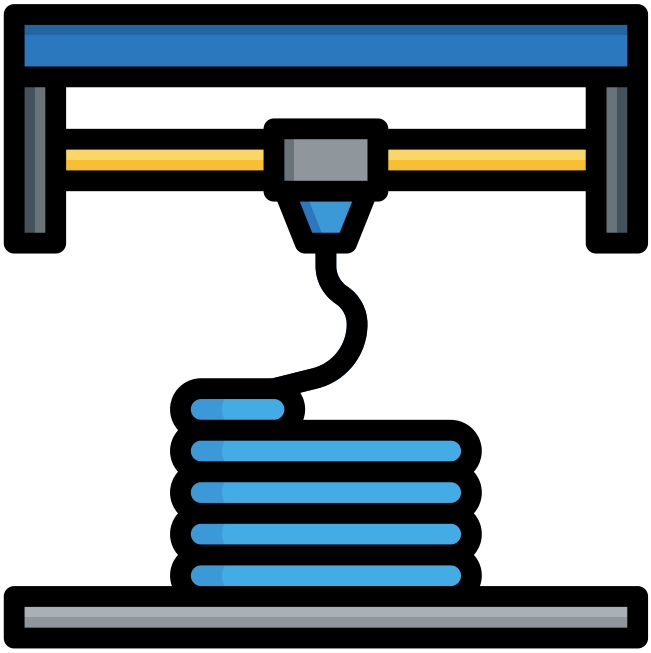
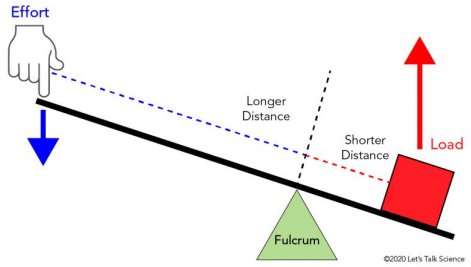
3D DESIGNING & PRINTING

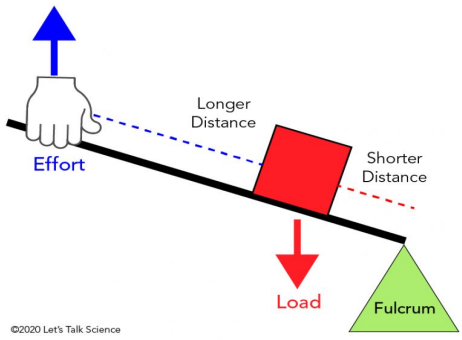


Introduction to Levers

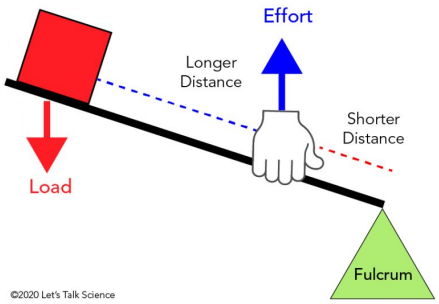
A lever is a simple machine made of a rigid **beam** and a **fulcrum**. The **effort** (input force) and **load** (output force) are applied to either end of the beam. The fulcrum is the point on which the beam **pivots**. When an effort is applied to one end of the lever, a load is applied at the other end of the lever. This will move a mass upward. Levers rely on **torque** for their operation. Torque is the amount of force required to cause an object to rotate around its **axis** (or pivot point).



First class: In a first class lever, the fulcrum is located between the load and the effort.



Second class: In a second class lever, the load is located between the effort and the fulcrum.



Third Class: In a third class lever, the effort is located between the load and the fulcrum.

Source:https://letstalkscience.ca

: 60 minutes

Module: 3D Design and Printing

Grade: 6th to 9th

Importance/ Value:
3D Printing and Design allows children to think, visualize their imaginative concepts and create prototypes on their own. It also enables the children to understand the basic design concepts while differentiating between 2D and 3D images.

Learning Goals:

1. Learners will be able to understand the basic concepts of 3D design.
2. Learners will explore and learn to use a simple 3D design software called Tinkercad.
3. Learners will design and 3D print a spanner exploring the possibilities of 3D Printing.

Time	Description
01 Min	Check-in-Experience (CIE)
05 Min	Icebreaker
10 Min	Introduction to module
35 Min	Activity
09 Min	Reflection and Learnings

Icebreaker (5 mins):

Play a beat!

Music brings people together and time for you to guess the song! Sit in a circle, Take turns whistling, tapping, or humming to the tune of a popular song and have your teammates guess the name. You can also play this game by dividing into two groups.

Materials Required :

1. Laptop with Internet Connection
2. 3D Printer

Safety Measures:

1. Put your 3D printer in an area which isn't easily accessible.
2. Wear gloves when handling your 3D printer.
3. Keep a mental note in your head that your 3D printer gets very hot.
4. Only reach for your printer when you are certain it's off.

Activity: Design a Spanner

In this activity you will learn how to use a 3D design software called TinkerCad and Design a simple 3D Spanner and 3D print it.

Step 1: Design the Ring

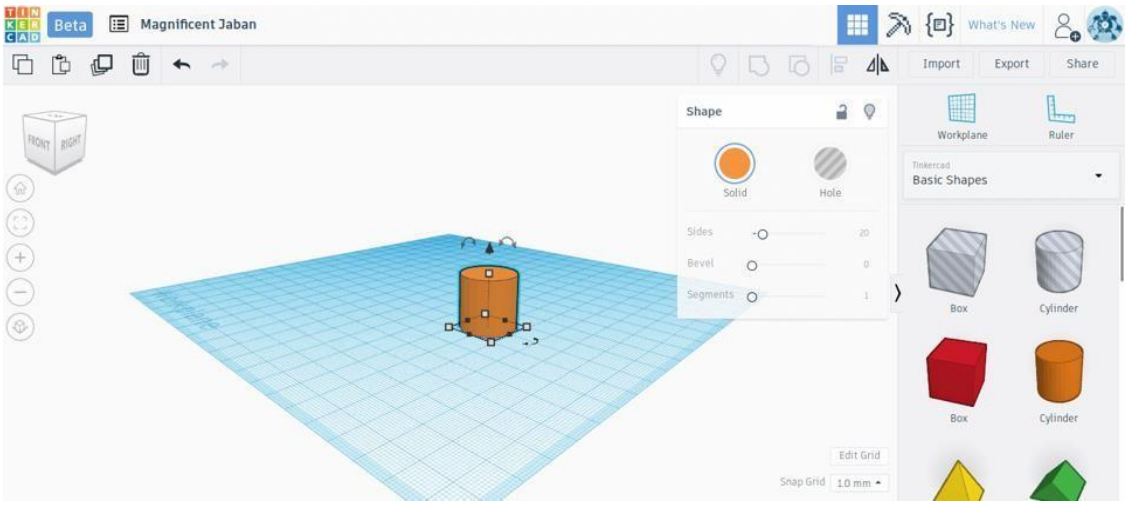
Step 1.1 - Divide and conquer: A key principle in 3D modeling is "divide and conquer." It means that when modeling a complex real world object, we should divide it into smaller geometric shapes and then design these smaller units individually. In the final step, we should put these small units together. This makes modeling a complex object easy.

Applying this principle to the spanner, we divide it into three basic units:

1. The ring
2. The handle
3. The Jaw

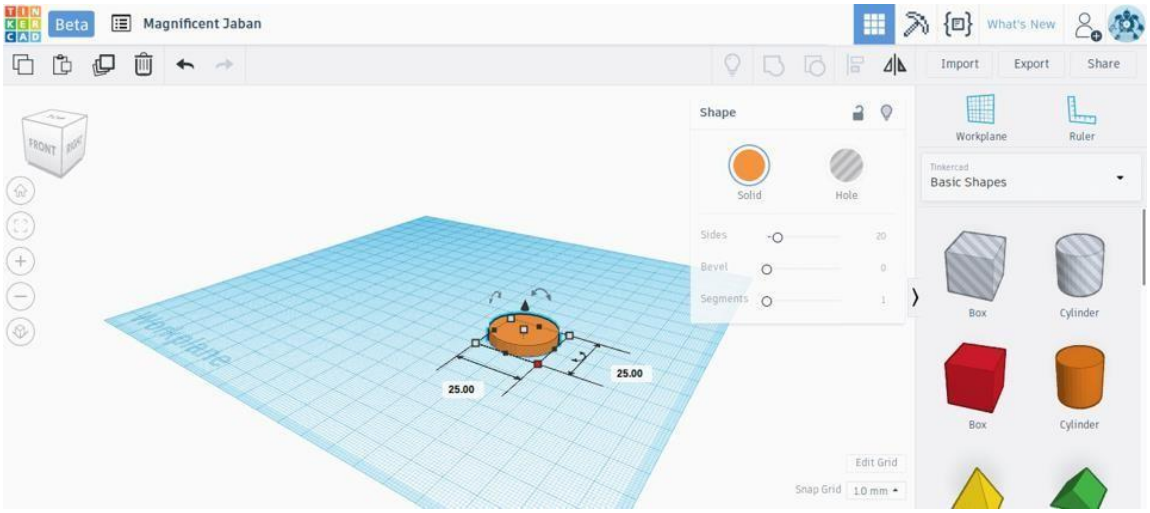
The different parts of a spanner – the ring, the handle, and the jaw. We will start by designing the ring. The ring of a spanner can be approximated by a solid circular disk with a hollow circular area in the middle.

Step 1.2: Creating the solid circular disk - To create this shape, we will first drag a cylinder from the Basic Shapes panel to the workplane. You will notice that the cylinder has five white square handles, four of which are on the plane and one of which is above the cylinder.



The white handles let users change the dimension of a Tinkercad shape.
The four handles on the plane can be used for adjusting the cylinder's length and width. We want our ring to have a diameter of 25 mm. Therefore, drag the square handles till the cylinder has a length and width of 25 mm.

The one above the cylinder can be used for adjusting its height. We want our spanner to have a height of 4 mm. Therefore, click the handle with the left mouse button and drag it down till the cylinder has a height of 4 mm.

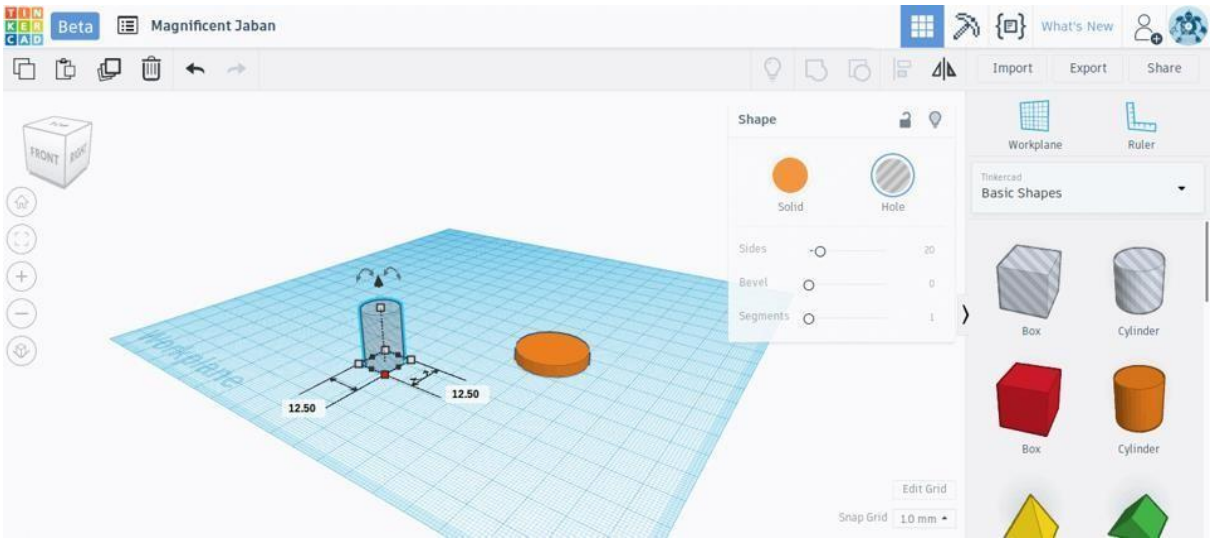


We changed the dimensions of the Tinkercad cylinder to make a disk with diameter 25 mm and height 4 mm.

We are making progress: We now have the solid disk. But how do we make the circular hole in the middle?

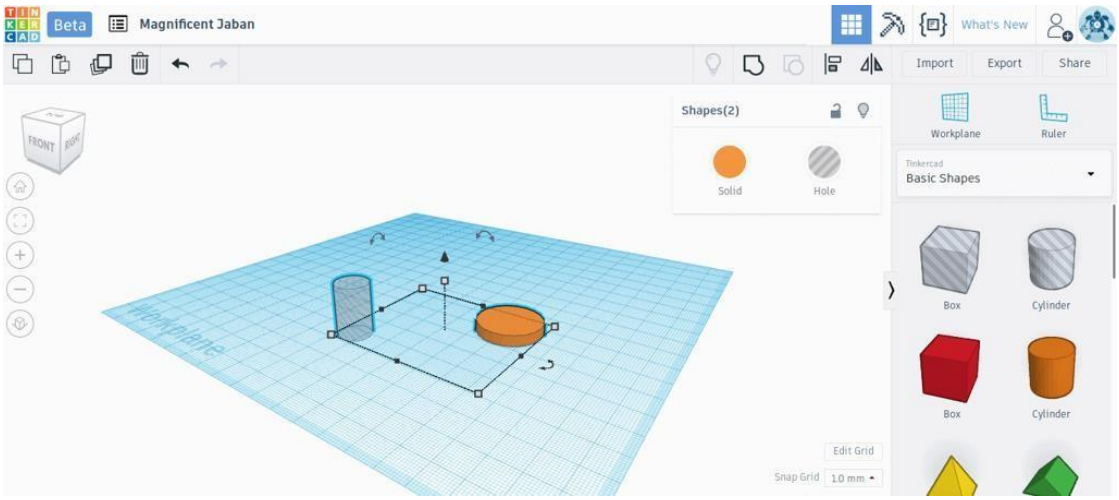
Tinkercad allows you to subtract objects to create hollow areas or add objects to join two shapes. In this case, we will need to use subtraction to create the circular hole in the middle of our ring. Let's see this in the next step below.

.**Step 1.3: Creating the circular hole -** First, drag another cylinder to the workplane. Use the white handles on the plane to adjust the length and width of the cylinder to 12.5 mm, which is the diameter of the hole that we want to create.
Now comes the fun part. With this cylinder selected, choose “Hole” in the panel on the upper right corner (marked by the blue rectangle in the image). This prepares this shape to be subtracted out.

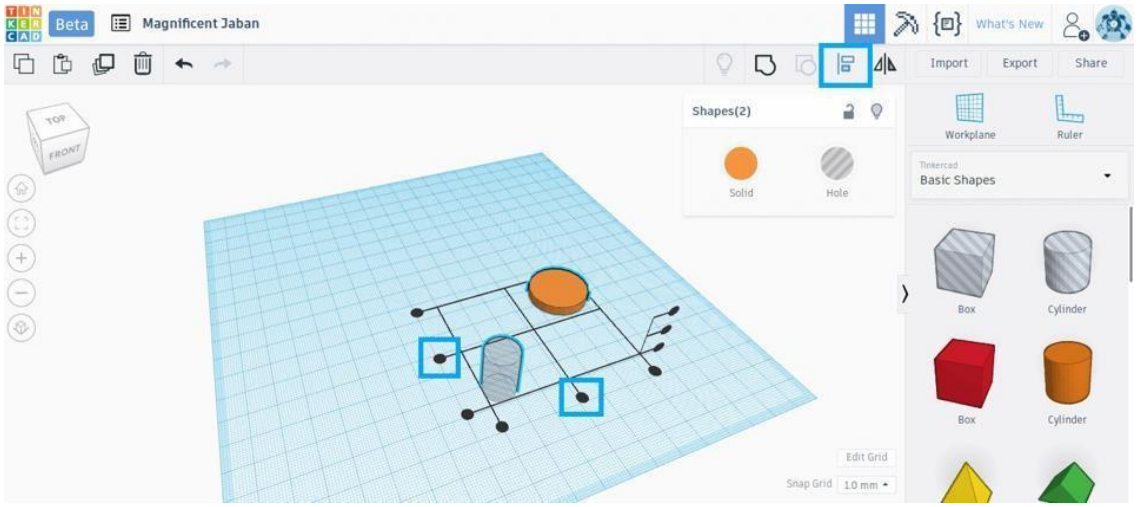


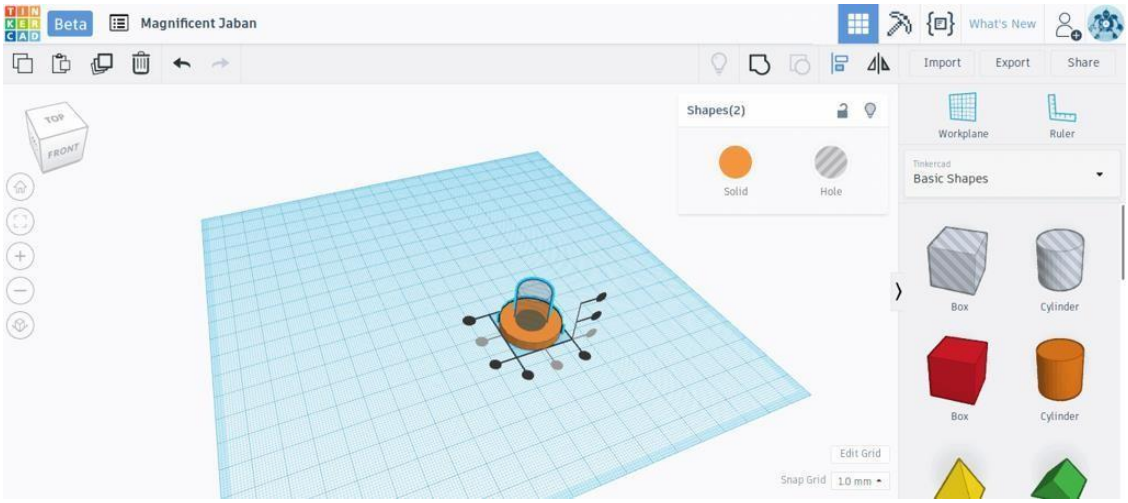
Step 1.4: Aligning the hole and the disk
Next, we need to bring this cylinder-shaped “hole” in the middle of the solid disk. We will use the alignment tool in the top menu to achieve this.

To use the alignment tool, select the cylinder-shaped hole by left-clicking. Now press the shift button and select the solid disk. If you do this correctly, you will see that both objects are now simultaneously selected and highlighted.



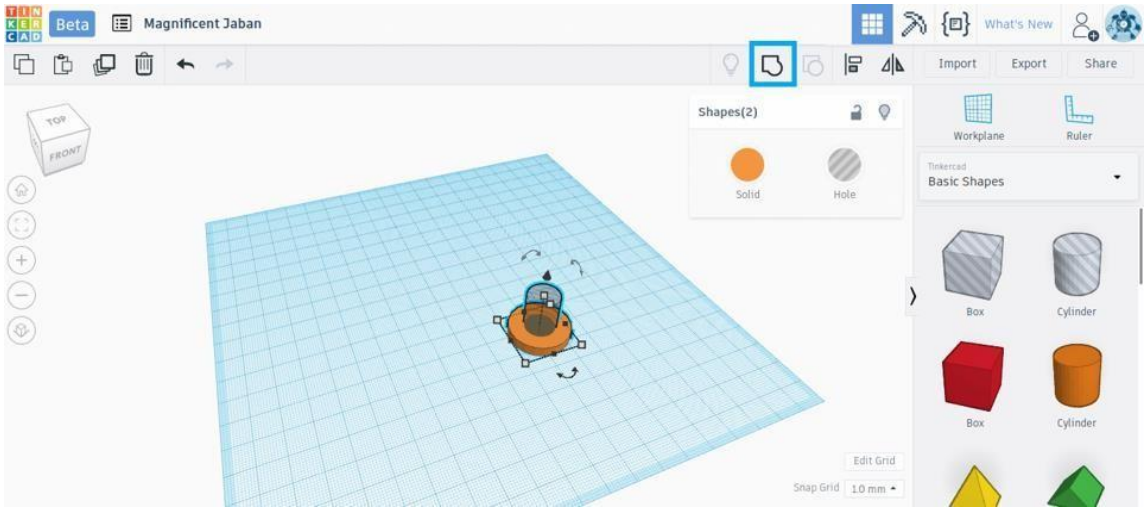
Press the Align button on the top menu (marked with a blue rectangle). Black alignment handles will appear on the workplane. Click on the appropriate handles (also marked with blue rectangles) to bring the solid cylinder in the middle of the solid disk.



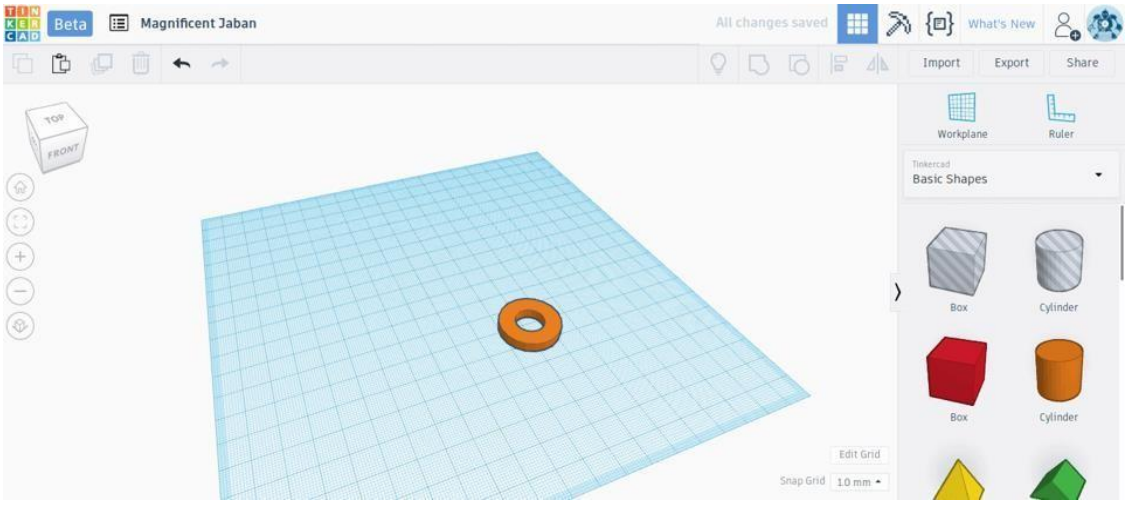


Note - The black alignment handles help align two shapes in Tinkercad.

Step 1.5: Grouping the cylinder shaped hole and the disk to create the ring
When the two shapes are aligned, press the “Group” button in the top menu (marked in the blue rectangle). The Group button essentially joins two shapes together. However, if one of the shapes is a hole, then it creates a hollow area instead.



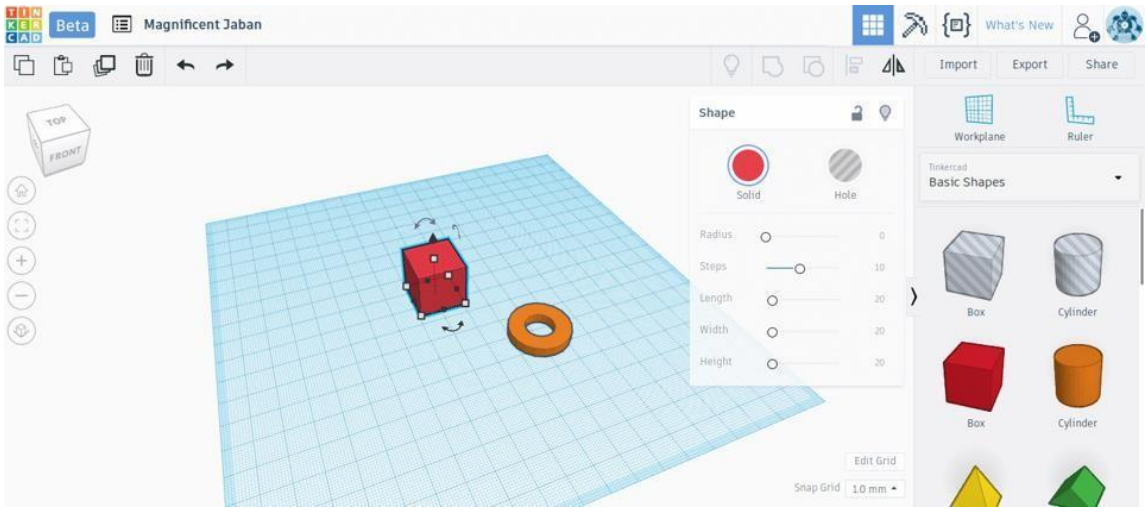
Note - The Group button merges two Tinkercad shapes.



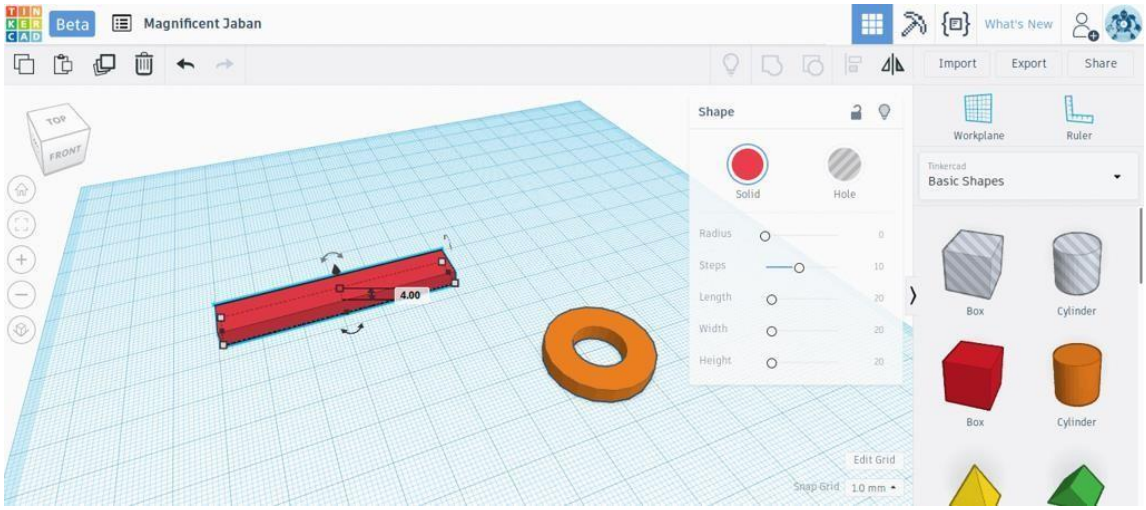
Great! We now have a beautiful ring and have finished the first part in creating our spanner.

Step 2: Design the Handle

Step 2.1: Resize the Box Shape
The handle is probably the easiest part of the spanner.
The handle is rectangular. So we simply drag a box from the basic shapes panel into the workplane.



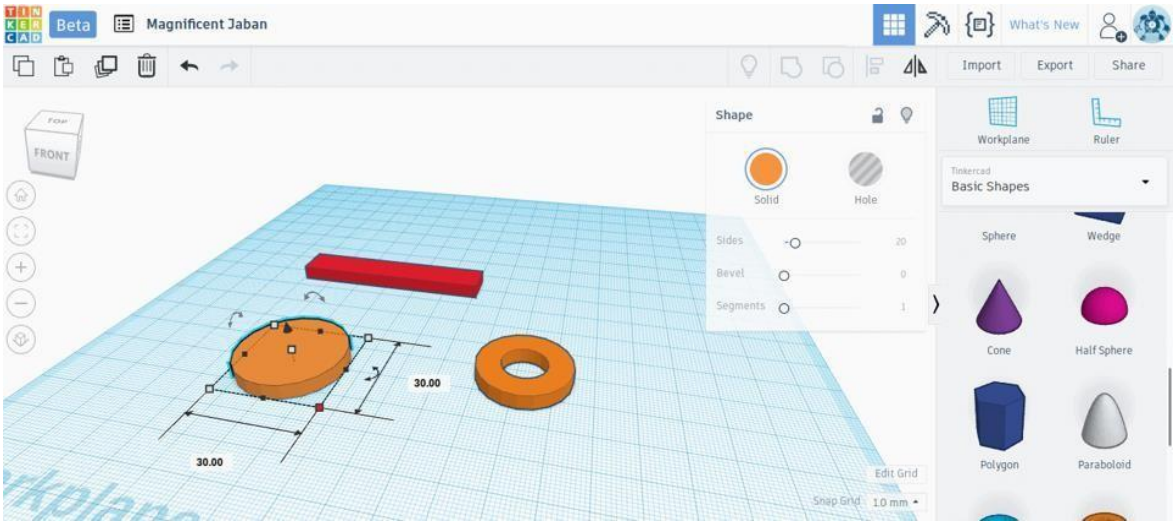
Note *- Using the white handles on the plane, we set the length of the box to 100 mm, the width of the box to 10 mm. By dragging the white handle on the top of the box, we set the height to 4 mm so that it matches the height of the solid ring.*



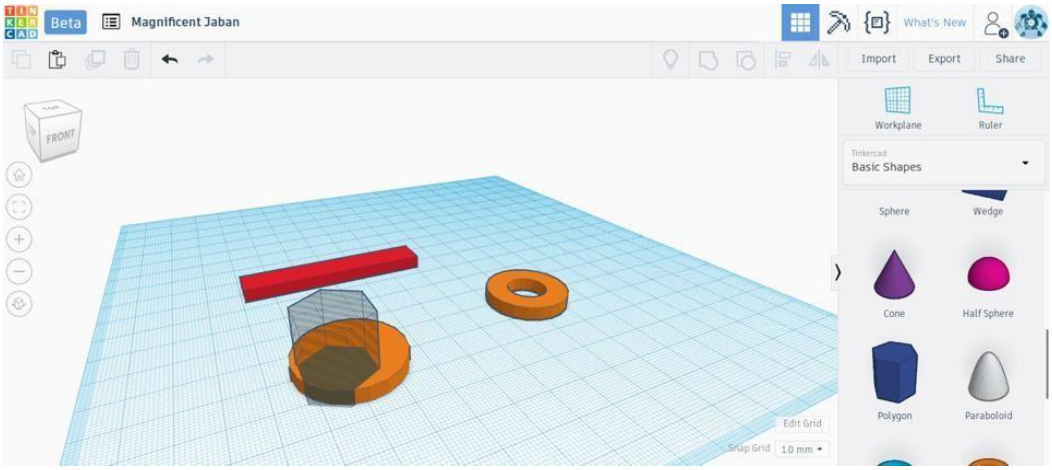
That's it. The handle is ready to go.

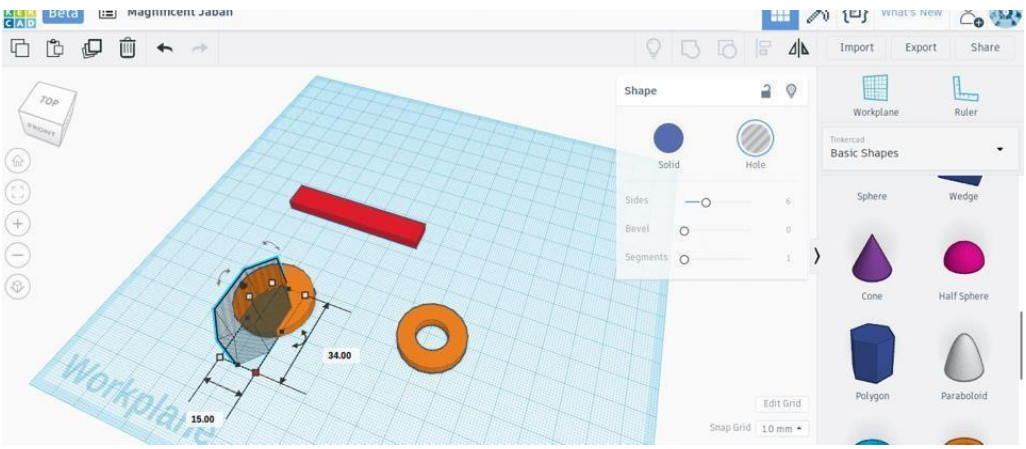
Step 3: Design the Jaw

Step 3.1: Create the Jaw Shape - To create the jaw, we first create a disk with diameter 30 mm and height 4mm. To create the jaw-like shape, we will use the basic shape called “Polygon”. Drag the Polygon to the workplane, select it, and turn it into a hole (as we did earlier).

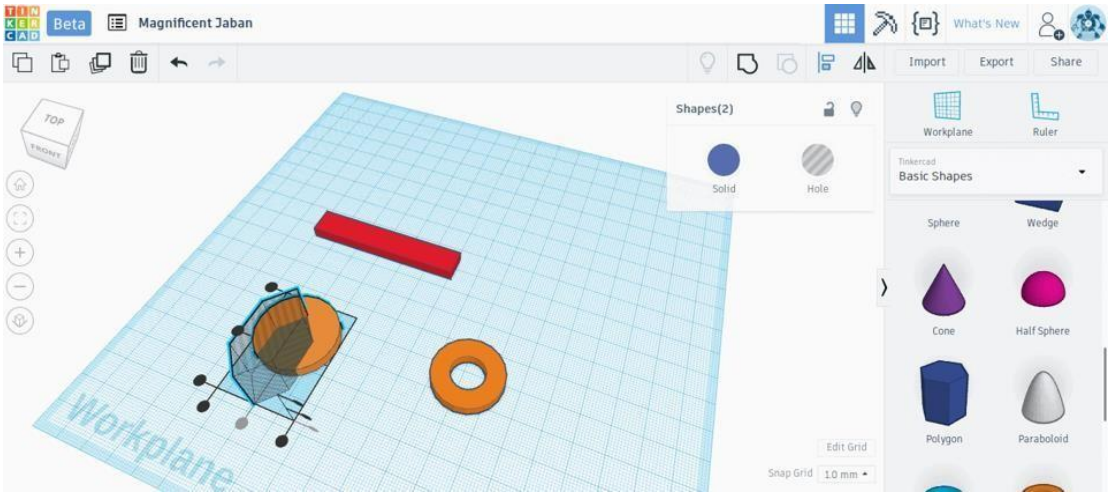


Step 3.2: Change the Dimensions - *Now position the Polygon and adjust its dimensions. We will use a 15 mm jaw and adjust the width of the polygon to 15 mm accordingly.*

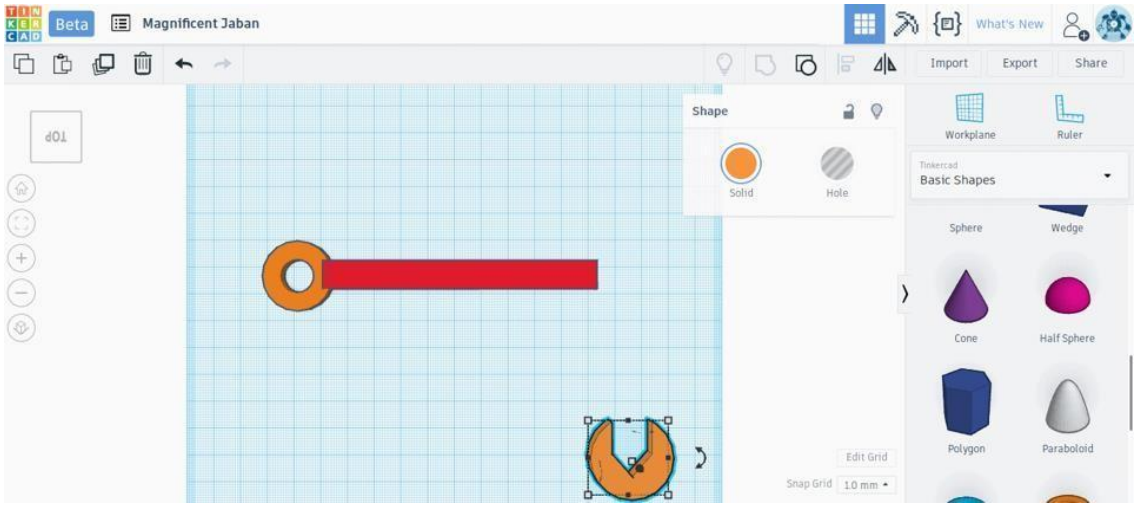




Make sure the polygon is aligned with the center of the disk by using the alignment tool. Select both the polygonal hole and the disk by holding shift and selecting both. When they are selected simultaneously, press the Group button on the top menu (marked in the blue rectangle).



Step 4.1: Align and Merge the ring with the handle - First, position the handle so that it goes a little bit into the body of the ring.

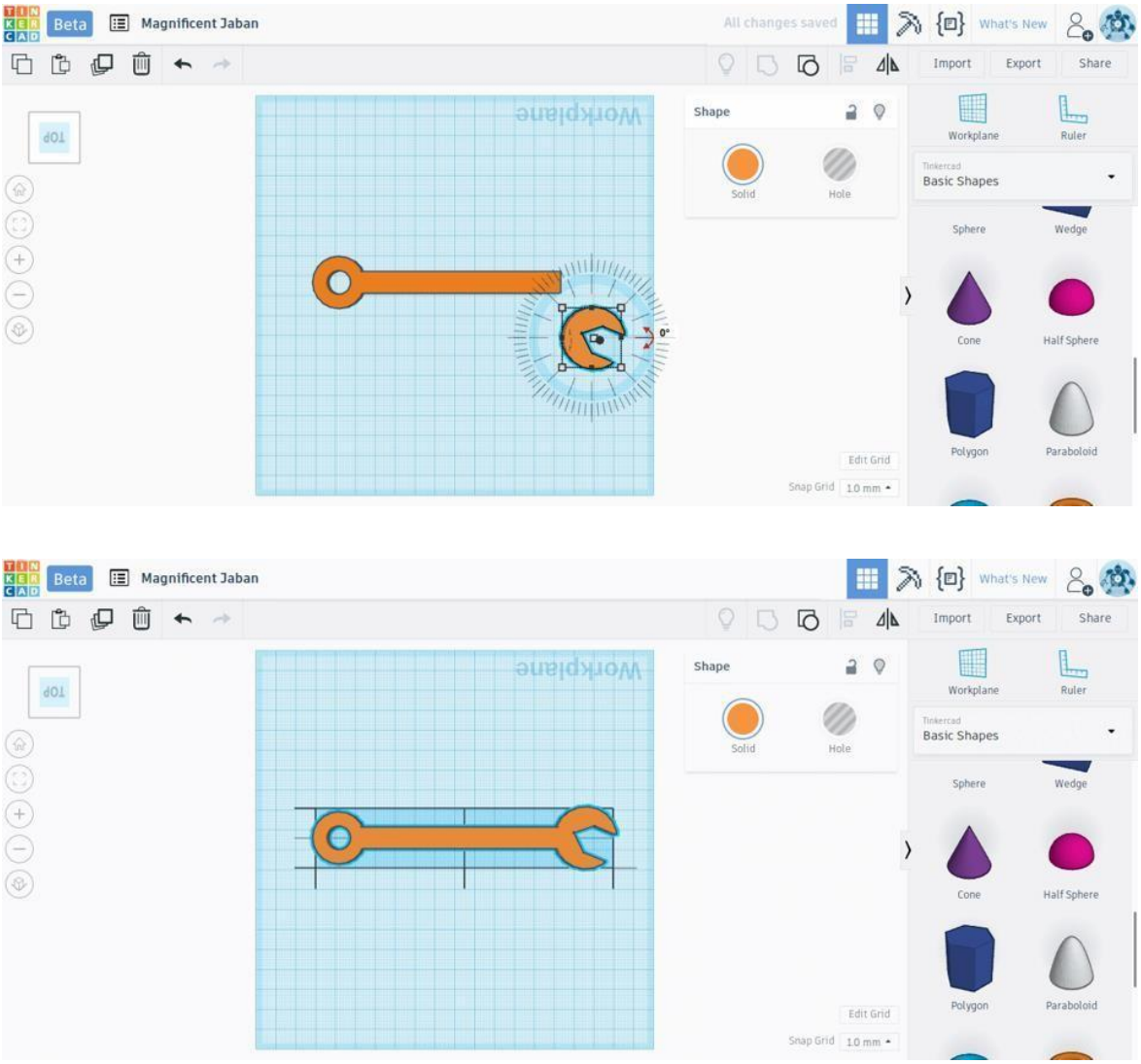


The handle should go just a little bit inside the ring.
Select the handle and the ring together and align it so that the handle aligns with the center of the ring. Now press the “Group” button. This should merge the handle and the ring into one continuous unit.

Notice that the merged unit now has a single color instead of two colors.

Step 4.2: Combine align and Merge all the shapes together

Now, Drag the jaw and position it so that the handle goes a little bit inside the body of the jaw. Select the jaw and the merged unit simultaneously and align them so that the handle aligns with the center of the jaw. Press the "Group" button to merge them.



Source: mneudorf.weebly.com/tinkercad

Note: The jaw should make a small angle to the handle.

Congratulations! You have successfully and amazingly completed your activity. Similarly you can design your required things with these basics steps.

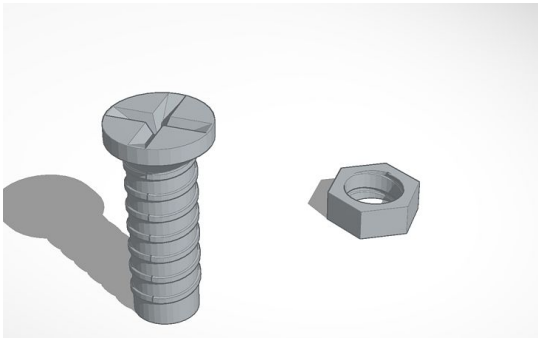
Reflection and Learnings (9 mins):

1. 1. What is a Simple Machine?
2. What will happen when you use the Align option in TinkerCad?
3. What is a Lever? What are the different classes of Levers? Research and find out which category of lever does spanner fall into?

Use the space given below to draw or write your reflections and learnings:

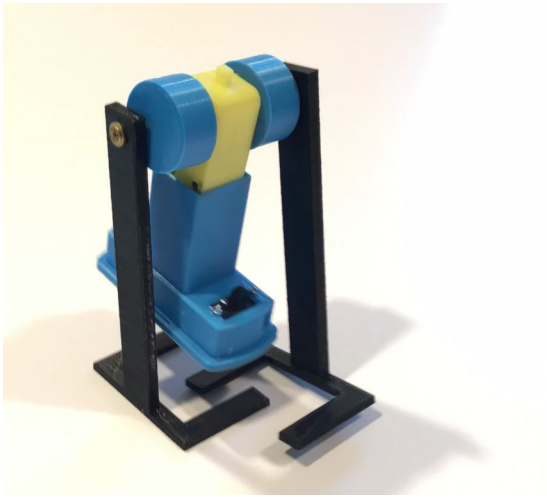
Try it yourself!

Using the concepts you have learnt so far, Try creating a simple Bolt and Nut as shown in the image.



Introduction to Robotics

Robotics is the branch of science focused on learning about and creating robots or machines that can do work.
Engineers, mathematicians, and computer scientists work together to build robots that move, have power and sensors, and complete tasks.



Source:CHEP youtube channel

We are already learned to design stationary objects in Tinkercad today we are going to design and fabricate a movable robot using Tinkercad, we are using the following additional materials to build this robot

Toy Motor

Battery Pack

Screws

Soldering Kit

: 60 minutes

Module: 3D Design and Printing

Grade: 6th to 9th

Importance/ Value:
3D Printing and Design allows children to think, visualize their imaginative concepts and create prototypes on their own.

Learning Goals:

1. Learners will be able to understand mechanical assembly in Tinkercad.
2. Learners will be able to design simple robots in Tinkercad.

Time	Description
01 Min	Check-in-Experience (CIE)
05 Min	Icebreaker
10 Min	Introduction to module
20 Min	Activity
15 Min	Challenge
09 Min	Reflection and Learnings

Icebreaker (5 mins):

I went to market and bought a___

To play, Form a circle, one person starts off by saying, 'I went to market and bought a _____', adding a grocery item he or she would buy. The next player continues by saying, 'I went to market and bought a <first player's item> and a _____'. Each player continues, adding items to the list as they go along. When a player makes a mistake, they are eliminated and the game continues until there is only one person left.

Safety Measures:

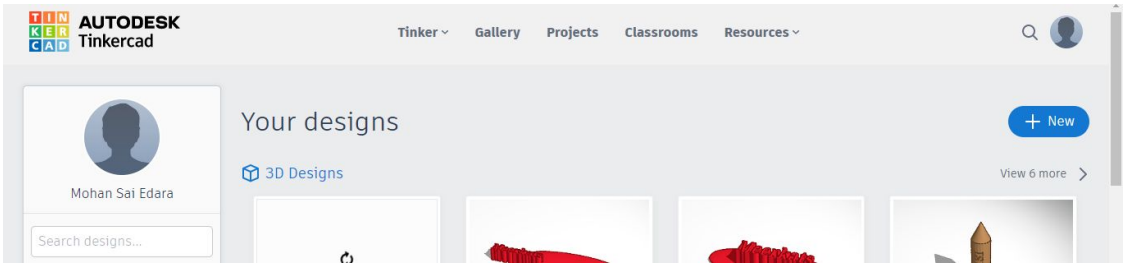
1. Put your 3D printer in an area which isn't easily accessible
2. Wear gloves when handling your 3D printer.
3. Keep a mental note in your head that your 3D printer gets very hot.
4. Only reach for your printer when you are certain it's off

Activity: Design & 3D Print a Walking Robot

Today we are going to design a walking robot using Tinkercad and after that, we will 3D print it, we need to attach a toy motor, battery pack, etc after 3d printing to make robot operational.

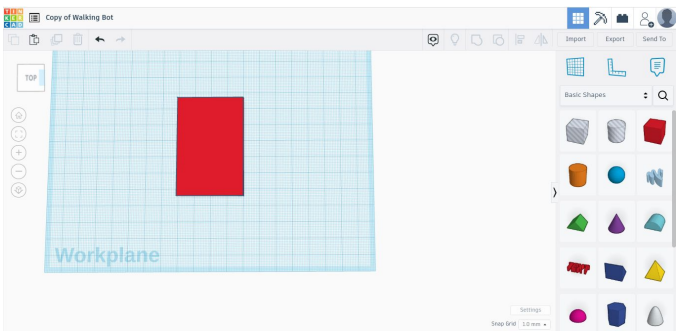
Step 1: Open a browser and type tinkercad in the url and press enter. Click on the first result www.tinkercad.com and you will be redirected to a tinkercad website. Click on sign in and use your google account or autodesk account to sign in to the tinkercad website.

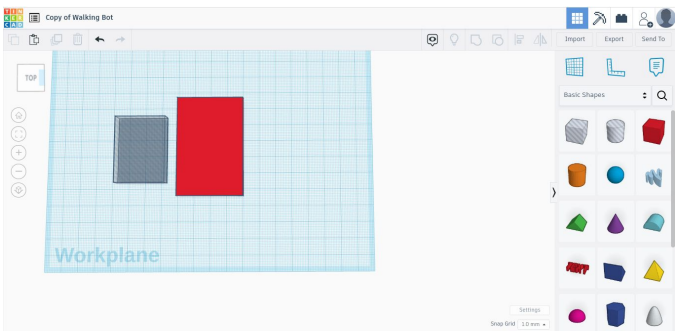
Step 2: After logging in, click on "+ New" to start a new design.

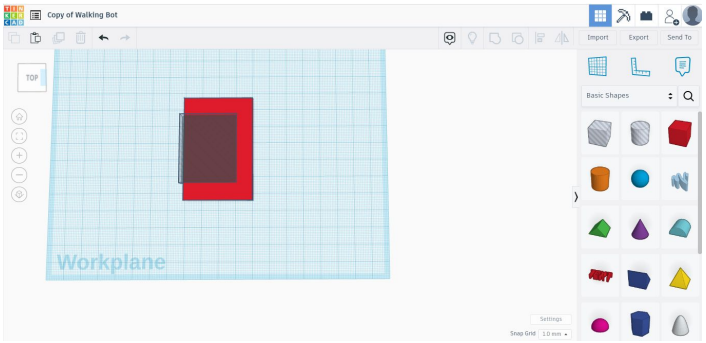


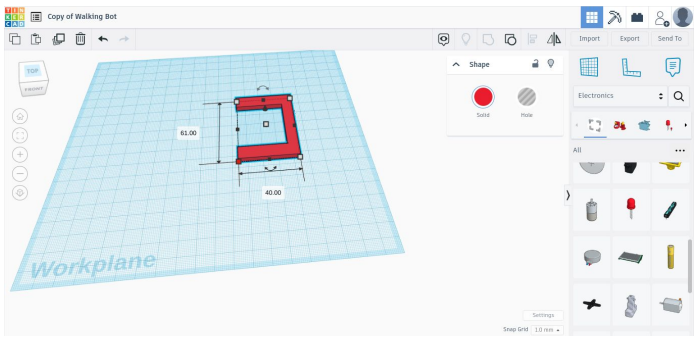
Step 3: First we need to create the base of the Robot leg

- Insert a solid box and change its dimensions to 60MMX40MMX3MM
- insert another hollow box with 40MMX30MMX5MM
- Group this two shapes and will get base of leg.



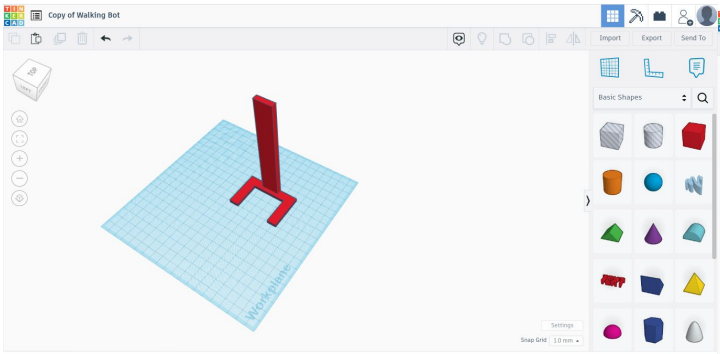


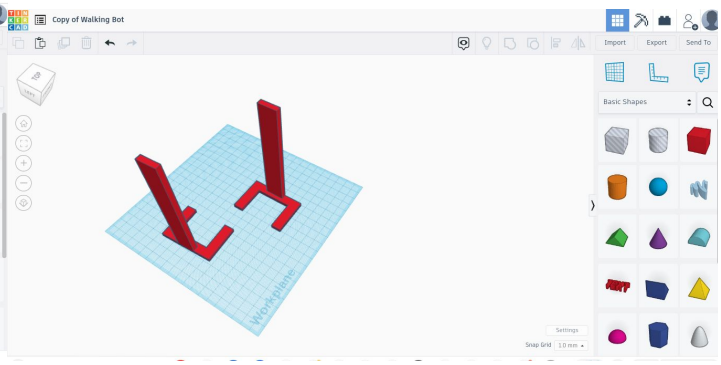




Step 4:

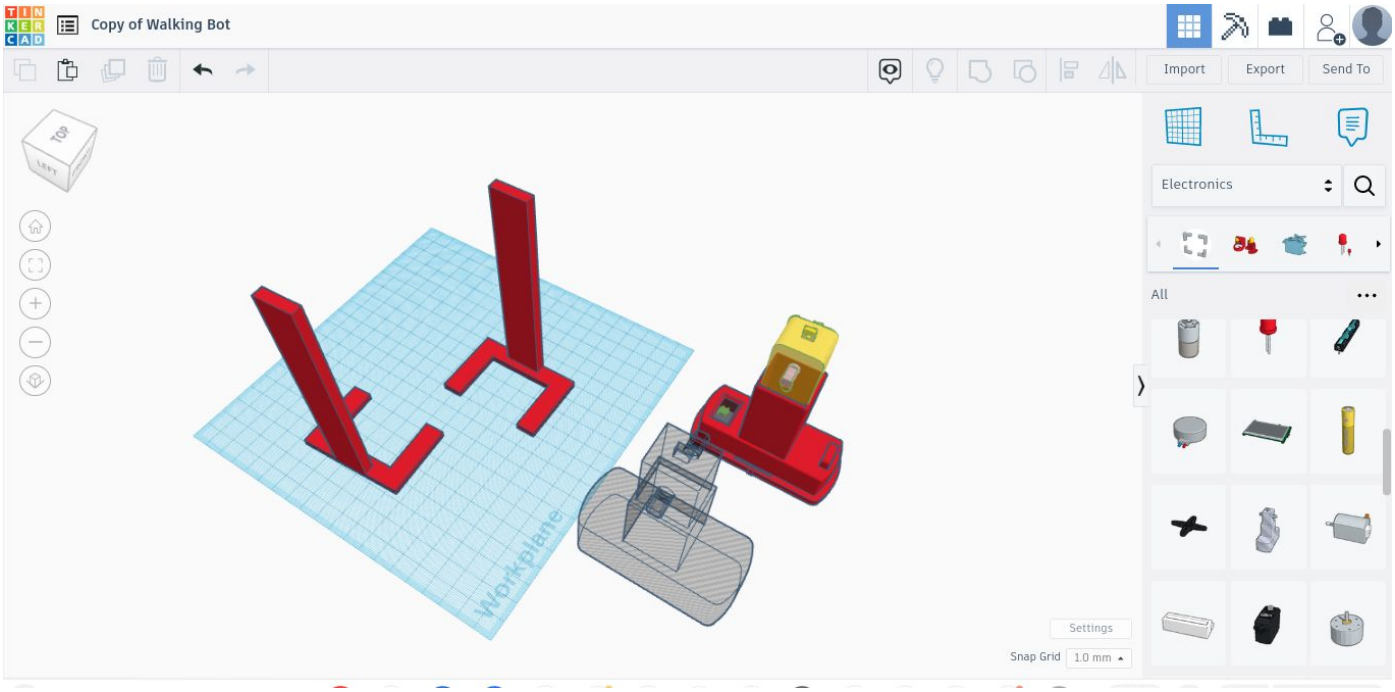
- Insert a solid box, change the dimensions 10MMX5MMX120MM and place it as shown in the image.
- Group the two parts of leg.
- Copy and paste the leg, we need two legs.





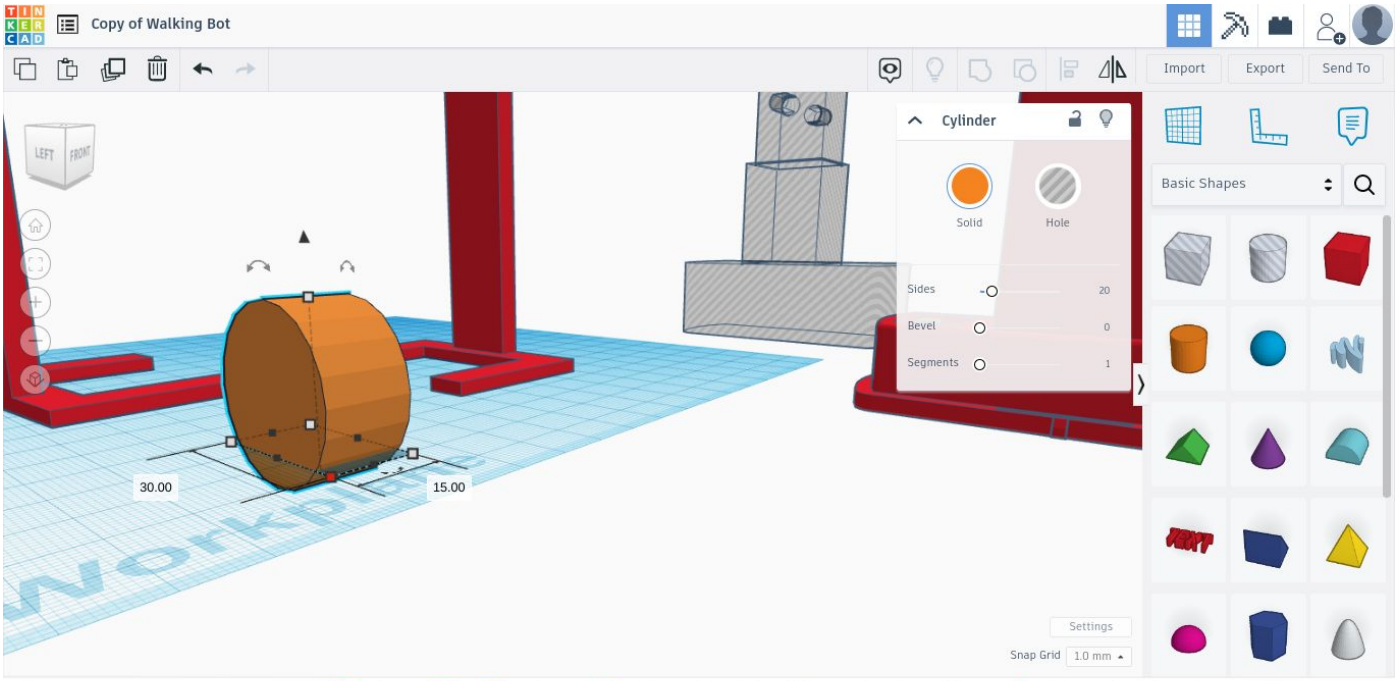
Step 5: Insert the motor part from the tinkercad assembly library for getting accurate measurements, we will need both the 3D Model and the Hollow cut part.

- Go To Toolbar (Right Side) -> Select Electronics ->Scroll Down and Select Spin
- Similarly insert Spin Cutout



Step 6: Design an attachment for connecting the robot leg and motor.

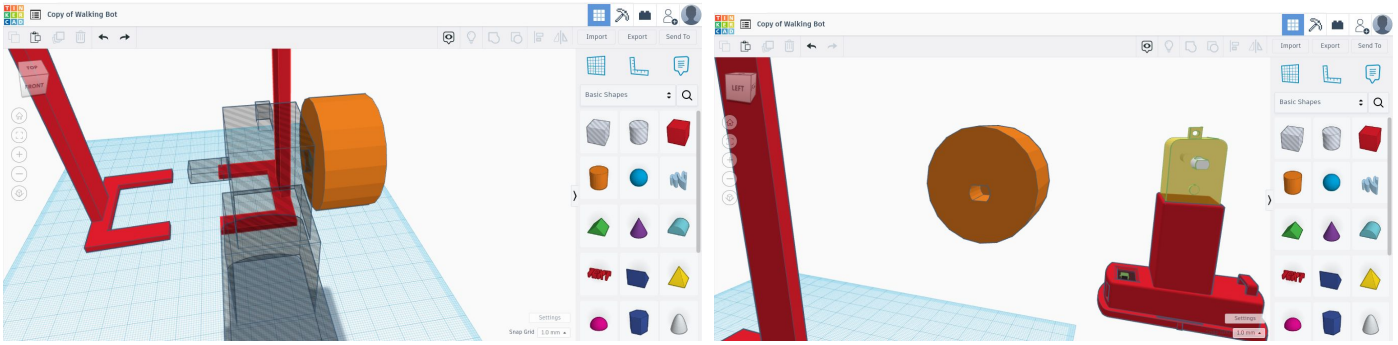
➢ Insert a cylinder and change dimensions (Diameter 30MM, Height 15 MM)



Step 7: Design an attachment for connecting the robot leg and motor.

➢ First we need to take the hollow cut out model of motor for making holes.

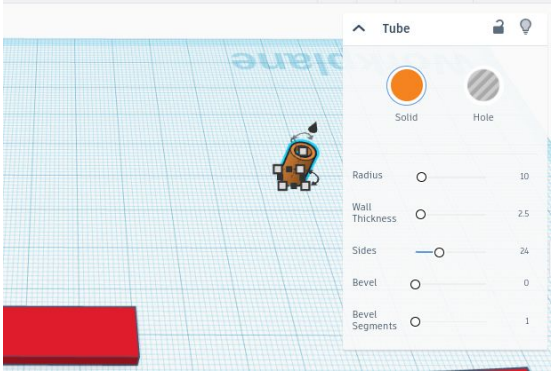
➢ Group motor hollow part and cylinder for getting a hole for holding motor.

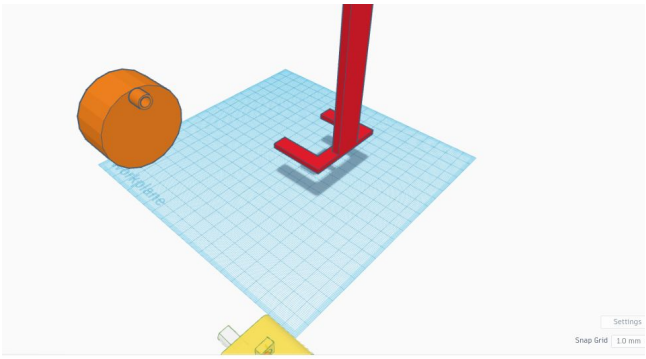


Step 8: Add a small cylinder to hold the attachment and leg.

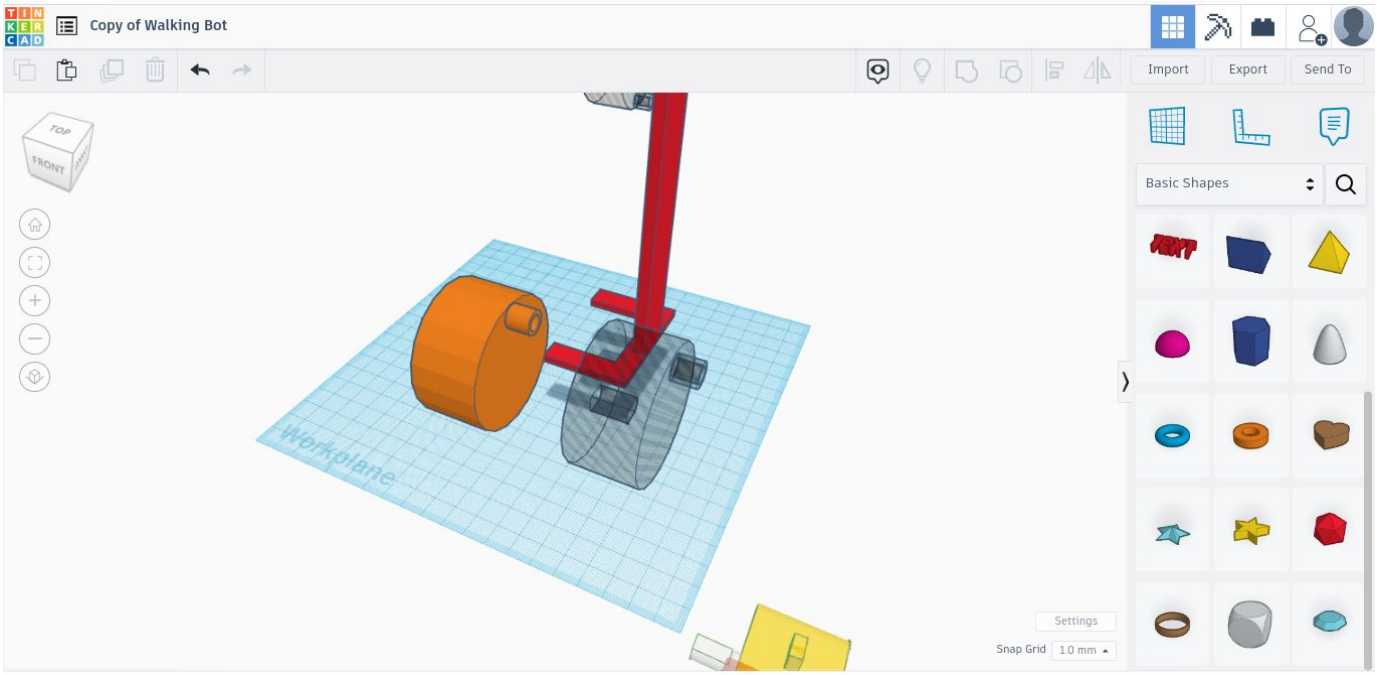
➢ Insert a tube with a 5MM radius and 5MM length.

➢ Attach the tube to the cylinder already created and group them.

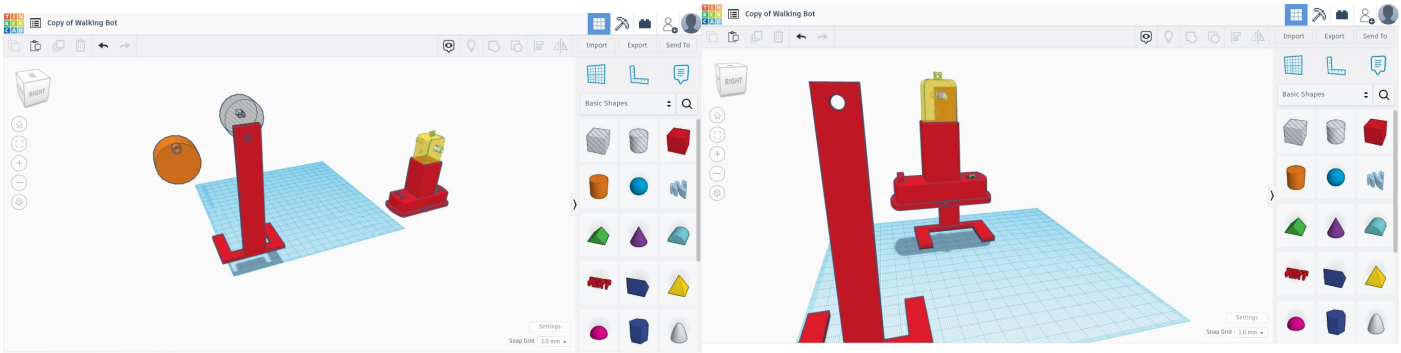




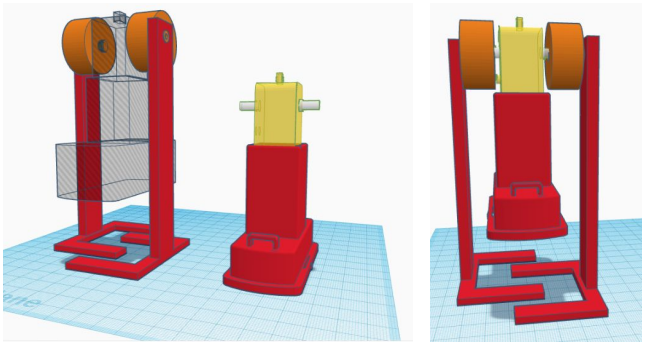
Step 9: Make a copy of the newly created attachment and make it hollow (we need a hollow model to make a hole in the robot leg).



Step 10: Group robot leg & the hollow attachment to make a hole as shown in the image given below.



Step 11: Make two copies of leg & cylinder attachment and assemble the robot.



Step 12: Export all STL files and 3D print it

Step 13: Assemble the robot using 3d printed parts and motors using a screw

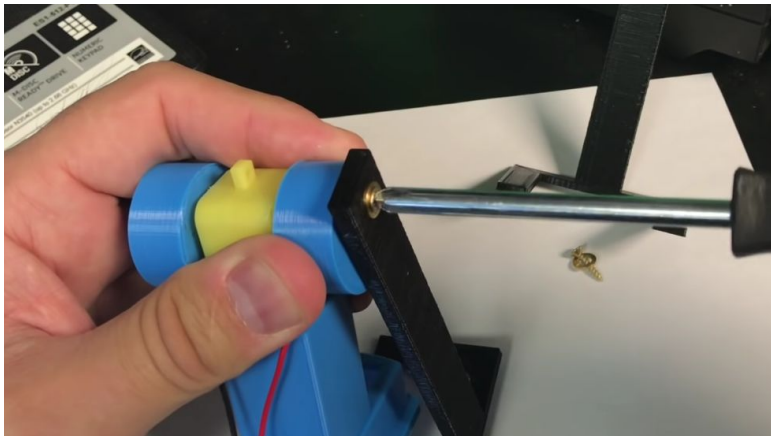


Image Source : CHEP Youtube Channel

Step 14: Take battery box and solder positive and negative terminals of battery to toy motor (Optionally you can add a switch otherwise connect battery terminals directly to battery).

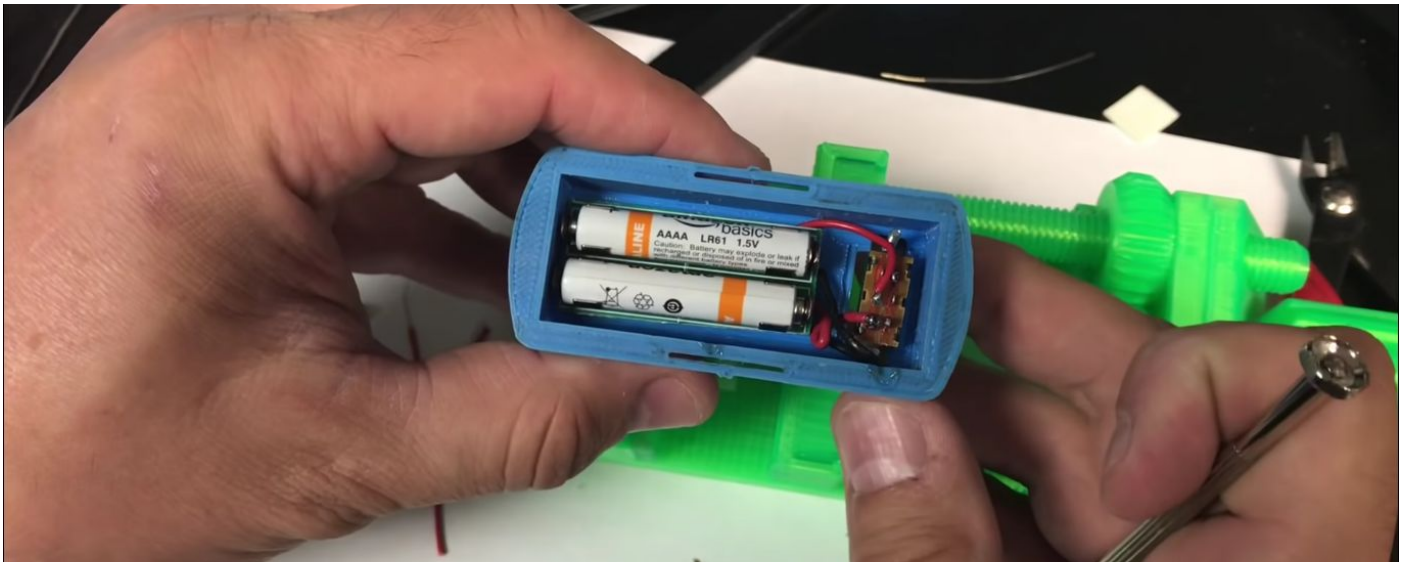


Image Source : CHEP youtube channel

Congratulations! You have successfully fabricated your first robot using Tinkercad.

Reflection and Learnings (9 mins):

1. What do you think is the difference between a Robot and Human ?
2. What will happen when you use the “Hole” option in TinkerCad?
3. Imagine you got a change to 3D print an item that solves a problem in your locality, what you would you 3D print and how will it solve the problem?
4. What did you or your team struggle with while doing this activity and why? How can you improve next time?

Use the space given below to draw or write your reflections and learnings