# Using MathType and Microsoft Word to Draw and Label Diagrams

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Design Science
*How Science Communicates™*

Welcome to *Using MathType and Microsoft Word to Draw and Label Diagrams*.

This session is not designed to teach you how to use Microsoft Word or MathType. We assume you already know how to use these products. In the session, you will learn how to use these products better and more efficiently – specifically to draw diagrams in Word and label them with MathType.

We will be using Microsoft Word today, but MathType also works very well with PowerPoint, and the same techniques you learn with Word can be used in PowerPoint.

I hope many of your needs will be addressed in this session but if you need help in the future, the following sources are available:

- ✓ **Equation Editor Tips & Tricks** – Even for MathType users, our Equation Editor Tips & Tricks most likely has several tips you can use. Access the tips from our home page: http://www.dessci.com. Your email address will be your password to access the page immediately.
- ✓ **Help File** – MathType has an extensive help file.
- ✓ **User Manual** – MathType comes with a comprehensive User Manual, and many questions can be answered by referring to the manual. Chapter 4 of the MathType User Manual includes 18 step-by-step tutorials to get you started. If you don't have a MathType User Manual, you can download a free PDF copy at http://www.dessci.com/en/support.
- ✓ **Design Science Newsletter** – By subscribing to our newsletter, you can stay on top of all the latest developments & techniques: http://www.dessci.com/newsletter.
- ✓ **Technical Support** – We provide lifetime technical support for MathType. For technical support:
  - Phone: 562-433-0685
  - Email: support@dessci.com
  - Web: http://www.dessci.com/en/support. There is a collection of support notices and tutorials that will cover most topics.

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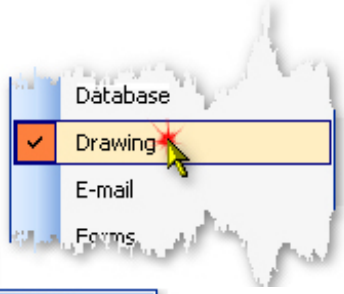
***NOTE:*** Techniques described in this handout apply to Word 2002 (Office XP) and Word 2003 for Windows. Earlier versions of Word for Windows may or may not be able to produce the results you see here. If you are using a Macintosh computer, you should be able to reproduce these results with Word X or Word 2004.

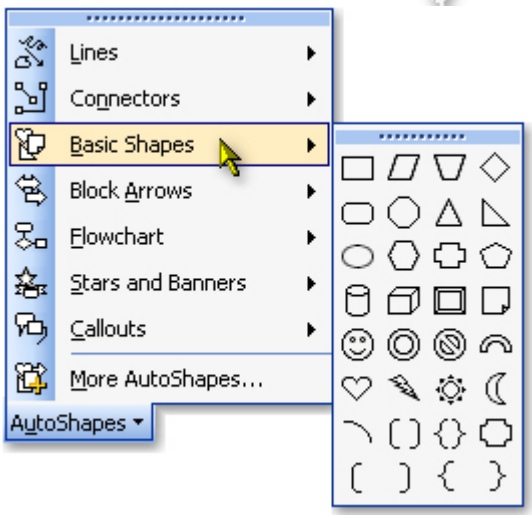
## Introduction to Word's Drawing Tools

Microsoft Word is a word processor, so it wouldn't be fair for us to expect to use it as our *primary* tool for graphing, drawing, manipulating photos, etc. Even so, Word does have a very good set of drawing tools available through the **Drawing** toolbar, and we can use these for a good number of our drawings.


Normally this toolbar will be at the bottom of the Word window, just above the Status Bar, and below the horizontal scrollbar. Yours may not look exactly like the one above, but if you don't have the Drawing toolbar showing, follow these steps:

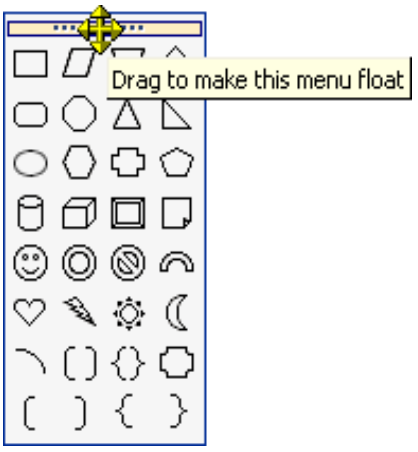



1. In Word's **View** menu, hover the mouse pointer over **Toolbars**.
2. Click on **Drawing** in the list of toolbars that appears, as shown in the screen shot to the right.
3. The **Drawing** toolbar should appear at the bottom of the Word window.




We will be working with **AutoShapes**, which is a sub-toolbar located about midway along the **Drawing** toolbar. Probably the section of the **AutoShapes** toolbar you'll be using most is the section titled **Basic Shapes**. Other sections are certainly useful, but you won't use them as often as the Basic Shapes.

As often as we'll be using the **Basic Shapes**, it's convenient to drag the palette off to make it floaing. To do that, place the mouse pointer over the dotted line at the top of the **Basic Shapes** palette. Notice when you do that, the mouse pointer changes from an arrow shape to a  shape. Hold down the left mouse button, and drag the palette wherever you want it on your page. You can move it at any time.



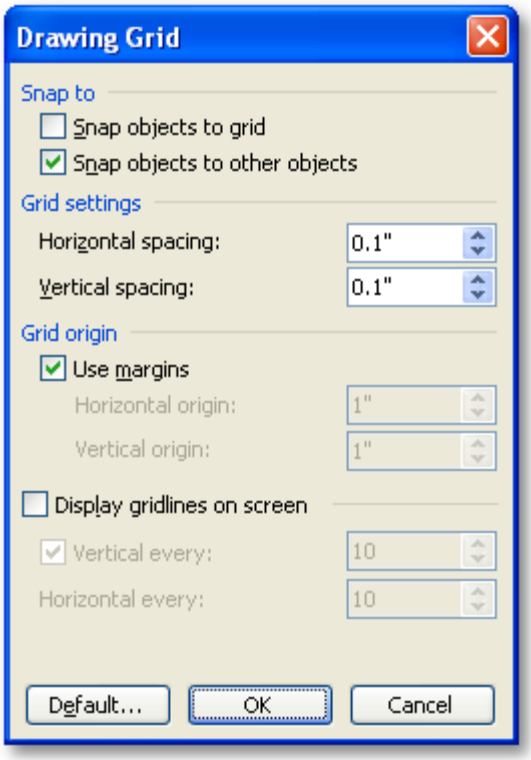

***NOTE:*** Whenever you see the double-arrow cursor, it means a mouse drag will result in the object beneath the mouse pointer being moved to a new location. This will become increasingly important as we get farther into the tutorial.

## Drawing Tool Fundamentals

### Placement of the drawing

There are some very important points we need to consider before we get into actually drawing any shapes.

**Grid settings:** Word divides the page up into an invisible grid. If you want, you can make this grid visible, as well as adjust other grid settings.




1. Click **Draw** > **Grid**.

> ***NOTE:*** Whenever there are successive levels of menus to navigate, our practice in this handout will be to denote subsequent menus with the greater-than symbol. For example, "**Draw > Grid**" means to first click the word **Draw** on the Drawing toolbar. Then on the menu that expands, click the word **Grid**.

2. In the first section, make sure **Snap objects to grid** is *un*checked, and **Snap objects to other objects** is checked.
3. The next section, **Grid settings**, isn't real critical when you don't have **Snap objects to grid** checked.
4. It's up to you what you select in the next section, but you can see what my preferences are.

**Drawing canvas:** This is a Windows-only feature that Microsoft introduced with Office XP. It was also included in Office 2003. The concept behind the drawing canvas wasn't all that bad, but it ends up generating more frustration than usefulness. Here's how to turn it off:

1. Click on **Tools** > **Options**, and select the **General** tab.
2. Make sure the box is ***un***checked that says "Automatically create drawing canvas when inserting AutoShapes".
3. Click OK.

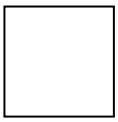
The next AutoShape you insert will be a simple "floating" object, meaning you can position it anywhere on the page.

### Drawing simple shapes

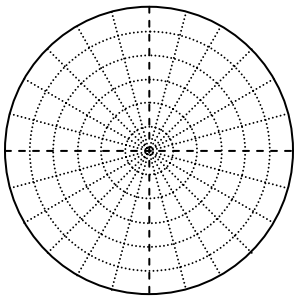
To create our first **AutoShape**, let's make a rectangle. The rectangle icon is the first icon in the first row of icons: ▭. When you click any of the **Basic Shapes** icons, notice your mouse pointer changes from an arrow to a crosshair shape: ┼. To create your rectangle, just click the left

mouse button and drag down and to the right. Now we have a simple rectangle, like the one you see here.

**The "constrain key".** What if we don't want a generic rectangle? What if the rectangle we want is a square? Fortunately, we don't have to guess. If you hold down the **Shift** key as you drag to create your rectangle, you will create a square like the one you see to the right. Microsoft calls the Shift key a "constrain key" because it constrains the shape to specific parameters. As a matter of fact, the **Shift** key will make a regular polygon out of any of the **Basic Shapes** polygons – an equilateral triangle out of an isosceles triangle, a circle from an oval, etc.

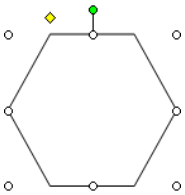


**Lines.** Lines are easy enough, but one thing to point out about drawing lines is the effect of the **Shift** key. If you hold down the **Shift** key while dragging to create a line, you can create a line that's perfectly horizontal, perfectly vertical, or any multiple of 15°. This will allow you to create drawings such as the polar grid you see to the right, which was created in Word 2000.

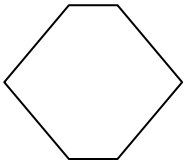


> ***NOTE:*** When using the **Shift** key to constrain your drawings, it's important to release the mouse button **before** you release the **Shift** key. If you mistakenly release the **Shift** key first, simply release the mouse button and press **Ctrl + Z** to undo the drawing. Now re-create the drawing and release the mouse button first.

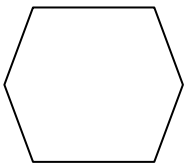
**Resizing and rotating drawings.** When an object is selected, you've no doubt noticed the presence of the 8 "resizing handles" around the object. These appear as open circles along the edges and at the corners of the object's bounding box, as in the hexagon you see to the right. When you click on any of the resizing handles and drag, the object resizes in the direction of the drag. If you hold down the **Shift** key as you drag a ***corner***, the object will re-size proportionally. Note that if you drag a resizing handle on the top, bottom, left, or right edge, the **Shift** key has no effect; it only constrains when you drag a corner.



Notice the green dot that's offset from the resizing handle on the top side. That's the **rotate handle**. When you place your mouse pointer over the rotate handle, notice it changes shape: . By clicking and dragging your mouse in any direction, you can rotate the object. If you hold down the **Shift** key while rotating the object, you can rotate it in precise 15° increments. Note that the 15° reference is based on the object's position *when you started the present rotation*, rather than the object's original position.



Notice the yellow diamond to the left of the rotate handle. Microsoft calls this the **adjustment handle**. You can use the adjustment handle to adjust the appearance but not the size of most AutoShapes. To see its effect on the above hexagon, compare these two hexagons with the original.



A chart on the next page summarizes the effects of the **Shift** key.

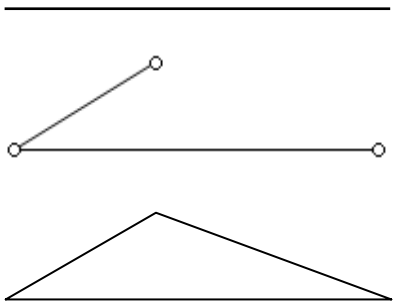
| Uses for the Shift key when using Word's Drawing tools | |
|---|---|
| **Action** | **Result of holding down the Shift key** |
| Creating a polygon | Creates a regular polygon |
| Creating an oval | Creates a circle |
| Creating a line | Creates a horizontal or vertical line, or any multiple of 15° |
| Rotating a shape | Rotates the shape in increments of 15° |
| Creating an arc | Creates an arc that's a portion of a circle |
| Dragging corner handle of an existing shape | Allows resizing while maintaining proportion and rotation |

The table lists 6 uses for the **Shift** key. We have discussed only the first 4 so far; we'll get to the other two in a bit.

## Exercise 1 – Scalene triangles

We've noticed there are two triangles on the AutoShapes palette – a right triangle and an isosceles triangle. There's no icon for a scalene triangle, but it's not real difficult to create one of our own. Follow the steps:

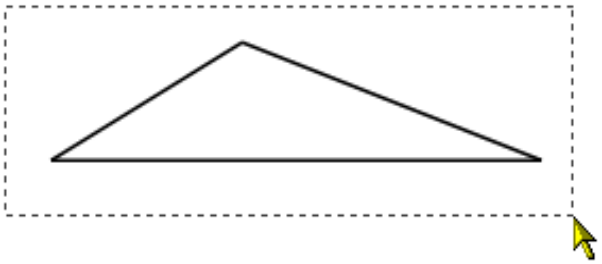
1. In **AutoShapes > Lines**, click on the **Line** icon. (If there is a **Line** icon on your **Drawing** toolbar, you can click that one if you want.
2. While holding down the **Shift** key, drag your mouse to create a horizontal line about 2" long.
3. Leave the line selected, and click the **Line** icon again.
4. Starting at the left end of the existing line, hold down the **Shift** key and drag to create a 30° line that's a bit shorter than 1".
5. Now for the final line, click on the **Line** icon and drag to create the line to close the open side of the triangle.



Not a bad-looking triangle, but what if we want to move it? If we just click on a side and drag, only that side moves. We could group the lines together so they'll move and resize as a group. That's exactly what we're going to do, but there's an easy way to do it… (next page)

> ***NOTE:*** If you didn't follow the instructions above about grid settings, it will be difficult, if not impossible, to create a scalene triangle without gaps or overlapping sides at the vertices.

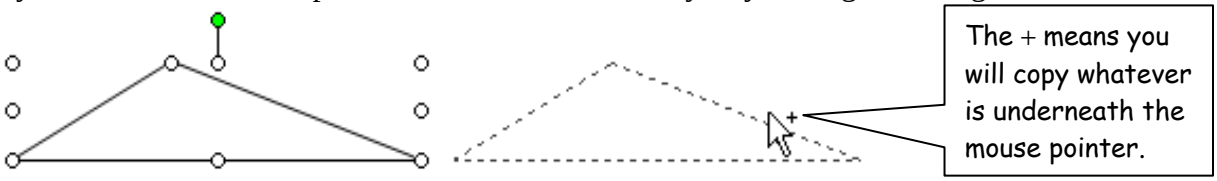
6. First of all, if you *really want* to select the lines individually, you can do that, but in the case of a complex object like the polar grid shown earlier, it's nearly impossible not to miss one or two lines. Therefore, we'll take the easy route. Click the **Select Objects** icon, which is the white arrow immediately to the right of the word **Draw** on the toolbar —.
7. Drag an imaginary rectangle (Microsoft calls it a "lasso") around the triangle.
8. Click **Draw > Group**. The triangle will now move, re-size, and totally act as one object.



## Exercise 2 – Congruent triangles

Let's start with the triangle we created in Exercise 1, and create a congruent triangle. Of course, copy & paste will work just fine, but the problem with copy & paste is that you have no control over where the new triangle will be pasted. We've already learned the great usefulness of the **Shift** key. Now we'll learn what the **Ctrl** key can do.

You of course know that if you click on your triangle and drag the mouse, the triangle will move. Did you know that if you just add one step, that you can create an exact copy and place it wherever you want? That one step is to hold down the **Ctrl** key as you drag the triangle:




Notice the + symbol above and to the right of the mouse pointer? The + indicates a **Copy** action, as opposed to a **Move** action. When you release the mouse button, you will have an exact copy of your triangle.

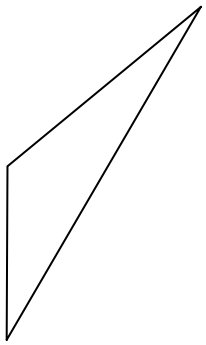
> ***NOTE:*** Be sure to release the mouse button ***before*** you release the **Ctrl** key! If you release the **Ctrl** key first, it will move the triangle, not copy it.

## Exercise 3 – Similar triangles

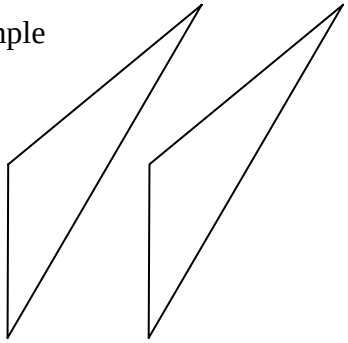
(Be patient – the MathType part is coming!)

Let's continue with our previous examples, and use the same triangle for this example. We want to rotate the initial triangle so that the shortest side is vertical (or nearly so). Then we want to create a similar triangle with a common side.

1. Starting with the triangle we created in Example 1, rotate it so the shortest side is vertical. It may help if you increase Word's zoom setting to 200%. (Zoom settings are on Word's **Standard** toolbar, which is most likely the toolbar immediately below the menu bar.)

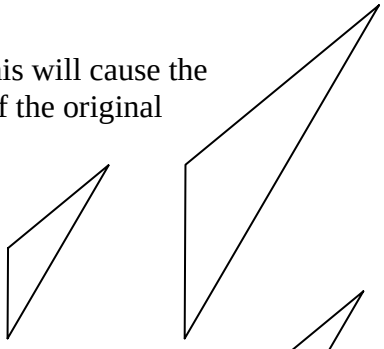


2. Now create a copy of the triangle to the left of the original. Use the simple technique you learned in Example 2.



3. Both triangles will still be selected, so press the **Esc** key to deselect them both. Click the triangle on the left, so that it is selected.

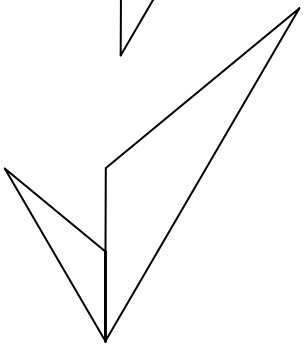
4. Drag one of the upper corners down while holding the **Shift** key. This will cause the triangle to become smaller, while still retaining the interior angles of the original triangle.



5. With the smaller triangle selected, click **Draw > Rotate or Flip > Flip Horizontal**.

6. Move the smaller triangle so that the smaller sides are tangent, and aligned at the bottom vertex.

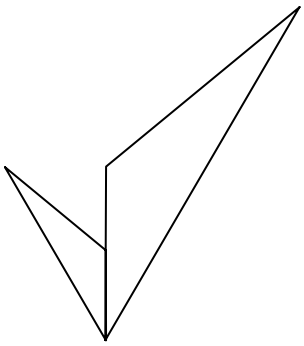
7. Group it together, as we did in Exercise 1.



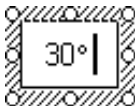
Now let's label it…

## Exercise 4 – Labeling drawings

We want to put labels on our triangles from Example 3. For the purpose of this example, we'll just label the 30° angles and the hypotenuse from each triangle. It's a similar procedure to label the remaining angles and sides.

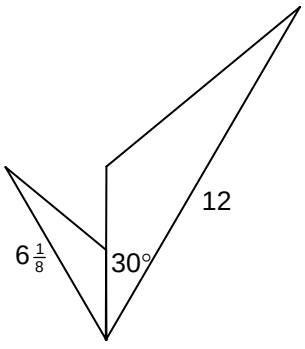


1. We'll do our labeling with Text Boxes. The Text Box icon is on your **Drawing** toolbar: . Click it.
2. Click and release the left mouse button (don't drag) in a blank spot on the page. This will create a 1" square text box. Don't worry about the size; we'll resize it later
3. On Word's **MathType** toolbar, click the **Insert Inline Equation** icon: ∑.
4. When MathType opens, type 30°. (The degree symbol is on the **Miscellaneous Symbols** palette, which is the third from the right on the top row of palette icons.)
5. Close the MathType window by clicking the ✕ in the upper right corner of the window. The MathType window will close, the 30° label will be inserted into the text box, and the text box will resize to enclose the contents. (Yours may look different from mine; mine is Arial 10 pt.)
6. Notice that when you close MathType, the text box is still selected. This is indicated by the diagonal marks along the edge of the text box. Click anywhere on these diagonal marks to move the text box into position in the larger triangle.




> ***NOTE:*** Your cursor **must** look like this  in order to move the text box. If it looks like this  or this , you will resize the text box instead of moving it. The latter two cursors appear when you click on a resizing handle.

7. Label the two hypotenuses $6\frac{1}{8}$ and 12, using a similar procedure. (You don't need MathType for the "12" – just type the number into a text box and manually resize it.)
8. Does your set of triangles & text boxes look like mine? Probably not. Read on…



### Text box properties

When we created the text boxes above, they had the default settings of "white fill" and "black line, 0.75 pt". We don't want a fill color inside our text box because it covers up part of our triangle. We don't want a line around it for equally obvious reasons.

(Does your head hurt yet? There's a lot to learn when using the Drawing Tools, but practice pays off!)

1. We can get rid of the fill and line very easily. First, we need the text box selected. Easiest way to do this is to first make sure nothing is selected. The "de-select" button is the **Esc** key on the keyboard. Press it.

2. Now, we'll learn another function of the **Shift** key – to select a text box or placeholder. Normally, when you click inside a text box or placeholder (i.e., the rectangles that hold the text in PowerPoint), a cursor appears inside the text box or placeholder, ready for you to edit existing text or equations, or insert new stuff. If you hold down the **Shift** key when clicking on the contents of a text box or placeholder, it selects the entire container.

3. There are two other very important icons on the **Drawing** toolbar that we haven't used yet – the **Fill Color** and **Line Color** icons. They look like this:  and  , respectively.

4. Notice the downward-pointing triangle to the right of the paint can and paint brush. Click on the one next to the paint can. A palette will pop up, and you can select from several different fill colors. The choice at the top is the one we want though – **No Fill**. Click it. Do the same for the paint brush, and select **No Line**.

   > ***NOTE:*** It's important that you click the triangle *next to* the paint can and paint brush. If you click the can itself (or the brush), you will apply the fill or line color previously selected.

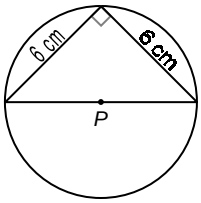
5. *Now* you can see the triangle(s) behind the text boxes.

6. The easiest way to label a drawing is to create one text box with a label inside it, *then* change its properties to no fill/no line, *then* "Ctrl-drag" the text box to copy it, *then* edit the contents for the individual labels. If the label is a MathType object, just double-click it, edit it in MathType, then close the MathType window.

   > ***NOTE:*** At some point, you will no doubt discover the item on the **Draw** menu that says **Set AutoShape Defaults**. This does exactly what you would expect it to do, but that *could* be a problem. If you have a text box with no fill/no line selected, and you click **Set AutoShape Defaults**, it will indeed make the default for text boxes no fill and no line. Problem is, ***all*** AutoShapes will now have properties of no fill/no line! Imagine drawing a triangle and it doesn't show up. It's there, but with properties of no fill/no line so you'll never see it. It's easy to see that clicking **Set AutoShape Defaults** is *not* what you want to do here.

## Example 5 – Circles

We want to give our students this problem on a geometry test:




Find the exact circumference of the circle shown here:

Let's create the circle with the inscribed right triangle.

1. First create the circle. This particular circle happens to have a diameter of 1". An easy way to create a circle with a 1" diameter is to select the **Oval** AutoShape and simply click and release the left mouse button. If you don't drag the mouse, there's no need to hold down the **Shift** key. The result will be a perfect 1" circle. (This is not a figure the students will measure with a ruler, as the sides of the triangle are clearly much shorter than 6 cm.)

2. Now we need to create the triangle. Again, the easiest way to start is to select the **Right Triangle** AutoShape, then click & release the left mouse button. Now we have a right triangle with sides of 1", and a hypotenuse of corresponding length. We need to do three things to it: rotate it, re-size it, and move it into position.

3. To rotate it, grab the green rotate handle, hold down the **Shift** key, click the left mouse button, and rotate until the hypotenuse is horizontal. Remember to release the left mouse button first, *then* release the **Shift** key.

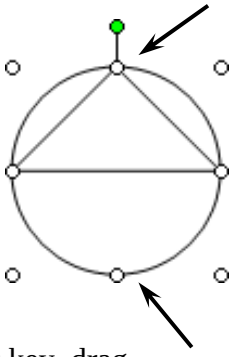
4. To re-size it, we *could* move it into position first, then while holding down the **Shift** key, drag a resizing corner until it's the proper size. There's nothing wrong with that method, and indeed that's what we'd do if the triangle and circle were more generic shapes. In this case though, we know the diameter of the circle is 1", and we know that's the length we need for our hypotenuse. ***If*** our hypotenuse were already 1", the other two sides would each have a length of $\sqrt{2}$", so why not adjust the formatting properties of the triangle so that its sides *are* 0.707" in length? (That's not exactly $\sqrt{2}$", of course, but the difference won't be perceptible). Here's how to do it:
   a. Right-click on the triangle, and from the context menu that appears, select **Format AutoShape**.
   b. In the **Format AutoShape** dialog, select the **Size** tab, and in the **Scale** section, enter values of **70.7%** for height and width. Click OK.
   c. You should now be able to move the triangle into position on the circle.

5. Once you get the triangle close, if you need to make fine adjustments, you can use the arrow keys on the keyboard to nudge it in any direction.

6. You probably noticed a slight difference in appearance between the two "6 cm" labels on the triangle's sides in the diagram above. The reason for that is because there's no easy way to rotate text in Word, so I used two methods, and you see them both above.
   a. The label on the left was created with **WordArt**, accessible from the **Drawing** toolbar via this icon: .

b. The label on the right was created in MathType, saved as a 384 dpi GIF, and reduced in Word to 25% of its original size. The expanding/reducing steps were necessary in order to preserve decent print quality.
c. In the interest of space in the handout, I'll leave it to you to experiment and figure out on your own how to create these labels. An alternative, of course, is to just use text boxes and have normally-oriented (i.e., horizontal) text. Nothing at all wrong with that.

7. The dot at the center of the circle is easy once you figure out where the center is. We already know where the horizontal diameter is, so if we can temporarily draw a vertical diameter, we can place the dot at the intersection. Here's how:



   a. First select the circle. The best way to do this without selecting the triangle by mistake is to click on the bottom half of the circle. You don't have to precisely click on the circle's circumference, since the circle has a white fill. Just click on the bottom half of the fill.
   b. With the circle selected, you can tell where to draw the vertical diameter because of the resizing handles on the circle. (That's why you selected the circle first – to get the resizing handles to appear.) Remember to hold down the **Shift** key as you draw the line.
   c. Click the **Oval** icon on the **Basic Shapes** palette. Holding down the **Shift** key, drag the mouse to create the smallest circle you can make. Don't worry about its size. It'll be too big, but we'll resize it.
   d. Right-click on the circle you just created and on the context menu, choose **Format AutoShape**.
   e. On the **Size** tab, enter a height and width of 0.02". **Don't click OK yet!**
   f. On the **Colors and Lines** tab, select a fill color of black. Now you can click OK, and move the dot into position.
   g. Delete the vertical diameter from the drawing. The only reason we put it there was so we'd know where the center is.

   ***NOTE:*** Be careful when you click on this itty bitty dot to move it – *make sure* you have the double arrow cursor on the mouse pointer  , and not a diagonal arrow.

8. The only other thing to do is to put the square in place to indicate that this is a right triangle. Just create a small square, rotate it to 45°, and move it in to place. You may want to set the line color to gray. The circle/triangle drawing at the beginning of this exercise has a gray square. However, if you do that, there is another difficulty introduced: you now have a couple of small gray lines on top of your triangle. Here's how to fix it:

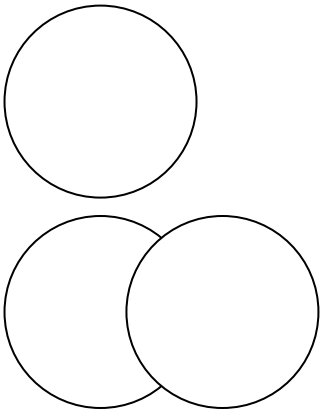
   a. Right-click on the triangle, and in the context menu, choose **Format AutoShape**.
   b. On the **Colors and Lines** tab, choose a fill color of **No Fill**.
   c. Select the square you created above.
   d. On the **Drawing** toolbar, click **Draw > Order > Send Backward**. Keep doing this until the two gray lines on top of the triangle are underneath the triangle.

We'll learn some more about fills and transparency in our final exercise, beginning on the next page.

## Exercise 6 – Venn diagrams & linear inequalities

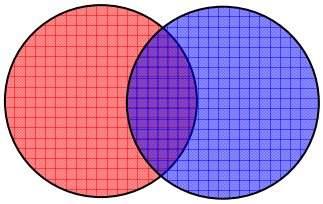
We want to create a simple Venn diagram to show the intersection of two sets, *A* and *B*.

1. Create a circle to represent set *A*. A simple circle of 1" diameter will do.



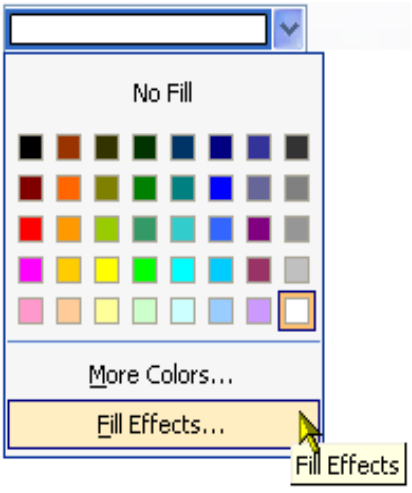
2. Using the "Ctrl-drag" method, create an identical copy of the original circle, and overlap at about the 25% point.
3. This isn't what we want to end up with, but it's exactly what we want at this point in our drawing.

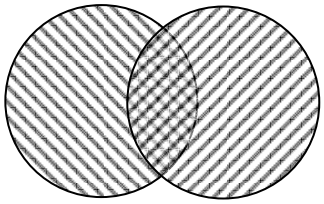
4. Let's color the circles red and blue, so that the intersection is purple.
5. Right-click the circle on the left. From the context menu, choose **Format AutoShape**.
6. In the **Colors and Lines** tab, choose a fill color of red and set the **Transparency** slider to 50%. If you prefer, you can also type in the value of 50% into the box next to the slider.
7. Click OK.
8. Following a similar procedure, set the fill color of the other circle to 50% blue. (I created the label with MathType and inserted it into a no fill/no line text box.)



$A \cap B$

You can use similar techniques to shade inequalities on a coordinate plane. These techniques with overlapping color work well when printing color transparencies or projecting on PowerPoint slides. For a test or other document that you'll be printing in black & white, using patterns works better than using colors. You can select a pattern by selecting **Fill Effects** on the **Fill Color** palette, as shown here:



$A \cap B$

Now that you're an expert at creating and labeling drawings and diagrams, try your hand at the practice exercises at the end of the handout.

## Customizing the Drawing toolbar

Since you're going to be using the **Drawing** toolbar often, it makes sense to put commonly-used items on the toolbar. Here's how:

1. Right-click on any toolbar. From the context menu, choose **Customize**. (It will be at the bottom of the list.)

   > ***NOTE:*** Whenever you see the word *Customize* on a product's toolbar or in a menu, it always means the same thing – it means to customize your toolbars. This is true in any of the Microsoft Office products, as well as Word Perfect, AppleWorks, and just about any other software application on the market today.

2. In the **Customize** dialog, click on the **Commands** tab.
3. In the **Categories** list, click on **Drawing**.
4. Find the commands you want in the **Commands** list and simply drag them to a convenient place on your **Drawing** toolbar.

   > ***SUGGESTION:*** Since there are probably icons on your **Drawing** toolbar that you'll most likely never use, it may be a good idea to drag these off the toolbar before you start adding new icons. After all, there's a limited amount of space!

5. Notice there's also a **Categories** listing for **AutoShapes**, so you may want to drag onto your toolbar the **AutoShapes** you use most.

You can see below what my toolbar looks like. I use a screen resolution of 1280x1024, so depending on your screen resolution, it may not be possible for you to include as many icons on your toolbar as I have on mine.


## Practice!

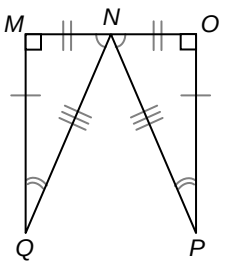
You learn best by doing – just like how your students learn math! Obviously we can't cover all the drawing techniques and commands in 90 minutes. Try things out for yourself. Click on an icon here and a command there and see what they do. If something doesn't do what you wanted it to do, remember your old friend "Ctrl+Z" (Undo).

Now see how many of the practice exercises on the next page you can complete on your own.

## Practice exercises

These are *definitely* not in any particular order of difficulty.

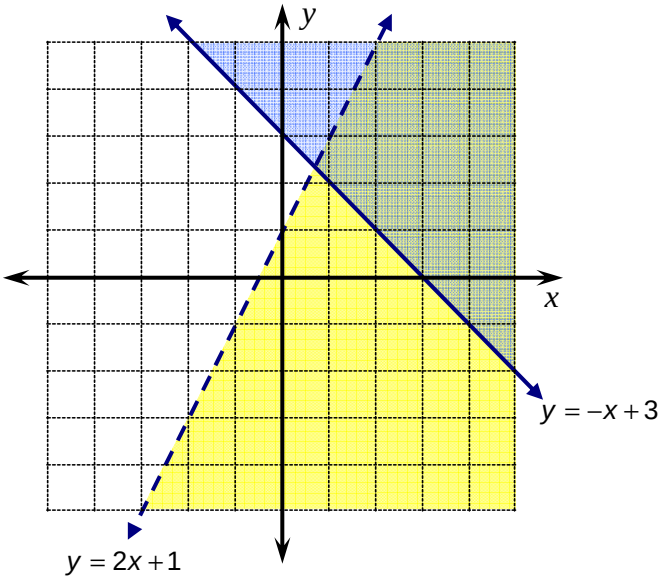
1. Complete the congruence statement: $\triangle MQN \cong \triangle$ ___?___ .




*NOTE: The arc is the **Arc** AutoShape that follows the crescent moon AutoShape in the palette (below the heart). Hold down the **Shift** key, or it will be an odd-shaped arc.*

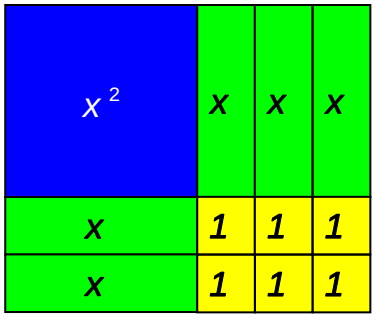
2. Solve the system of inequalities by graphing:

$$\begin{cases} y < 2x + 1 \\ y \geq -x + 3 \end{cases}$$




*NOTE: The yellow fill is a combination of a rectangle and a right triangle with 50% transparency. The light blue fill is a right triangle with 70% transparency. The grid was created with MathType, and the arrows and shading created in Word.*

3. Factor the polynomial $x^2 + 5x + 6$, using Algebra Tiles.




4. Use your ruler to find actual measures for *a*, *b*, and *c*. Do these measures confirm that $a^2 + b^2 = c^2$?