Rich Mathematical Task – Grade 7 – *Which Microscope?*

Task Overview/Description/Purpose:
• In this task, students will determine which microscope they would use to view as many of the four samples of microorganisms as possible. • This task is designed to deepen understanding of converting between numbers written in standard form and scientific notation, and comparing and ordering numbers written in scientific notation.

Standards Alignment: Strand – *Computation and Estimation*	
Primary SOL: 7.1b- The student will compare and order numbers greater than zero written in scientific notation. **Related SOL (within or across grade levels/courses):** 7.1a, 6.2b, 5.2ab	
Learning Intention(s): • **Content –** I am learning to convert numbers between standard form and scientific notation, and how to compare and order numbers written in scientific notation. • **Language-** I am learning to justify my solution using scientific notation in real world contexts. • **Social –** I am learning how to explain my strategy and work to others so I can refine my strategies for problem solving.	
Success Criteria (Evidence of Student Learning); • I can convert between standard form and scientific notation. • I can compare and order numbers greater than zero in scientific notation. • I can justify my conversions and explain how they were ordered, and report my conclusions. • I can make suggestions and utilize suggestions made by my peers to make revisions to my work and thinking.	
Mathematics Process Goals	
Problem Solving	• Students will convert numbers between standard form and scientific notation to compare and order the numbers.
Communication and Reasoning	• Students will justify verbally and with mathematical evidence how they converted numbers between standard form and scientific notation. • Students will justify verbally and with mathematical evidence how they ordered their numbers and compared them with the range of the microscope.
Connections and Representations	• Students will use number lines to compare and order numbers in scientific notation. • Students will connect their prior knowledge of powers of ten to converting and comparing scientific notation.

Task Pre-Planning
Approximate Length/Time Frame: 25-30 minutes

Task Pre-Planning	
Grouping of Students: This task would be best completed with students working together in the beginning to determine the best strategies for approaching the problem. Once students have had a chance to discuss different strategies, then they can split off and work independently to complete the task.	
Materials and Technology: • Number Line	**Vocabulary:** • Scientific Notation • Standard Form • Exponents • Powers of Ten
Anticipate Responses: See Planning for Mathematical Discourse Chart (Columns 1-3)	

Task Implementation (Before)

Task Launch

- Ask students to brainstorm some of the smallest items they think they could see with their bare eyes. Discuss what would help us see items we are unable to see with our bare eyes
- Introduce them to microorganisms, or microbes, through this video.

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – Teacher will listen and observe students as they work on task and ask assessing or advancing questions (see chart on next page)
- Select – Teacher will decide which strategies or thinking that will be highlighted (after student task implementation) that will advance mathematical ideas and support student learning
- Sequence – Teacher will decide the order in which student ideas will be highlighted (after student task implementation) during the closure discussion.
- Connect – Teacher will consider ways to facilitate connections between different student responses

Suggestions For Additional Student Support

- Question students, in both assessing and advancing formats, to help students refine their strategies.
- Provide a number line to students who might be struggling to visualize the numbers or struggling to put them in order. Have multiple number lines prepared for students at different levels: one with only markings, one with negative powers of ten, and one with standard form powers of ten. This will allow students to have a visual and concrete way to help them compare the numbers. (See below in extra resources)
- Some students get stuck at one way of thinking and using one method. Asking questions like "How confident are you?" and "What would convince someone?" will help students get past this point.
- For students with motor processing difficulties, allow them to communicate the reasoning in other ways such as video recording or typing answers. Also, provide students with graph paper so that when they convert numbers to and from standard form they can keep the digits of the numbers organized and more easily determine decimal place value movement.
- For students with attention challenges ask student to restate the problem or important information.
- For students who need more support in justifying their thinking, you may choose to provide them with the sentence frames below.
  - What I know about the problem is…
  - My method for solving the problem was…
  - I know that ____ is the biggest/smallest because…
  - I know that ____ can see these microorganisms because…
- For ELs with first language literacy, try to provide prompt, or parts of prompt, in their home language

Task Implementation (After)

Connecting Student Responses (From Anticipating Student Response Chart) and Closure of the Task:

- Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion. Some possible big mathematical ideas to highlight could include:
  - Common misconceptions
  - Concrete to representational to abstract
- Connect different students' responses and connect the responses to the key mathematical ideas to bring closure to the task. Possible questions and sentence frames to connect student strategies:
  - How are these strategies alike? How are they different?
  - Where do you see _____'s strategy in ______'s strategy?
  - Why is this important?
- Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion. Some possible ways to do this are to-
  - Assign roles like time keeper, task master, material fetcher, and recorder of strategies to each member of the group.
  - Students will begin the task independently to give each student a chance to work through different solution pathways on their own. After students have had a chance to explore the task independently, they will join groups. Before students start collaborating, each student will take one minute to share their work to ensure that all students are actively engaged in the task and that they have had an opportunity to share their own unique pathway to solving the problem.

Teacher Reflection About Student Learning:

- Teacher should use the chart on the next page with the anticipated student solutions to monitor which students are using each strategy as well as record any additional strategies encountered. The sequence of tasks will inform what will come next in instruction to further student ideas and thinking. Form small groups to address misconceptions that are not addressed in the class debrief.
- Information gathered from the task rubric could identify small groups for later instruction, identifying specific students to partner with one another, and/or identifying students who need more teacher modeling and think alouds.

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Planning for Mathematical Discourse

Mathematical Task: Which Microscope

Content Standard(s): SOL 7.1b

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions:** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions:** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: I don't know what to do?	• What is the question asking you? • What information do you have? • What do you notice? • What do you wonder? • What do you predict the solution might look like?	• What could you use to model the problem? • What do you predict the solution might be?		
Anticipated Student Response: Students reverse the order of the numbers.	• Does is make sense that ___ is bigger/smaller than ___? • Does this approach seem reasonable or unreasonable to you?	• What are you thinking now? • What new understandings did you come to?		
Anticipated Student Response:	• Can you explain your method for converting	• Did you end up reexamining anything		

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions:** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions:** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Students convert numbers to and from scientific notation improperly.	to/from scientific notation? • What was going through your head when you noticed that?	you'd thought you knew?		
Anticipated Student Response: Students mistake negative powers of ten as negative numbers in standard form.	• Tell me what you know about powers of ten/numbers written in scientific notation. • How are numbers in scientific notation with positive powers of ten different than those with negative powers of ten.	• Can organisms have a size smaller than zero? • Is there anything about this solution that doesn't make sense?		

Name_________________________________ Date________________________

Which Microscope?

You are a scientist working in a lab studying marine microbes. Your team has found samples of several types. In the table below is a list of the microbes and the size of each.

Name	Size (in meters)
Protists	0.00275
Archaea	0.000062
Copepods	0.003
Microfungi	0.000159

Your team needs to study these microbes under a microscope. There are several different microscopes in your lab and each one has a different depth of focus (range in which objects can be focused and sharp).

Microscope A has a depth of focus of $7.5\ x\ 10^{-5}$ to $2.5\ x\ 10^{-3}$ meters.

Microscope B has a depth of focus of $8.0\ x\ 10^{-6}$ to $4.0\ x\ 10^{-3}$ meters.

Microscope C has a depth of focus of $4.9\ x\ 10^{-6}$ to $2.9\ x\ 10^{-3}$ meters.

Which microscope should your team use to study the samples? Provide evidence and explain your reasoning.

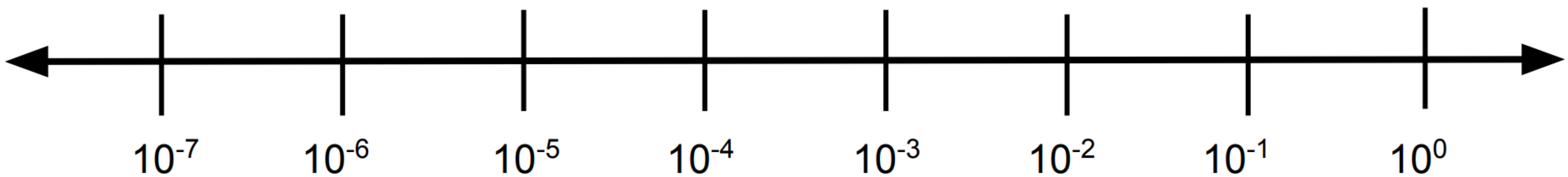
	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: • Uses relationships among mathematical concepts	• Demonstrates an understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to a valid and correct solution	• Demonstrates a partial understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to an incomplete or incorrect solution	• Demonstrates little or no understanding of concepts and skills associated with task • Applies limited mathematical concepts and skills in an attempt to find a solution or provides no solution
Problem Solving	Proficient Plus: • Problem solving strategy is efficient	• Problem solving strategy displays an understanding of the underlying mathematical concept • Produces a solution relevant to the problem and confirms the reasonableness of the solution	• Chooses a problem solving strategy that does not display an understanding of the underlying mathematical concept • Produces a solution relevant to the problem but does not confirm the reasonableness of the solution	• A problem solving strategy is not evident or is not complete • Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: • Reasoning is organized and coherent • Consistent use of precise mathematical language and accurate use of symbolic notation	• Communicates thinking process • Demonstrates reasoning and/or justifies solution steps • Supports arguments and claims with evidence • Uses mathematical language to express ideas with precision	• Reasoning or justification of solution steps is limited or contains misconceptions • Provides limited or inconsistent evidence to support arguments and claims • Uses limited mathematical language to partially communicate thinking with some imprecision	• Provides little to no correct reasoning or justification • Does not provide evidence to support arguments and claims • Uses little or no mathematical language to communicate thinking
Representations and Connections	Proficient Plus: • Uses representations to analyze relationships and extend thinking Uses mathematical connections to extend the solution to other mathematics or to deepen understanding	• Uses a representation or multiple representations, with accurate labels, to explore and model the problem • Makes a mathematical connection that is relevant to the context of the problem	• Uses an incomplete or limited representation to model the problem • Makes a partial mathematical connection or the connection is not relevant to the context of the problem	• Uses no representation or uses a representation that does not model the problem • Makes no mathematical connections

Extra Resources

[Click here for virtual resources on Google Draw]

Number Line without numbers:

Number Line with powers of ten in exponential notation:



Number Line with powers of ten in standard form: