PROBLEM-SOLVING TUTORIAL

2.2 Mathcad Basics: Exercises

Introduction

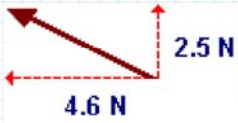
In this section and subsequent **Exercise** sections of this Problem-Solving Tutorial, you will work out a few problems (with some prompting) so that you will become more familiar with working in Mathcad.

In this section, we will introduce another way of selecting regions, how to edit text, and where to find trigonometric functions. First, we will review some of the equation writing skills you learned in the Tutorial.

Question 1

During summer vacation, a student decides to walk his two dogs while wearing roller-skates.

a) If his Dalmatian starts pulling **north** with a force of **2.5 newtons** and the retriever pulls **west** with a force of **4.6 newtons,** then what is the magnitude of the force felt by the student?



b) After a few seconds of pulling by the dogs the skater has been imparted a **northward** component of displacement of **5.7 ft** by the Dalmatian while the Retriever has caused a **westward** displacement of **3.2 ft**. What is the net displacement?

Solution

In both parts of the problem, the vectors related to the dogs are perpendicular to each other. We can calculate the magnitude of the resulting vector with the Pythagorean theorem.

Sticky operations

In the open space, compute the resulting magnitude of the **2.5** and **4.6 newton** force vectors with the Pythagorean theorem.

Use the "sticky operations" icon in the margin if you are having difficulty.

$$\sqrt{2.5^2 + 4.6^2} = 5.24$$

The second part of the problem also uses the Pythagorean theorem. Instead of typing almost the same expression again, let's try to be clever and save time.

Selecting regions

Cut, Copy, and Paste

Select and **Copy** the calculation that you just completed, then **Paste** it in the open space to the right. Now **double-click** on each number and edit the equation to compute the resulting magnitude of the **5.7** and **3.2 mph** displacement vectors.

$$\sqrt{5.7^2 + 3.2^2} = 6.54$$

Pretty slick! Remember, cutting and copying are the key to being efficient with PTC Mathcad.

You have calculated the values, but the solution is not organized into a final form. Next we explain the elements of a well organized solution. Then you will use these suggestions to compose your own solution for this problem.

Composing a Solution

1. Restate the problem:

Copying the problem statement into your solution is a good reminder to read the question again and make sure that you are answering what is being asked!

Selecting Regions

Selecting regions

You will have to select all the regions in the problem statement to copy them into your worksheet window. We presented one method for selecting regions already (dragging the mouse), but here is another way to select and deselect regions:

You can select, or deselect, a region by holding down the [Ctrl] and clicking on it with the mouse button. Ctrl-clicking allows you to be selective about what you want to move.

Let's say you have three regions in a row, like the equations below and you want to select the first and the third equations, but not the second.

$$75+\frac{8}{5}=76.6 \qquad \frac{45-8}{6}=6.17 \qquad \frac{\sqrt{76}}{9}=0.97$$

2. Answer the question:

A well written solution requires more than just your calculations. You must explain your work so that the reader can follow your logic and the answer is clearly described in words.

For your problem, you probably want to start by explaining why the Pythagorean theorem can be used to calculate the answers. Your calculations should follow. Then you should write a summary sentence, presenting the magnitudes with their appropriate units.

Cut, Copy, and Paste

Go back and **Copy** the question, as well as your calculations, and **Paste** them into your worksheet window. Recall that pictures, text and equations are all regions that can be copied or dragged.

Sample Solution

Question 1

During summer vacation, a student decides to walk his two dogs while wearing roller-skates.

a) If his Dalmatian starts pulling **north** with a force of **2.5 newtons** and the Retriever pulls **west** with a force of **4.6 newtons**, then what is the magnitude of this initial force felt by the student?

Answer: Force is a vector, so the magnitude is given by adding up the components using the Pythagorean theorem (since the components are at right angles).

$$\sqrt{(2.5\ N)^2 + (4.6\ N)^2} = 5.24\ N$$

b) After a few seconds of pulling by the dogs the skater has been imparted a **northward** component of displacement of **5.7 ft** by the Dalmatian while the Retriever has caused a **westward** displacement of **3.2 ft**. What is the net displacement?

Answer: Displacement is also a vector, so the magnitude is computed just as before

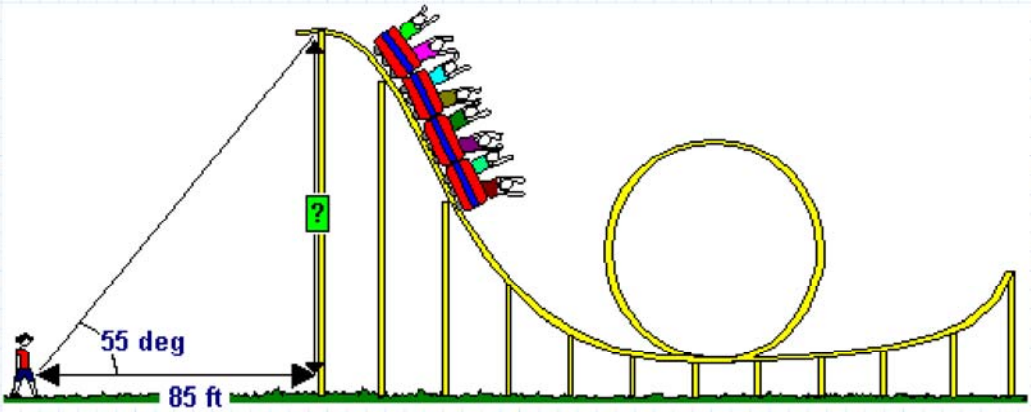
Have you saved your changes?

$$\sqrt{(5.7\ ft)^2 + (3.2\ ft)^2} = 6.54\ ft$$

Let's try another problem to learn a few more Mathcad editing and math features.

Question 2

A physics student wants to determine the height of the Sooper Dooper Looper roller coaster at Fun-All-Day Amusement Park. When the student is **85 feet** away from the roller coaster, she measures the angle from the horizontal to the top of the roller coaster to be **55 degrees**. How high is the roller coaster?



Finding a solution to this problem requires that we use a trigonometric function, which we have not yet discussed.

Built-in Functions

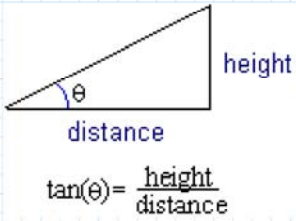
Built-in Functions

Mathcad has many **built-in** functions in addition to the standard trigonometric functions. There is the **Functions tab** from where you can add whatever function you might need.

Trig functions

To find the height of the roller coaster, we need to use a **tangent** function.

The height is the product of the distance to the coaster times the tangent of the angle.



Place the crosshair in your main Worksheet window. Use the **Functions tab** to find the tangent function and **Insert** it at the crosshair.

You'll see $tan(\blacksquare)$ appear. Refer to our explanation above if you have difficulty finding the tangent function.

Radians versus Degrees

We have already typed out the tangent function below. The only thing missing is the "**argument**" of the function, which is the angle.

Put in an argument of 55 into the $tan(\blacksquare)$ function at right and then type an equals sign to display the answer.

$\tan(\blacksquare)$

Content TIP

Radians versus Degrees

Notice that the result is a negative number. If we multiply that result by the distance to the roller coaster, we would end up with a **negative** height! Where did we go wrong???

The value of the tangent function came out negative because we did not tell Mathcad that we meant 55 **degrees**. By default, Mathcad assumed we wanted 55 **radians**, which is a totally different way of measuring angles. The difference is explained in detail in the icon to the left.

To tell Mathcad that we want degrees, you have to **multiply** the argument by the degree unit *deg*.

At right, find the tangent of $55 \cdot deg$ by typing the following (no spaces):

85 * tan(55 * deg) = $85 \cdot \tan(55 \cdot deg) = 121.39$

The result should be more reasonable than before.

This example shows that solving science problems without **units** is dangerous. In the next chapter, you will see that working with units in Mathcad will save you time and help you understand more about science. For now, we must go back to the basics.

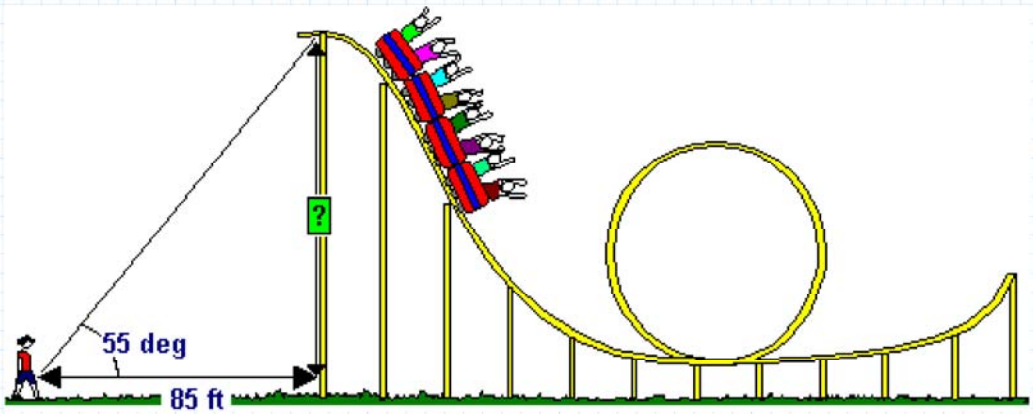
Having calculated the height, you are ready to finish up this problem:

Copy and paste the question and your calculations, together with some words of explanation, in your worksheet window.

Problem Space

Question 2

A physics student wants to determine the height of the Sooper Dooper Looper roller coaster at Fun-All-Day Amusement Park. To do this, she measures the distance from the roller coaster to her position to be 85 feet, and the angle from the horizontal to the top of the roller coaster to be 55 degrees. How high is the roller coaster?



Trig functions

Solution: The *height* of the coaster is the **distance** to the **base** times the tangent of the rise angle.

Have you saved your changes?

$$85\ ft \cdot \tan(55 \cdot deg) = 121.39\ ft$$

The height is 121.39 feet, or approximately 120 feet.

Let's take some time to learn how to enhance the appearance of the text in your solution. Maybe you want to have the question and the solution to be side-by-side, with key words in **bold** for emphasis. How would you do that? As you continue to read, you will learn how to resize text regions; cut, copy, and paste text; and change the style of text.

Resizing a Text Region

How can I change the size of a text region?

A **text region** is as wide and high as the text it contains. When you are typing, Mathcad will automatically wrap your text around at the right margin. Do not try to use the [Enter] key to give the region a certain shape. You can change the shape of a text region after you have finished typing. To practice, you are going to change the shape of the paragraph below.

Selecting regions

First, select *this* text region. A box will outline the region. Then, move the mouse to a side of the box and the pointer will become a black hand. Next drag the region to your Worksheet window so you can resize it.

Click in the region, and go to the small square at the side until you see a double-arrow. Now, hold down the mouse button and drag the double arrow to change the width of the box. Release the button when the box is as wide as you want. What do you get? The text wraps around to stay within the new width of the box. You have changed the shape of a text region.

Cut, Copy and Paste with Text

We have discussed how to **Cut** or **Copy** regions after you have selected them. You can also **Cut** or **Copy** parts of text that you select in an existing text region. For example, you may want to use a word or sentence again in another text region. We assume that you are familiar with highlighting text from using a word processor.

Changing the Font

The **Text Formatting tab** is for altering the appearance of your text. You must first select and highlight the piece of text you want to change. If you do not select the text first, you will change the default font of the whole document (not just the next thing you type, as with a word processor).

What if you just want to change one word, a sentence, or just one text region? You must first select and highlight what you want to change with the mouse. You can highlight single words by double-clicking on them or dragging the mouse to highlight multiple words.

Double-click on this † **word.** Now look at the **Text Formatting tab** again. With a piece of text highlighted, the selected text is shown to be Times New Roman 12 pt font and the **B** is selected, though the text is bold.

Once the text has been highlighted, you can change the font or the size and see what happens. Your changes will apply only to the highlighted text.You can also make text **bold** or *italic* or underlined.

Now you can make your solutions look even better.

Return to your solution for the roller coaster problem. Change the size of the question so that it fits alongside your solution. Put the picture at the bottom. Also, emphasize at least **five** words using different irqw, **bold**, *italics*, or underline.

You are now ready to solve some problems on your own. These will reinforce the skills you have already learned. Be sure to save your work first!