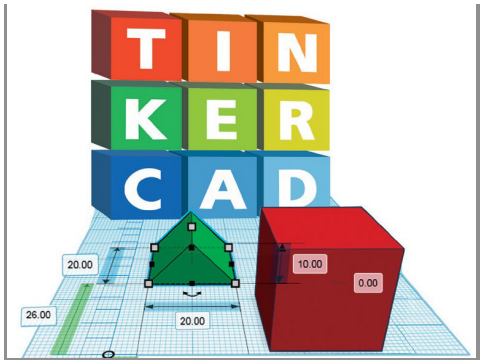
8 3D Printing Using Tinkercad

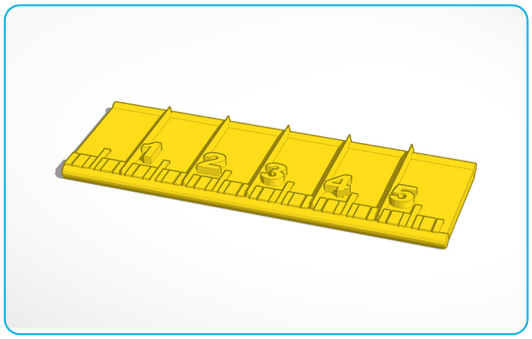
Let's Learn

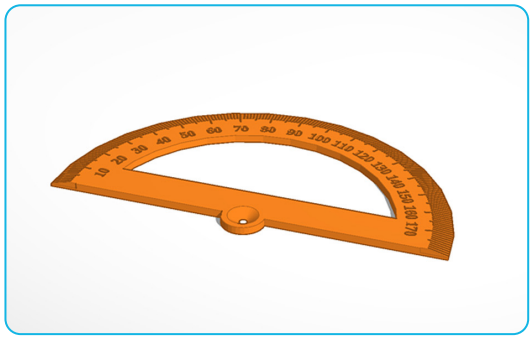
- to use the ruler tool
- to explore the edit grid and snap grid tool
- to change the size of the workplane
- to change the measurement units
- to create designs using precise measurements
- to convert 2D images into 3D objects
- to understand the 3D printing process
- to identify the different components of a 3D printer
- to identify the various components of 3D printing software XYZware



Jump Start

You wish to design simple tools that can be used to draw geometric shapes in Tinkercad as shown below. The numbers and the measurements lines of these tools should be placed accurately so that they can be used practically by students. Which tools in Tinkercad will you use to design these objects?





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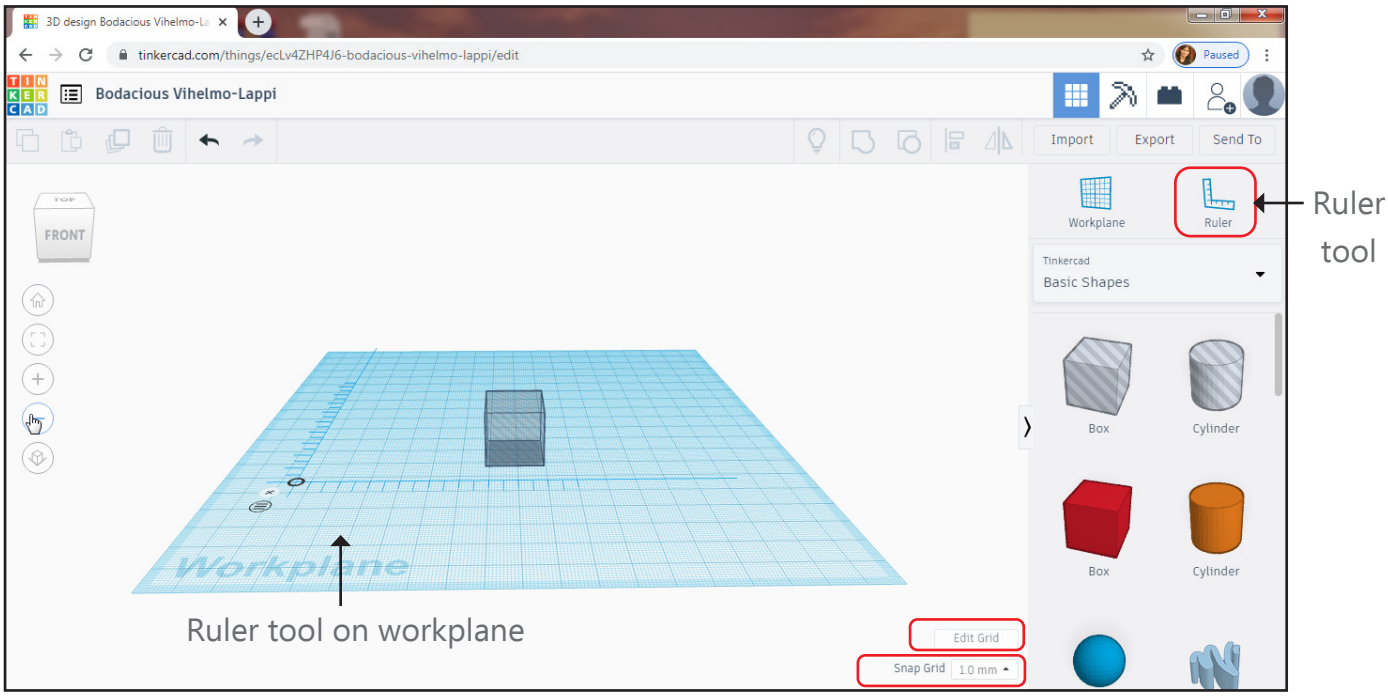
You know that Tinkercad is a simple online 3D design tool that is used to create simple designs from scratch or to quickly modify existing designs. These designs are stored on the cloud, and therefore, they can be accessed easily from anywhere using an internet connection.

In the previous class, you learnt to create simple 3D models using the different features and basic shapes in Tinkercad. You will now learn to create 3D models using proper measurements. You will also learn about the process of printing objects using a 3D printer.

Tinkercad also provides additional tools that allow you to create 3D objects with appropriate dimensions and accurate movements. This is very useful while making individual parts of an object that have to be fitted together to create the object. Let's take a look at some of these tools.

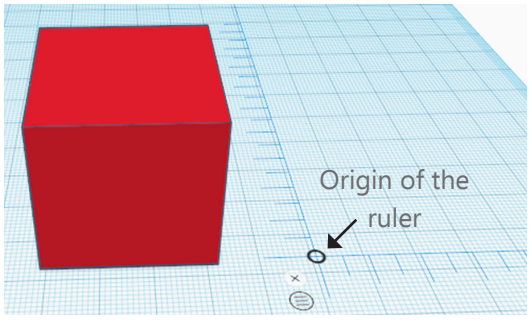


Tinkercad interface

Ruler Tool

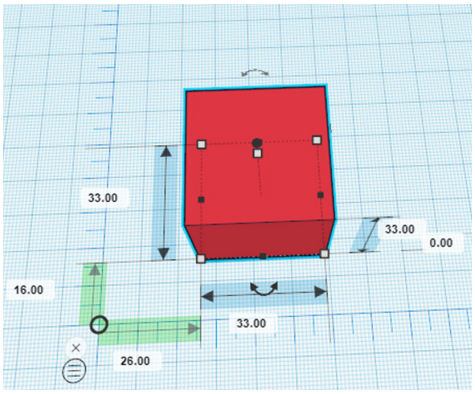
The ruler tool is present on the right-hand side of the Tinkercad window. It allows us to view different dimensions of objects and distances between them. If you click an object near the ruler, it will show distances from the ruler in two directions. The ruler has a positive and negative side similar to the X axis.

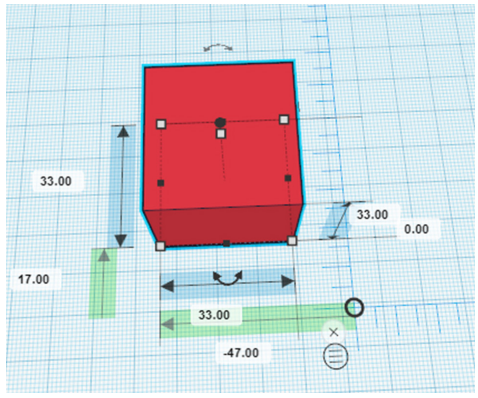
To use the ruler, you can simply drag the **Ruler** tool from the top-right section onto the workplane.



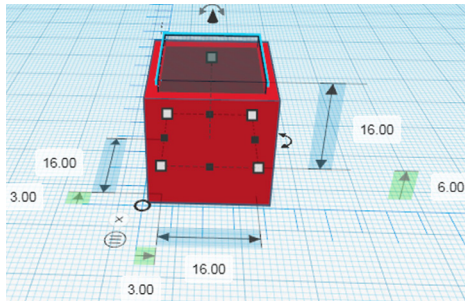
You can click and drag the circle to move the ruler. It allows you to align the ruler to any node of your object by dragging it.

In the first image given below, the object is placed on the right side of the ruler; therefore, it shows a positive distance. The green horizontal arrow displays the distance of the object from the origin of the ruler. The second image shows that the object is placed to the left side of the ruler origin, so it shows a negative horizontal distance. Here, the green horizontal arrow displays the distance of the object from the origin of the ruler that also includes the width of the object.

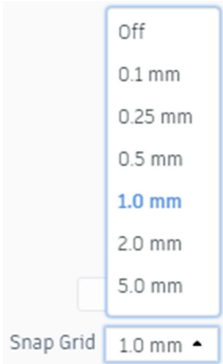




The ruler can be also used to measure holes in an object. For example, if you line up the ruler tool with the two edges of a shape, you can see the distance of the hole from those edges. To dismiss the ruler, click on the **x**.



Snap Grid

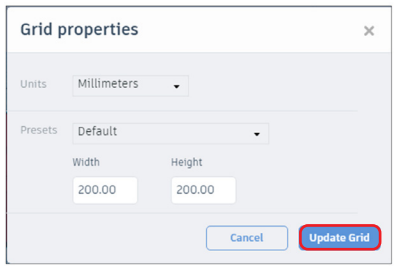


Tinkercad allows you to move objects placed on the workplane in mm using the arrow keys. If you wish to change to smaller or larger movements, you can use the **Snap Grid** tool provided by Tinkercad. The Snap Grid is placed at the bottom right corner of the design area. You can click the drop-down arrow to see the snap grid options. The lower the number, the higher the precision with which you can move objects.

Edit grid

We know that a workplane consists of a blue grid where objects are placed to create different designs. The default measurement of the workplane is 200 x 200mm. However, it is also possible to modify the size of the grid in Tinkercad. This is useful when you want to make sure that your design will fit on your printer without having to scale it.

Steps to modify the size of the grid

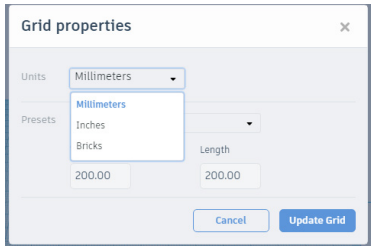


Step 1: Click the **Edit Grid** option present at the bottom right corner of the workplane.

Step 2: Enter the desired width and height of the new grid that you would like to use.

Step 3: Click the **Update Grid** option to change the size of the workplane.

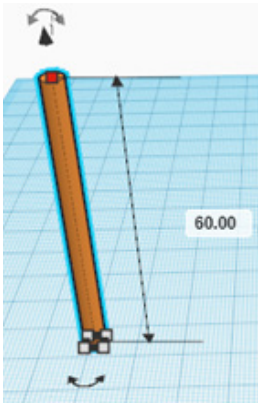
Changing the units of measurement



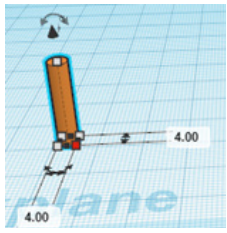
Almost all 3D programs use millimetres (mm) as the unit of measurement. Tinkercad allows you to change measurements using the **Edit Grid** option. In the **Grid properties** window, click the drop-down arrow of **Units** to switch from Millimeters to Inches.

Creating a Key

To create a key using measurements, click the Create new design button to open a new design and follow the steps given below:

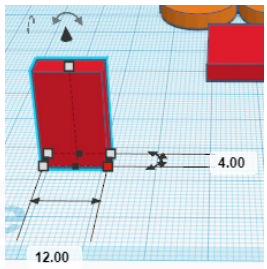


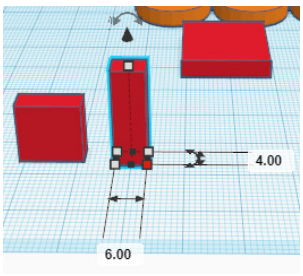
Step 1: Add a cylinder to the workplane and change its diameter to 4mm.



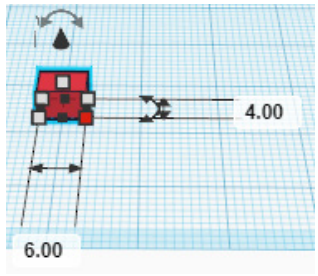
Step 2: Click the top point of the cylinder and set the length to 60mm. You can also pull the point vertically upwards until the cylinder has a length of 60mm.

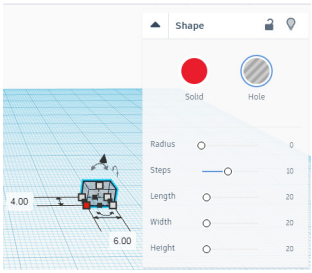
Step 3: Add a box to the workplane and set its base to 12mm x 4mm. Set the height to 12mm.



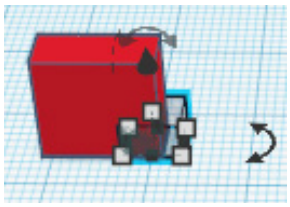


Step 4: Add another box to the workplane and set its dimension to 6mm x 4mm. Change the height of the box to 4mm.

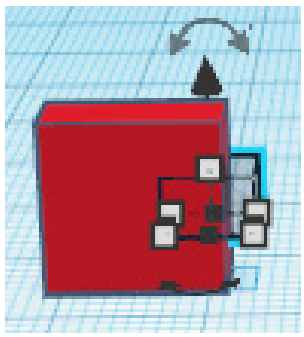


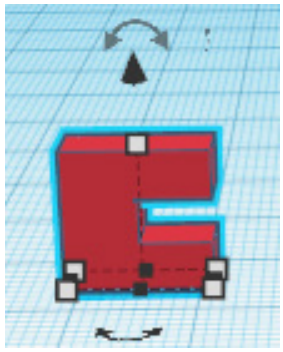


Step 5: Select the 6x4x4 box and change the format of the object to Hole using the Inspector menu, at the top right of the page.

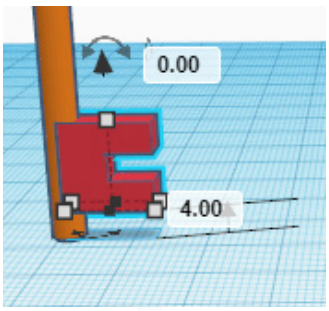


Step 6: Bring the hole-type box closer to the base of the larger box and raise the hole-type box using the black cone-shaped arrow until the distance of the box from the base is 4mm.

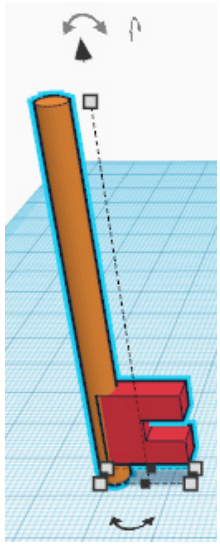




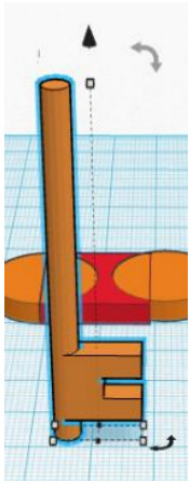
Step 7: Select both objects and click the **Group** tool . The group tool merges both the boxes to form a box with a cut out as shown.



Step 8: Bring the Box close to the 4mm diameter cylinder by clicking and dragging it. Make sure the box touches and overlaps the cylinder.

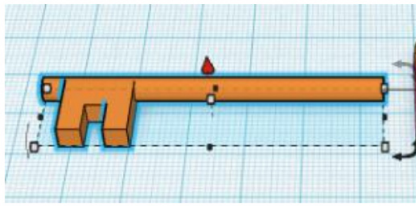


Step 9: Keeping the box still selected, click and drag the cone-shaped arrow at the top to raise the object to a height of 4mm from the base.



Step 10: Select both the cylinder and box, and use the Group tool to merge both objects together. This creates the lower part of the key.

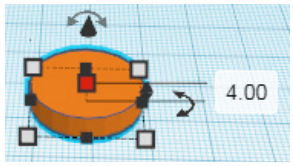
Step 11: Keeping the lower part of key selected, drag the rotation arrow at the top right corner of the object and rotate the object to 90° to make it parallel to the workplane.



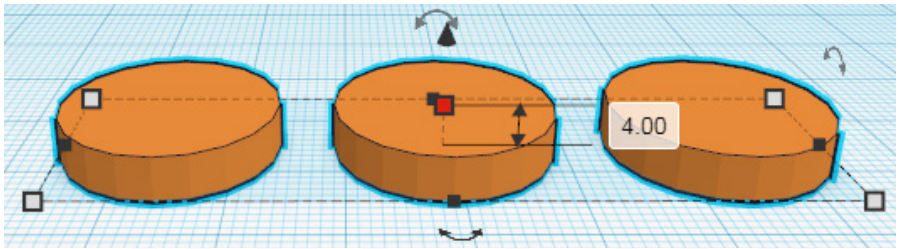
Step 12: Bring the lower part of the key down to the workplane by clicking on the cone-shaped arrow and dragging it down vertically.

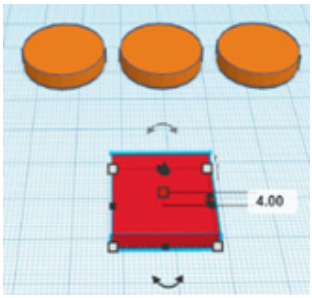
Step 13: Select the **Cylinder** object under the Basic Shapes section of the right sidebar and drag it on the workplane.

Step 14: Select the white point at the top plane on the cylinder object. A textbox appears displaying the current height of the cylinder. Change the height of the cylinder by typing 4 in the textbox.



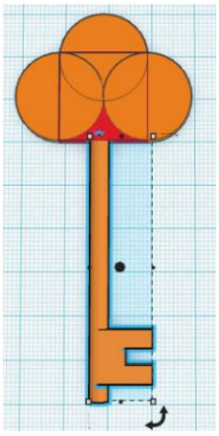
Step 15: Select the resized cylinder and click the **Copy** button on the top left bar of the Tinkercad design environment. Copy and paste the cylinder again to have a total of 3 cylinder objects on the workplane.



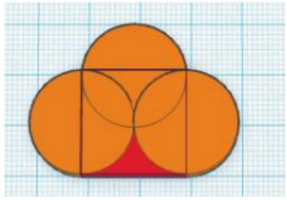


Step 16: Select the box object in the Basic Shapes and click on the workplane to place the box on it.

Step 17: Change the height of the box to 4 mm.

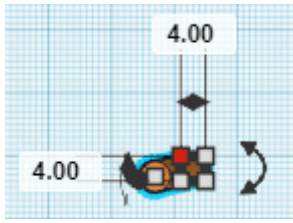


Step 18: Move the three cylinder objects to intersect with each other as shown within the box.



Step 19: Move the lower part of the key to the center of the intersecting cylinder and box objects as shown.

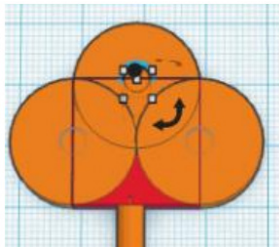
Step 20: Add another cylinder object to the workplane and change its diameter to 4mm. keep the Shift key pressed while dragging the corner handle.

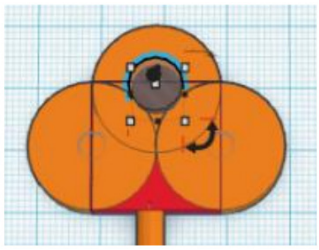


Quick tip

You can resize an object proportionately by selecting the object, pressing the Shift key and dragging any one of the selection handles away or towards the centre of the object.

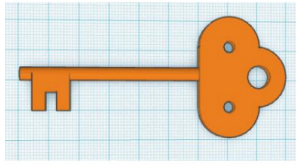
Step 21: Change the cylinder to a hole using the **Hole** option in the Inspector menu. Move the hole cylinder to the center of the topmost larger cylinder.





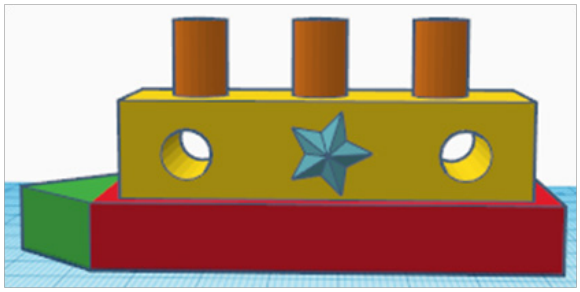
Step 22: Copy and paste the hole-type cylinder twice to make two more copies. Change the diameter of these cylinders to 8mm and make sure they are aligned with the centre of the left and right larger cylinders.

Step 23: Select the objects on the workplane and use the **Group** tool to merge them together to create the final key.



Learn by Doing

Create a boat in Tinkercad with the dimensions given below.



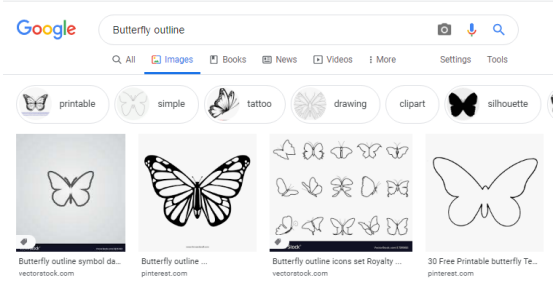
- Set the length, width and height of the base to 70mm, 30mm and 5 mm, respectively.
- Set the length, width and height of the yellow box above the base to 62mm, 22mm and 15 mm, respectively.
- Set the diameter of the smokestacks to 8mm and height to 12 mm, respectively.
- Place the smokestacks in such a way that they are 19mm apart from each other.
- Place the cabin windows of radius 8 mm at a distance of 11mm from the edges of the yellow box.
- Ensure that both the windows are placed at a distance of 10mm from the yellow box and 52mm apart from each other.
- Add a star or any other shape of your choice at the center of the boat.

Converting 2D Images into 3D Objects

Tinkercad allows you to convert certain 2D images into 3D objects so that you can use them in your designs. The 2D images must have only solid colours and not include gradients or shadows. To convert a 2D image to 3D object, you need to convert the image into the SVG format.

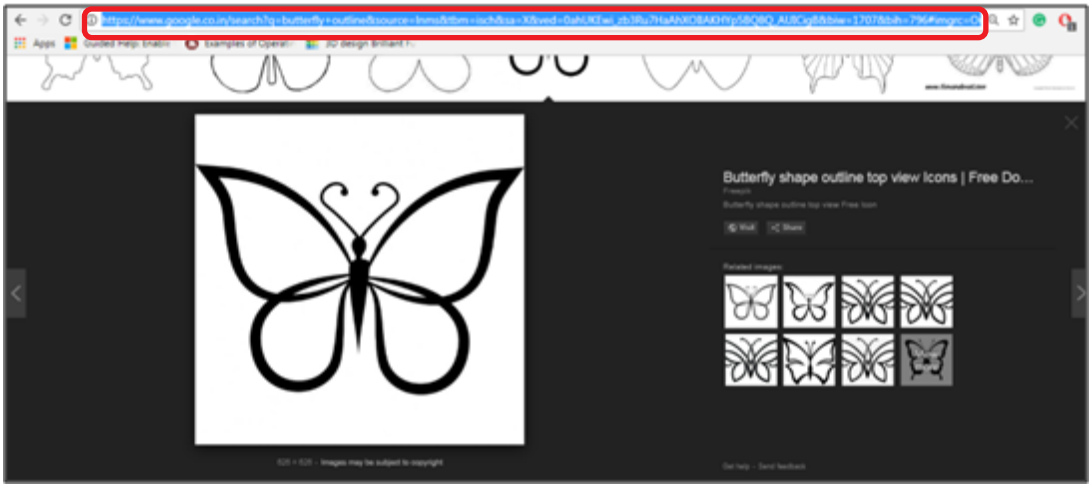
Steps to convert a 2D image into 3D object

Step 1: Search for a 2D image that you wish to convert on the internet.



Step 2: Identify the format of the selected image, for example JPEG, PNG and so on

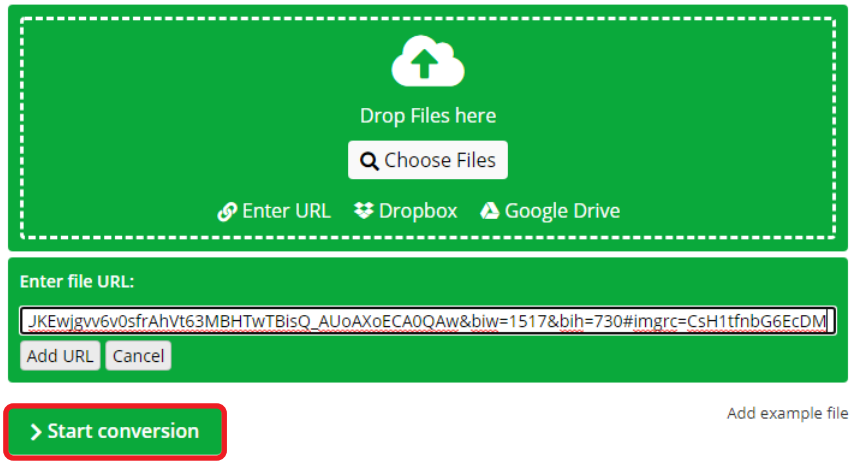
Step 3: Copy the URL link of the image.



Step 4: Convert the image to an SVG (Scalable Vector Graphic) format by using a free online tool.

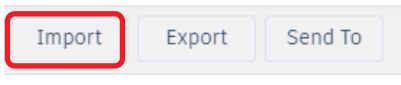
Step 5: Search for free online image converters that help convert an image to the SVG format.For example: https://image.online-convert.com/convert-to-svg

Step 6: You can select the file saved in your computer directly by clicking the **Choose Files** option or select the **Enter URL** option and paste the URL that you copied in Step 3 and click the **Start Conversion** button.

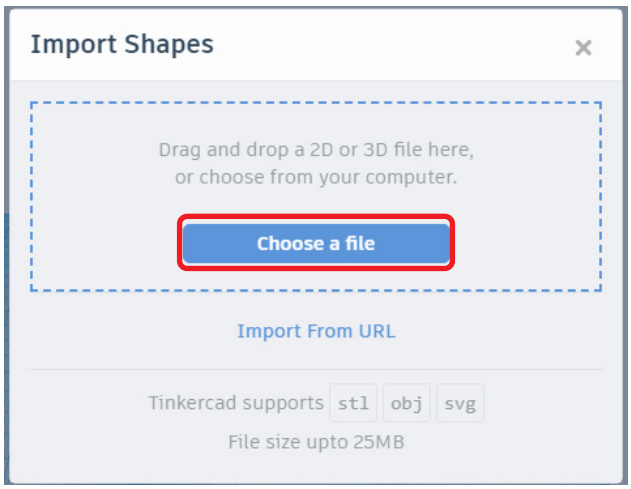


Step 7: The image gets converted into the SVG format and downloaded in the **Downloads** folder.

Step 8: Login to your Tinkercad account and select the **Import** option on the top right-hand side.



Step 9: Click **Choose a file** to select the downloaded file.

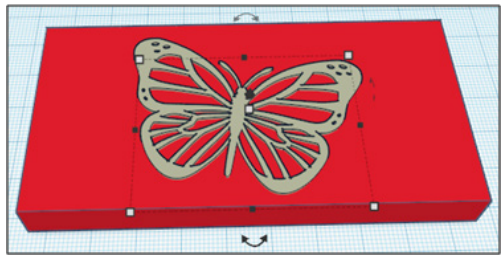


Step 10: Select the file from the **Downloads** folder and click **Import**. The file gets imported and is placed on the workplane. The imported shape can be used to create a design on various shapes present in Tinkercad.

For example, you can use the imported design as shown below.

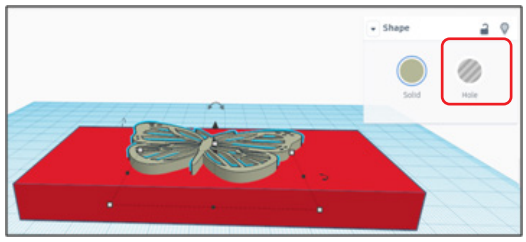
Step 11: Select a box from the **Basic Shapes** section, and place it on the workplane. Set the length and width of the box to 100mm and 50mm, respectively. Reduce the height of the box to 10mm.

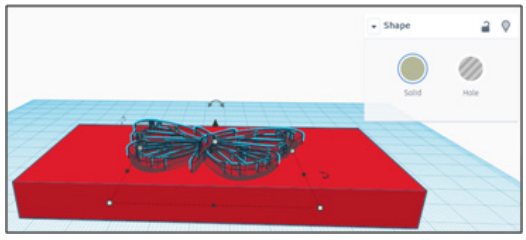
Step 12: Import the image using the steps given above and adjust the size of the imported image by pressing the Shift key and dragging the image inwards or outwards using any one of the corners handles.



Step 13: Place the design appropriately so that it fits on the top surface of the box.

Step 14: Select the design and using the black arrow, push it downwards so that it penetrates into the box. Then select the Hole option from the Inspector window.

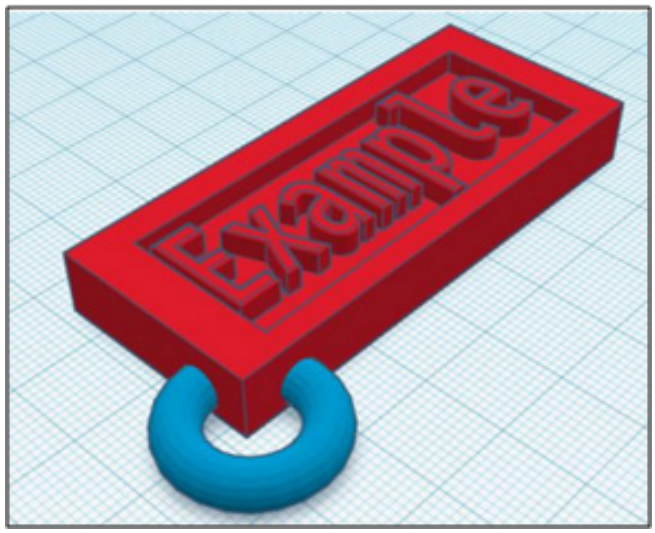




Step 15: Select all objects and group them using the **Group** icon.This method can be used to inscribe a 2D image into your existing 3D model to create keychains, mobile phone covers, and so on.

Learn by Doing

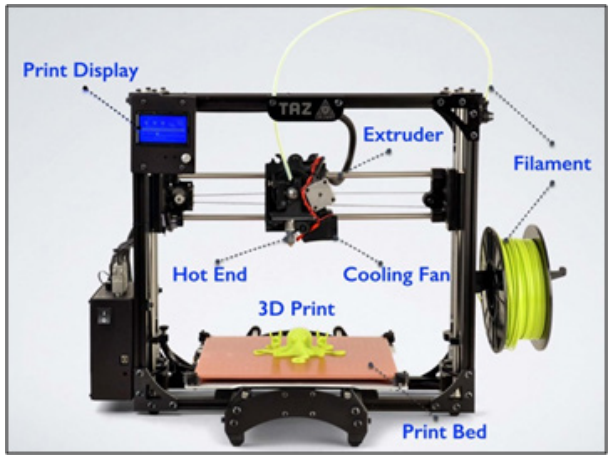
Create a simple keychain using any 2D image of your choice. A sample keychain is shown below.



The 3D Printing Process

The 3D printing technology is used to create a physical object from a digital model designed in a 3D modelling software. The 3D printer uses an additive process that involves depositing successive layers of material, one over the other to create the object. These models are first sliced into layers since the 3D printer prints out a model layer by layer. The object is converted into thousands of tiny little slices and it is then built from the bottom-up, slice by slice. These tiny slices or layers stick together to form a solid object. Some important components of a 3D printer are given below.

Components of a 3D printer



Filament

It is also known as the ink of a 3D printer. The filament used is either ABS (Acrylonitrile Butadiene Styrene) or PLA (Polylactic acid). It needs to be heated above 200 degree celsius to melt and create strong layers so that it can be printed on an enclosed, heated plate.

Extruder

It is a place where the plastic gets drawn in, melted and pushed out. It consists of hot end and cold end. The cold end draws the filament in and pushes it through. The hot end melts the filament before it is forced through the print nozzle and placed on the print bed. The extruder is also called the print head of the 3D printer.

Nozzle

It is a small hollow steel rod. It is used by the extruder to push the melted filament onto the print bed.

Print bed

The print bed is the surface on which 3D objects are printed.

Layer cooling fan

It is used to cool the plastic immediately after it is deposited by the nozzle. It helps the object to hold its shape.

SD Card reader

It helps to load the design files and other information directly to the 3D printer without the need to have a computer instruct the printer on what to print.

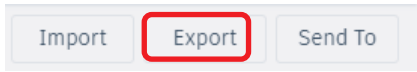
Maintenance of a 3D printer

A 3D printer needs to be maintained and used very carefully. We need to take some precautions while using a 3D printer.

- Do not use the printer unless you have been trained.
- Always keep the print bed clean.
- The nozzle may clog from time to time. Thus, you should clean the nozzle periodically with a small drill.
- Always remove the filament from the printer and keep it away from moisture when the machine is not in use.

Exporting and printing

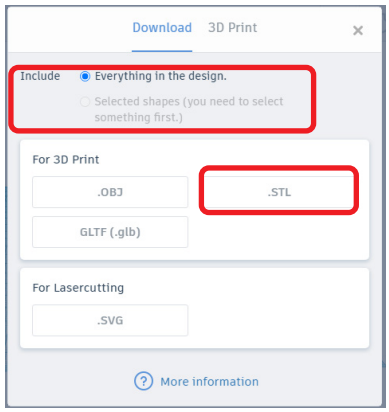
Once you have completed designing your 3D object using Tinkercad, you need to export it as an **.STL** file.



Steps to export a 3D design

Step 1: Click the Export button present at the top right of the Tinkercad window.

Step 2: From the download menu, you can select the following :



Include option:

- **Everything in the design**: It is used to print the entire model at the same time.
- **Selected shapes**: It is used to print the different parts of your design separately.

For 3D print option:

Click on the .**STL** option to save the file in the STL format. Once you click on .STL, the 3D model is saved locally with an .STL file extension and it gets downloaded in the **Downloads** folder of the C drive.

XYZware

It is an application used for printing digital 3D models. It imports objects in the 'STL' file format and is used with the Da Vinci 3D printer to quickly print 3D objects. The XYZware automatically finds any inappropriately positioned object and marks it with a distinguished color. This prevents the object from being printed off the print bed.

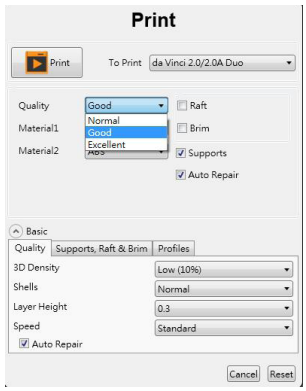
The software provides a list of different print options while printing a 3D object. Some of these print options are given below.

Print options

You can select the da Vinci 1.0 series or da Vinci 2.0 Duo series for output. It is possible to modify the printing results by changing the printing preferences.

For example, setting the print speed to slow and checking the **Supports** box will result in a fine print quality.

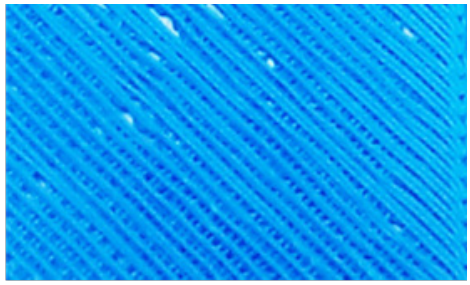
Quality



The print quality impacts the estimated time it will take for an object to print.

For example, high quality prints will take longer to make than low quality prints, as each layer printed is comparatively thinner creating a more detailed finish.

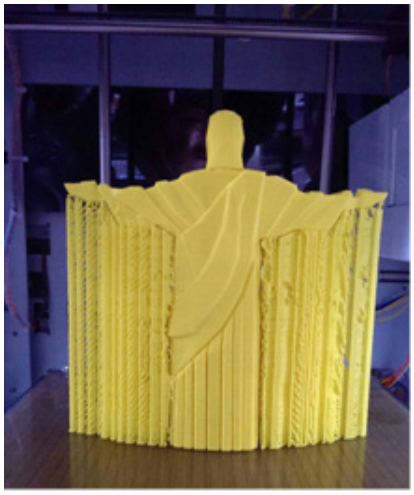
Raft



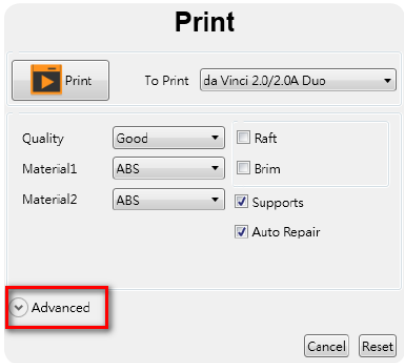
Rafts create stability and can be removed after your object has been printed. It is very difficult to print thinner and longer objects, as it requires more attention due to the shape's physical instability. The object can buckle or twist under its own weight. You can increase the area of contact between your object and the print bed by checking the Raft box while printing long and thin objects.

Support

It is used to create structural strength and ensure that your model does not collapse during the printing process. The supportive structures are printed according to the object's features.



Advanced Settings



You can click on the **Advanced** button to check for printing options.

3D Density

This function is used to adjust the print density of the object(s). The default printer setting on the da Vinci 3D printer creates the internal structure of the object(s) based on honeycomb structures.

Low (10%): It requires shorter printing time, but the structure is relatively weak. It is suitable for decorative objects.

Medium (30%): It gives higher strength to the structure than low density. To print an object for mechanical purpose, it is advised to set the density to 30% or above.

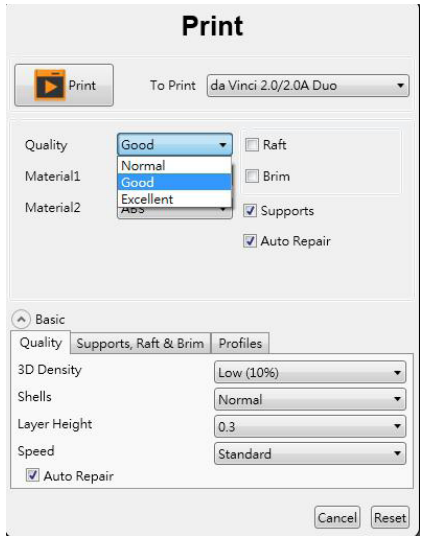
High (50%): For an object which should be durable or will be used as a functional mechanical part, it is suggested to select higher density.

Solid (90%): It creates a highly dense object and is more durable. However, it takes a longer time and needs more filament for printing.

Shells

Shells are the outer layer of the objects.

- Thick shells have better printing quality but take longer for printing.
- The outer structure of normal shells consists of 2 layers.
- Thin shells shorten the duration of printing but may be vulnerable to break.



Layer Height

It is used to alter the thickness of each layer created by the printer.

Speed

It is used to adjust the printing speed based on the size and precision of the object. You can print a 3D object with better quality at a lower printing speed.

Once you have finished customising your object to your preferences, it can be 3D printed or saved for future use.

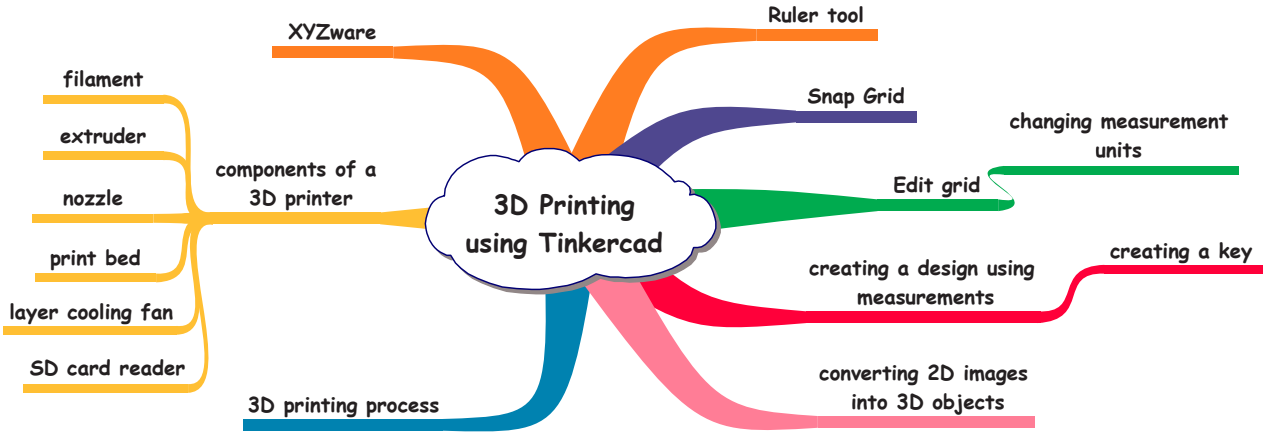
Word Galaxy

filament: the plastic material used in a 3D printer to create 3D objects

corner handles: white dots that appear at the corner of the selected object

gradient: slow transition or change from one colour to another colour

Let's Summarise



Let's Exercise

1. **Fill in the blanks.**
   a. To convert a 2D image to 3D object, you need to convert the image file into the _____ format.
   b. In Tinkercad, the distance by which the selected object moves each time an arrow key is pressed, is determined by the value of _____
   c. _____ called the ink of the 3D printer.
   d. The surface on which 3D objects are printed in a 3D printer is called the _____.
   e. The _____ printing option allows you to decide the strength of a 3D printed object.

2. **Answer in one word.**
   a. Which tool allows you to view the dimensions of objects and calculate the distance between them?
   b. Which tool will allow you to move the objects placed on the workplane with a distance of 5.O mm using arrow keys?
   c. Which tool in Tinkercad is used to combine two objects into a single object?
   d. Which component of a 3D printer is used to cool the plastic deposited from the nozzle?

3. **Answer the following questions.**
   a. Explain the significance of the Ruler tool.

b. Explain the steps to change the measurement units to inches?

c. How will you change the default size of the workplane?

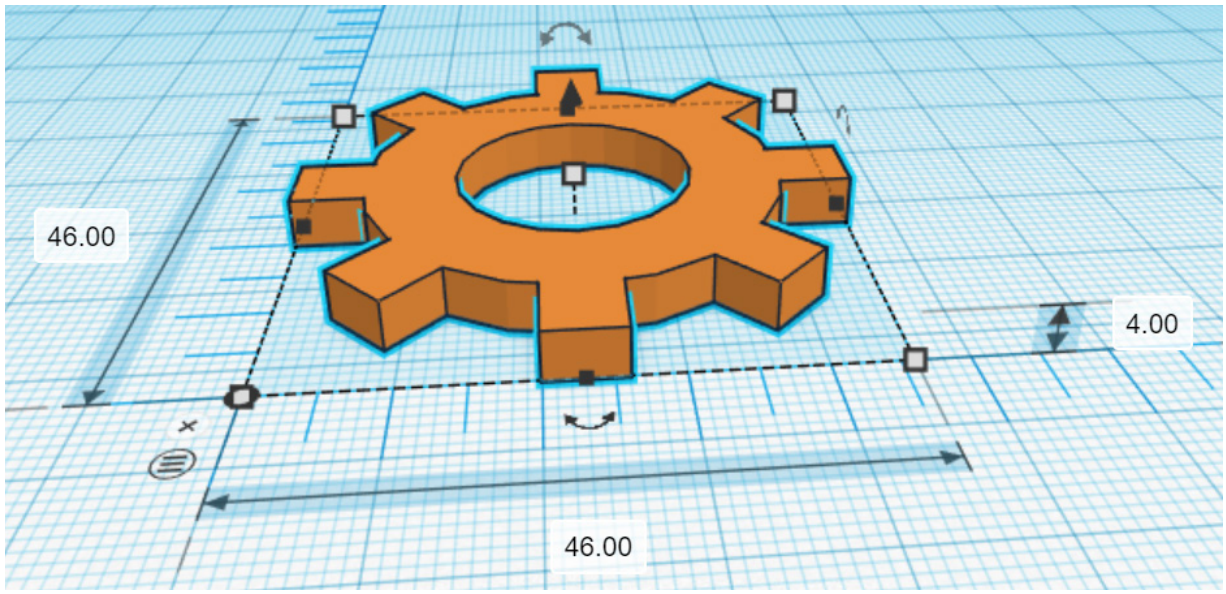
d. List the main components of a 3D printer.

e. Explain the role of the extruder.

Lab Activity

Design a gear wheel in Tinkercad having the dimensions as shown below.

The inner diameter of the gear is 20 mm and the width of each tooth is 6mm.



Smart Challenge

Explore the Circuits components in Tinkercad. Find out how you can make your 3d object move or spin by using Circuits Assemblies?

Web Links

http://allabout3dprinting.com/the-parts-of-a-3d-printer/ https://www.matterhackers.com/articles/anatomy-of-a-3d-printer

https://www.eapl.org/sites/default/files/docs/Basic%203D%20Design.pdf

As on 1/09/2020