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[INTERMEDIATE 3D MODELING IN TINKERCAD]

WHAT IS ADVANCED 3D MODELING?

The basics of 3D modeling will only get you so far; in order to model more complex and unique items you'll need to learn how to use the tools at your disposal to create the shapes needed for your model. It is important to plan out how you will build your model, from what pieces you will need to what tools and techniques each piece will need.

WHAT IS TINKERCAD?

Tinkercad is by far the easiest 3D modeling tool available. It is entirely based in the cloud and can be accessed from anywhere that you have an Internet connection. In Tinkercad, you combine shapes to create three dimensional objects. To get a Tinkercad account follow these steps:

Go to www.tinkercad.com

Click Create Free Account

CREATE FREE ACCOUNT

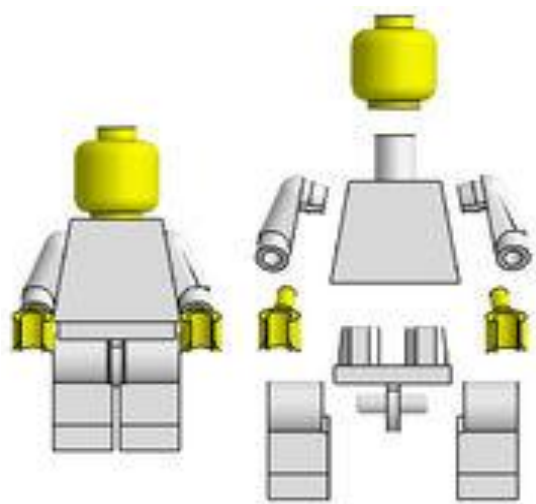
Fill in the information to create an account. Note: If you are not 13 years or older, you must provide a parent's email address and a parent must confirm your account in order to start creating your own designs. You can still go through the design tutorials without a parent's consent.

Once you have created an account, you will automatically be brought to the first tutorial. If you are under 13 years old, we will provide you with a login to use for this class.

WHAT WE'LL DO

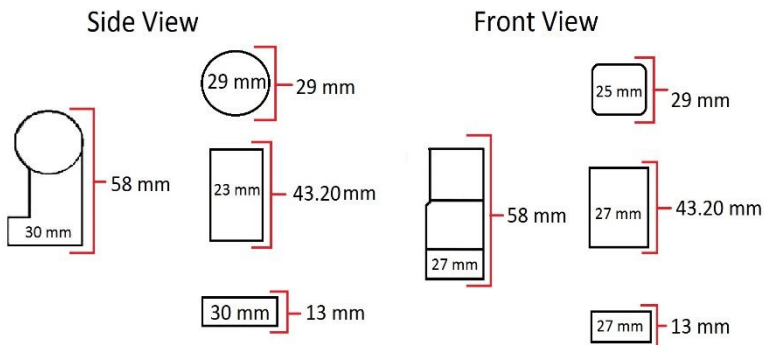
One common technique used for 3D modeling is to think of your object as made out of different simple shapes combined together. For this class we will be creating a Lego Minifigure which will use many of the advanced features in Tinkercad.

Another technique we'll use is measuring; Since we are drawing inspiration from a real-world object and want to duplicate it in 3D, we'll need to know the exact measurements of every part of our figure. The image on the right which breaks down a standard Minifigure into its different components. Though we will be building the body, we will **NOT** create the internal mechanism which allows the figure to move. What we will be building is the head, torso, waist, legs, feet, arms and hands.

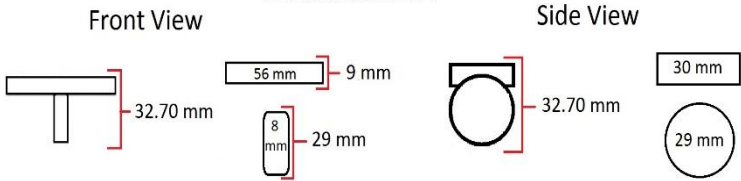


Before we can open up Tinkercad we need to make blueprint of our model. Below are images with all the measurements for every part of the Minifigure we will be modeling (in millimeters) that were measured ahead of time (not included are the degrees of rotation).

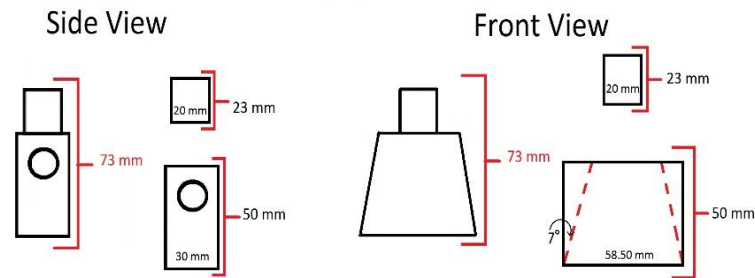
Leg



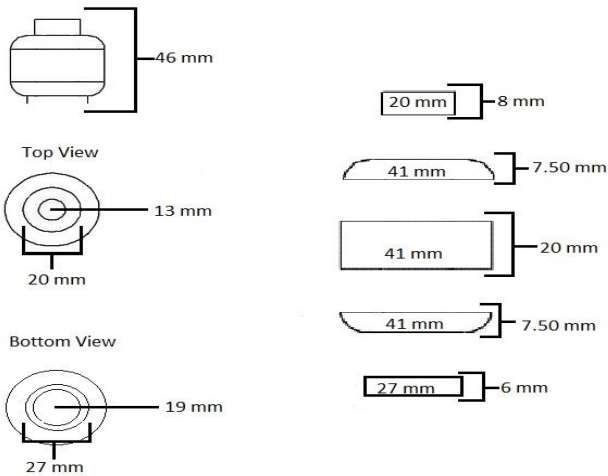
Midsection



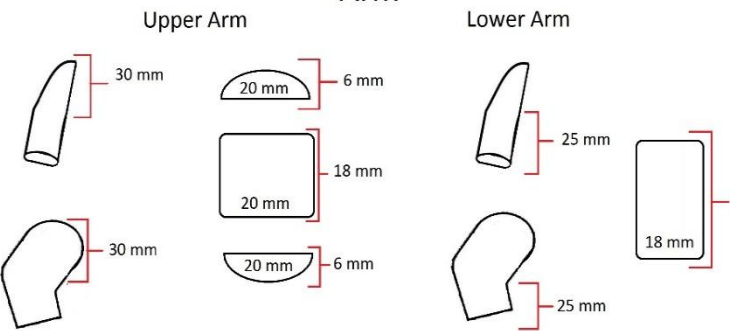
Torso



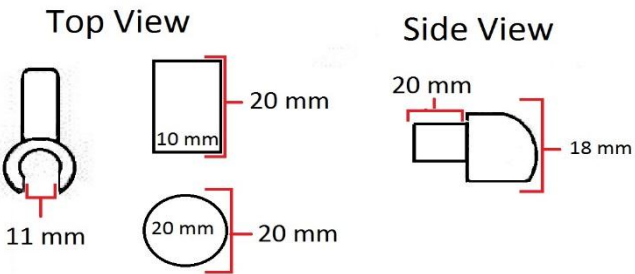
Head



Arm



Hand and Wrist



THINGS TO KNOW

Copy and Paste

When an object is selected, using CTRL + C will copy the object; Using CTRL + V will paste a copy of that object next to the original object.

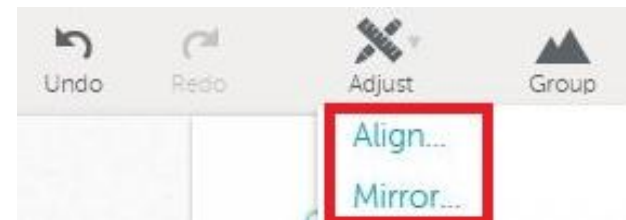
Duplicate

Found under “Edit” this tool will duplicate an object much like the “Copy and Paste” method but will paste the copy in the exact spot of the original.



Align

Found on the top right hand side of the screen, align will align multiple selected objects.



Mirror

Mirror will create a mirror image of a selected object.

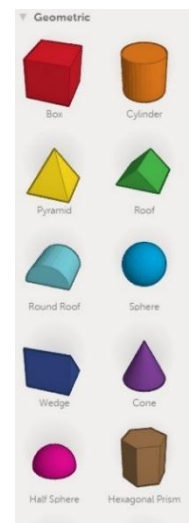
Group

This tool will take multiple objects and join them together to form one object.



Geometry

The name given to pre-made objects within a 3D modeling program.

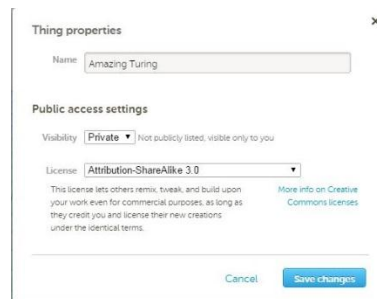
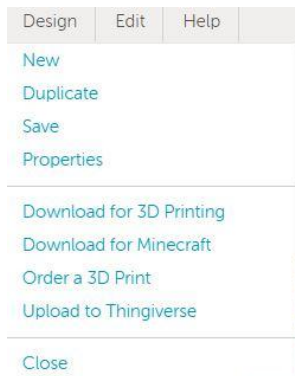


GETTING STARTED

This process will start with the easiest piece to model (the legs) and move up toward the more difficult of the pieces (the arms). As we proceed we'll learn about the different modeling options of Tinkercad.

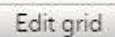
Step 1: Create a new design.

- To start a new design, simply click the **Create new design** button.
- You will be taken to a blank canvas.
- You will notice that Tinkercad automatically gives your design a name. To change this, click **Design** in the top left corner of the screen and select **Properties**.
- Then, replace the automatic name with whatever you would like to call the design.

A blue rectangular button with the text "Create new design" in white.

Step 2: Choose Millimeters

- Go to "Edit Grid" on the lower right hand side of the screen. The default grid will be in **millimeters**.
- In the **Grid properties** box that appears, select **Millimeters**. You can also change the size of your workplane. Change it to the dimensions shown below.

A button with the text "Edit grid" in a light gray box.A screenshot of the "Grid properties" dialog box. It shows a "Units" dropdown set to "Millimeters", "Width" and "Height" fields both set to "177.80", and a "Use a Preset" dropdown set to "Custom". There are "Cancel" and "Update Grid" buttons at the bottom.

Grid properties

Units

Millimeters

Width

177.80

Height

177.80

Use a Preset

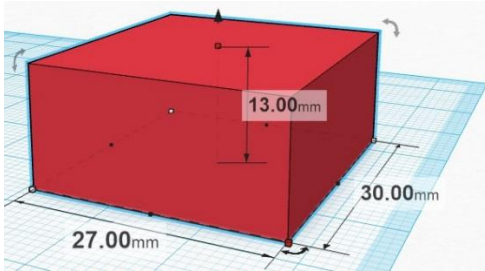
Custom

Cancel

Update Grid

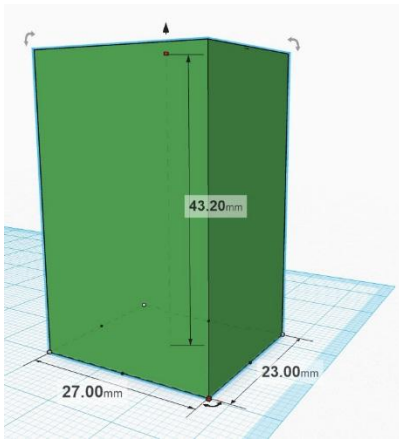
The Legs

Step 1: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below.



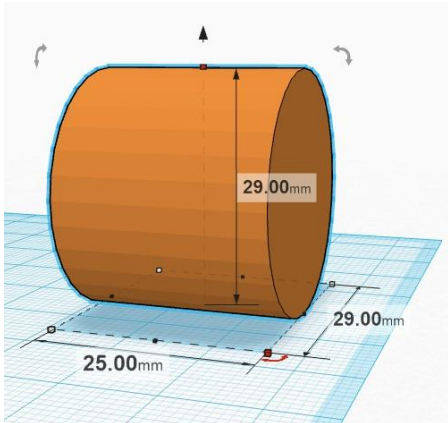
This will be the foot of our leg.

Step 2: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below.



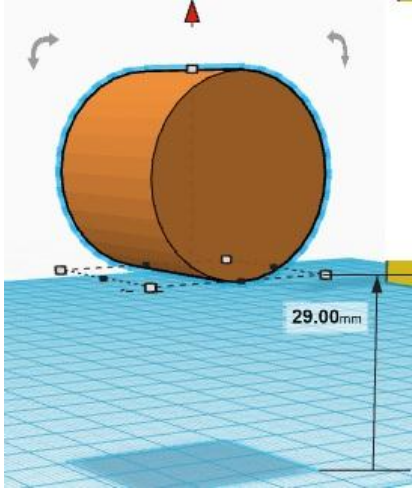
This is the shin of our leg.

Step 3: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below and rotate it using the arrows.

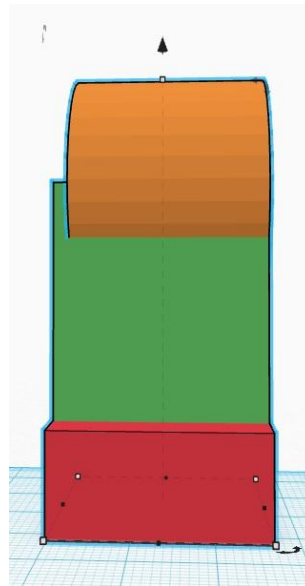
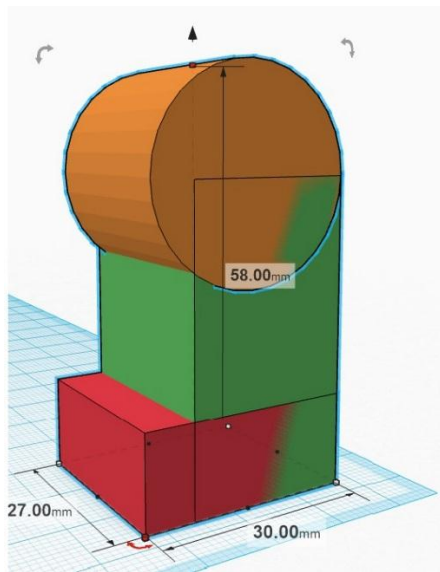


This will be the thigh of our leg

Step 4: Using the cone located at the top of the cylinder, raise the cylinder up 29 mm.

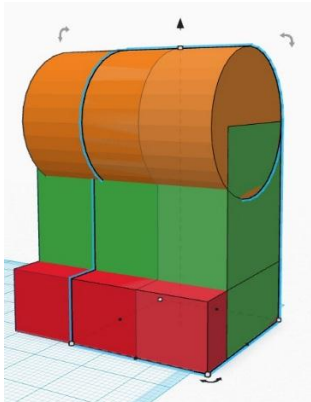


Step 5: Bright the “thigh” and the “foot just under the cylinder. This is how it should look.



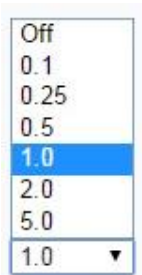
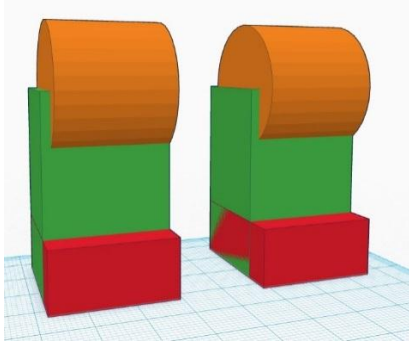
Notice how the “thigh” (orange cylinder) does not reach all the way across the green cube, this is normal.

Step 6: Highlight all 3 shapes. There should be a light blue outline over the whole thing. Press CTRL + C to copy the shapes; Press CTRL + V to paste a copy. This is what you’ll see.

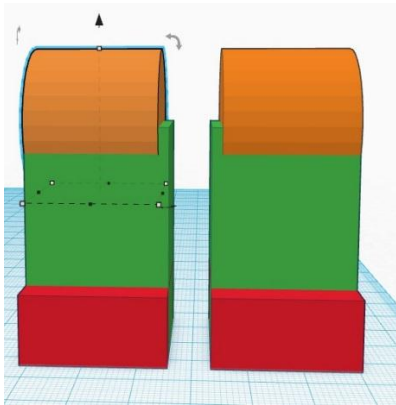


Step 7: At the bottom right side of your screen change the “snap grid” to “5.0”.

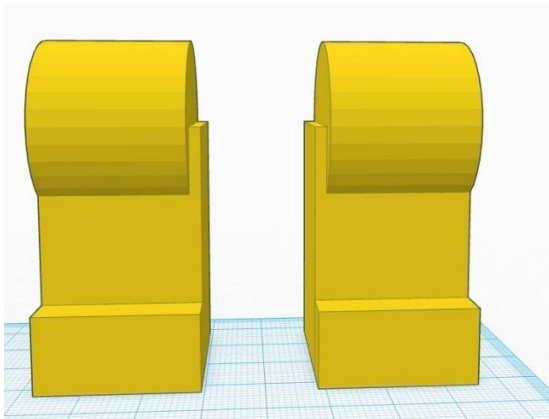
This will allow any movements to move 5 millimeters at a time, which will be useful for moving objects though larger distances. Use the arrow keys on your keyboard to move the copy away from the original.



Step 8: Click on any empty area to “deselect”. Go back to “snap grid” and select “0.1” for more accurate movements. Click on the cylinder of the copy, use the arrow keys to move the cylinder to the left.

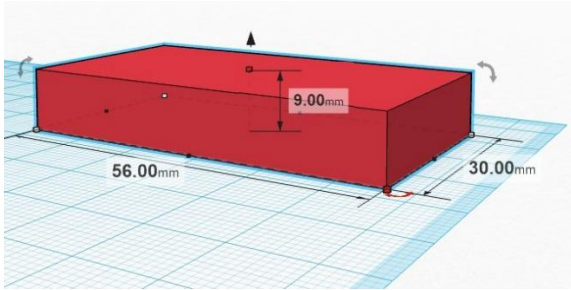


Step 9: Highlight all the objects of one leg (not both) and click on group. Change the color to yellow. Repeat the process for the other leg.

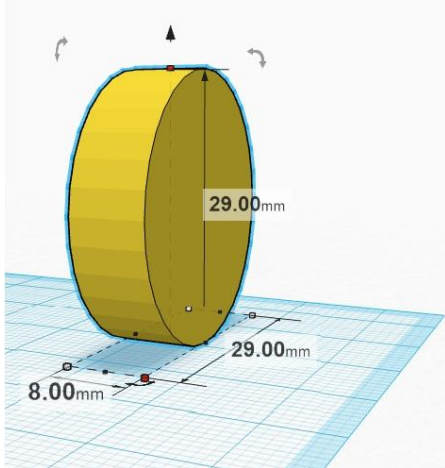


The Midsection

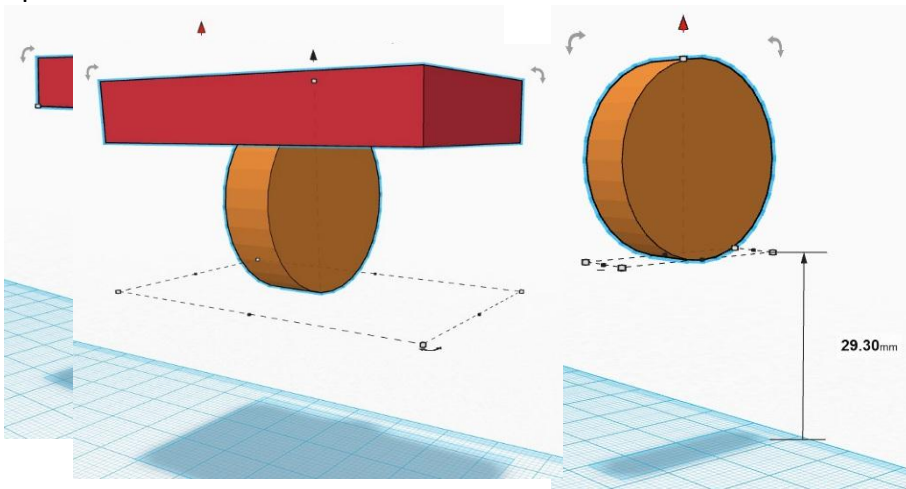
Step 1: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below.



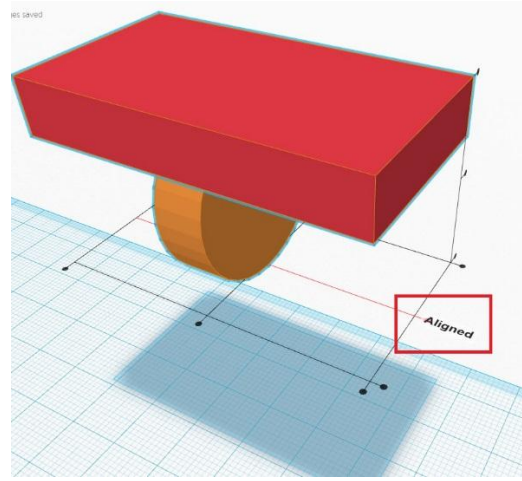
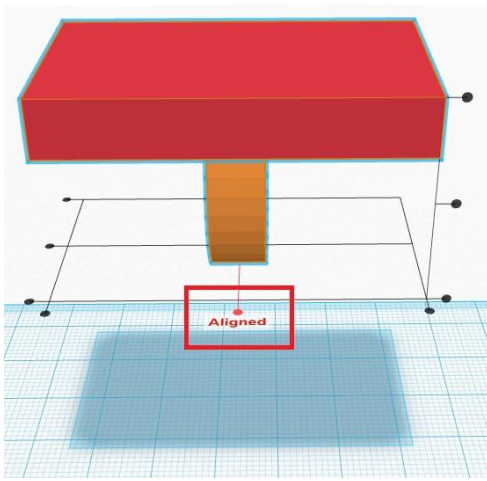
Step 2: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below and rotate it using the arrows.



Step 3: Using the cone located at the top of the cube, raise it up 53 mm. Do the same with the cylinder but raise it up 29.30 mm.



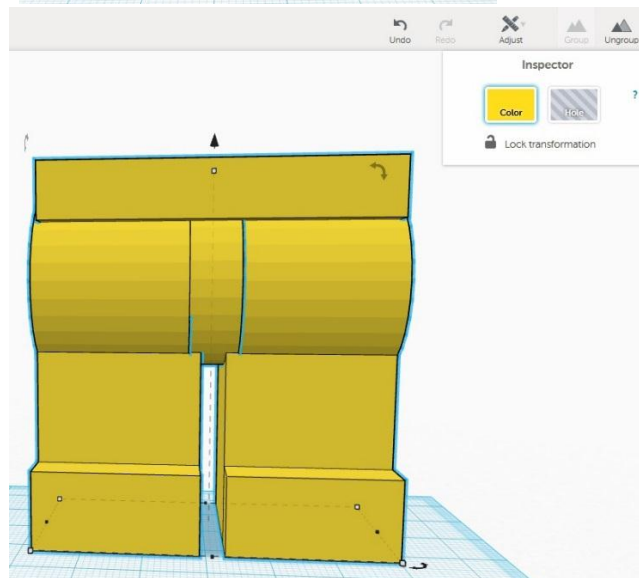
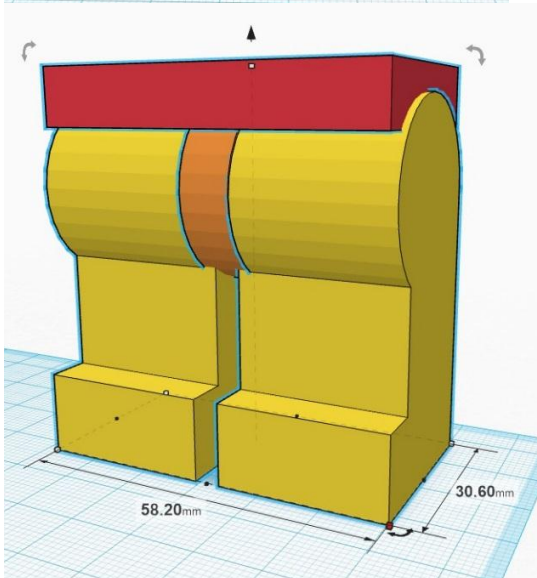
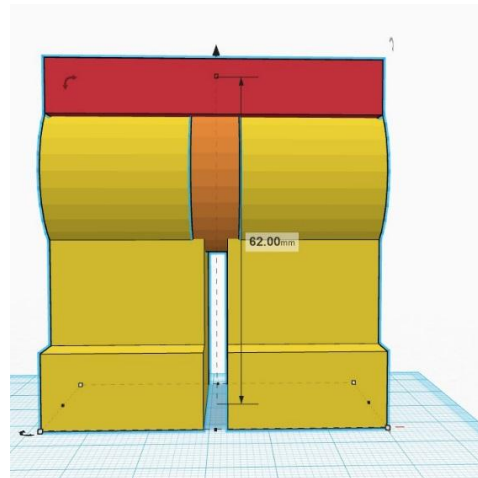
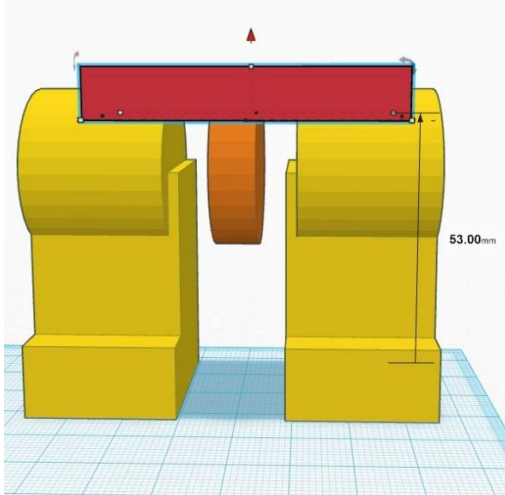
Step 4: Highlight both the cube and the cylinder, go to “Adjust” at the top of the screen and select “Align”. Looking down at the objects, click on the center dots to align the objects.



Using both align “dots” will insure that the objects are perfectly centered with one another.

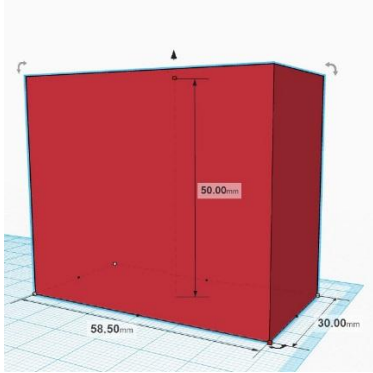
Step 5: Highlight both objects and group them together. Change the color to yellow.

Step 6: Bring over the legs from earlier and place the midsection between them. See the images below. When all objects are positioned, highlight legs and midsection and click “Group”.

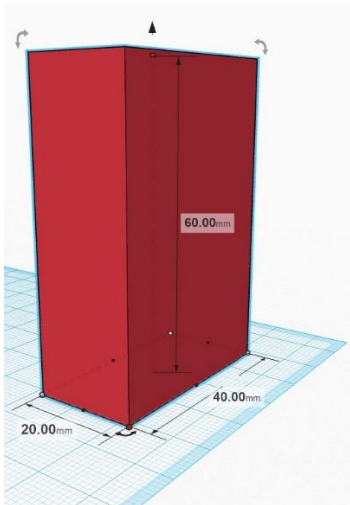


The Torso

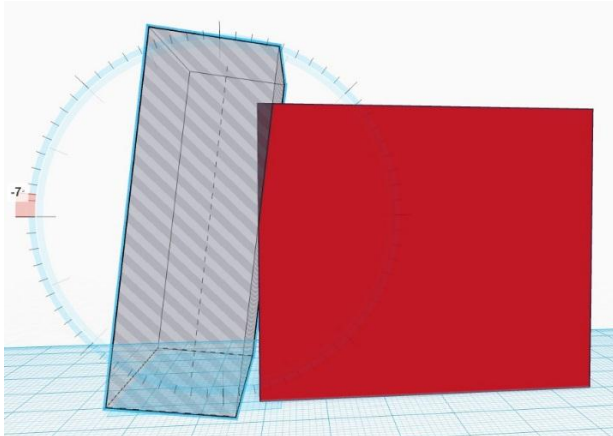
Step 1: The torso will be a bit trickier than the other models. Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below.



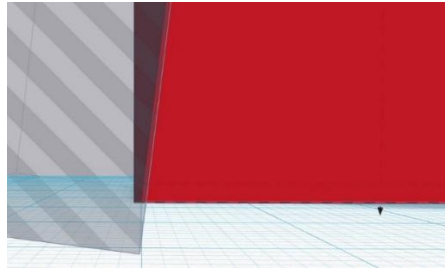
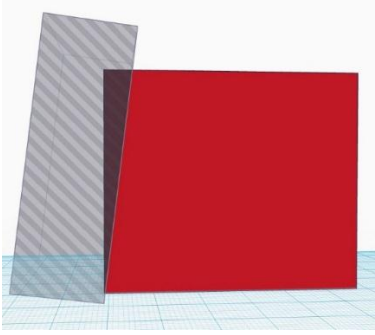
Step 2: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below. This will be used to cut out parts of the original cube. Make it a hole



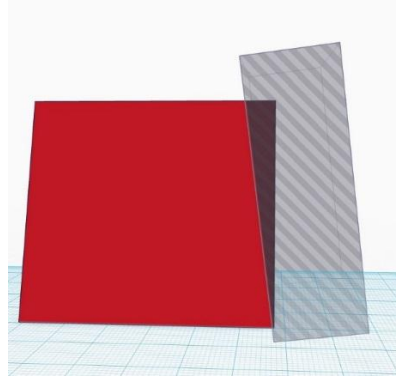
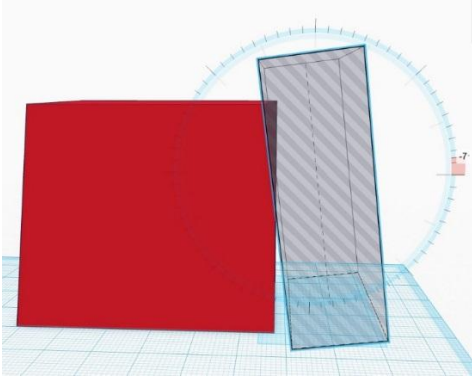
Step 3: Place the hole next to the original cube, using the arrows rotate the hole 7 degrees; See image below.



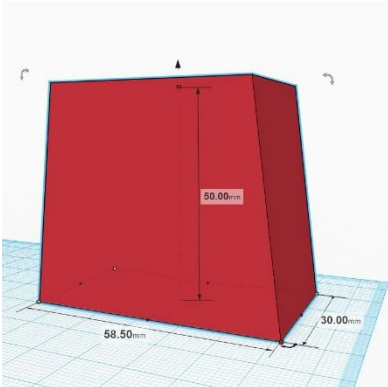
Step 4: Move the hole so the bottom of the red cube intersects with bottom of the hole.



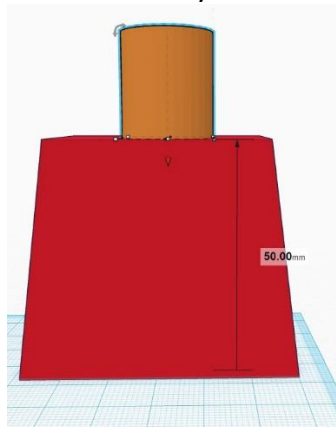
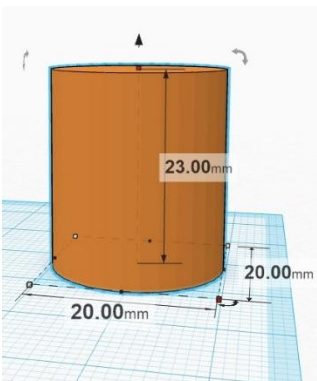
Step 5: Highlight both objects and group; There will now be a slant on the side of the red cube. Repeat the above steps for the other side of the red cube.



This is the result

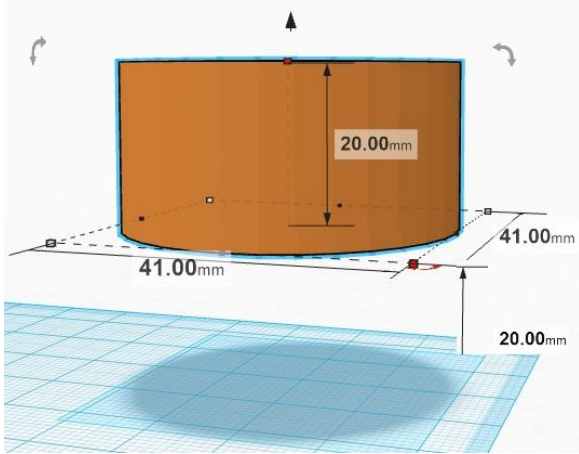


Step 6: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. Place the cylinder above the torso to create the “neck”.

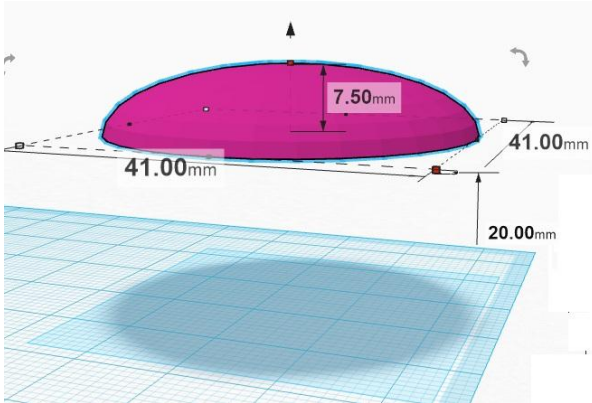


The Head

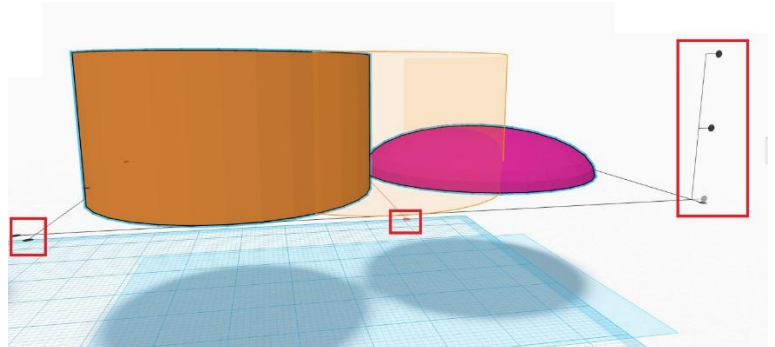
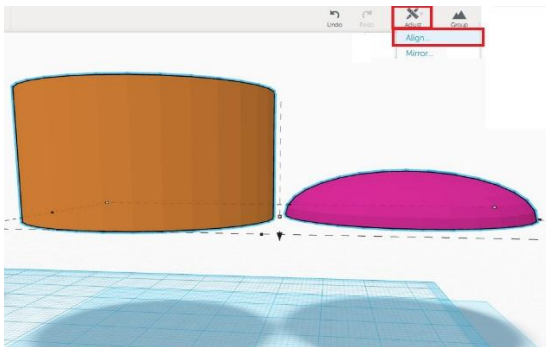
Step 1: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. Raise it 20 mm.

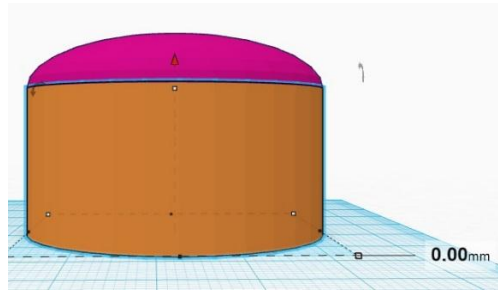
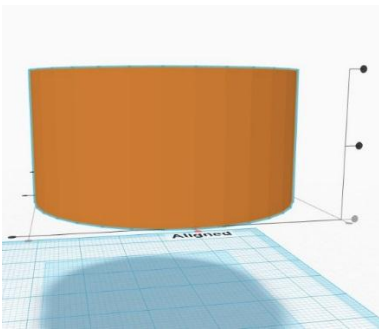


Step 2: Bring out a half sphere onto the workplane. Using the dots located on the corners and the middle of the half sphere, resize it to the measurements below. Raise it 20 mm.



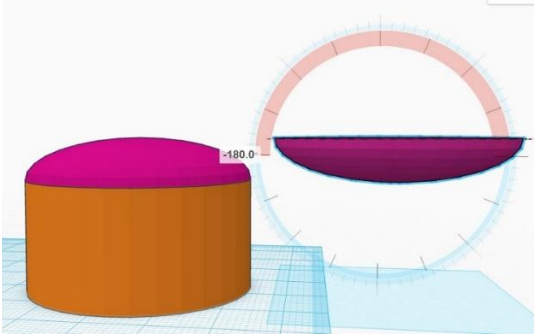
Step 3: Bring the sphere and the half sphere together; Highlight and use the “align” tool.



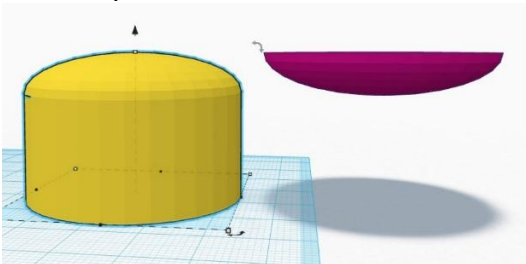


After the alignment, it'll look like the half sphere has disappeared but it's actually inside the orange cylinder. Click on any empty space to deselect the objects. Click on the orange cylinder and using the cone on the top, push it down until the purple half sphere is visible.

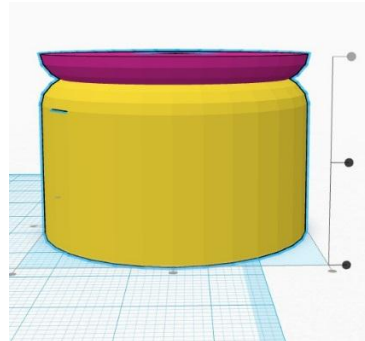
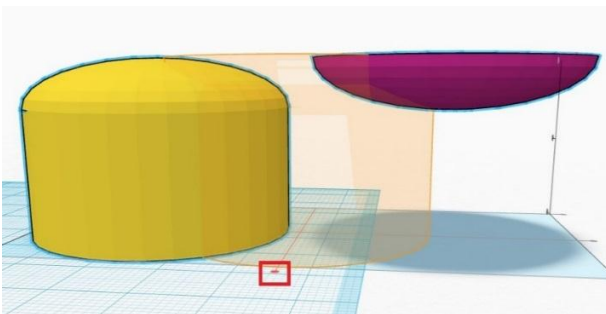
Step 4: Click on the purple half sphere, go to "Edit" and click "Duplicate". Use the arrow keys to separate the copy from the original. Use the arrows around the copy to rotate it 180 degrees.



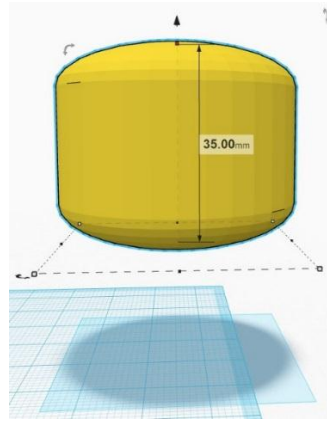
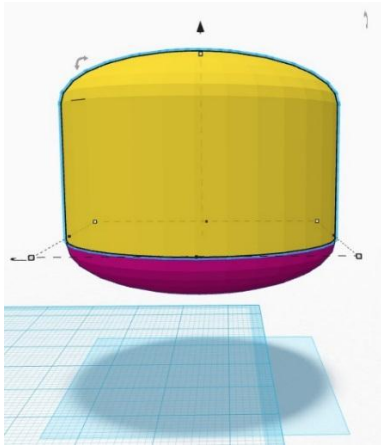
Step 5: Highlight the orange cylinder and the original purple half sphere on top of it and group them, change the color to yellow.



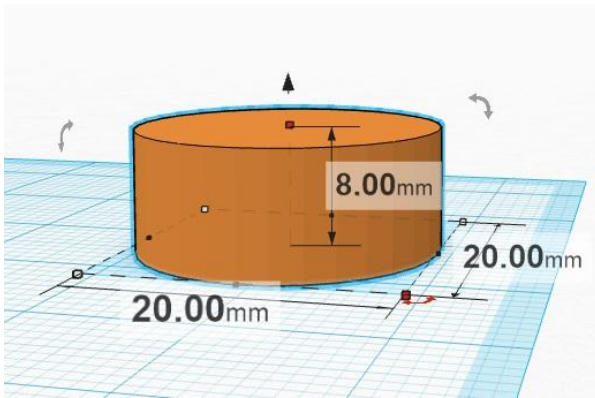
Step 6: Highlight the newly created object and the upside down half sphere and align them.



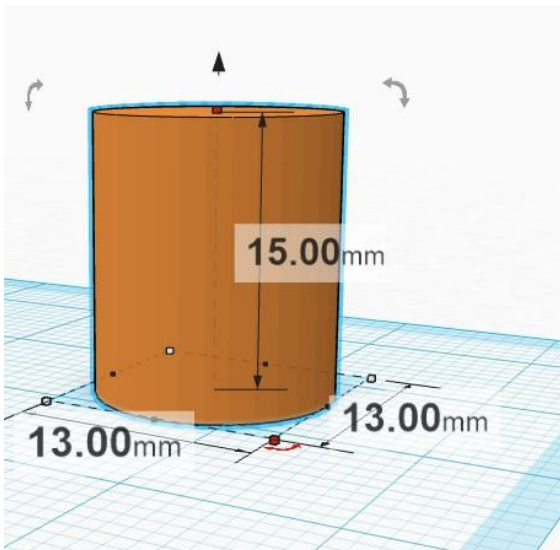
Step 7: Click on the yellow object and move it up using the cone above it. When the half sphere is under the yellow object as shown below, group both objects. Change color to yellow. The size of the new object will be 35 mm.



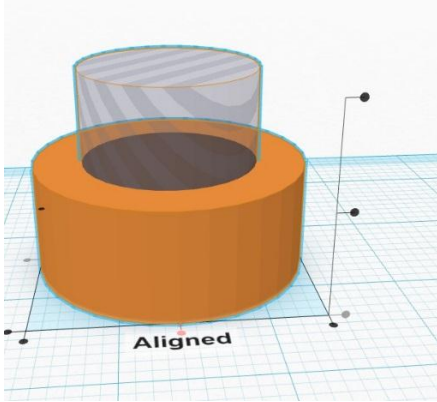
Step 8: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. This will be the cylinder on the top of the head.



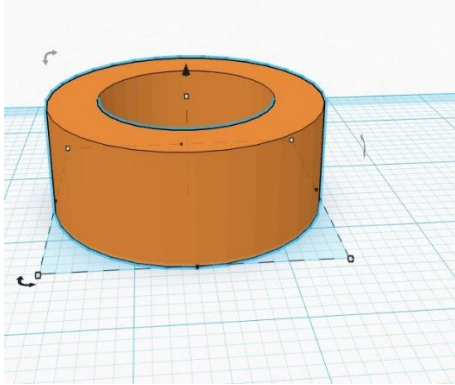
Step 9: Before placing the cylinder, we're going to create the hole. Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. Turn it into a hole.



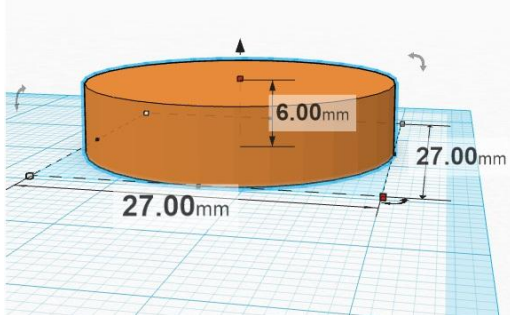
Step 10: Using the “align” tool, align the first cylinder with the hole cylinder.



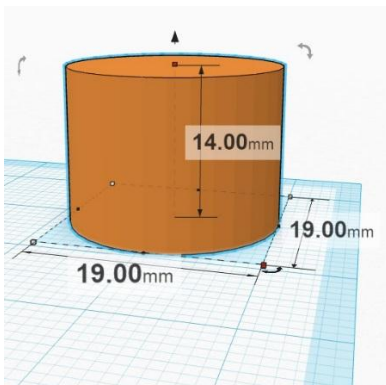
Step 11: Highlight both cylinders and group them together; This is the result.



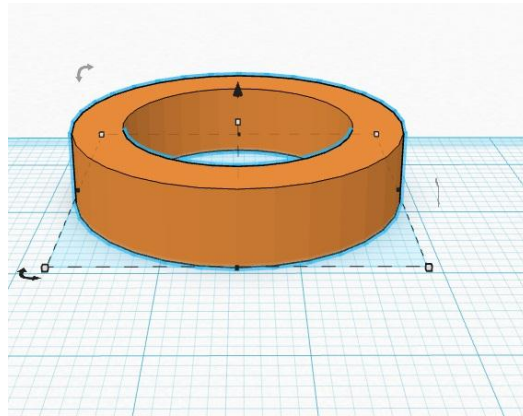
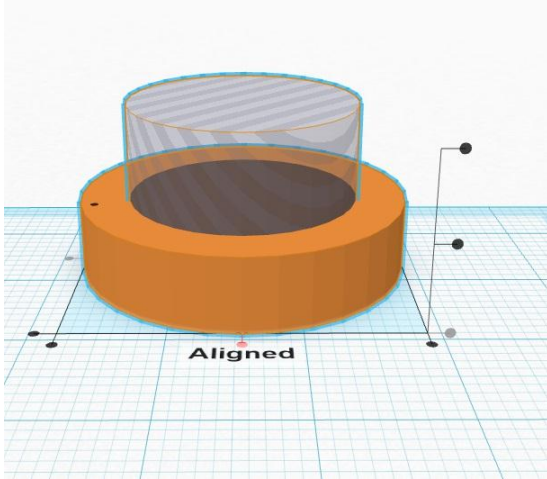
Step 12: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. This will be the cylinder on the bottom of the head.



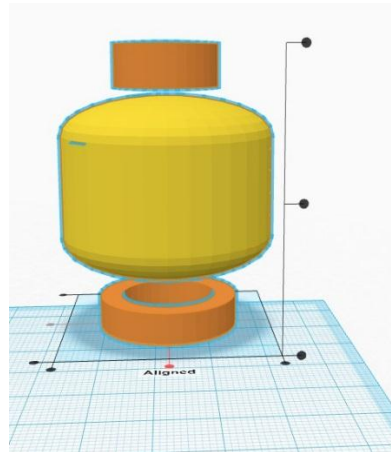
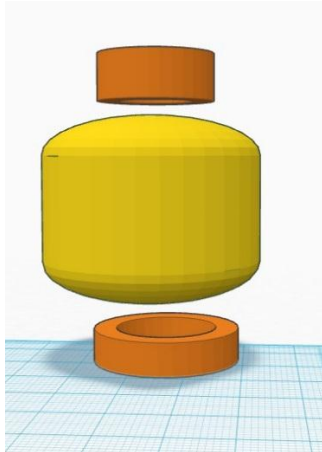
Step 13: Before placing the cylinder, we’re going to create the hole. Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. Turn it into a hole.



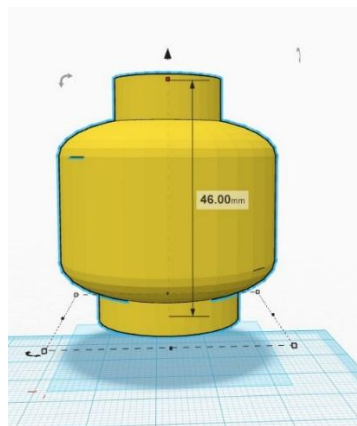
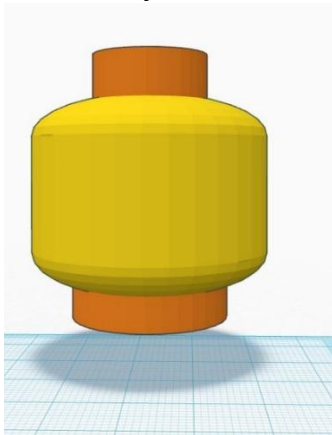
Step 14: Using the “align” tool, align the first cylinder with the hole cylinder and group them.



Step 15: Bring all three objects together, highlight all and align.



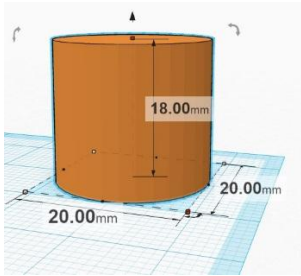
Step 16: Once aligned, place the top cylinder into the head, do the same with the bottom cylinder, see image below. Once everything is placed, group all the objects together, group and change color to yellow. The size of the newly created object is 46 mm.



The Arms

(The Upper Arm)

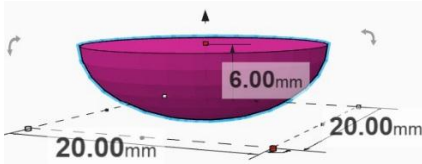
Step 1: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below.



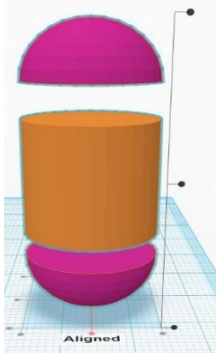
Step 2: Bring out a half sphere onto the workplane. Using the dots located on the corners and the middle of the half sphere, resize it to the measurements below.



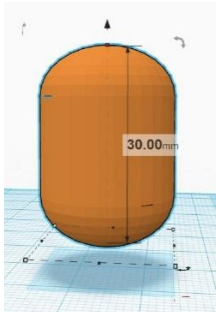
Step 3: Click on the purple half sphere, go to “Edit” and click “Duplicate”. Use the arrow keys to separate the copy from the original. Use the arrows around the copy to rotate it 180 degrees.



Step 4: Bring all three objects together, highlight all and align.

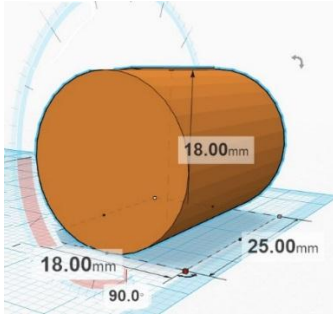


Step 5: Once aligned, join the pieces together and group. The size of the new shape will be 30 mm.

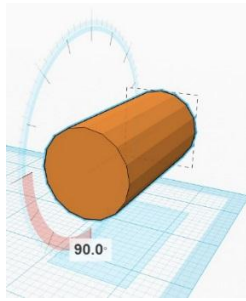
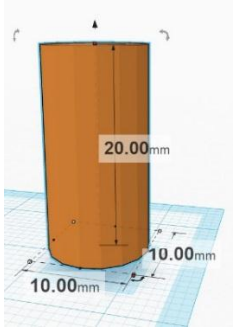


(The Lower Arm, Wrist and Hand)

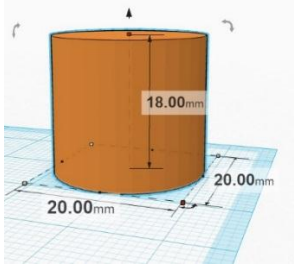
Step 1: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize and rotate it to the measurements below. This will be the lower arm of the arm.



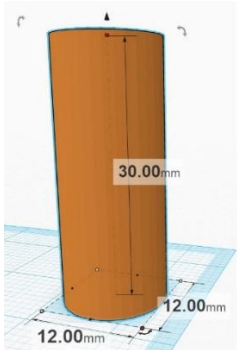
Step 2: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize and rotate it to the measurements below. This will be the wrist of the arm.



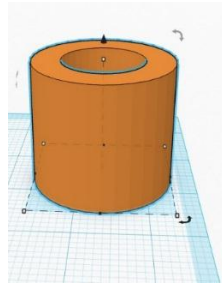
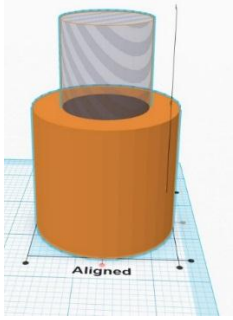
Step 3: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. This will be the hand of the arm.



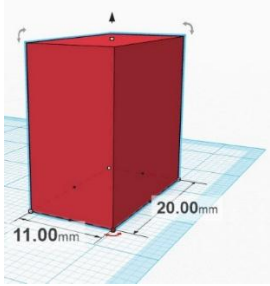
Step 4: Bring out a cylinder onto the workplane. Using the dots located on the corners and the middle of the cylinder, resize it to the measurements below. Turn it into a “Hole”. This will be used to shape the hand.



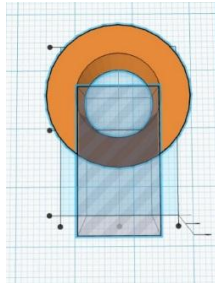
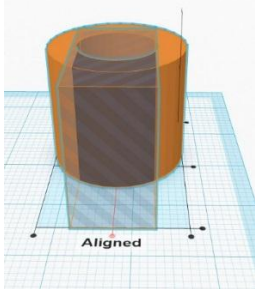
Step 5: Bring the hand cylinder and the hole cylinder together, align and group them.



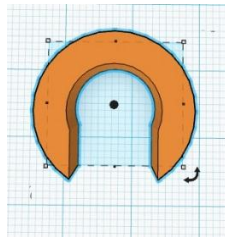
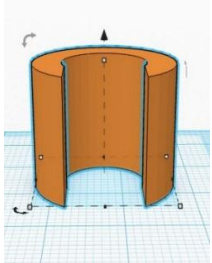
Step 6: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below. Turn it into a “Hole”. This will be used to create the opening of the hand.



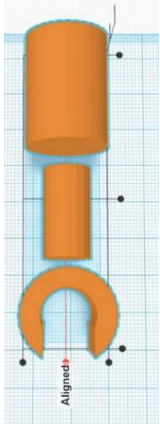
Step 7: Bring the hand cylinder and the cube together as shown below and align.



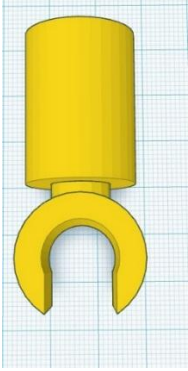
Step 8: Group the two objects. The result is shown below.



Step 9: Bring the lower arm, wrist and hand together as shown below and align them.



Step 10: Bring the objects together as shown below, group them and change the color to yellow.

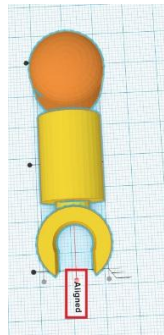
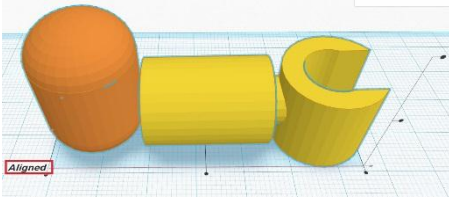


Assembly: Part 1

Here we'll bring together the newly created objects in order to form the arm.

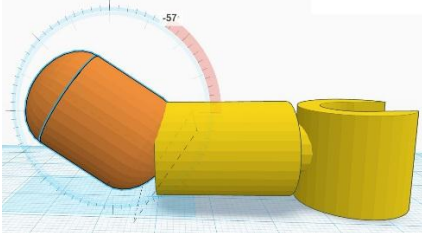
(Note: The following positioning and rotations are based on the model as built by this guide, your numbers may differ)

Step 1: Bring the upper arm and the lower arm together as shown below, align.

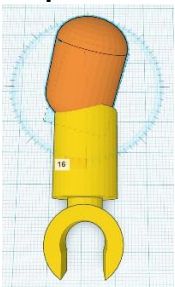


Step 2: A minifigure's arms are not straight, the upper arm slants towards the torso, causing a small bump at the elbow. The lower arm and the hand do follow a straight line.

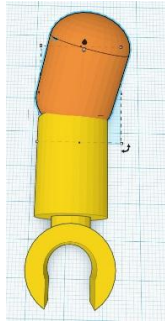
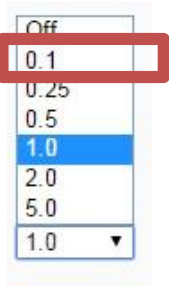
-Using the rotation arrows around the upper arm, rotate it -57 degrees as shown below.



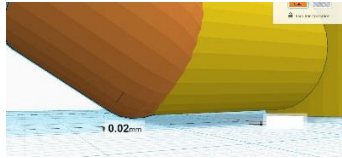
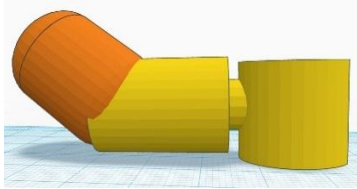
Step 3: From the top view, rotate the upper arm 16 degrees as shown.



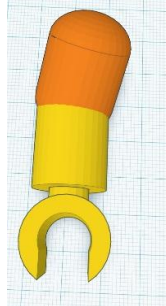
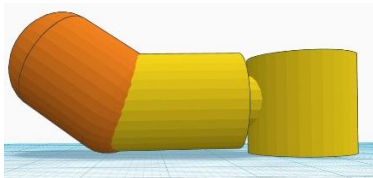
Step 4: While still in top view, change the offset amount to 0.1 for more accurate movements. Using the arrow keys on your keyboard, move the upper arm to the right until it resembles the image below.



Step 5: In side view, you should see something like the first image below. Using the arrow keys on your keyboard, nudge the upper arm so the yellow of the lower arm cylinder can no longer be seen, see second image below.



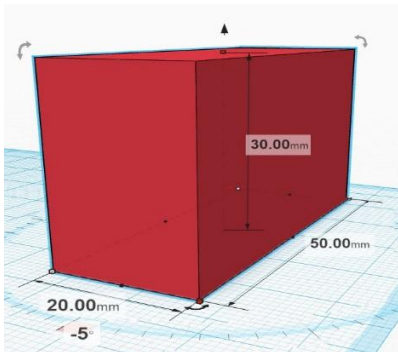
Step 6: After the adjustments are complete the images below show how the objects should look from side and top views. Group both objects together; change color to yellow.



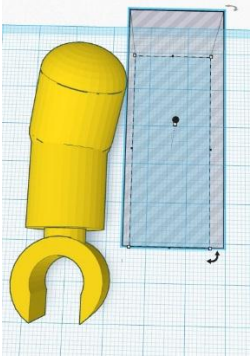
Assembly: Part 2

The arm of a Minifigure is not round all the way around. The part of the arm that faces the torso is flat so the arm does not run into the torso when rotated. Here we'll create the flat part of the arm.

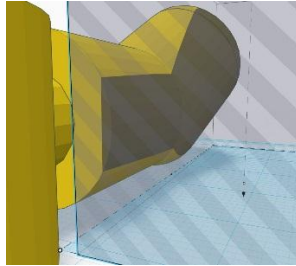
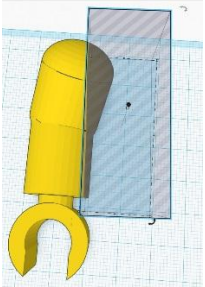
Step 1: Bring out a cube onto the workplane. Using the dots located on the corners and the middle of the cube, resize it to the measurements below. Turn it into a hole.



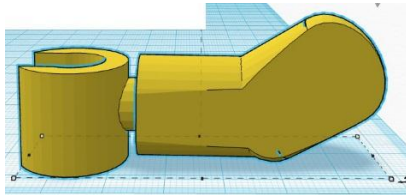
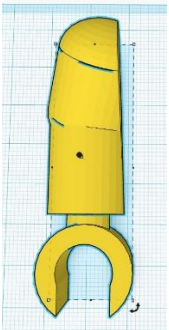
Step 2: Bring the newly formed arm and the cube together as shown below.



Step 3: Using the arrow keys on your keyboard, move the hole cube into the arm as shown below.

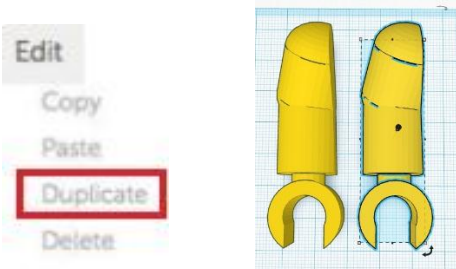


Step 4: Group both objects together. Result shown below. The right arm has been created.



With the right arm created, now we need the left. Since the flat part will now have to be on the other side of the arm, we can't just copy and paste like we did to create the legs and since we're not going to want to go through construction again we'll be using another advanced tool of Tinkercad, the mirror tool.

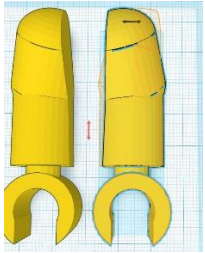
Step 5: Using the duplicate tool under Edit, make a copy of the arm and separate them. Keep one selected (blue outline)



Step 6: Under Adjust, select Mirror. An arrow symbol will appear next to the copy of the arm.



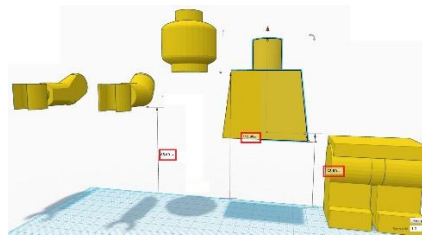
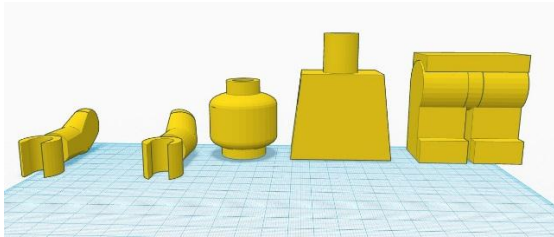
Step 7: Clicking on the arrow highlighted above will rotate the selected arm vertically, mirroring the original arm.



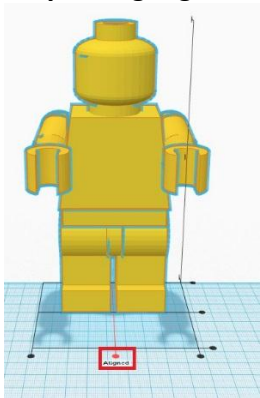
Assembly: Part 3

Now that we have all of the individual pieces together, it's time to assemble it all.

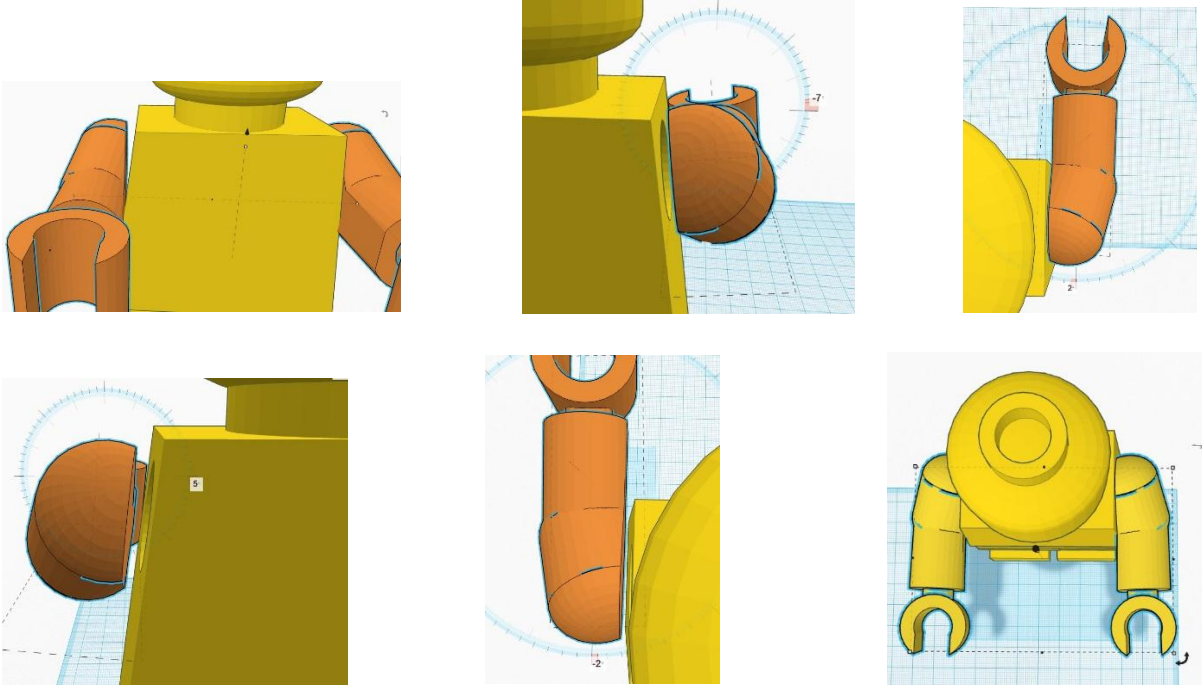
Step 1: Bring all the created parts together. Raise each piece to the designated height as shown below.



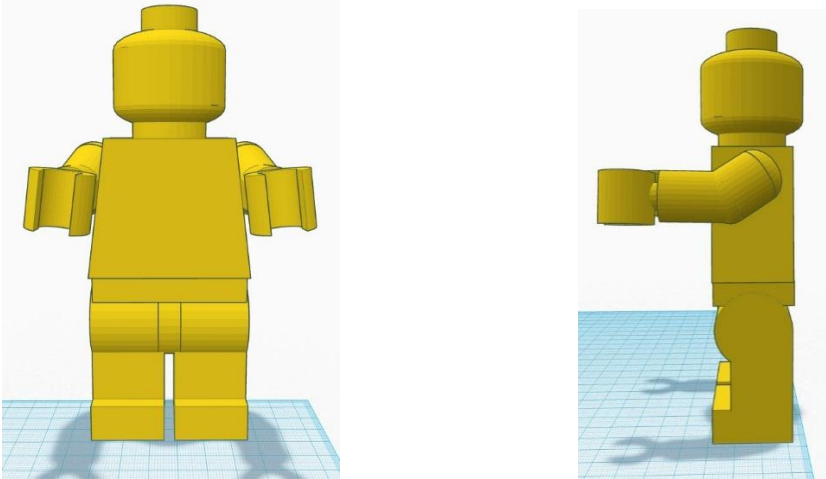
Step 2: Highlight all the objects, align.



Step 3: The arms of my model need some work. The arms need to fit well with the torso so they'll need to be rotated (individually). In the case of this model, the arms will need to be rotated as shown below; same for the other arm.



Step 4: Highlight everything, group, make sure the color is yellow. And that's it! Lego Minifigure complete!



Using everything you've learned, if you wish to create the holes in the back of the legs or at the bottom of the feet, go for it.

If you need further assistance, don't hesitate to:

- Email or call Erica Acevedo, Bilingual IT Assistant (and digital master builder ((that's not a real title but it would be cool))) at eracevedo@frvpld.info or 224-802-8000.

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2. Hovering over **Events and Registration**
3. Clicking on **Computer Classes**