

# Rubric: Bridge Building on the Rio Grande

## Key APS Mathematics Content and Performance Standards:

### Target Performance Standards – Grade 5

1. **Forms** a hypothesis about and **tests** a rule for the pattern in a sequence of numbers (e.g., What is the 10<sup>th</sup> number in this sequence: 4, 9, 14, 19...?).
2. **Uses** patterns and numerical rules to represent and solve problems.
3. **Uses** representations to model and interpret physical, social, and mathematical phenomena.

- If the student does not attempt to solve the task or the work on the problem is completely unrelated to the task, the student’s work for the task is considered “**Unscorable**” and should not be assigned a performance level of Novice, Apprentice, Practitioner, or Expert.

Level	Understanding	Strategies, Reasoning, & Procedures	Communication												
<b>Novice</b>	<ul style="list-style-type: none"> <li>❖ The student understands that the task is a multiple step problem, but does not have the mathematical knowledge to complete the task and will only attempt to solve 1 or 2 aspects of the problem.</li> <li>❖ The student understands that they must:                             <ul style="list-style-type: none"> <li>• Convert kilometers to meters, but may not be able to carry out the conversions accurately.</li> <li>• Determine the number of trusses in 1 km (1,000 m), but may not be able to compute the calculations.</li> </ul> </li> <li>❖ The student cannot identify the pattern for the number of beams in a truss, and cannot extend the pattern to 200 trusses and find the total number of beams.</li> </ul>	<ul style="list-style-type: none"> <li>❖ The student has started the task by using manipulatives and representations, but does not address all of the steps needed to solve the task.</li> <li>❖ The student does not use an effective strategy to solve the problem or makes errors in their calculations.</li> </ul> <p><b>Sample Strategy:</b>  <b>Step 1:</b> 1 km = 1000 m  <b>Step 2:</b> Makes chart does not attempt to find the number of beams.</p> <table style="margin-left: 20px;"> <thead> <tr> <th><u># of Trusses</u></th> <th><u># of Meters</u></th> </tr> </thead> <tbody> <tr><td>1</td><td>5</td></tr> <tr><td>2</td><td>10</td></tr> <tr><td>3</td><td>15</td></tr> <tr><td>4</td><td>20</td></tr> <tr><td>5</td><td>25</td></tr> </tbody> </table> <p><b>Step 3:</b> Continues chart establishes that 200 trusses are needed to build the bridge.</p>	<u># of Trusses</u>	<u># of Meters</u>	1	5	2	10	3	15	4	20	5	25	<ul style="list-style-type: none"> <li>❖ There is little or no communication, the student did not label the work, and/or their thinking is difficult to follow.</li> <li>❖ <b>Summary:</b> The student does not write his/her final answer, and/or uses little or no mathematical language and symbols to explain (in writing) how s/he calculated the number of trusses to build the 1 km bridge and the total number of beams needed to build the 200 trusses.</li> <li>❖ <b>Representations:</b> The student has no system (charts/t-tables/graphs) to track the calculations for the number of trusses and beams needed to build the bridge.</li> </ul>
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1	5														
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<p><b>Apprentice</b></p>	<ul style="list-style-type: none"> <li>❖ The student understands that the task is a multiple step problem, but cannot use the information at each of the steps to progress the problem.</li> <li>❖ The student understands that they must: <ul style="list-style-type: none"> <li>• Convert kilometers to meters.</li> <li>• Determine the number of trusses in 1 km (1,000 m).</li> <li>• Identify the pattern for the number of beams in a truss, but cannot extend the pattern to 200 trusses and find the total number of beams.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>❖ The student has started the task using manipulatives or representations, has chosen a strategy to solve the task, attempts to address all of the steps of the task, but does not achieve a correct solution.</li> <li>❖ The student may not know how to address all of the aspects of the task or may get an incorrect answer due to computation or conversion errors.</li> </ul> <p><b>Sample Strategy:</b> The apprentice will either not attempt to solve the second part of the task or will not be able to accurately calculate the total number of beams.</p> <p><b>Step 1:</b> 1km = 1000m  <b>Step 2:</b> 1 truss = 5m, so <math>1000 \div 5 = 200</math> trusses  <b>Step 3:</b> 1 truss = 3 beams, so 200 trusses <math>\times</math> 3 beams = 600 trusses (Does not correctly identify and extend the pattern.)</p>	<ul style="list-style-type: none"> <li>❖ 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.</li> <li>❖ <b>Summary:</b> The student states his/her final answer; and uses some mathematical language and symbols to explain (in writing) how s/he calculated the number of trusses to build the 1 km bridge and the total number of beams needed to build the 200 trusses.</li> <li>❖ <b>Representations:</b> The student has not established an accurate system (charts/t-tables/graphs) to track the calculations for the number of trusses and beams needed to build the bridge.</li> </ul>
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<p><b>Practitioner</b></p>	<p><b>Proficiency</b></p> <ul style="list-style-type: none"> <li>❖ The student understands that the task is a multiple step problem and that the answer at each step, progresses the problem.</li> <li>❖ The student understands that they must: <ul style="list-style-type: none"> <li>• Convert kilometers to meters.</li> <li>• Determine the number of trusses in 1 km (1,000 m).</li> <li>• Identify the pattern for the number of beams in a truss and extend the pattern to 200 trusses to find the total number of beams.</li> </ul> </li> </ul>	<p><b>Proficiency</b></p> <ul style="list-style-type: none"> <li>❖ The student uses one accurate and appropriate strategy to correctly solve all of the steps of the task.</li> <li>❖ Task calculations include: <ul style="list-style-type: none"> <li>• Convert Kilometer to meters.</li> <li>• Determine the number of trusses in 1 kilometer (1,000m)</li> <li>• Identify the pattern for the number of beams needed to make 1 truss and extend the pattern to 200 trusses.</li> </ul> </li> </ul> <p><b>Sample Strategy:</b>  <b>Step 1:</b> 1km = 1000m  <b>Step 2:</b> 1 truss = 5m, so <math>1000 \div 5 = 200</math> trusses  <b>Step 3:</b> Makes chart</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th style="text-decoration: underline;"># of Trusses</th> <th style="text-decoration: underline;"># of Beams</th> </tr> </thead> <tbody> <tr><td>1</td><td>3 +4</td></tr> <tr><td>2</td><td>7 +4</td></tr> <tr><td>3</td><td>11 +4</td></tr> <tr><td>4</td><td>15 +4</td></tr> <tr><td>5</td><td>19 +4</td></tr> <tr><td colspan="2">Continues pattern to...</td></tr> <tr><td>200</td><td>799</td></tr> </tbody> </table>	# of Trusses	# of Beams	1	3 +4	2	7 +4	3	11 +4	4	15 +4	5	19 +4	Continues pattern to...		200	799	<p><b>Proficiency</b></p> <ul style="list-style-type: none"> <li>❖ The student can represent his/her work in a clear, organized manner.</li> <li>❖ <b>Summary:</b> The student uses appropriate mathematical language and symbols to explain (in writing) how s/he calculated the number of trusses to build the 1 km bridge and the total number of beams needed to build the 200 trusses.</li> <li>❖ <b>Representations:</b> The student has created an efficient system (charts/t-tables/graphs) to track the calculations for the number of trusses and beams needed to build the bridge.</li> </ul>
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**Scoring Note:**

- To be a Practitioner for this task, the student can extend the pattern for the number of beams in 200 trusses using any appropriate method. The student may state the pattern but does not write a formal algebra equation/formula.
- To be an Expert the student must extend their algebraic thinking and develop an algebra equation/formula to solve for the number of beams and provide detailed representations and summaries of their mathematical work and thinking.

<p><b>Expert</b></p>	<ul style="list-style-type: none"> <li>❖ The student understands that the task is a multiple step problem and that the answer for each step, progresses the problem.</li> <li>❖ The student understands that they must: <ul style="list-style-type: none"> <li>• Convert kilometers to meters.</li> <li>• Determine the number of trusses in 1 km (1,000 m).</li> <li>• Identify the pattern for the number of beams in a truss and extend the pattern to 200 trusses to find the total number of beams.</li> </ul> </li> <li>❖ <b>Task Extension:</b> The student extends the task by including a written rule, equation, generalization, or observation about their understanding of the algebra in the task.</li> </ul>	<ul style="list-style-type: none"> <li>❖ The student uses more than one accurate and appropriate strategy to correctly solve all of the steps of the task.</li> <li>❖ Task calculations include: <ul style="list-style-type: none"> <li>• Convert Kilometer to meters.</li> <li>• Determine the number of trusses in 1 kilometer (1,000m)</li> <li>• Identify the pattern for the number of beams needed to make 1 truss and extend the pattern to 200 trusses.</li> </ul> </li> <li>❖ <b>Task Extension:</b> Using my chart, I realized there was a pattern, so I did not have to calculate all 200 trusses to find the beams. The pattern is: 1 truss = 3 beams, 2 trusses = 7 beams, 3 trusses = 11 beams, so the number of beams needed is 4 times the number of trusses minus 1. Beams = 4 x Trusses (T) – 1 or <math>(4 \times T) - 1</math>.</li> </ul>	<ul style="list-style-type: none"> <li>❖ The student can represent his/her work in a clear, organized manner.</li> <li>❖ <b>Summary:</b> The student uses appropriate mathematical language and symbols to explain (in writing) how s/he calculated the number of trusses to build the 1 km bridge and the total number of beams needed to build the 200 trusses.</li> <li>❖ <b>Representations:</b> The student has created an efficient system (charts/t-tables/graphs) to track the calculations for the number of trusses and beams needed to build the bridge.</li> <li>❖ <b>Task Extension:</b> The student includes a written rule, equation, generalization, and/or observation about their mathematical insights for identifying and extending patterns.</li> </ul>
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