-9}	0.00000000891
4	2.6×10^{-8}	0.000000026

Strain D Cells	Mass of Cells (grams)	
	Scientific Notation	Standard Form
1	8.56×10^{-11}	0.0000000000856
2	9.2×10^{-12}	0.0000000000092
3	1.2×10^{-14}	0.000000000000012
4	3.4×10^{-13}	0.00000000000034

You determine that Strain C is *Listeria*. *Listeria* is a rod-shaped bacterium found in soil, in water, and in some animals. It can be present in foods made from raw milk. It can also live in food processing plants and contaminate many processed meats. Most other germs would die, but *Listeria* can grow in cold temperatures such as refrigerators. *Listeria* outbreaks can be very harmful to older people, pregnant women, and patients with compromised immune systems.

One of your scientists spends some time researching *Listeria* growth in water. The cells are arranged in chains, or strepto-, and each individual cell is approximately 1.25 micrometers long. In her report, the scientist shows the total length of the streptobacilli chains in different water samples. She left her notes as exponent expressions but did not simplify them.

7. For each sample, simplify the expression so there is only one exponent.

Sample Number	Length of Bacilli (nanometers)	
	Exponent Expression	**Simplified Expression**
1	$1.25^2 \times 1.25^4$	1.25^6
2	$(1.25^5)^2$	1.25^{10}
3	$1.25^3 \times 1.25$	1.25^4
4	$\frac{1.25^9}{1.25^7}$	1.25^2
5	$\frac{1.25^6}{1.25}$	1.25^5
6	$\frac{1.25^9 \times 1.25^5}{1.25^3}$	1.25^{11}

Your team of researchers found that strain B is cocci, or spherical bacteria. Through observation, the team determined that the cocci are clustered together, called staphylococci, some are large clusters and some are small.

8. Looking at a cluster of strain B bacteria, one of your research scientists observes that the bacteria are arranged in a perfect square. He finds that each square-shaped cluster has a different number of bacteria. He provided his findings in the table below, expressing the number of bacteria on the surface of each square. Complete the table by finding the number of bacteria that make up each side length of the square.

Bacteria	**Number of Bacteria on Top Face**	**Side Length in Number of Bacteria**
Cluster 1	169	13
Cluster 2	49	7
Cluster 3	121	11
Cluster 4	9	3
Cluster 5	196	14
Cluster 6	225	15
Cluster 7	400	20
Cluster 8	324	18

9. After noticing the square arrangement of the bacteria on the surface, the scientist looks deeper and finds that the bacteria are arranged to form a cube. He provides the findings in the table below, expressing the total number of bacteria in the cubic clusters. In the table, find the number of bacteria that make up one length of one side of each cube.

Bacteria	**Number of Bacteria on Top Face**	**Side Length in Number of Bacteria**
Cluster 9	8	2
Cluster 10	125	5
Cluster 11	729	9
Cluster 12	27	3
Cluster 13	216	6
Cluster 14	343	7
Cluster 15	64	4
Cluster 16	1000	10

10. Your team estimates that the total number of bacteria in a large 1,500 L tank of lake water is 23,421,000,000. Express that number in scientific notation. Show or explain how you found the answer.

2.3421×10^{10}

Sample response: I got my answer by moving my decimal place 10 spaces to the left so that there is only one digit to the left of the decimal point.

11. An average individual bacterium of strain A has a mass of 4.32×10^{-12} grams, and you estimate that there were 1.6×10^{7} bacteria in the 1,500 L tank of water at the time of the sample. What is the total mass of bacteria A in the tank? Show or explain how you found the answer.

$4.32 \times 1.6 = 6.912$

$-12 + 7 = -5$

6.912×10^{-5} grams

12. Four hours later, your team takes another one-gallon sample of the water and estimates that there are now 4,300,000,000 bacteria of strain A present. An average individual bacterium of strain A has a mass of 4.32×10^{-12} grams. What is the total mass of the bacteria in the new sample? Show or explain how you found the answer.

$4{,}300{,}000{,}000 = 4.3 \times 10^{9}$

$4.32 \times 4.3 = 18.576$

$-12 + 9 = -3$

1.8576×10^{-2} grams

