PROBLEM-SOLVING TUTORIAL

2.1 Mathcad Basics: Tutorial

Introduction

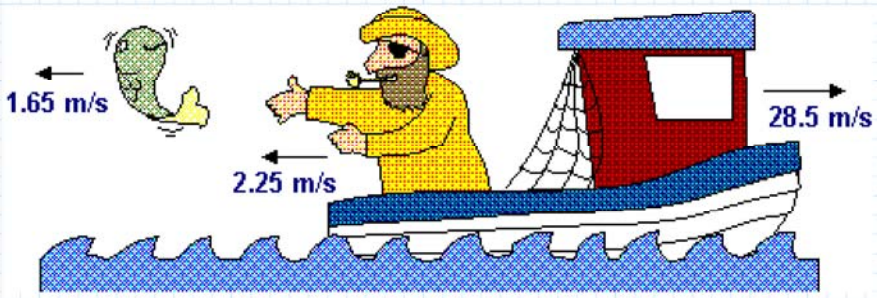
One approach to problem solving, which you no doubt have taken, is to extract the numbers from a word problem and “plug” them into a calculator. Although this method is a very limited approach to problems, we will introduce you to the basics of PTC Mathcad in the context of examples that assume this simplistic approach.

In this chapter, you will learn to do simple calculations, write text, and organize your work into a coherent solution. One of the nicest features of PTC Mathcad is that it allows you to fix mistakes quickly, and then it automatically recalculates your answers.

These basic skills hardly begin to exploit the full power of PTC Mathcad as a tool for solving problems, but they are essential for producing a well organized solution. As you go along, you will find that PTC Mathcad can do far more than just arithmetic; however, let's begin by solving a problem as you would with a calculator.

Question

A fisherman walks towards the back of his boat at a constant velocity of **2.25 m/sec** (with respect to the boat). The boat is moving at a constant velocity of **28.4 m/sec** forward with respect to an observer on the shore. While walking, the fisherman throws a fish out of the back of the boat with an initial velocity of **1.65 m/sec** with respect to himself. What is the initial velocity of the fish as viewed by someone on the shore?



Let's call the direction of the boat the positive **x** direction. To get the fish's speed, you should take the boat's speed and subtract the speed of the fish and the speed that the fisherman is walking. Again, using PTC Mathcad for this problem is overkill, but you need to learn the basics first.

Writing an Equation

Writing equations

Click in the open area at right to mark a place for your equation.

A blue crosshair will appear wherever you click.

Blue crosshair: +

The crosshair marks the starting place for equations.

What are those dotted boxes?

With the crosshair in place, type in the equation:

28.4 - 2.25 - 1.65 =

5;17−5158−4198=5718

Press [Enter] to leave the equation and the crosshair will reappear below.

We now have a number, but physics problems also need an explanation to really answer the question. So, let's add some text to explain the solution. Take another look:

What is the initial velocity of the fish as viewed by someone on the shore?

Velocity is a **vector** quantity, so it has both a speed and a **direction**. We know the speed, but in which direction is the rock headed? Even though it was thrown out the back, the fish is seen by someone on shore as going in the same direction as the boat. We need a sentence which says that.

Creating a Region of Text

Text regions

Unlike a word processor, Mathcad needs to be told when to begin a section of text. To start a **Text Region**, you need to select the **Document** tab and then click on either **Text Block** or **Text Box.**

Click in the open space at right.

Ctrl + T for Text Box or Ctrl + Shift + T for Text Block.

How can I adjust the size of the text region?

In your text region, write an explanation like the one below:

"*The initial velocity of the fish is 24.5 m/sec in the same direction as the boat is moving.*"

You add blank lines to your text region or move text to a new line by pressing [Enter]. To exit the text region, you must click outside the region.

Click in an unused space to exit the text region.

Separate Regions

Often when you add new material to a file, or use cut and paste, the regions will overlap. Use the command **Separate Regions** from the **Document** tab to do exactly that. The overlapped material will move vertically or horizontally in the file. You should recheck the file, to make sure everything is still where you need it to be.

Selecting and Moving Regions

Imagine that this white background is a corkboard, and all the regions are pinned onto the background. You can sketch out a problem, like we did above, and then organize the regions into a coherent solution after you have finished your work. First, you must select a region.

Selecting regions

If you click on the edge of a region you will see a small black hand. Use this hand to grab the region and move it.

To select several regions, click and drag over them. The regions get a blue fill. To undo a selection, click again in an unused part of the screen.

Try to select this equation: $\frac{;9+47}{78}=5155\,5$

$\frac{;\bullet<+578}{4:-8}=5917\,4:$

Moving regions

If you select both regions at once, they will move as a group.

Try selecting both equations at once and moving them.

Cut, Copy, and Paste

To really use PTC Mathcad effectively, you must master the ability to **Cut** or **Copy** a selected region and **Paste** it back into the Mathcad document.

Cut, Copy, and Paste

The **Cut** command will remove the selected region from the document and place it on the clipboard (memory), while **Copy** just makes a copy of the region for the clipboard. Any region on the clipboard will be replaced by the next cut or copied region, so the **Cut** command can be used to "delete" regions. The **Paste** command places the region contained on the clipboard at the crosshair, so you should click at the location you want the region to go before you paste.

Arranging Your Work

Now you are ready to pull together everything we did before into one spot and organize your solution.

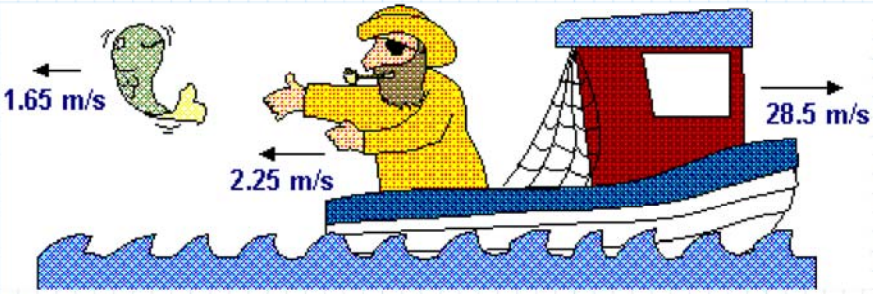
Scroll back up to the start of the problem and **Copy** the question and picture; then come back and **Paste** these in your Worksheet window (a blank Mathcad screen.).

Copy your calculation and explanation into the space as well. After you get everything in one place, move the regions around and organize your solution.

Problem Space

How to create more space

A fisherman walks towards the back of his boat at a constant velocity of **2.25 m/sec** (with respect to the boat). The boat is moving at a constant velocity of **28.4 m/sec** forward with respect to an observer on the shore. While walking, the fisherman throws a fish out of the back of the boat with an initial velocity of **1.65 m/sec** with respect to himself. What is the initial velocity of the fish as viewed by someone on the shore?



Save your changes!

Find the initial velocity of the fish according to an observer from the shore by adding up all the component velocities:

5;17−5158−4198=5718

Final answer: The initial velocity of the fish is 24.5 m/sec in the same direction as the boat is moving.

"Sticky" Operations

In the previous problem, the boat's speed was **28.4 m/s**. Suppose the boat had been going $\frac{5}{6}$ as fast; how would the problem change?

The calculation would be: $5;17\cdot\frac{5}{6}-5158-4198$

Why is my typing green?

Click in the open space and type in the equation.
28.4 * 2 / 3 - 2.25 - 1.65 =

$$5;17\cdot\frac{5}{6-5158-4198}=-961444$$

Strange?!?! Mathcad subtracted the other two speeds from the 3 in the denominator, which is not what you had intended.

Division is an example of a "**sticky**" operation in Mathcad. Once you get into the denominator, you are stuck. The **space bar** will get you unstuck. Here is how:

Editing with the Spacebar

Click in the open space. Notice the difference this time when you type:

28.4 * 2 / 3 space space - 2.25 - 1.65 =

$$5;17\cdot\frac{5}{6}-5158-4198=481366$$

$\frac{2}{3}$

A grey fill surrounded the fraction after you press the space bar. The blue editing lines enclose what will be affected by your next operation. In general, pressing the space bar more than once encloses a larger section of the equation. Here are some examples to illustrate:

Click in the open space and type:
7 + 3 / 4 space space * 12 =

$$:+\frac{6}{7}\cdot 45=49$$

Let's say you wanted $\left(:+\frac{6}{7}\right)\cdot 45=<6$ instead.

Type this:
7 + 3 / 4 space space space * 12 =

$$\left(:+\frac{6}{7}\right)\cdot 45=<6$$

PTC Mathcad even put in parentheses to clarify exactly what you were doing. Great!

The space bar "releases" you from sticky operations by expanding the grey fill that encloses what is affected by your next operation. Here are some sticky operations that require the use of the space bar:

Operation	Example	Keystroke	
Division	$\frac{4;8}{4<+93}$	/	slash
Square Root	$\sqrt{45+6}$	\	backslash
Power (Exponent)	8^{5} or $9135\cdot 43^{56}$	^	caret ([Shift] 6)

If you do not press the space bar, you remain *under* the square root or *up* in the exponent.

5b4edvlf1p fg{ ;

The Math Tab

The **Math** tab is an easy way to enter math symbols like square roots, and Greek characters such as e. Each button in the **Math** tab brings up another selection of operations.

> Feel free to investigate the different tools contained within the **Math** tab.

Editing Equations

Making changes to an equation is often faster than starting over from scratch. You can use the [Backspace] key to correct mistakes while typing, but once you have left an equation you have to get back into it to make modifications. To edit an equation, you must click on the equation with the mouse, but you will get various results depending on where you click. We list three examples below.

Editing Equations

1.

Click just to the right of a number and you will get the **blue bar** that allows you to edit like a word processor. The editing lines are good for changing single numbers, but they can be used to do all your editing. Mathcad will update the answer when you leave the equation.

$3.65-\sqrt{5.2}$

In our boat example, suppose we typed $\frac{4}{6}$ instead of $\frac{5}{6}$.

How would we fix that mistake?

> Change the 4 to a 5 in the equation and click outside the equation. $5;17\cdot\frac{4}{6}-5158-4198=8189:$

2. You can also add an operation over an existing expression.

> Enclose the sum :+< with blue editing lines by clicking and using the space bar. Now take the square root of :+< by pressing \ or choosing the square root from the **Math** tab.

:+<=49

7+9=16

$\sqrt{:+<}=7$

5b4edvlf1p fg{ <

Result format

3.

When you use the equal sign = to calculate the result of an expression, you cannot edit the answer (like you have been above); however, you can change the way that the answer is displayed with the **Math Formatting tab**. For example, you may want to show more significant figures in your answer or choose not to display the result in scientific notation.

Moving Within an Equation

While you are in an equation, you can switch between the different levels of editing and move through the equation. The and ↕ arrow keys on your keyboard move from the denominator to the numerator.

Click on a number in the equation below. Press the and ↕ arrows or the space bar to see what happens as you do this.

$$\frac{78-\sqrt{65}}{(;+8)\cdot 45}+\frac{6}{49}=3177$$

Moving in equations

The ← and → arrow keys on your keyboard move through the equation like a word processor. When you have enclosed only part of the equation, the ← and → arrows move to different sub-expressions. They also indicate the insertion point, where the next character will appear. Experiment on the equation above until you feel comfortable with this feature.

The Insert Key

When you are typing in a mathematical expression, Mathcad puts each new operation to the right or below. Here are some examples:

$15\cdot\square \qquad 17-\square \qquad \frac{56}{\square}$

What are those black boxes?

If you want to reverse the order of typing, you can use the **fl** keys. When you press that key, the next operation will be placed to the left or above the current expression. You can tell which way by the blue insertion line.

The next character will be to the right.

Have you saved changes?

Now that you have finished the Tutorial, you are ready to try a few exercises (with a little help). Go to the next chapter **2.2 Mathcad Basics: Exercises**.