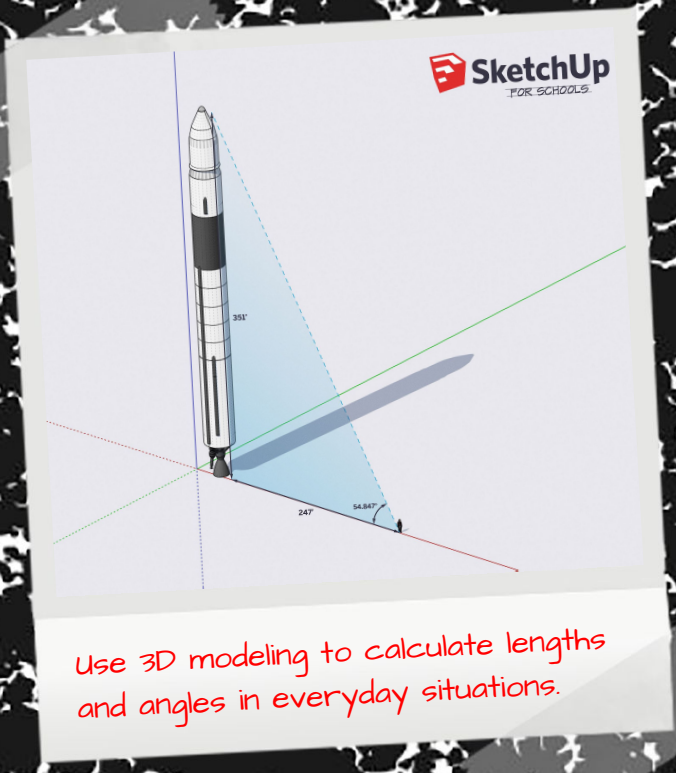
SketchUp FOR SCHOOLS

Lesson Plan:

3D Modeling for Math Class

Beginner Lesson · Time to Complete: 30 mins



Use 3D modeling to calculate lengths and angles in everyday situations.

outline

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9 Step-by-step Tutorial: 3D Modeling for Math Class

- Part 1: Measure the Height of a Rocket
- Part 2: Measure the Length of a Road

Hi, I'm Temple

Thanks for checking out another SketchUp for Schools lesson plan! I'll be with you the whole way, giving you tips and tricks for how to model like a pro in SketchUp for Schools.

Don't forget, there's also a video for this lesson plan!

Happy Sketching,
Temple

Learning Objectives

In this lesson, students will learn how to use the following SketchUp tools:

 pan

 orbit

 zoom

 tape measure

 protractor

 line

 move

 select

At the completion of this lesson, students should feel comfortable with the following on their own:

- [x] Using SketchUp for Schools' navigation tools to move around the model
- [x] Adding and resizing components using SketchUp's 3D Warehouse
- [x] Labelling and dimensioning a 3D model
- [x] Using SketchUp for Schools' drawing and snapping tools to create geometry

ISTE Standards for Educators

1 Learner

Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning.

This lesson fulfills 1a

2 Leader

Educators seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning.

This lesson fulfills 2a, 2b

4 Collaborator

Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems.

This lesson fulfills 4a, 4b

5 Designer

Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability.

This lesson fulfills 5a,

6 Facilitator

Educators facilitate learning with technology to support student achievement of the ISTE Standards for Students.

This lesson fulfills 6a, 6b, 6c, 6d

Common Core Standards

Geometry

>> Use trigonometric ratios and the Pythagorean theorem in applied problems

- CCSS.MATH.CONTENT.8.G.B.7
- CCSS.MATH.CONTENT.HSG.SRT.C.8

Measurement & Data

>> Describe and compare measurable attributes

- CCSS.MATH.CONTENT.K.MD.A.1

Intro to SketchUp for Schools

5 minutes

Before we get started, let's go through some of the basics together.

Getting Access

1. Go to https://edu.sketchup.com/app
2. Sign in with the Google or Microsoft email address provided by your school.

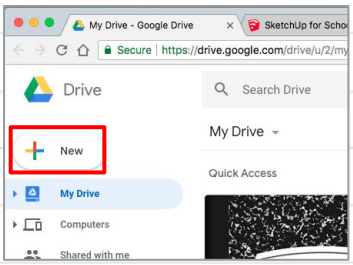
   Note: If you have trouble logging in, check with your administrator that your school or district has installed SketchUp for Schools (Instructions for Google & Microsoft Admins)

PRO TIP #1

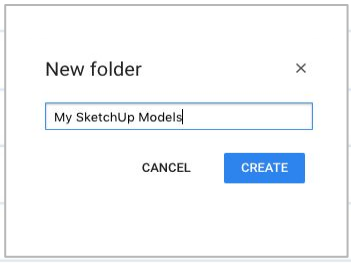
Save often!

If you get into the habit of saving your work, you'll be less likely to lose any progress if class ends and you close your laptop.

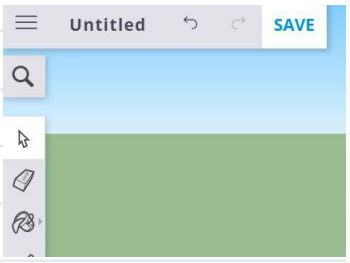
Saving Files



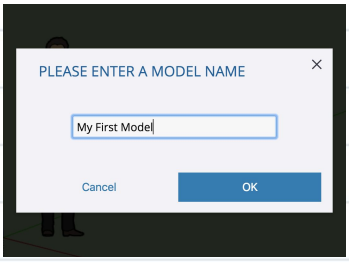
A Before you build your first model, go to your Google Drive or Microsoft OneDrive and create a new folder.



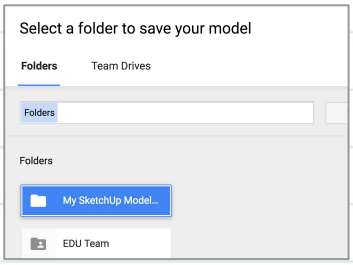
B Give your folder a name.



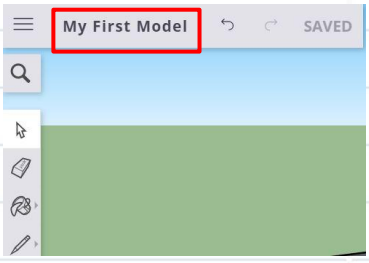
C Whenever you start a new model, it's a good idea to save your file first. Click on the folder icon on the top left, then click 'Save As.'



D Give your model a name, then press 'OK.'



E Next, you'll be asked to save your model to a folder in your Google Drive or Microsoft OneDrive. Click on the folder you just created, then click 'Select.'

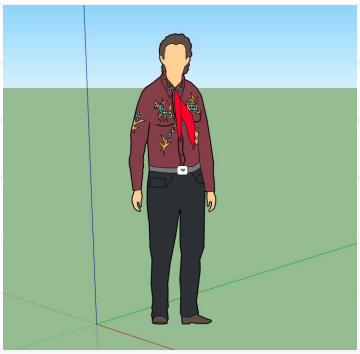


F If you've done everything correctly, you'll see your file name in the top left corner along with a 'Saved' message.

The Scale Figure

Every time you open a new model in SketchUp for Schools, you will see Temple Grandin's scale figure. Temple's job is to give us a sense of the size of the objects we draw in our model.

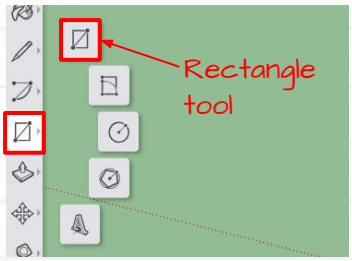
For example, Temple is 5'9". If we draw a 3 foot cube next to her, the cube will be about half her height.



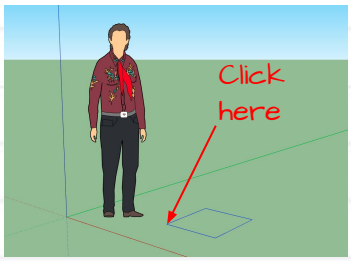
PRO TIP # 2
Unless otherwise specified, a click in SketchUp is executed as "click and release."

Drawing a Cube

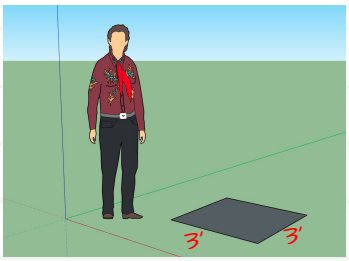
Let's test it: let's draw a 3 foot cube next to Temple.



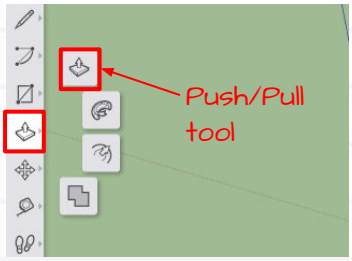
A Select the rectangle tool from the menu on the left.



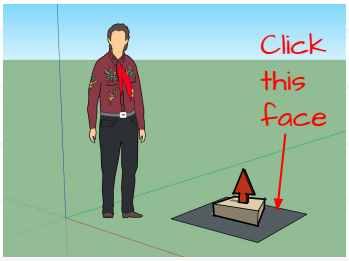
B Click once on the ground near Temple's feet to set one corner of your cube.



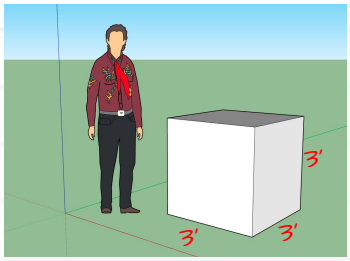
C Without clicking again, move your mouse anywhere on the screen, then type " 3', 3' ", then hit 'enter'.



D Select the push/pull tool from the menu on the left.

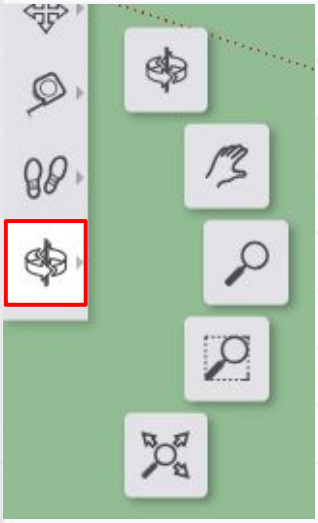


E Click once on the face you just drew. Without clicking again, move your mouse to make your cube 3D.



F Type " 3' ", then hit 'enter' to complete your cube.

PRO TIP #3
We recommend using a mouse with a scroll wheel when modeling in SketchUp. Using a trackpad is totally possible, but not as fun.



Navigation Tools

One of the most important things to learn in 3D modeling is how to move around in your model window. Click the orbit tool from the menu on the left to expand all the navigation tools.

orbit

The Orbit tool allows you to rotate around your model.
Click on the Orbit tool, then left click-hold-drag your mouse from side to side in the model window.
Mouse shortcut: hold down the scroll wheel to activate the Orbit tool, then move your mouse in any direction to orbit.

pan

The Pan tool allows you to move your model across your screen.
Click on the Pan tool, then left click-hold-drag your mouse from side to side in the model window.
Mouse shortcut: hold down the scroll wheel, then hold down the shift key at the same time. Move your mouse in any direction to pan.

zoom

The Zoom tool allows you to look closer at the details in your model.
Click on the Zoom tool, then left click-hold-drag your mouse up and down in the model window.
Mouse shortcut: use the scroll wheel to zoom in and out.

zoom window

The Zoom Window tool allows you to select an area of your model to view closer. Click on the Zoom Window tool, then left click-hold-drag your mouse to highlight an area of your model.

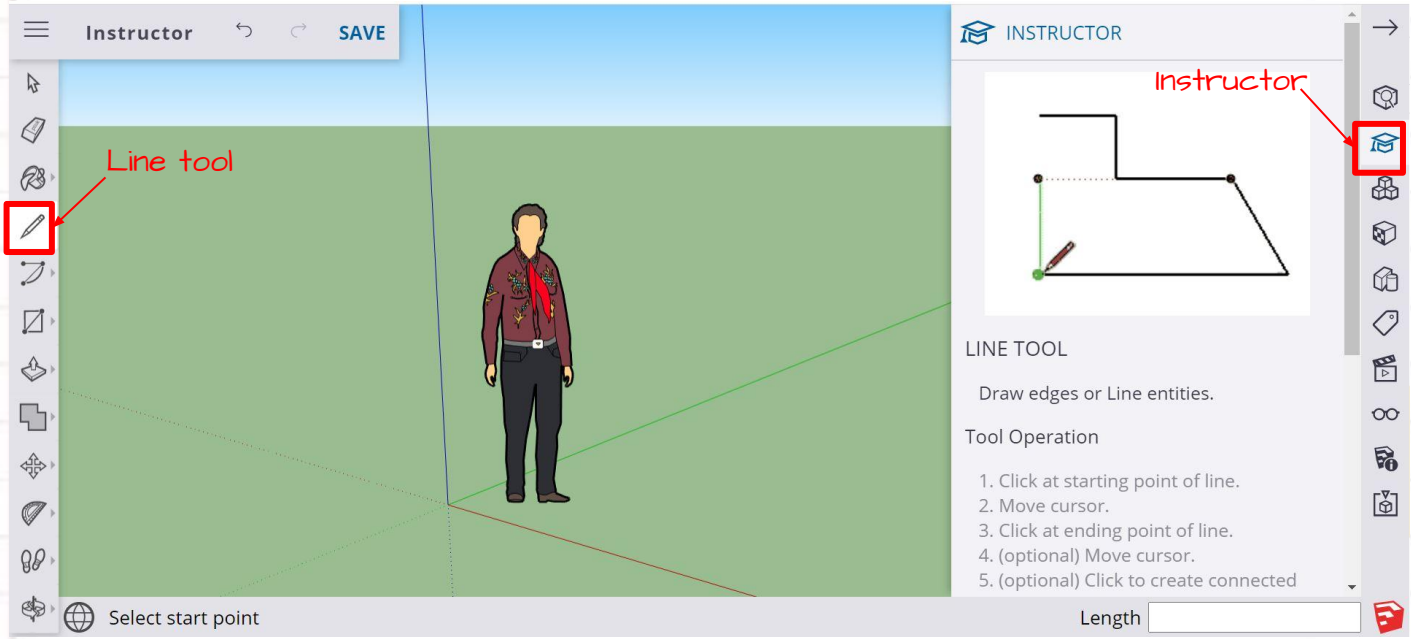
zoom extents

The Zoom Extents tool allows you to see all the geometry in your model.
Click on the Zoom Extents tool and everything in your model will come into view.

The Instructor Panel

Open the 'Instructor' from the SketchUp panels for help with understanding how to use any of SketchUp's tools.

The way it works: click on a tool with the instructor panel open and you will see a description of the tool and a step-by-step guide on how to use it.



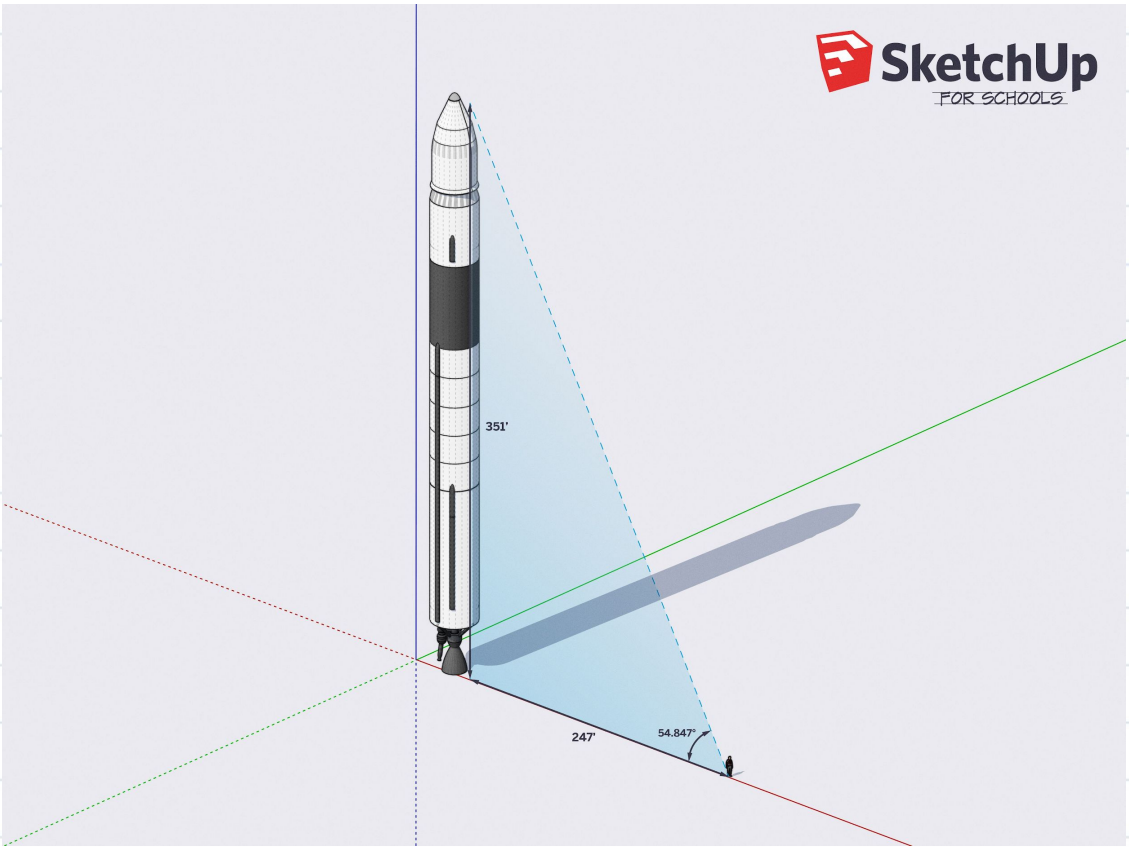
That's it for the intro.
You're ready to get started on modeling!

step-by-step tutorial:

3D Modeling for Math Class

pre-flight checklist

- [x] You're logged in at edu.sketchup.com/app
- [x] You've gone through the SketchUp for Schools intro and feel comfortable navigating around in the model window.
- [x] You've setup at least one folder in Google Drive or Microsoft OneDrive for your SketchUp models



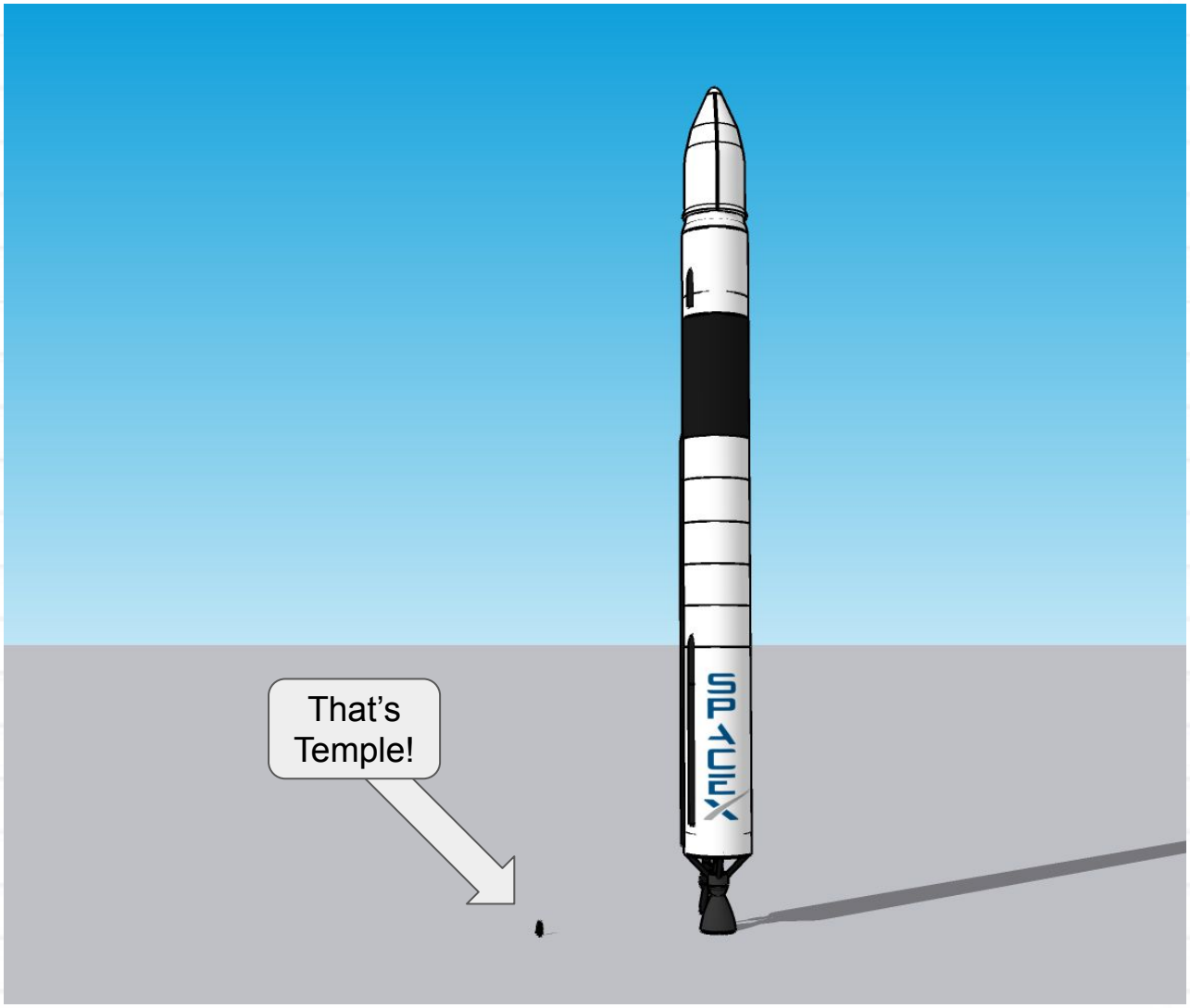
Check out the companion video for this lesson plan here!

The Pythagorean Theorem, Sine, Cosine, and Tangent are useful tools for calculating values in math class, but they can also be used in real life situations! In this tutorial I will be showing you tools that will help you bring math from the digital world to the physical world.

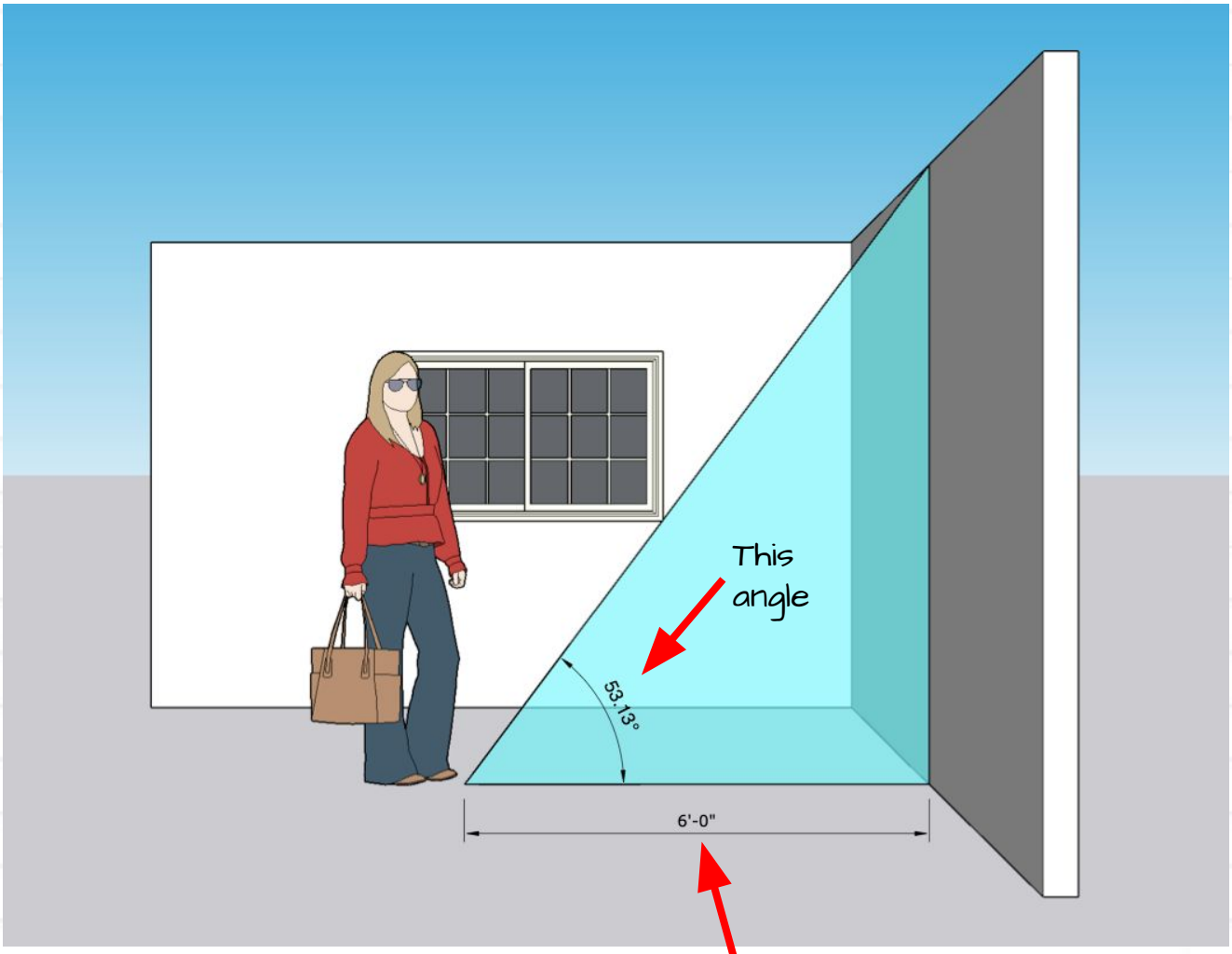
Part 1a Measure the height of a rocket

Have you ever stood next to something really tall and thought "How tall IS that thing?"

Turns out, there's a simple way you can figure it out. Today we're going to learn how to do that in SketchUp. Read along with my first example, and then I'll show you how to do it step by step!



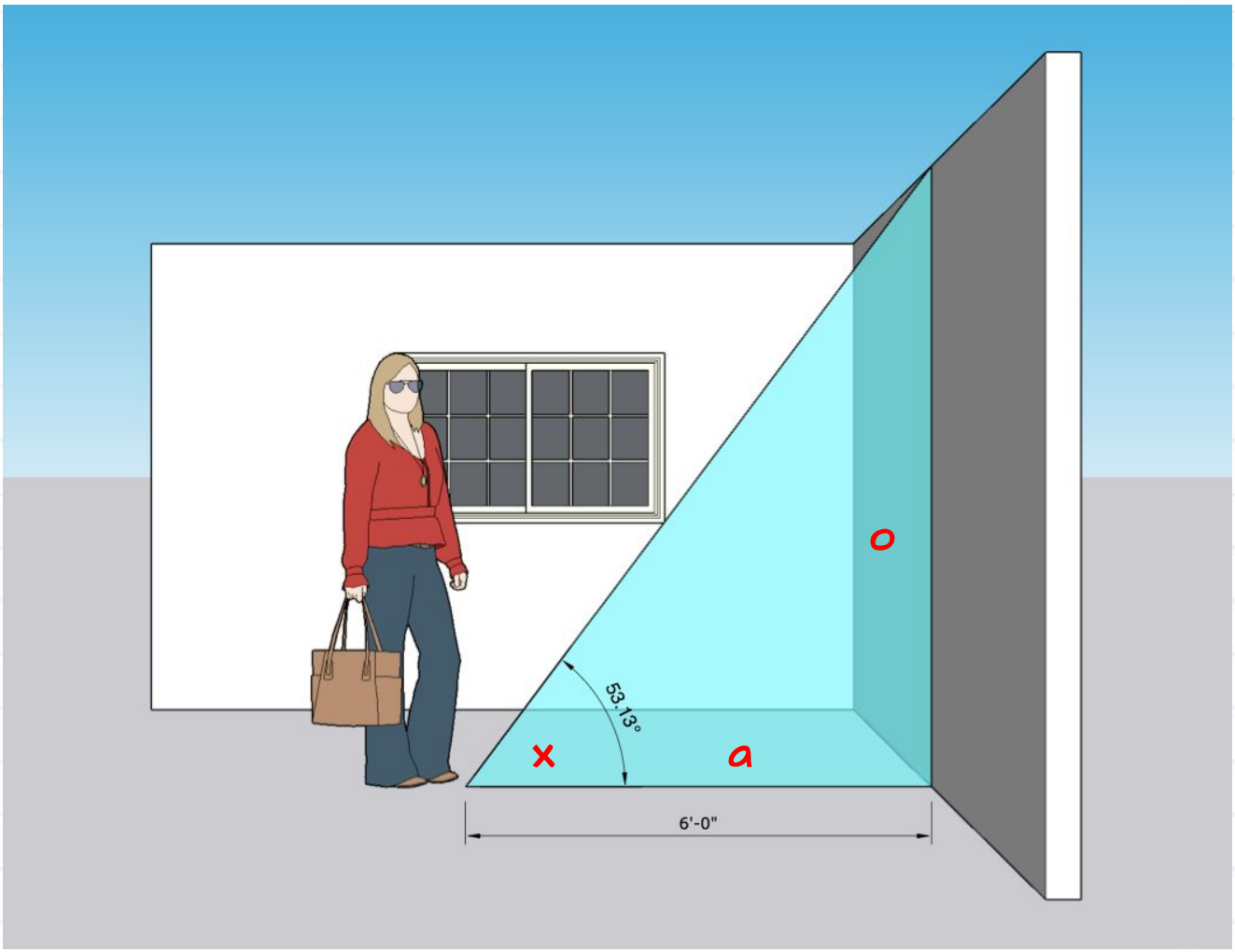
To begin, we'll start with something a little smaller, like the height of a wall in your classroom. Could you calculate the height of this wall if you were standing in front of it? Maybe if you knew things like:



*In this example we've done some of the work for you, but don't worry, we'll show you how to take these measurements yourself in the next stage!

With these two numbers we can use what we know about tangents to help us calculate the height of the wall.

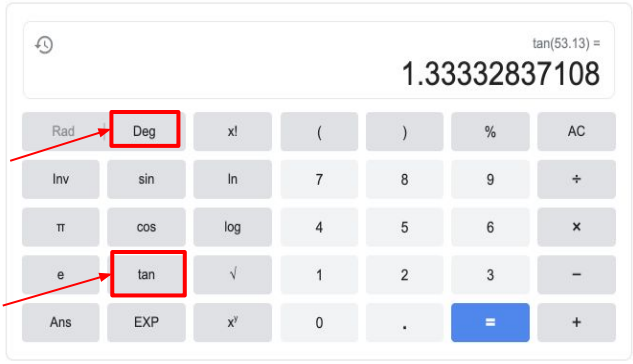
$$\text{Tan}(x) = \frac{o}{a}$$



In this case we're missing the o value and so that's what we'll solve for in the next step.

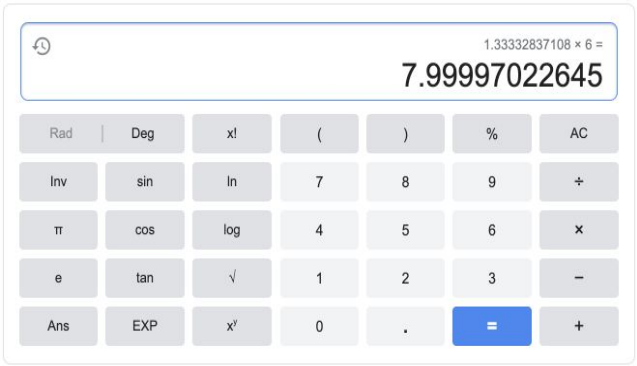
Let's do the math and solve for our wall height (o):

1 I'm searching in Google for a calculator to use, but you can feel free to use your own.



2 Before I enter in any numbers, I'm making sure that Degrees are selected on my calculator. Otherwise, my calculations might get a little confusing!

Now I have to calculate the Tangent of my angle, so I'm going to select "tan" followed by "53.13", which gives me the answer shown here.

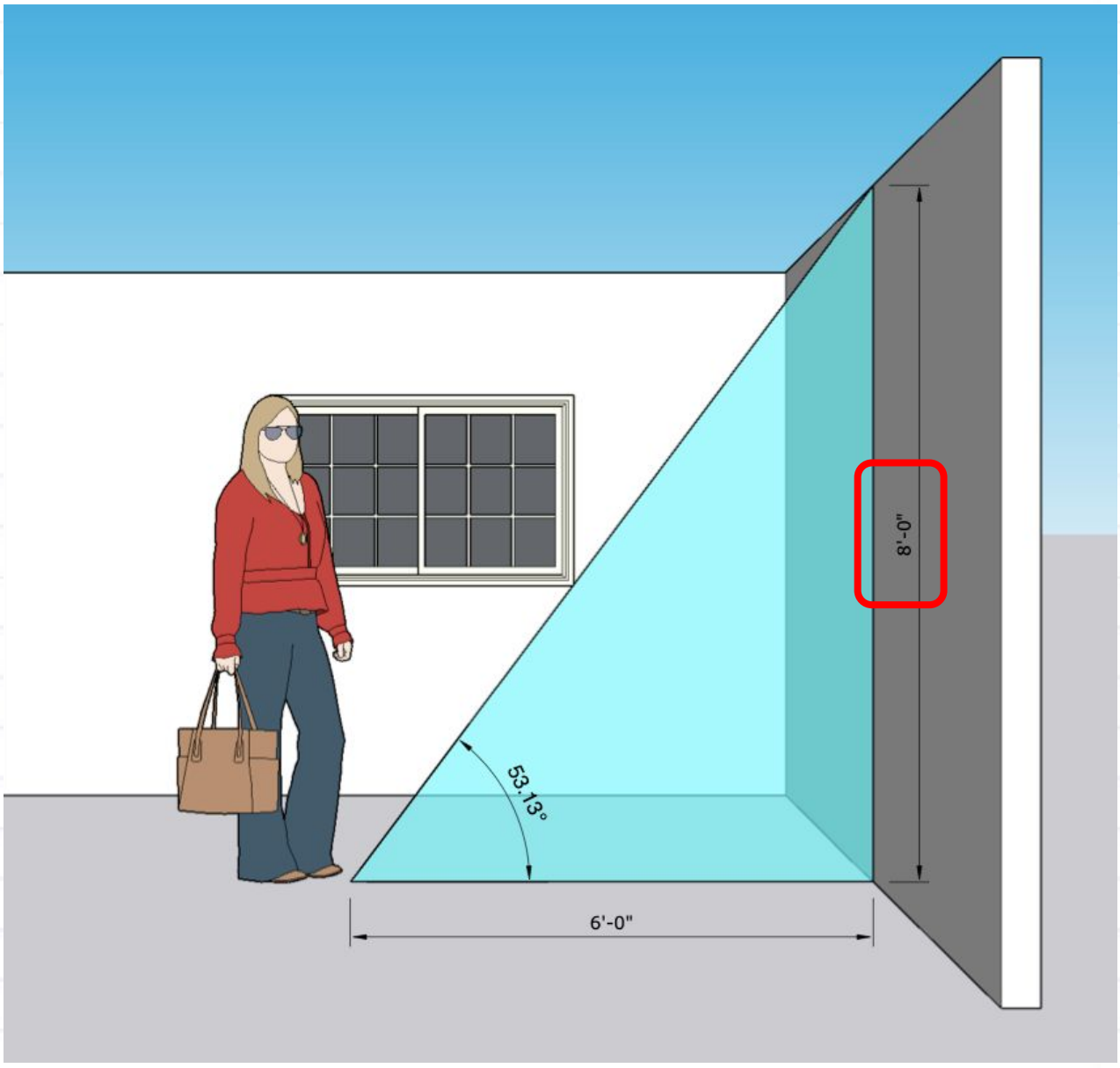


3 Now I'm going to multiply my previous answer by my distance away from the wall, or my "a" value, which in this case is 6ft.

My final answer comes out to 7.99ft, or 8ft rounded up.

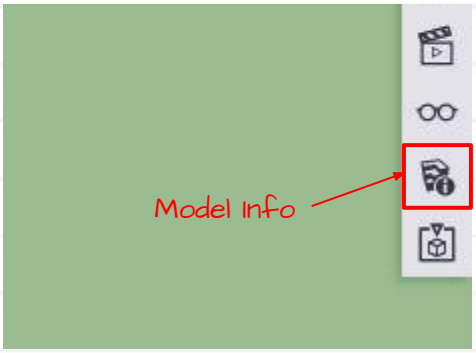
Time to check our math using SketchUp!

Our calculations gave us a wall height of 8ft, and when I measure that wall in SketchUp it gives me the same answer!



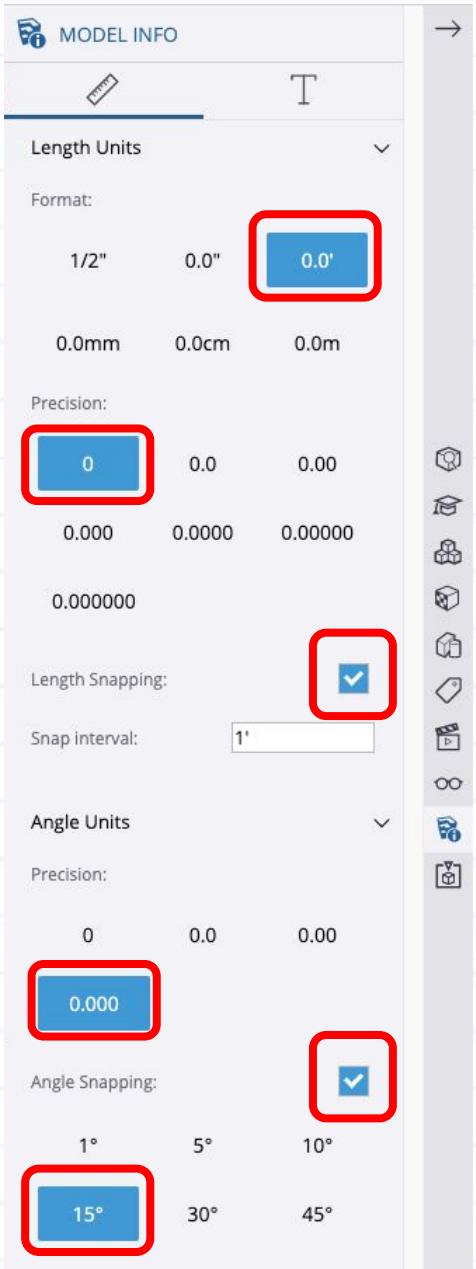
Now it's your turn to try!

Part 1b



A First things first: save your file!

Now we can start by adjusting our unit settings. Select the Model Info button from the menu on the right. This will open the Model Info panel, where we can adjust our unit settings.

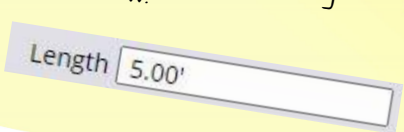


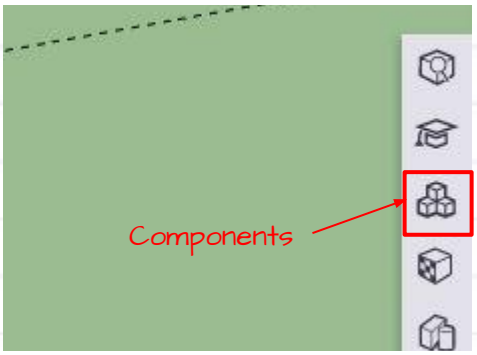
B Make sure that all of your unit settings match those in the picture on the left. This will set our units to feet, and give us a few extra decimal places of precision to help us with our calculations.

If you prefer to work in metric, that's great too. Just remember that your answers will look a little different from ours!

PRO TIP #1

Unsure if you've made the right choice? Check the precision of your length measurements in the box at the bottom right of your modeling window.

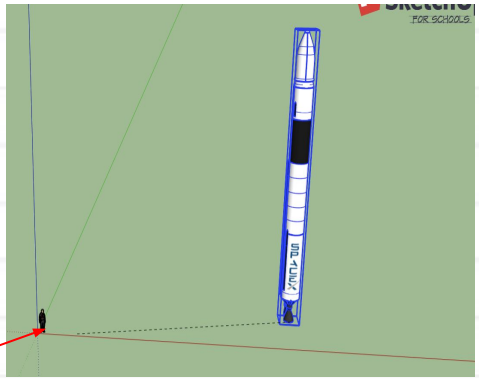




C

Time to find a rocket! Select the Components icon from the right hand menu to open up the Components panel and search 3D Warehouse.

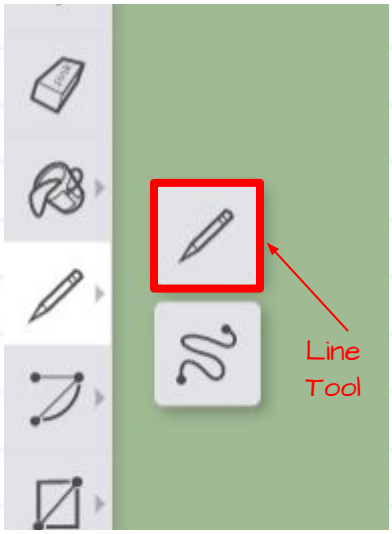
Search for Rocket sus2020 to find the model shown in the tutorial and click to select it.



D

Once selected, the rocket will be "attached" to your mouse pointer. Zoom in or out until Temple is really small on the screen, and you can see both Temple and the rocket.

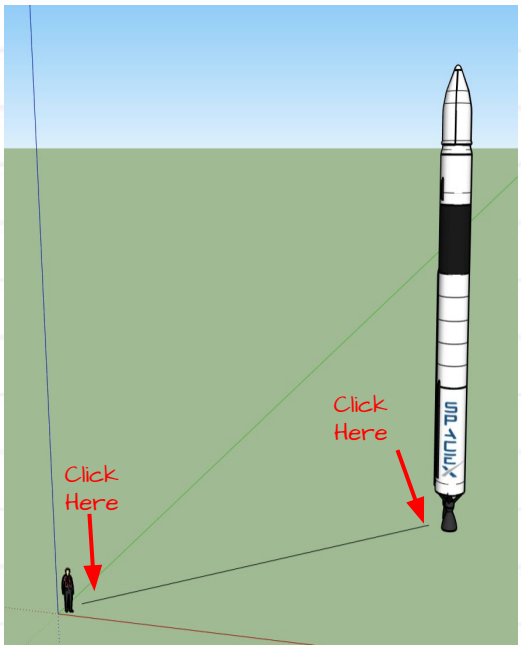
Set the rocket down a reasonable distance away from Temple, similar to what you see in the picture, by clicking to release it from your mouse. It can help to use the orbit tool to change your point of view and make sure that the rocket is sitting on the ground.



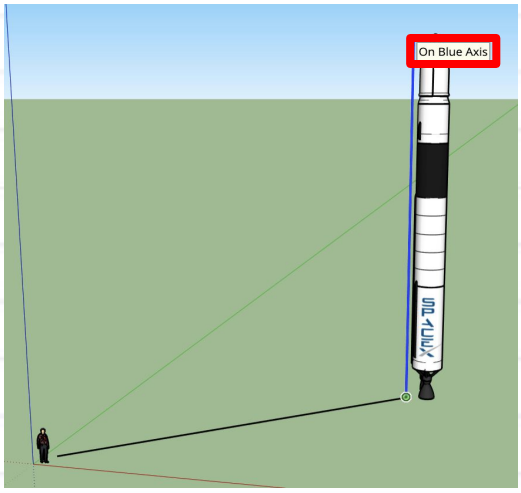
E

Now move to the left toolbar and select the Line tool. We're going to use this to draw a line between Temple and the rocket.

Once you've selected the line tool, zoom in to Temple's feet.



F Click once next to Temple to start drawing your line, and then click again at the base of the rocket to finish the line. You want your line to be close to Temple and the rocket, but make sure that it doesn't touch either of them.



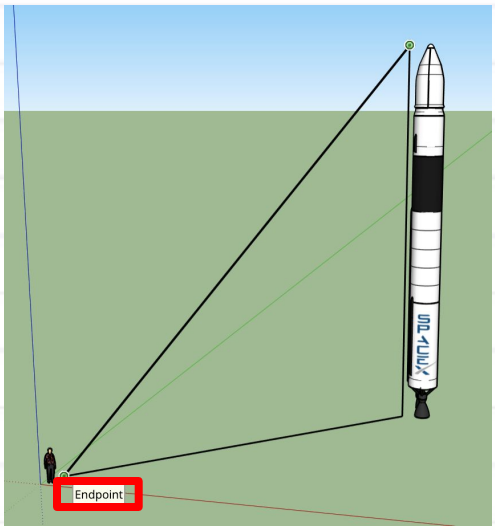
G Next we want to continue by adding a second line that is the same height as the rocket. Still using the Line tool, move your mouse upwards until you see the note "On Blue Axis", and your line turns blue. This means that your line is going straight up along the blue axis.

Move your pencil to the top of the rocket and click once to finish the line.

PRO TIP # 2

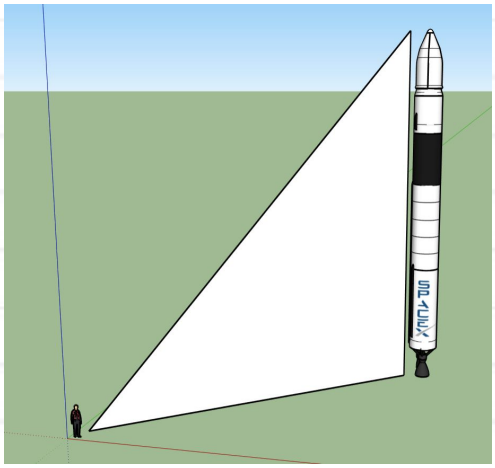
Hold down the Shift key to lock your Pencil onto an axis and stop it from drifting off in a different direction.

Shift +

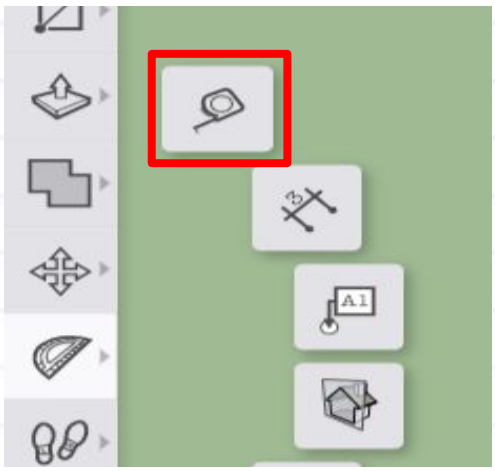


H To complete our triangle we're now going to end our third line back where we started next to Temple.

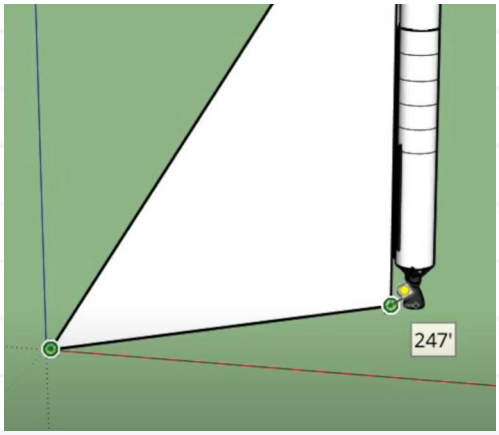
Move your mouse back to the beginning and your cursor should "snap" to the end point of the first line. When you see the word "Endpoint" pop up you'll know you're in the right place. Click once to finish!



I If you've completed these steps, you should now see a white triangle like the image on the left. If not, retrace steps F - H and make sure that all of your lines are connected and running along the same plane.

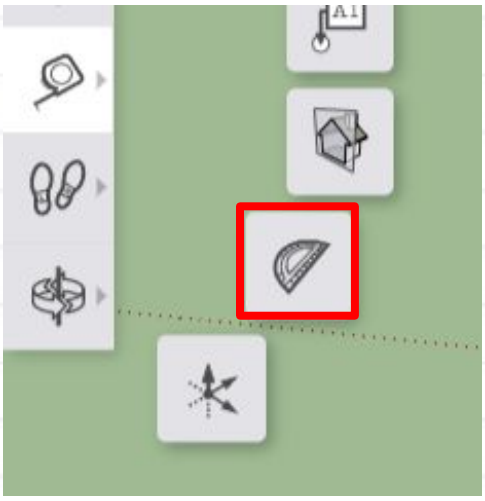


J Once your triangle is complete, select the Tape Measure tool from the left hand toolbar.



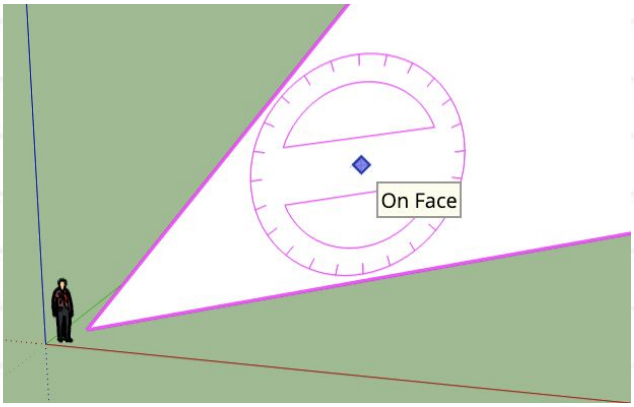
K With the tape measure tool selected, click and release on the base of the triangle near Temple and then click on the corner of the triangle near the base of the rocket.

The distance measurement will show in a small box at the end of your mouse pointer, as well as in the bottom right corner of your SketchUp window. Write this number down as we'll need it in our formula later.

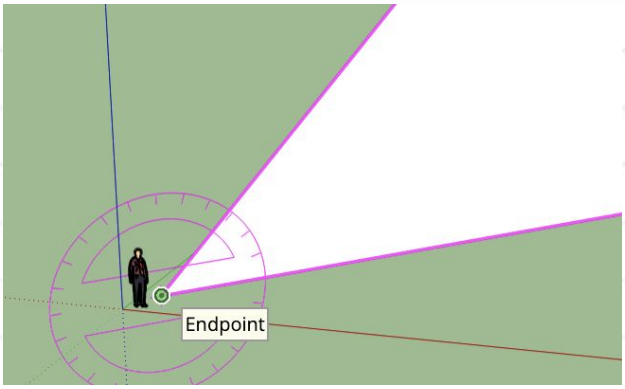


L Find the protractor tool in the left side toolbar and click to select it.

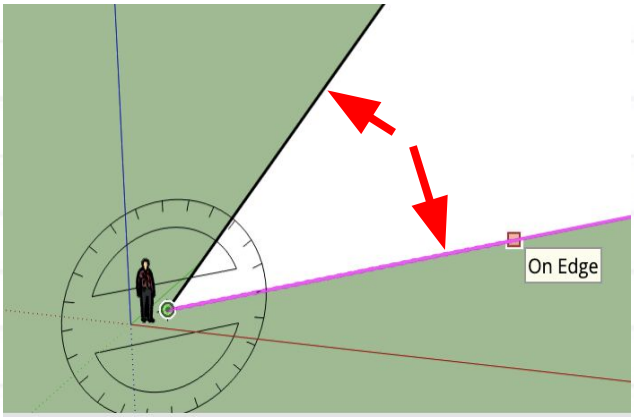
Now you might notice that when you move, the protractor tool will align itself to various faces or objects. If placed on the ground it will align to the ground , and if placed on our triangle it will align to the triangle.



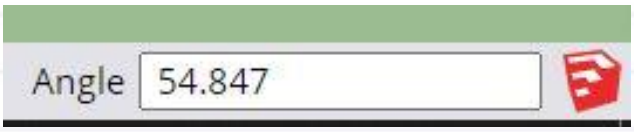
M Place the protractor on the face of your triangle until you see the On Face textbox. Press and hold the SHIFT key and you will see the triangle and the protractor turn purple. This locks the protractor on the face of the triangle so it won't jump around when we move it.



N Still holding the Shift key, click the bottom left corner of the triangle to lock the protractor in place. After you've clicked, release the Shift key.



O Next, click anywhere along the bottom edge of your triangle. Then click along the upper edge of the triangle that connects Temple to the top of the rocket.



P Once you've selected both edges, you will see that SketchUp has measured the angle for you in the bottom right corner of the window. In this example, our angle is 54.847 degrees.

Write down your angle measurement to use in your calculations in the next step.

PRO TIP # 3

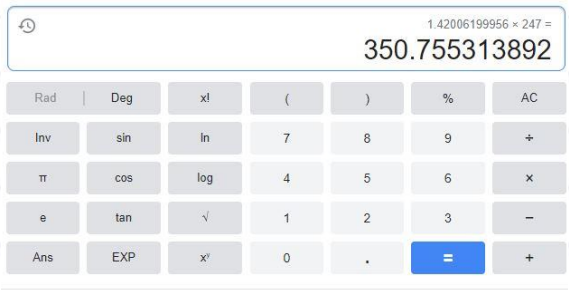
You might notice the tilde ~ symbol in the SketchUp measurement box. This means that SketchUp is rounding up the number for you. To see more or fewer decimal places, change your precision using the Model Info panel.

Q Now that we have all of our measurements, it's time to get out your calculator! Before entering your numbers, remember to check that your calculator is in degrees, otherwise the calculations will be off.

$$\text{Tan}(x) = \frac{o}{a}$$

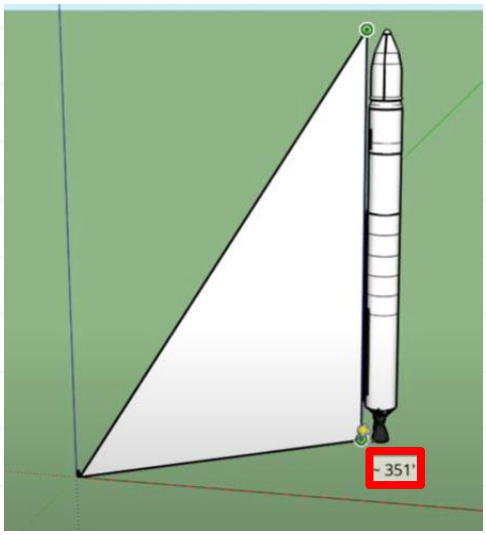
R To calculate the height of your rocket (o), we're going to use the formula for Tangent shown on the left.

First we want to find the tangent of the angle, so select Tan on your calculator and enter the angle that you wrote down earlier. In this example that's 54.847, and it gives us a tangent of 1.42.



S Next, multiply your previous answer by the distance between Temple and the base of the rocket. In our example, this gives us a rocket height of 350.76 ft.

Time to check our math using SketchUp!



To check your math, select the Tape Measure tool from the left toolbar and click once on the triangle at the top of the rocket, and then once more at the base of the rocket. You will see a measurement box appear that shows the rocket height, and the value will also appear in the box at the bottom right of the modeling window.

In this example, our height is about 351 ft, just like we calculated!

Congratulations! You've finished part 1

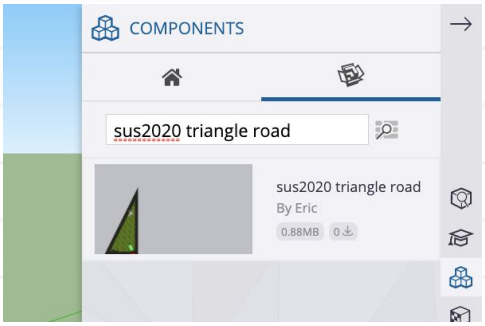
Now, I bet after all that you're asking yourself, "Why didn't we just use the measuring tool and skip all of those other steps?", and that's a fair question. The great thing about SketchUp is that it's pretty easy to measure just about anything, but out in the real world it can be a lot more difficult. Using techniques like Sine, Cosine and Tangent can help us to solve real world math problems in situations where a measuring tape just isn't practical.

Thanks for sticking with me through all of those steps. To learn how we can use the Pythagorean Theorem in SketchUp, check out Part 2 of this tutorial!

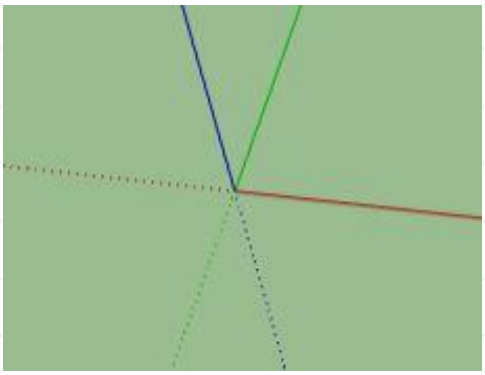
Part 2

Measure the length of a road

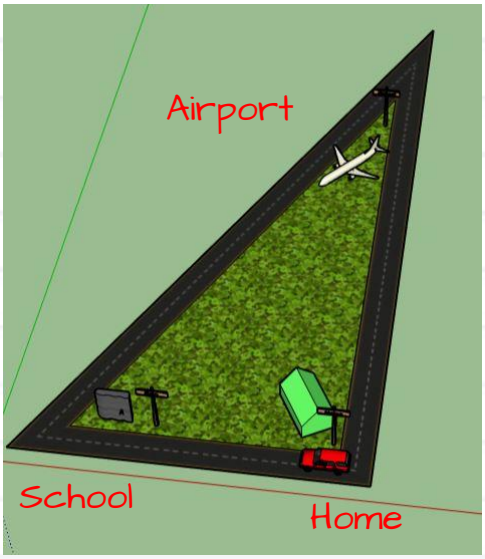
In Part 1 of this tutorial we used the laws of Sine, Cosine and Tangent to help calculate height. In this tutorial we're going to explore the link between the physical and digital worlds using the Pythagorean Theorem.



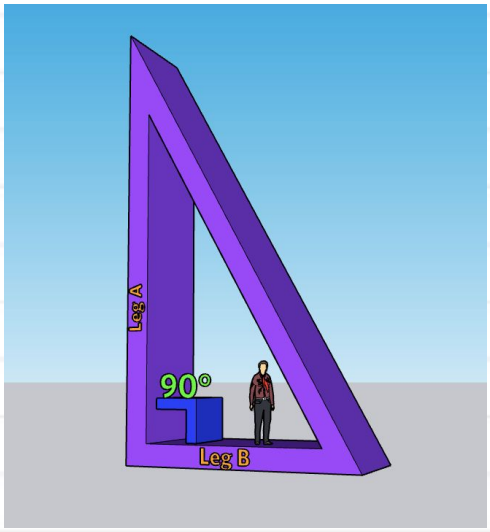
A To start, open the Components panel from the right side menu and search for the model called "sus2020 triangle road". You should see a model of three roads that intersect in a triangular shape. Click the model to select it.



B Once selected the model will move around with your cursor. To place the model flat on the ground, click the origin point in the modeling pane like I've shown you on the left.

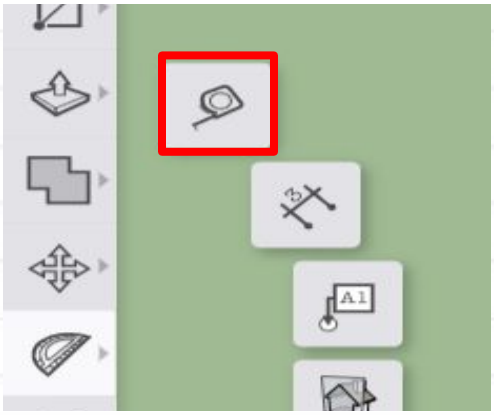


C Now imagine that this model represents an area in your neighborhood at home. If you knew the distance between the airport and your house on one side, and the distance between your house and school on the other, could you calculate the distance between the airport and school? You could if you imagined your neighborhood as a right angle triangle.

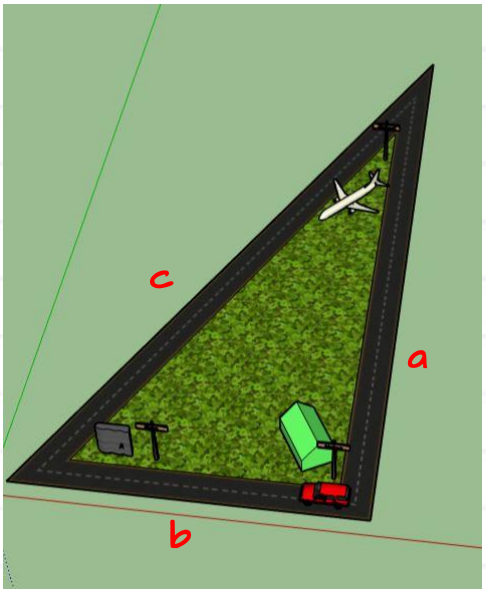


D If we know the length of two sides of a right angle triangle, we can use the Pythagorean Theorem to calculate the missing side!

$$c^2 = a^2 + b^2$$

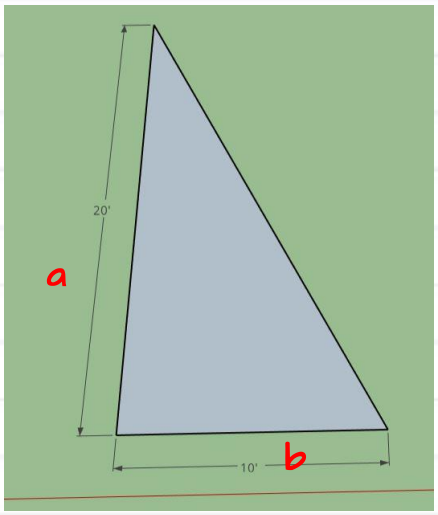


E To start, we need to measure the length of the a and b sides of our triangle. Select the Tape Measure tool from the left toolbar.



F With the Tape Measure tool selected measure side a and side b of the triangle. We can do this by clicking once at the top of side a (near the airport), and again at the bottom near the house. Write down the measurement that you see in the bottom right corner of the modeling window. You'll need this number later.

Repeat this step with side b of the triangle.



D Now that we know the length of our two roads, it's time to plug them into our formula to calculate the distance from between the airport and the school.

I'm going to use a sample triangle that I drew in SketchUp so that I don't give away all of the answers, but you can use the numbers that you wrote down earlier.

$$c^2 = a^2 + b^2$$

$$c^2 = 500ft$$

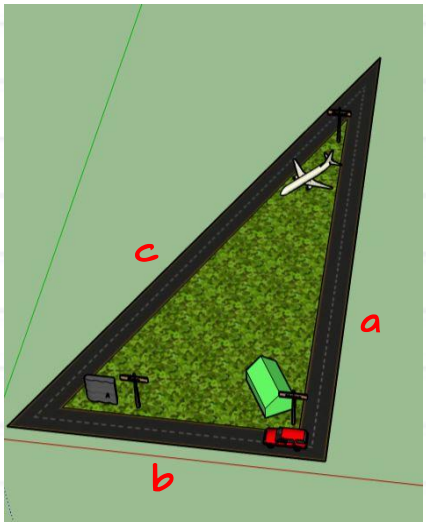
$$c = \sqrt{500ft}$$

$$c = 22.36ft$$

E Time to get your calculator out!

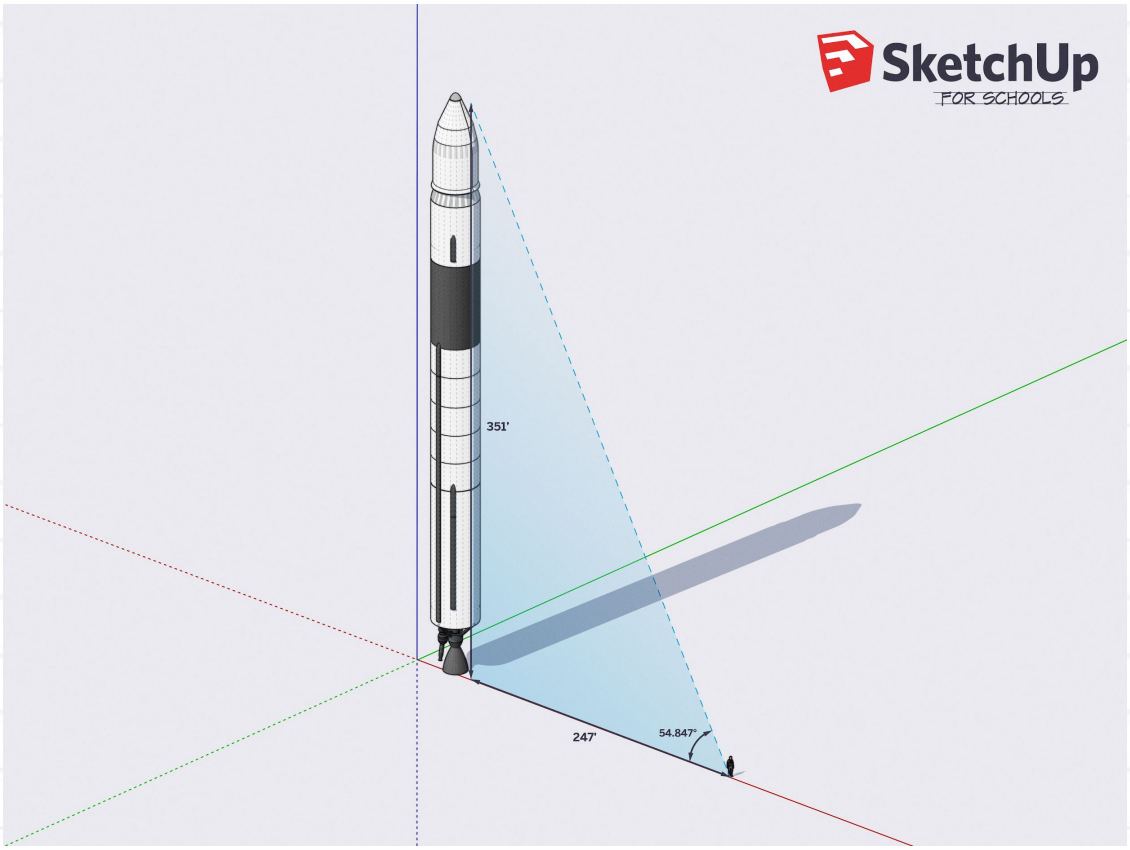
Using the a and b lengths that we've already calculated, I can complete the first part of the equation by multiplying *a* x *a* or 20x 20 which equals 400ft. Then *b* x *b* or 10 x 10 which equals 100ft. Adding these together my equation now shows that c squared equals 500ft.

In order to calculate the length of side c of my triangle I need to take the square root of 500ft which equals 22.36ft.



F Check your math with SketchUp!

Grab the Tape Measure tool from the left toolbar and click once at each end of side c on your triangle. If your numbers match, you got it! If not, don't worry, just follow through this tutorial and try again.



Congratulations, you're done!

Thanks for practicing your math and modeling skills with me! To continue working on your SketchUp skills check out our other tutorials here.

Happy Modeling!

-Dr. Temple Grandin