

Rubric: Cord Wood Dilemma

Key APS Mathematics Performance Standards: Sixth Grade




- ☐ **Measures** objects using U.S. and metric units for length, volume, mass, and area.
- ☐ **Converts** accurately from one unit to another accurately within the same system (e.g., 36 inches = 3 feet or 2 kilometers = 2000 meters).
- ☐ **Selects and uses** the appropriate number form (e.g., fraction, decimal, or percent) in a variety of situations, including measurement in U.S and metric systems.

| Level | Understanding | Strategies, Reasoning, & Procedures | Communication |
|-------------------|---|--|--|
| Novice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood, but cannot use the information to calculate the volumes and make the comparisons. • That s/he needs to determine the volume of one cord of wood, but may not be able to calculate the volume. ❖ The student does not understand: <ul style="list-style-type: none"> • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student does not see a need to convert any of the linear measurements of the wood and cannot accurately calculate the volume of the wood. The student will not use measurement units throughout the task. The student does not base their final decision using mathematical reasoning. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4 \times 4 \times 8 = 128$ Stack 1 = $72 \times 167 \times 16 = 221,184$ Conclusion: The person got plenty of wood.</p> | <ul style="list-style-type: none"> ❖ There is little or no communication, the student did not label the work, and/or their thinking is difficult to follow. ❖ Summary: The student cannot write his/her final answer, and/or uses little or no math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student has no system (charts/t-tables/graphs) to track the measurement conversions or the volume of the 2 stacks of wood. |
| Apprentice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood, but may not understand that the comparison is for 2 cords of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches, but may not accurately convert the measurements. ❖ The student may not understand: <ul style="list-style-type: none"> • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student converts the linear measurements, finds the volume for a cord of wood and the 2 stacks of wood, but cannot accurately compare the volume of the two stacks of wood to the cord of wood. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4' \times 4' \times 8' = 48'' \times 48'' \times 96'' = 221,184$ inches³ Stack 1: $72'' \times 167'' \times 16'' = 192,384$ inches³ Stack 2: $65'' \times 266'' \times 16'' = 276,640$ inches³ Total = $469,024$ inches³ Conclusion: $469,024 - 221,184 = 247,840$ inches³. Yes the person got way more wood than they needed.</p> | <ul style="list-style-type: none"> ❖ The student has communicated his/her understanding of the task by labeling their work, but the task is not clearly organized and the student's thinking is hard to follow. ❖ Summary: The student states his/her final answer and uses some math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, but has not established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. |

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| <p>Practitioner</p> | <p>Proficiency</p> <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <p>Proficiency</p> <ul style="list-style-type: none"> ❖ The student must have a correct solution and demonstrate one strategy that will determine whether or not the person received the correct amount of wood. ❖ The student must be able to solve this multi-step task: Convert the linear measurements of the wood from inches to feet or feet to inches; calculate the volume of one cord of wood; calculate the volume of the 2 stacks of wood; and mathematically determine whether the person received the correct amount of wood. Sample Strategy: Student converts everything to inches: Cord of Wood: 12inches = 1 foot so, $4' \times 4' \times 8' = 48" \times 48" \times 96" = 221,184 \text{ inches}^3$ 2 cords of wood = $221,184 \times 2 = 442,368 \text{ inches}^3$ Stack 1: $72" \times 167" \times 16" = 192,384 \text{ inches}^3$ Stack 2: $65" \times 266" \times 16" = 276,640 \text{ inches}^3$ Total = $469,024 \text{ inches}^3$ Conclusion: I compared the volume of 2 stacks of wood to the total volume of 2 cords of wood. The person got $26,656 \text{ inches}^3$ more wood than they ordered. So yes they got at least 2 cords of wood. | <p>Proficiency</p> <ul style="list-style-type: none"> ❖ The student can represent his/her work in a clear, organized manner. ❖ Summary: The student states his/her final answer and uses appropriate math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, and has established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. |
| <p>Expert</p> | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. • Task Extension: The student includes a rule, equation, generalization, and/or observation (in writing) about their understanding of measurement conversions or volume concepts. | <ul style="list-style-type: none"> ❖ The student must have a correct solution and demonstrate more than one strategy that will determine whether or not the person received the correct amount of wood. ❖ The student must be able to solve this multi-step task: Convert the linear measurements of the wood from inches to feet or feet to inches; calculate the volume of one cord of wood; calculate the volume of the 2 stacks of wood; and mathematically determine whether the person received the correct amount of wood. Sample Strategy: See 'Practitioner' Strategy Task Extension: At sixth grade, the student could be an expert by demonstrating their understanding of volume by comparing cubic inches to cubic feet. For example: The student may expand their comparison of one cord of wood from feet to inches: $4' \times 4' \times 8' = 128 \text{ feet}^3 = 48" \times 48" \times 96" = 221,184 \text{ inches}^3$ - the volume from feet to inches expands $12" \times 12" \times 12" = 1,728 \text{ inches}^3$. Once I have calculated the cubic inches, I can convert inches cubed to feet cubed by dividing by 1,728. Stack 1 = $192,384 \text{ inches}^3 \div 1,728 = \text{approximately } 111.33 \text{ feet}^3$ of wood. | <ul style="list-style-type: none"> ❖ The student can represent his/her work in a clear, organized manner. ❖ Summary: The student states his/her final answer and uses appropriate math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, and has established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. ❖ Task Extension: The student includes a rule, equation, generalization, and/or observation (in writing) about their understanding of measurement conversions or volume concepts. |

Rubric: Cord Wood Dilemma

Key APS Mathematics Performance Standards: Seventh Grade




-  **Develops** and **tests** strategies for finding volume and surface area of polyhedra, cylinders, and cones.
-  **Translates** problem-solving strategies into formulas for surface area and volume using appropriate mathematical symbols (e.g., cubic feet = ft³).
-  **Finds** length, area, volume, and angle measures to appropriate levels of precision selecting appropriate techniques and tools.

| Level | Understanding | Strategies, Reasoning, & Procedures | Communication |
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| Novice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood, but cannot use the information to calculate the volumes and make the comparisons. • That s/he needs to determine the volume of one cord of wood, but may not be able to calculate the volume. ❖ The student does not understand: <ul style="list-style-type: none"> • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student does not see a need to convert any of the linear measurements of the wood and cannot accurately calculate the volume of the wood. The student will not use measurement units throughout the task. The student does not base their final decision using mathematical reasoning. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4 \times 4 \times 8 = 128$ Stack 1 = $72 \times 167 \times 16 = 221,184$ Conclusion: The person got plenty of wood.</p> | <ul style="list-style-type: none"> ❖ There is little or no communication, the student did not label the work, and/or their thinking is difficult to follow. ❖ Summary: The student cannot write his/her final answer, and/or uses little or no math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student has no system (charts/t-tables/graphs) to track the measurement conversions or the volume of the 2 stacks of wood. |
| Apprentice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood, but may not understand that the comparison is for 2 cords of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches, but may not accurately convert the measurements. ❖ The student may not understand: <ul style="list-style-type: none"> • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student converts the linear measurements, finds the volume for a cord of wood and the 2 stacks of wood, but cannot accurately compare the volume of the two stacks of wood to the cord of wood. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4' \times 4' \times 8' = 48'' \times 48'' \times 96'' = 221,184$ inches³ Stack 1: $72'' \times 167'' \times 16'' = 192,384$ inches³ Stack 2: $65'' \times 266'' \times 16'' = 276,640$ inches³ Total = $469,024$ inches³ Conclusion: $469,024 - 221,184 = 247,840$ inches³. Yes the person got way more wood than they needed.</p> | <ul style="list-style-type: none"> ❖ The student has communicated his/her understanding of the task by labeling their work, but the task is not clearly organized and the student's thinking is hard to follow. ❖ Summary: The student states his/her final answer and uses some math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, but has not established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. |

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| <p>Practitioner</p> | <p>Proficiency</p> <p>❖ The student understands:</p> <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood. • That s/he needs to convert the woods linear measurements from inches to feet and feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <p>Proficiency</p> <p>❖ The student must have a correct solution and demonstrate one strategy that will determine whether or not the person received the correct amount of wood.</p> <p>❖ The student must be able to solve this multi-step task: Convert the linear measurements of the wood from inches to feet or feet to inches; calculate the volume of one cord of wood; calculate the volume of the 2 stacks of wood; and mathematically determine whether the person received the correct amount of wood.</p> <p>Sample Strategy: Student converts everything to inches: Cord of Wood: 12 inches = 1 foot so, $4' \times 4' \times 8' = 128 \text{ feet}^3$ Stack 1: $72'' \times 167'' \times 16'' = 6' \times 13.9' \times 1.3' = 108.42 \text{ feet}^3$ Compare to one cord of wood: $128 - 108.42 = 19.58 \text{ feet}^3$ – Stack 1 is not a full cord of wood. Stack 2: $65'' \times 266'' \times 16'' = 5.4' \times 22.16' \times 1.3' = 155.56 \text{ feet}^3$ $155.56 - 128 = 27.56 \text{ feet}^3$ - Stack 2 is more than a full cord of wood.</p> <p>Conclusion: I compared each stack to one cord of wood. Stack 1 is short 19.58 cubic feet short and Stack 2 is 27.56 cubic feet over. If I put 19.58 cubic feet of wood on stack 1, I would have 2 full cords of wood with approximately 27.56 - 19.58 = 7.98 cubic feet of wood leftover.</p> | <p>Proficiency</p> <p>❖ The student can represent his/her work in a clear, organized manner.</p> <p>❖ Summary: The student states his/her final answer and uses appropriate math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood.</p> <p>❖ Representations: The student can convert the linear measurements and calculate volume, and has established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood.</p> |
| <p>Expert</p> | <p>❖ The student understands:</p> <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. • Task Extension: The student includes a rule, equation, generalization, and/or observation (in writing) about their understanding of measurement conversions or volume concepts. | <p>❖ The student must have a correct solution and demonstrate more than one strategy that will determine whether or not the person received the correct amount of wood.</p> <p>❖ The student must be able to solve this multi-step task: Convert the linear measurements of the wood from inches to feet or feet to inches; calculate the volume of one cord of wood; calculate the volume of the 2 stacks of wood; and mathematically determine whether the person received the correct amount of wood.</p> <p>Sample Strategy: See 'Practitioner' Strategy Task Extension: At seventh grade, expert should be able to show a deeper understanding of the mathematics. For example: Let's assume that a piece of wood has a dimension of 6" x 6" x 12". The average volume of a piece of wood is 432 cubic inches. In one cord of wood with a volume of 221,184 in³, there would be approximately $221,184 \div 432 = 512$ logs in one cord of wood.</p> | <p>❖ The student can represent his/her work in a clear, organized manner.</p> <p>❖ Summary: The student states his/her final answer and uses appropriate math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood.</p> <p>❖ Representations: The student can convert the linear measurements and calculate volume, and has established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood.</p> <p>❖ Task Extension: The student includes a rule, equation, generalization, and/or observation (in writing) about their understanding of measurement conversions or volume concepts.</p> |

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Key APS Mathematics Performance Standards: Eighth Grade

-  **Selects** appropriate mathematical representations to describe thought-provoking real-life situations.
-  **Manipulates** all real numbers, their properties, and operations.
-  **Represents, describes, and analyzes** numerical patterns and relationships using tables, graphs, words, and standard algebraic notation.

| Level | Understanding | Strategies, Reasoning, & Procedures | Communication |
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| Novice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood, but cannot use the information to calculate the volumes and make the comparisons. • That s/he needs to determine the volume of one cord of wood, but may not be able to calculate the volume. ❖ The student does not understand: <ul style="list-style-type: none"> • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student does not see a need to convert any of the linear measurements of the wood and cannot accurately calculate the volume of the wood. The student will not use measurement units throughout the task. The student does not base their final decision using mathematical reasoning. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4 \times 4 \times 8 = 128$ Stack 1 = $72 \times 167 \times 16 = 221,184$ Conclusion: The person got plenty of wood.</p> | <ul style="list-style-type: none"> ❖ There is little or no communication, the student did not label the work, and/or their thinking is difficult to follow. ❖ Summary: The student cannot write his/her final answer, and/or uses little or no math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student has no system (charts/t-tables/graphs) to track the measurement conversions or the volume of the 2 stacks of wood. |
| Apprentice | <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood, but may not understand that the comparison is for 2 cords of wood. • That s/he needs to convert the woods linear measurements from inches to feet or feet to inches, but may not accurately convert the measurements. ❖ The student may not understand: <ul style="list-style-type: none"> • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <ul style="list-style-type: none"> ❖ The student has started the task using manipulatives/representations, but does not use an effective strategy to determine whether or not the person received the correct amount of wood. ❖ The student converts the linear measurements, finds the volume for a cord of wood and the 2 stacks of wood, but cannot accurately compare the volume of the two stacks of wood to the cord of wood. <p>Sample Strategy: Wood: The student calculates the volume of one cord of wood: $4' \times 4' \times 8' = 48'' \times 48'' \times 96'' = 221,184 \text{ inches}^3$ Stack 1: $72'' \times 167'' \times 16'' = 192,384 \text{ inches}^3$ Stack 2: $65'' \times 266'' \times 16'' = 276,640 \text{ inches}^3$ Total = $469,024 \text{ inches}^3$ Conclusion: $469,024 - 221,184 = 247,840 \text{ inches}^3$. Yes the person got way more wood than they needed.</p> | <ul style="list-style-type: none"> ❖ The student has communicated his/her understanding of the task by labeling their work, but the task is not clearly organized and the student's thinking is hard to follow. ❖ Summary: The student states his/her final answer and uses some math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, but has not established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. |

| <p>Practitioner</p> | <p style="text-align: center;">Proficiency</p> <ul style="list-style-type: none"> ❖ The student understands: <ul style="list-style-type: none"> • That s/he needs to determine if the person received the correct amount of wood. • That s/he needs to determine the volume of one cord of wood. • That s/he needs to convert the woods linear measurements from inches to feet and feet to inches. • That s/he must determine the volume of the two stacks of wood the person received. • That the volume measurements are estimated measures. | <p style="text-align: center;">Proficiency</p> <ul style="list-style-type: none"> ❖ The student must have a correct solution and demonstrate one strategy that will determine whether or not the person received the correct amount of wood. ❖ The student must be able to solve this multi-step task: Convert the linear measurements of the wood from inches to feet and feet to inches; calculate the volume of one cord of wood; calculate the volume of the 2 stacks of wood; and mathematically determine whether the person received the correct amount of wood. Sample Strategy: Student converts everything to inches & feet. Cord of Wood: 12 inches = 1 foot $4' \times 4' \times 8' = 128 \text{ feet}^3$ and $48'' \times 48'' \times 96'' = 221,184 \text{ inches}^3$ Stack 1: $72'' \times 167'' \times 16'' = 192,384 \text{ inches}^3$ and $6' \times 13.9' \times 1.3' = 108.42 \text{ feet}^3$ Stack 2: $65'' \times 266'' \times 16'' = 276,640 \text{ inches}^3$ and $5.4' \times 22.16' \times 1.3' = 155.56 \text{ feet}^3$ <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>WOOD</th> <th>Feet³</th> <th>Inches³</th> </tr> </thead> <tbody> <tr> <td>Stack 1</td> <td>108.42</td> <td>192,384</td> </tr> <tr> <td>Stack 2</td> <td>155.56</td> <td>276,640</td> </tr> <tr> <td>Total</td> <td>263.98</td> <td>469,024</td> </tr> <tr> <td>2 Cords of Wood</td> <td>$128 \times 2 = 256 \text{ ft}^3$</td> <td>$221,184 \times 2 = 442,368 \text{ in}^3$</td> </tr> <tr> <td>Compare</td> <td>+7.98 ft³</td> <td>+26,656 in³</td> </tr> </tbody> </table> <p>Conclusion: Using the chart above, I converted both stacks into cubic inches and feet, both clearly show that the person got more than 2 cords of wood delivered.</p> | WOOD | Feet ³ | Inches ³ | Stack 1 | 108.42 | 192,384 | Stack 2 | 155.56 | 276,640 | Total | 263.98 | 469,024 | 2 Cords of Wood | $128 \times 2 = 256 \text{ ft}^3$ | $221,184 \times 2 = 442,368 \text{ in}^3$ | Compare | +7.98 ft ³ | +26,656 in ³ | <p style="text-align: center;">Proficiency</p> <ul style="list-style-type: none"> ❖ The student can represent his/her work in a clear, organized manner. ❖ Summary: The student states his/her final answer and uses appropriate math language and symbols to explain (in writing) how s/he determined whether or not the person received the correct amount of wood. ❖ Representations: The student can convert the linear measurements and calculate volume, and has established an accurate system (charts/t-tables/graphs) to compare the volumes of the stacks of wood to the two cords of wood. |
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| WOOD | Feet ³ | Inches ³ | | | | | | | | | | | | | | | | | | | |
| Stack 1 | 108.42 | 192,384 | | | | | | | | | | | | | | | | | | | |
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| 2 Cords of Wood | $128 \times 2 = 256 \text{ ft}^3$ | $221,184 \times 2 = 442,368 \text{ in}^3$ | | | | | | | | | | | | | | | | | | | |
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