A man launches his boat from point $A$ on a bank of a straight river, 4 kilometers wide, and wants to reach point $B$, 9 kilometers downstream on the opposite bank, as quickly as possible. Suppose that he can row at a rate of 6 kilometers per hour and run at a rate of 8 kilometers per hour.

**Exercise 1.** Draw a picture of the river. Be sure to label the points $A$ and $B$ as well as any of the known distances.

**Exercise 2.** How long will it take the man to reach point $B$ if he chooses to land his boat at the point along the opposite bank, 12 kilometers downstream (and subsequently to run 3 kilometers upstream)?

**Exercise 3.** Could the route suggested in the previous exercise be the optimal route (in the sense that it minimizes the man’s travel time)? Why or why not?

**Exercise 4.** How long will it take the man to reach point $B$ if he chooses to land his boat at the point along the opposite bank, 3 kilometers upstream (and subsequently to run 12 kilometers downstream)?
Exercise 5. Could the route suggested in the previous exercise be the optimal route (in the sense that it minimizes the man’s travel time)? Why or why not?

Exercise 6. How long will it take the man to reach point \( B \) if he chooses to row directly to and land his boat at the point \( B \) (so that he doesn’t have to run at all)?

Exercise 7. How long will it take the man to reach point \( B \) if he chooses to land his boat at the point along the opposite bank directly across from point \( A \) (and subsequently to run 9 kilometers downstream)?

Exercise 8. Write a formula for a function that gives the man’s total travel time in terms of the distance \( x \) kilometers downstream that he lands his boat. Be sure the function’s output values agree with the answers obtained in each of the four situations considered previously.

Exercise 9. Given the results of Exercises 3 and 5, what are the most reasonable values of \( x \) over which to optimize the function found in Exercise 8?

Exercise 10. Considering the answer to Exercise 9, is there any way in which the function found in Exercise 8 can be simplified? Explain.
Exercise 11. What is the first derivative of the simplified function from Exercise 10?

Exercise 12. Apply the methods of calculus to find the minimum of the simplified function from Exercise 10 over the domain specified in the answer to Exercise 9.

Exercise 13. Name any theorems, methods, and/or tests from Sections 4.2 and 4.3 in the textbook used in performing Exercise 12. Why are these theorems, methods, and/or tests applicable?

Exercise 14. What is the least amount of time that the man can expect to travel during his journey to point B?

Exercise 15. How many kilometers downstream should the man plan to land his boat in order to achieve the minimum time found in Exercise 14?

Exercise 16. Thus far, it has been assumed that the river’s current is negligible in comparison to the man’s rowing speed. Suppose, now, that the river’s current is significant. How might the answers to Exercises 3 and 5 change?
## Critical Thinking VALUE Rubric

**STUDENT ARTIFACT #: _____**

**Definition**
Critical thinking is a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion.

**Circle the appropriate rating for each criterion.** Evaluators are encouraged to assign a zero to any work, sample, or collection of work that does not meet benchmark (cell one) level performance.

### Explanation of issues

<table>
<thead>
<tr>
<th>Capstone</th>
<th>Milestones</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue/problem to be considered critically is stated clearly and described comprehensively, delivering all relevant information necessary for full understanding.</td>
<td>Issue/problem to be considered critically is stated, described, and clarified so that understanding is not seriously impeded by omissions.</td>
<td>Issue/problem to be considered critically is stated but description leaves some terms undefined, ambiguities unexplored, boundaries underdetermined, and/or backgrounds unknown.</td>
</tr>
</tbody>
</table>

### Evidence

**Selecting and using information to investigate a point of view or conclusion**

<table>
<thead>
<tr>
<th>Applicable Exercises: Exercises 2,4,6,7</th>
<th>Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis.</th>
<th>Information is taken from source(s) with some interpretation/evaluation, but not enough to develop a coherent analysis or synthesis.</th>
<th>Information is taken from source(s) without any interpretation/evaluation. Viewpoints of experts are taken as fact, without question.</th>
</tr>
</thead>
</table>

### Influence of context and assumptions

<table>
<thead>
<tr>
<th>Applicable Exercises: Exercises 3,5,9,10</th>
<th>Thoroughly (systematically and methodically) analyzes own and others’ assumptions and carefully evaluates the relevance of contexts when presenting a position.</th>
<th>Identifies own and others’ assumptions and several relevant contexts when presenting a position.</th>
<th>Shows an emerging awareness of present assumptions (sometimes labels assertions as assumptions). Begins to identify some contexts when presenting a position.</th>
</tr>
</thead>
</table>

### Student's position (perspective, thesis/hypothesis)

<table>
<thead>
<tr>
<th>Applicable Exercises: Exercises 8,11,12,13</th>
<th>Specific position (perspective, thesis/hypothesis) is imaginative, taking into account the complexities of an issue. Limits of position (perspective, thesis/hypothesis) are acknowledged. Others’ points of view are synthesized within position (perspective, thesis/hypothesis).</th>
<th>Specific position (perspective, thesis/hypothesis) takes into account the complexities of an issue. Others’ points of view are acknowledged within position (perspective, thesis/hypothesis).</th>
<th>Specific position (perspective, thesis/hypothesis) is stated, but is simplistic and obvious.</th>
</tr>
</thead>
</table>

### Conclusions and related outcomes (implications and consequences)

<table>
<thead>
<tr>
<th>Applicable Exercises: Exercises 14,15, and 16 (2 Points)</th>
<th>Conclusions and related outcomes (consequences and implications) are logical and reflect student's informed evaluation and ability to place evidence and perspectives discussed in priority order.</th>
<th>Conclusion is logically tied to a range of information, including opposing viewpoints; related outcomes (consequences and implications) are identified clearly.</th>
<th>Conclusion is inconsistently tied to some of the information discussed; related outcomes (consequences and implications) are oversimplified.</th>
</tr>
</thead>
</table>

### Reader/Rater #: 1 or 2 or 3 (circle the appropriate number)