PROBLEM-SOLVING TUTORIAL

2.3 Mathcad Basics: Problems

Introduction

You are now ready to try some problems on your own. In all Problem sections, you will work out problems so that you can test your new abilities with Mathcad. There are only two problems in this section.

Remember, Mathcad allows you to organize the problem after you have the solution. Start out by experimenting with a few calculations to get an understanding of the problem, but then go back and include some text to explain your thought process and discuss the answer.

Always double-check to see if the answer you are getting seems reasonable. Mathcad may know how to do math, but that does not mean it is good at reasoning.

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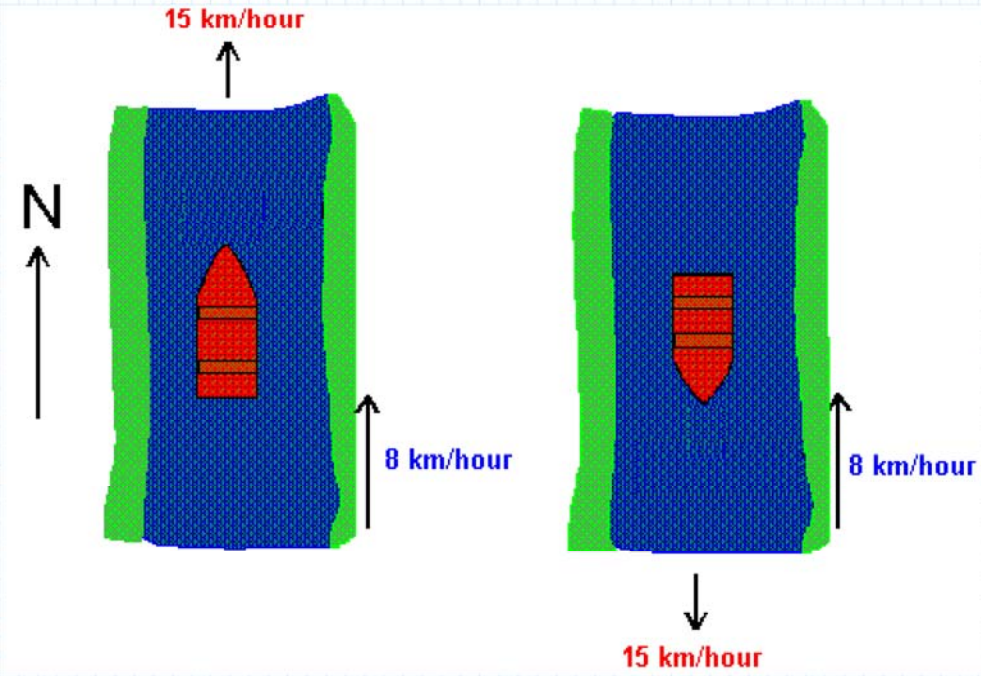
Question 1

A boat is traveling with respect to the water in a river at 15 km/hr. The velocity of the river is 8 km/hr north.

a. What is the velocity of the boat as seen from the shore if the boat is heading north?
b. What is the velocity of the boat as seen from the shore if the boat is heading south?



Problem Space

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Solution

a. First we will define north to be positive and south to be negative. Now by adding the magnitude of the velocity we can solve the problem.

$$15\ \frac{km}{hr}+8\ \frac{km}{hr}=23\ \frac{km}{hr}$$

b. Since the boat is traveling southward, its velocity is negative.

$$-15\ \frac{km}{hr}+8\ \frac{km}{hr}=-7\ \frac{km}{hr}$$

Final Answer: If the boat heads north, the velocity is 23 km/hr northward and if the boat heads south, the velocity is 7 km/hr southward.

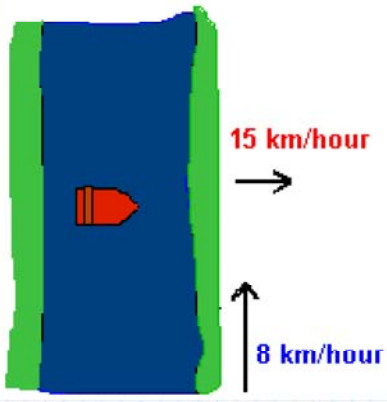
Have you saved your changes?

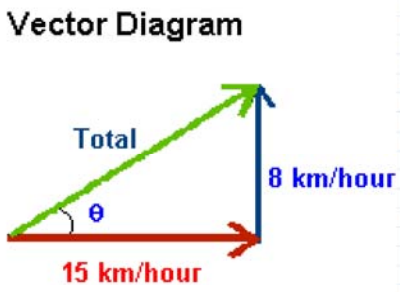
Now on to a second problem, where you need to use Pythagoras' Theorem and some trigonometry.

Question 2

The same boat as in the first question is now trying to cross the river. Again, the velocity of the river is 8 km/hr north. The boat travels 15 km/hr directly east with respect to the river.

a. What is the velocity of the boat as seen from the shore? Remember that velocity is a vector, so you need to determine both the magnitude and direction.
b. If the boat takes one-tenth of an hour to cross the river, how wide is the river?
c. How far downstream does it end up with respect to its starting point?





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Content TIP

Radians versus Degrees

Hint: When you calculate the direction of the velocity vector, your answer will be an angle (in **radians**). Remember, Mathcad uses **radians** by default. If you want to convert radians to degrees, use the tab in the right corner, Getting Started. In the next chapter, you will learn how Mathcad makes units conversions simple (and almost unnecessary!).

Assemble your solution in your worksheet window.

Problem Space

Question 2

The same boat as in the first question is now trying to cross the river. Again, the velocity of the river is 8 km/hr north. The boat travels 15 km/hr directly east with respect to the river.

a. What is the velocity of the boat as seen from the shore? Remember that velocity is a vector, so you need to determine both the magnitude and direction.
b. If the boat takes one-tenth of an hour to cross the river, how wide is the river?
c. How far down stream does it end up with respect to its starting point?

Solution

a. The resultant of the vectors is the velocity of the boat as seen from the shore. The magnitude is found from Pythagoras' Theorem. The angle is found by taking the arctangent of the triangle.

$$\sqrt{\left(15 \cdot \frac{km}{hr}\right)^2 + \left(8 \cdot \frac{km}{hr}\right)^2} = 17 \ \frac{km}{hr}$$

$$\operatorname{atan}\left(\frac{8}{15}\right) = 0.49 \ rad$$

$$0.49 \cdot rad \cdot \frac{360}{2 \cdot \pi} = \left(1.61 \cdot 10^3\right) \ deg$$

b. Since we know the boat travels 15 km/hr for one tenth an hour, we know the distance it traveled across the river by simply multiplying.

$$15 \ \frac{km}{hr} \cdot 0.1 = 1.5 \ \frac{km}{hr}$$

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c. Since the river is moving at 8 km/hr, by multiplying this by one tenth an hour we find how far it traveled downstream.

$$8 \cdot \frac{km}{hr} \cdot 0.1 = 0.8 \ \frac{km}{hr}$$

Have you saved your changes?

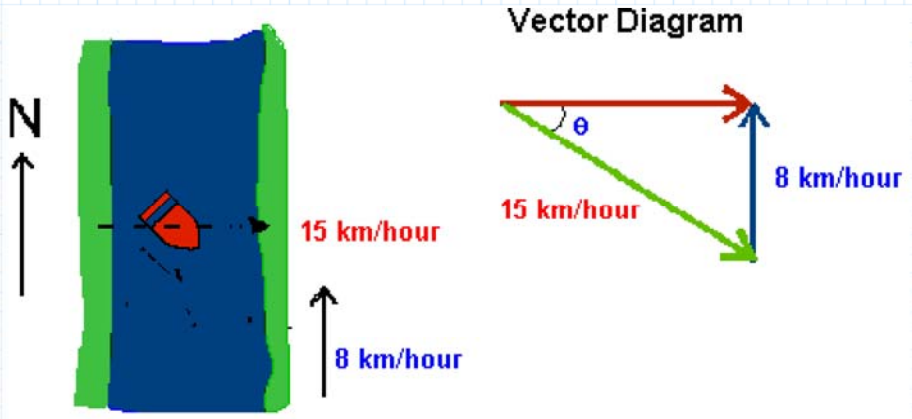
Final Answer: As seen on land, the boat travels at 17 km/hr at an angle 28.07 deg from the perpendicular to the shore. The river is 1.5 km wide and the boat ends up 0.8 km downstream from where it started.

The last problem is an extension of the second. Again, you need to use Pythagoras' Theorem and some trigonometry. Try copying and editing your solution to the second problem instead of typing everything over.

Question 3

The same boat as in the first two problems is now trying to reach a point directly across the river, without drifting downstream or heading up the river.

a. If the boat's speed is 15 km/hr, then what direction should it travel?
b. Assuming that the boat travels straight across the river, what is the total speed of the boat as it crosses the river as seen from the shore?



Radians versus Degrees

Hint: Again, your answer for the direction will be an angle (in **radians**). Use the icon in the margin for help.

Assemble your solution in your worksheet window.

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Problem Space

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a. If the boat's speed is 15 km/hr, then what direction should it travel?
b. Assuming that the boat travels straight across the river, what is the total speed of the boat as it crosses the river as seen from the shore?

Solution

a. By finding the arcsin of the triangle shown above we can calculate the angle from the perpendicular that the boat should head upstream

$$\operatorname{asin}\left(\frac{8}{15}\right) = 0.56\ \textit{rad}$$

b. To find the total speed of the boat as seen from shore, we must again use Pythagoras' Theorem.

$$\sqrt{\left(15 \cdot \frac{\textit{km}}{\textit{hr}}\right)^2 - \left(8 \cdot \frac{\textit{km}}{\textit{hr}}\right)^2} = 12.69\ \frac{\textit{km}}{\textit{hr}}$$

Have you saved your changes?

Final Answer: To travel directly across the stream, the boat must head 32.23 degrees from the perpendicular upstream and will travel across the river at a speed of 12.69 km/hr.

You made it! Now you can go to **Chapter 3: Variables and Units**. There you will learn how Mathcad can be used to make solving problems more sensible and unit conversions simple.

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