3D Design & Printing with Tinkercad

Learning Outcomes

Students will be able to:

- know what is 3d printing
- understand the workplane
- insert objects and view them differently
- move & scale objects
- rotate an object
- change the workplane
- align objects
- flip objects
- group/ungroup objects
- hide objects
- create hollow objects – hole

What is 3D printing?

3D printing is a process of making three-dimensional objects from a digital file created in a design software. Every 3D printer follows a method that adds the material (needed to build a 3D object) layer by layer to create the desired shape. The design files are sliced into thin layers which are then sent to the 3D printer

Introduction to Tinkercad

3D Design software helps you to design in 3D. Tinkercad is a free online 3D design program that you can use in your web browser without downloading any software.

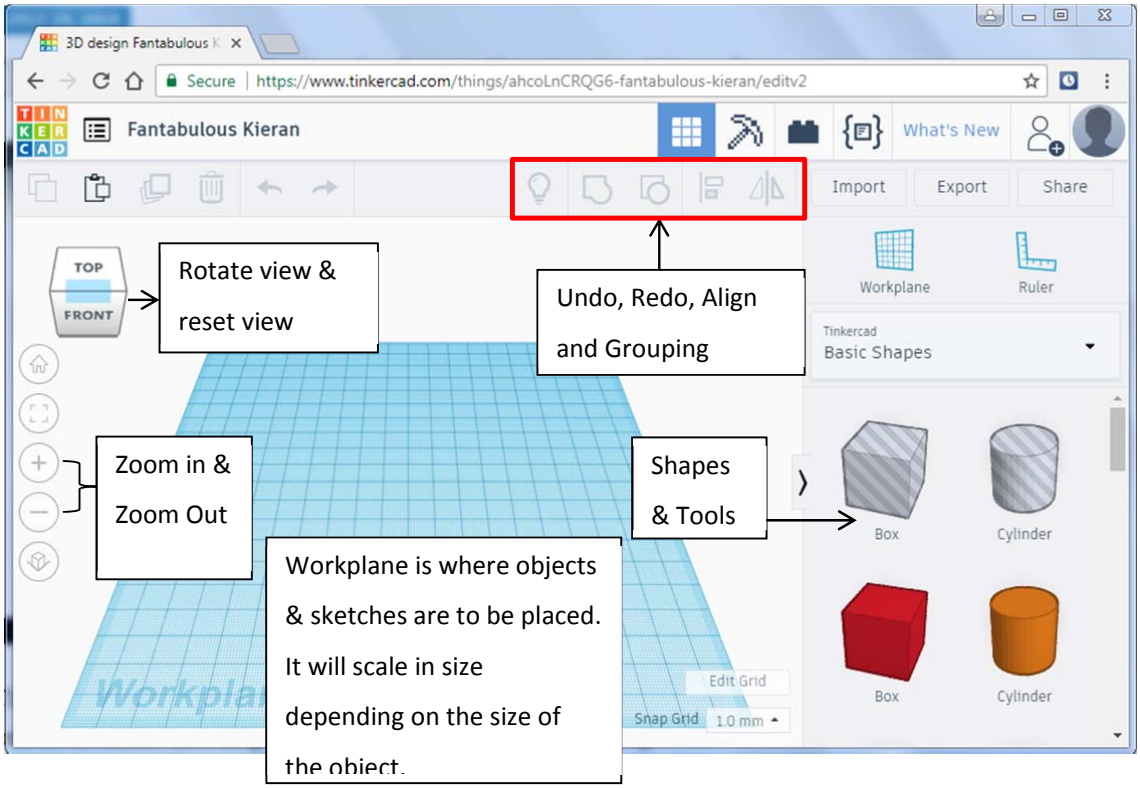
Steps to open Tinkercad

Step 1: Type www.tinkercard.com on the web browser, preferably Chrome.

Step 2: Create a new account by clicking 'Sign Up'. Please note students will need email ids to create their new accounts.

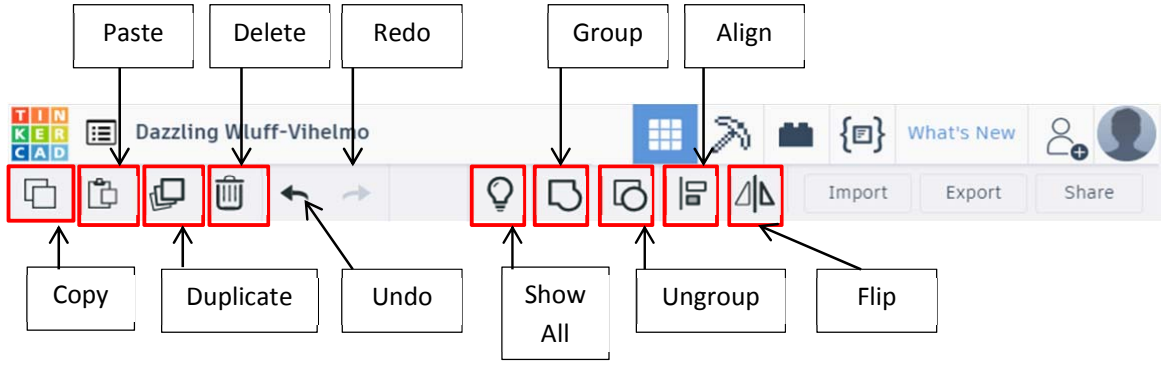
Step 3: Once you log in, click on Create new design button.

Let us look at the Tinkercad interface:



Tinkercad Interface

Toolbar



Tinkercad Window Toolbar

Copy: This option copies a selected object/s

Paste: It pastes the copied object/s.

Duplicate: It duplicates the selected object/s.

Delete: Deletes the selected object

Undo: Reverses the last action performed.

Redo: Reverses the undo action.

Show All: Displays all the objects on the screen that are hidden by 'Hide' option.

Group: groups the selected objects together

Ungroup: Ungroups the grouped objects

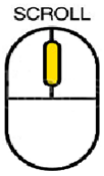
Align: aligns the selected objects

Flip: creates a mirror object of the selected object

How to navigate in Tinkercad

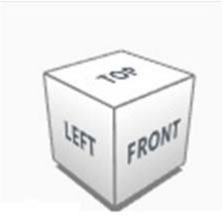
To navigate through the screen of Tinkercad, you have to follow the given techniques.

Hold to turn the screen



Scroll to zoom

The ViewCube is a way to help out with navigation in 3D, and also allows users to align to specific views. We can see and edit an object in six different views.

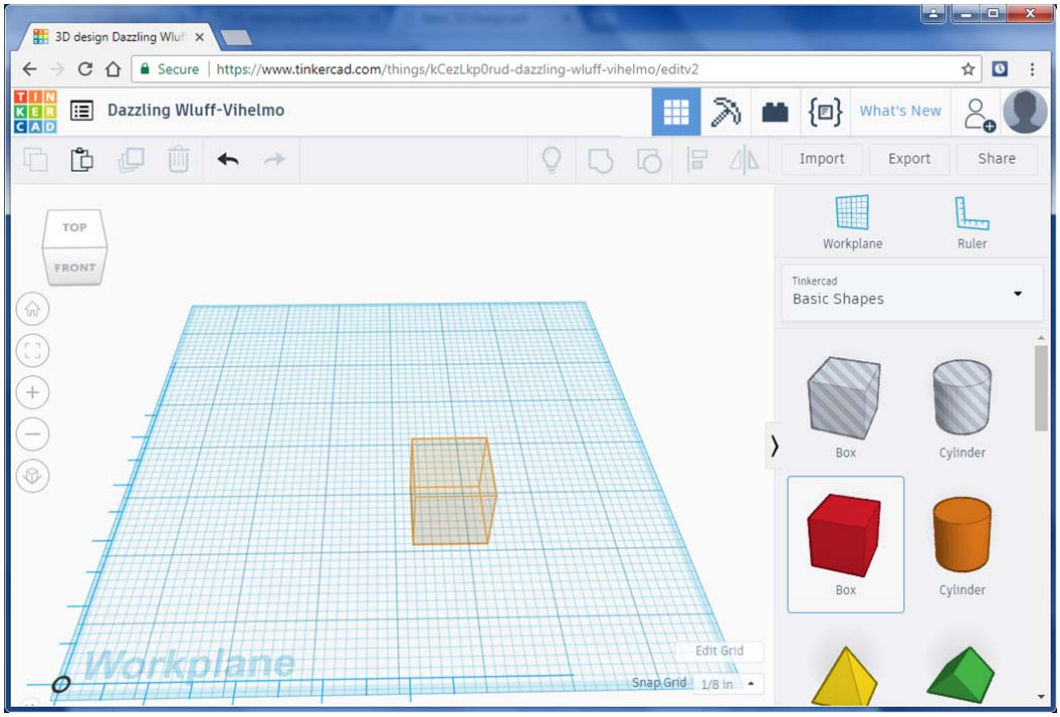


Inserting Objects

We can add custom shapes in Tinkercad workplane to create a 3D design. The shape option can be seen on the right side menu. To insert a shape on the workplane, click on the shape and drag it to the workplane.

There are different pre-defined shapes in Tinkercad. Let's look at some of the shape options:

- **Basic shapes** have many shapes such as boxes, cylinders, pyramids, and more.
- **Text and Numbers** have pre-made number and letter shapes.
- **Characters** have some unique characters like eggs, ice cream cone, spectacles, and more.
- **Connectors** have some shapes which can be used as connectors between two shapes.

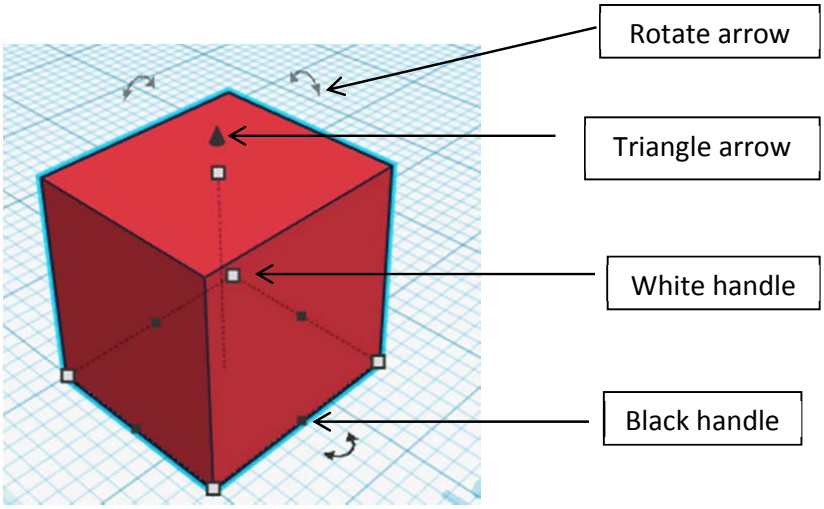


Inserting an object

Moving and Scaling Objects

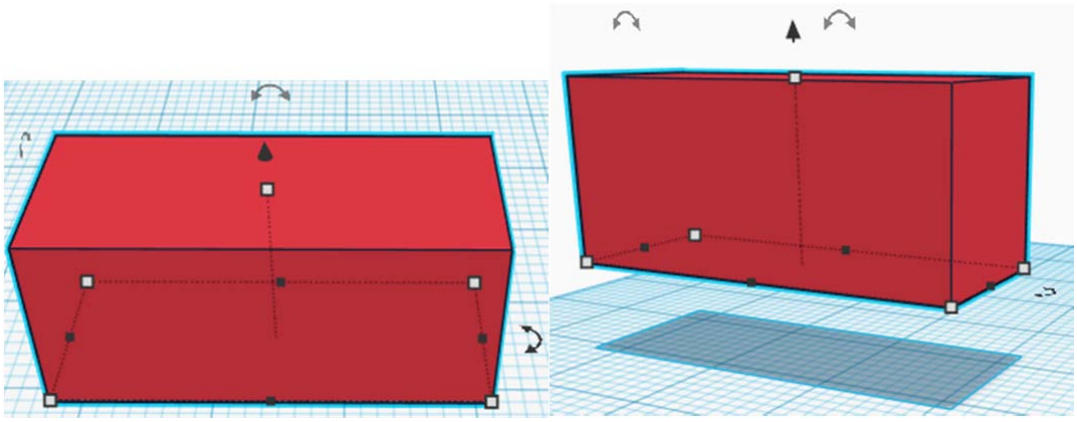
Moving and scaling an object helps to position it wherever required and reshape, resize it on the workplane. The object can be moved by selecting and dragging it to the required position.

When you add a shape on the workplane, you can see various controls around it such as arrows, black and white square handles. (If you don't see the controls, simply click on the object.) These controls are used to rotate and resize the object.



You can resize the object with constant proportions using the shift key and a corner white handle together.

You can resize the object from its respective side using the black arrow.

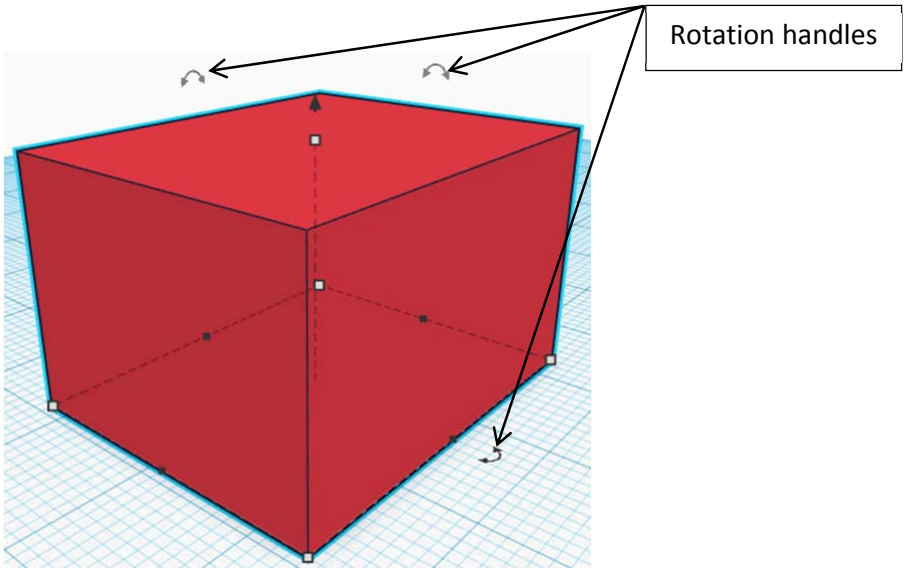


Clicking on the triangle arrow and dragging it upwards/ downwards would raise or reduce the distance from the workplane.

Clicking the rotate arrow, the object would change an angle and rotate to the specified degree.

To rotate a shape, single click on it. If you're looking at this shape from a diagonal angle, you should be able to see all 3 curved arrow rotation handles (pictured above).

Note: Holding the Shift key down while changing the angle will change it by 45 degrees every time the object is rotated.



Changing Workplanes

The workplane is the blue grid base where the shapes/objects automatically get placed in Tinkercad. We can use any side of the object we have designed as a new base using the workplane tool. It is very important to learn how to change workplanes.

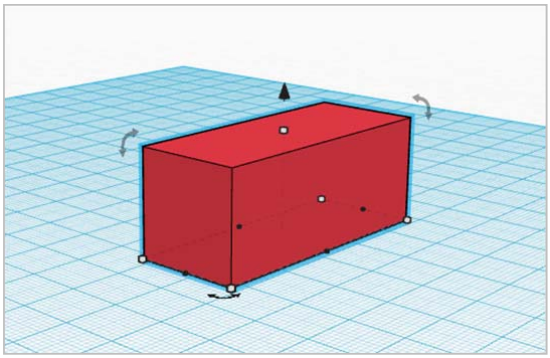
Take for example you need to make a house, it will involve a roof object on top of a rectangular object. When you insert the rectangle shape it gets placed on the workplane, we will have to change the workplane base to top of the rectangle to add a rooftop.

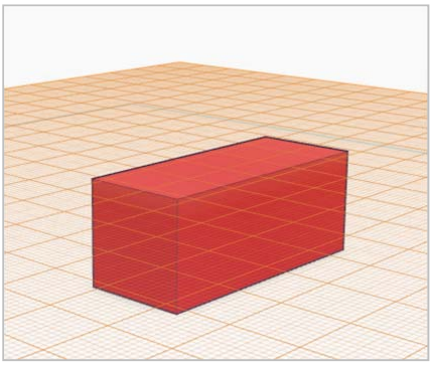
Steps to follow

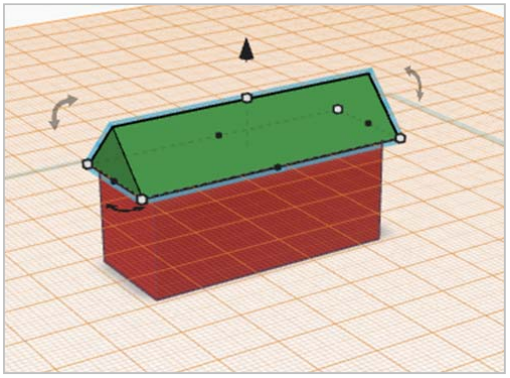
Step 1: Insert a square from basic shapes on workplane. Click on it and increase the width so that it looks like a rectangular.

Step 2: Select the Workplane tool from the sidebar menu, and then click on top of the rectangle. You will notice that the workplane base has changed to the top of the rectangle. Increase the width of the roof according to the measurements of the rectangle.

Step 3: Select the Workplane tool again and click on the original workplane to get back to the original workplane base.



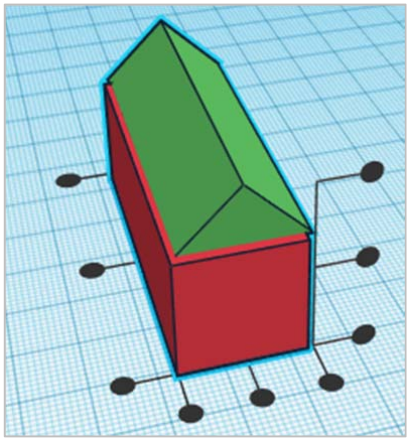
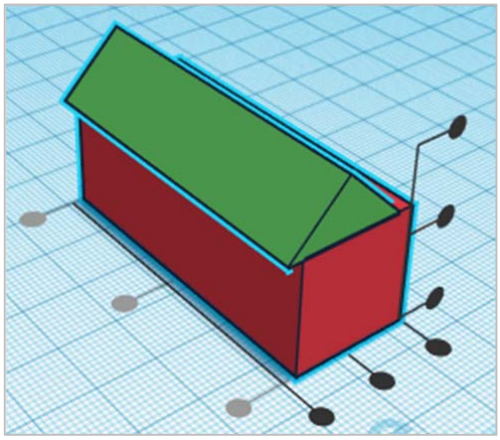
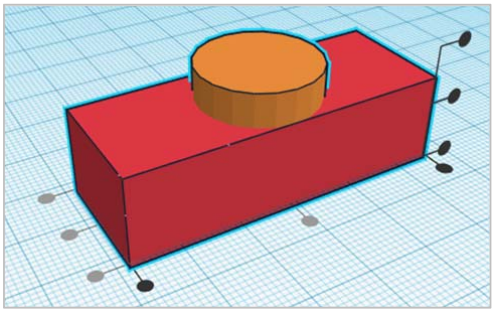
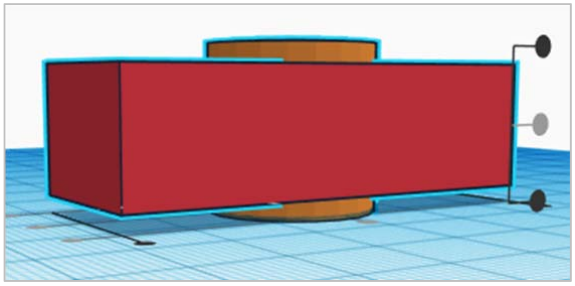




Working with objects

Aligning objects

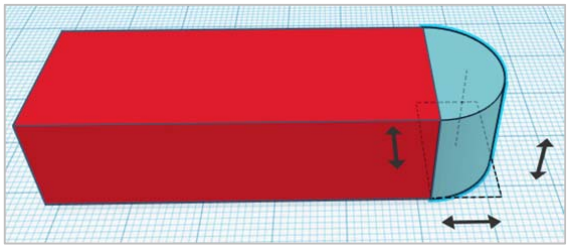
Aligning objects in Tinkercad is very simple. Use the mouse to select the objects to be aligned. Alternately Shift + click can be used to select multiple objects. Once both the objects are selected click on Adjust Align. The grey dot shows the current alignment, and clicking on any black dots aligns the objects accordingly.

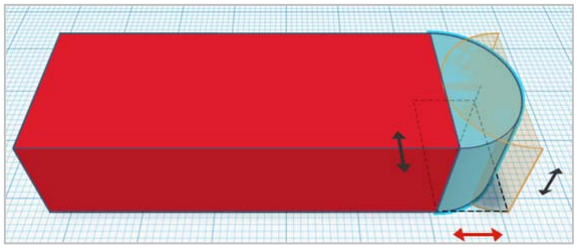





Flipping Objects

The flip tool is used to mirror an object/shape. When you select the shape and click the flip tool option. You can see three arrows with possible directions for mirroring, and when you move the mouse over one of the arrows, you get a preview of where the objects will end up.

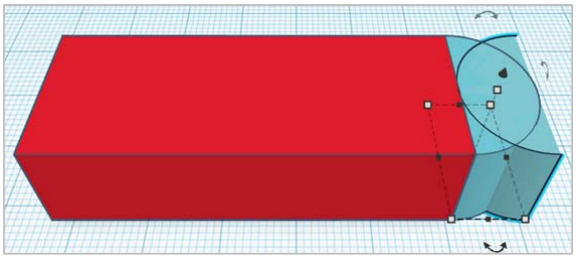
Let's check the example of a boat. We will use flip option to get an identical round roof object on each side of the rectangle.

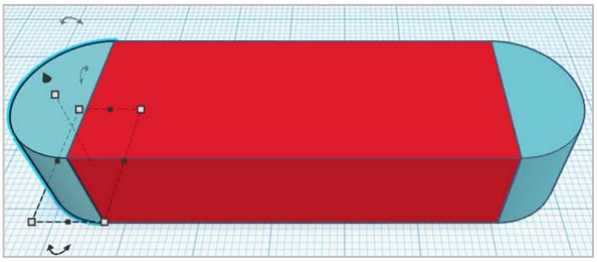




Using the Ctrl +D, duplicate the object and flip it to get the same object on the other side of the rectangle.

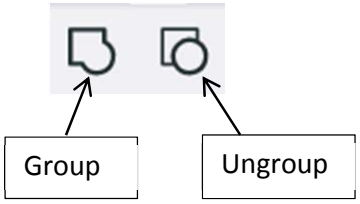
Using the Shift key drag the object in the same direction on the other side.





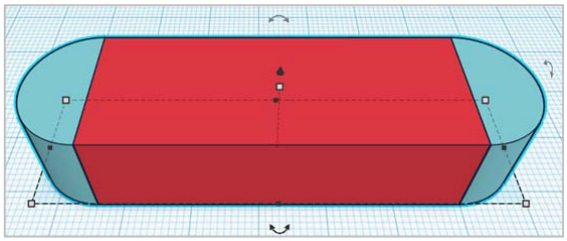
Grouping Objects

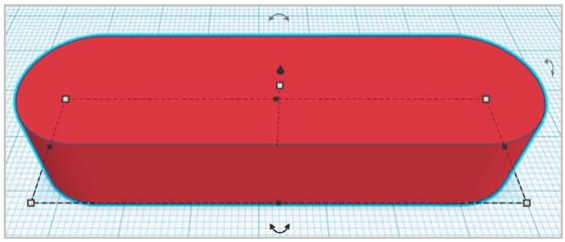
Grouping objects is very useful when you would like to combine more than one object. When the Objects are grouped together, the colour of the objects becomes the same.



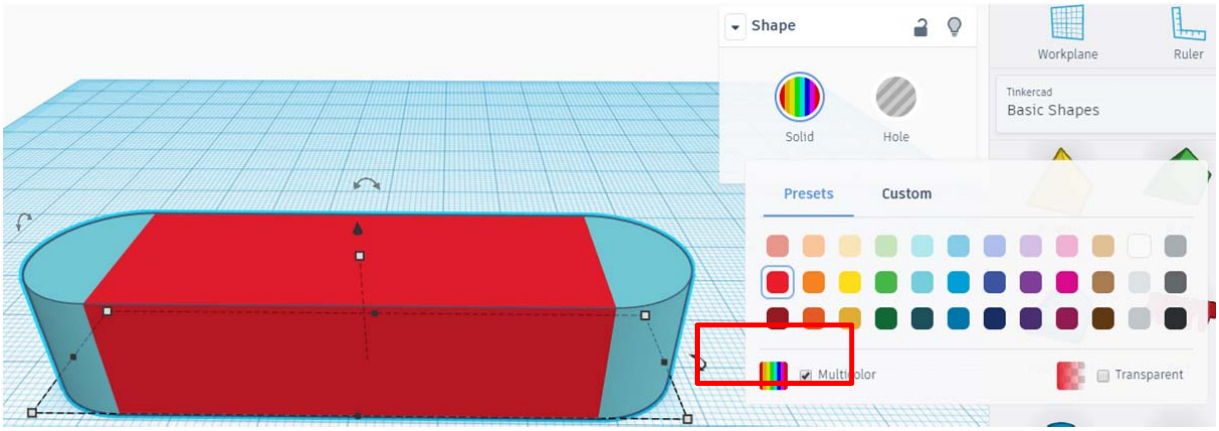
Step 1: Select the objects you want to group together.

Step 2: Click on the 'Group' option from the top right corner.





Step 3: Both the shapes will get the same colour. To get the previously selected colours back, click on Solid and select 'multicolor'.



To ungroup the objects, select the object and click 'Ungroup' option.

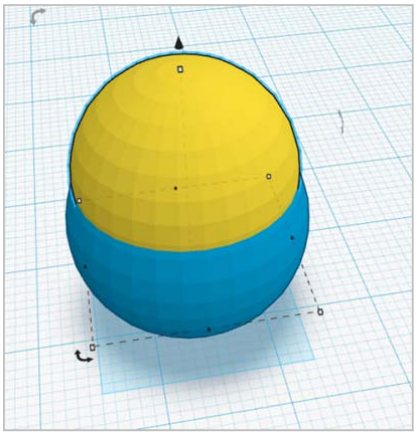
Creating Hollow Objects – Using the Hole Option

To create objects with hollowness, for example, a vase or a dish or a cup, Tinkercad presents a very simple option – Hole. This option can also be used to subtract objects.

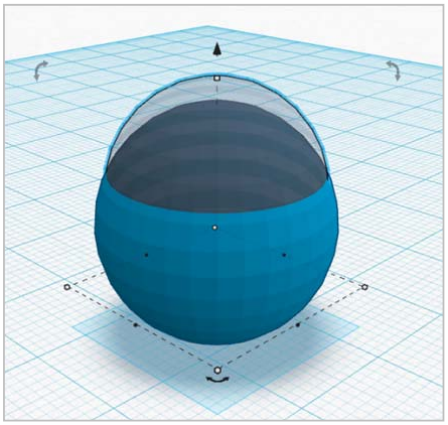
Step 1: First insert a sphere on workplane. Press Ctrl + D to duplicate it.

Step 2: Reduce the size of the duplicated sphere by 2mm (Press Shift key and select any edge on the circle). You will have two circles of different radius.

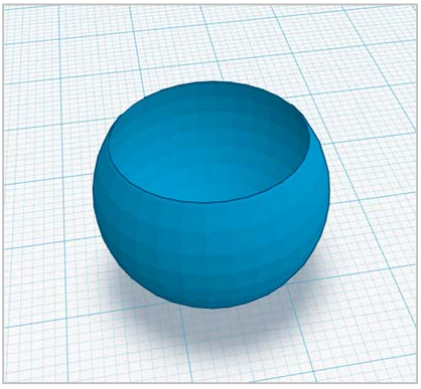
Step 3: Place the smaller sphere on the larger one. Use the triangle holder of smaller circle to place it inside the larger circle.



Step 4: Keeping the smaller circle selected, press 'Hole' option from the inspector tab (which shows Solid and Hole option). You will notice that the smaller circle has become transparent.

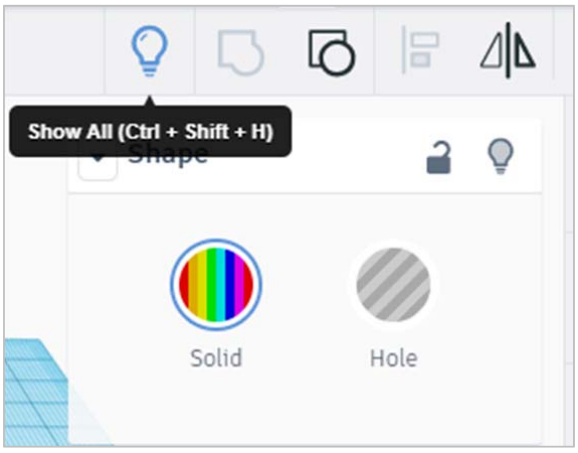


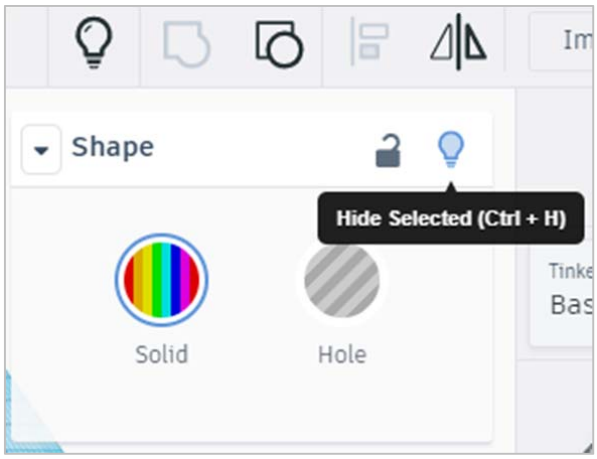
Step 5: Select both the objects and group them. The transparent sphere will turn hollow as shown below.



Hiding an object

Tinkercad has one more feature used to hide an object via the Inspector. If you hide one or more objects, you can use “Show all” in the top toolbar to see it on the canvas again.

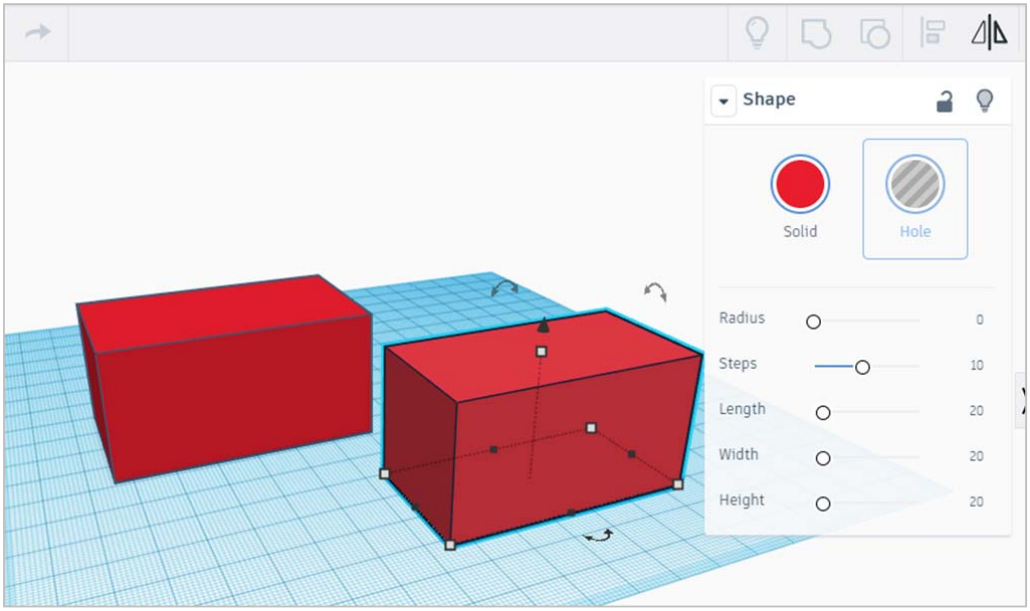




Learning by Doing

1. 3D house

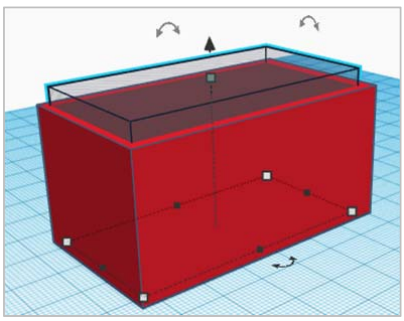
Step 1: First add a square shape on the workplane. Increase the width of the square to make it look like a rectangle.

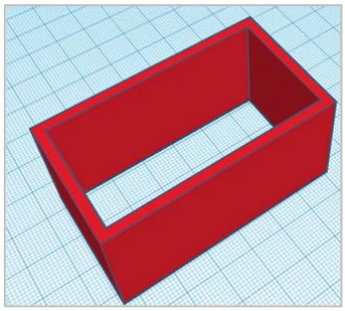


Step 2: Duplicate the rectangle and reduce the size to a smaller rectangle and place it in the middle of the bigger rectangle. Make sure it's little bigger in height than the big one. Press Hole from the inspector tab (which shows colour and hole option) and raise it slightly above the workplane.

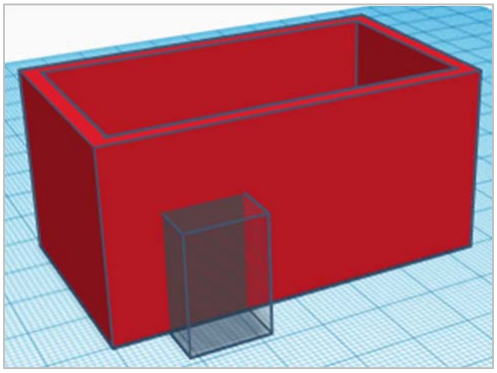
Tinkercad provides us with two hollow shapes: a box and a cylinder that can be used to directly create holes.

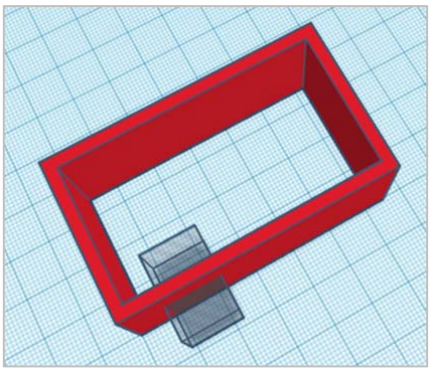
Step 4: Align the solid rectangle and the hole rectangle, as shown and group them to form the hollow of the rectangle.



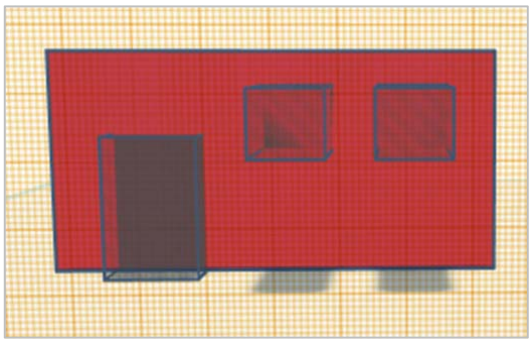


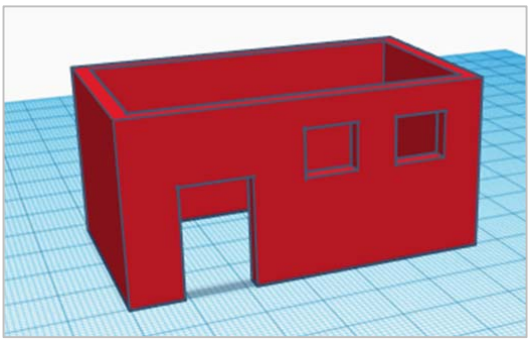
Step 5: Add a hole square shape on the workplane as a door. Push it slightly in the rectangle and adjust the measurements to group it.



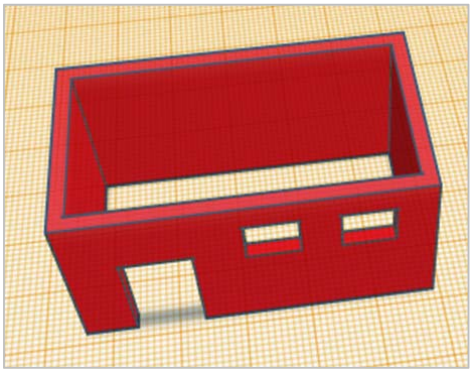


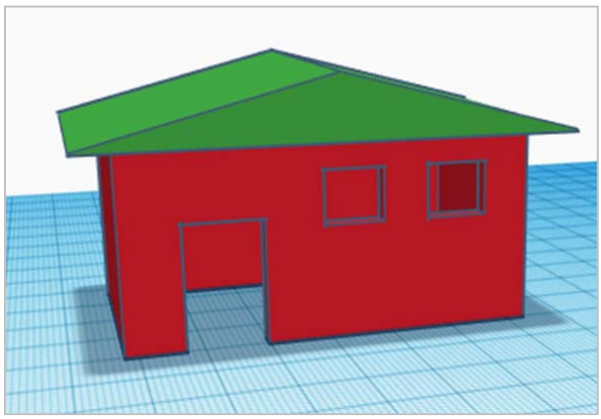
Step 6: Change the workplane to the front of the rectangle to create two windows and group them together.





Step 7: Change the workplane to the top of the rectangle to add a rooftop and align the shapes together to create a final object- 3D house.

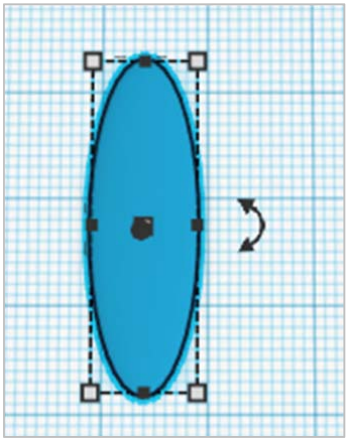


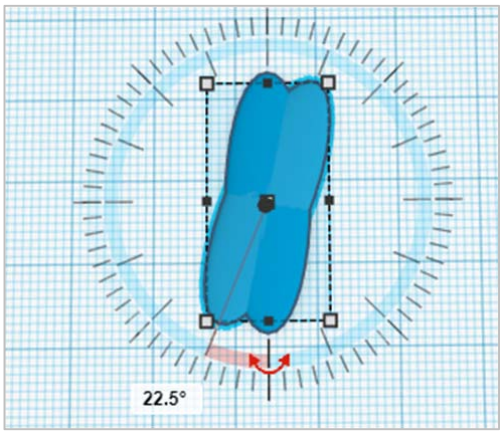


2. Create a flower

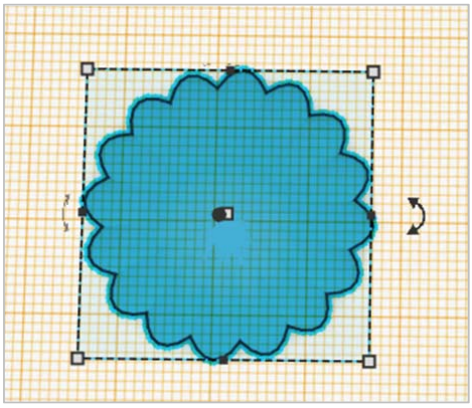
Duplicating (Ctrl + D) is a very effective tool in Tinkercad for designing different kinds of objects. Let us have a look how a flower can be designed in 3d in Tinkercad.

Step 1: Insert a sphere on the workplane. Reduce the height to 2mm and width to 5mm. It will look like a petal as shown below.

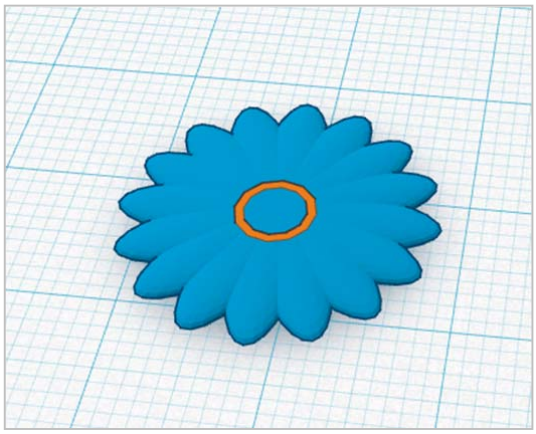




Step 2: Press Ctrl + D and use rotate handle to rotate the new object to 22.5 degrees.
Step 3: Keep pressing Ctrl + D, You will see that at every 22.5 degrees angle a new flower petal is placed. Ctrl + D has kept a record of rotating and thus subsequently whenever Ctrl + D is pressed it adds another petal at 22.5 degrees angle from the previous petal.

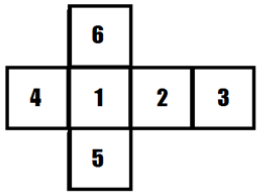


Step 4: Insert a thin Tube in the middle of the flower and increase its height to 2-3mm. The flower is ready.



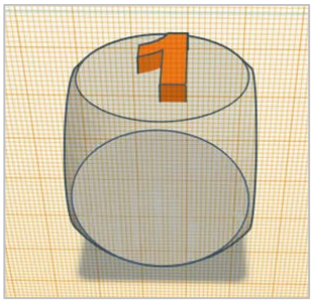
3. Create a Dice

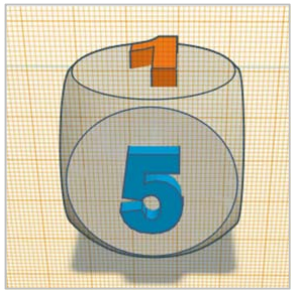
Step 1: Choose a dice shape from the Basic shapes from the right side menu. The order of numbers on dice is as below



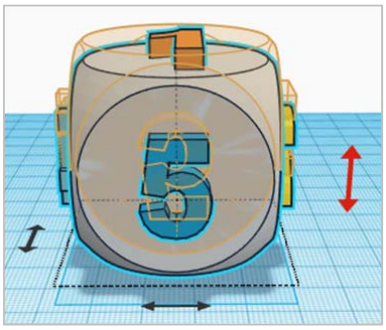
Step 2: Click on the top face of the dice and select the workplane as the dice top. Insert number 1 from the Text and Numbers and align them properly.

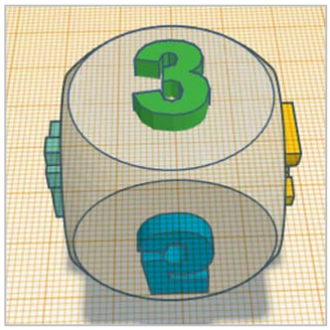
Step 3: Follow the same process for other sides of the dice. Make sure the number goes about 1-2mm inside the dice and the number at the bottom should touch the workplane before giving for printing.

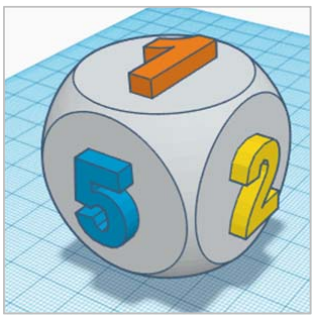




Step 4: At the end, to add number 3 at the bottom of the dice, flip the dice using the flip tool. Flip the dice back to the original position with number 1 at the top.

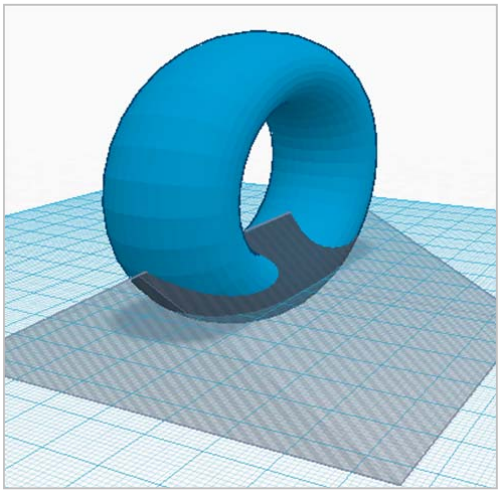




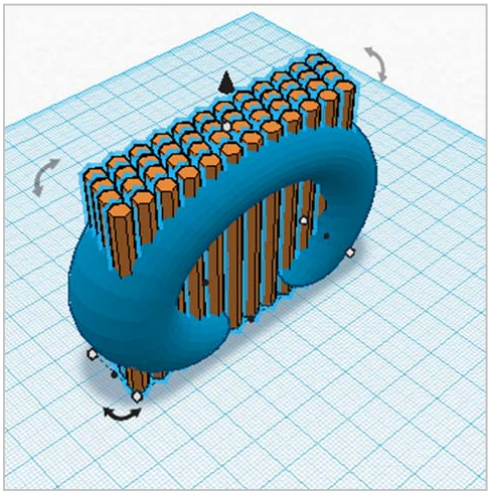


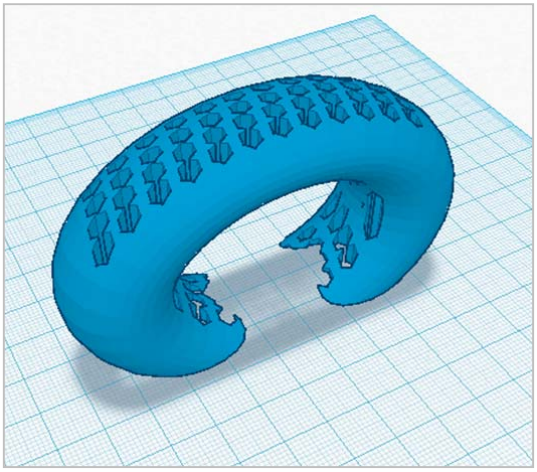
4. Design a Bangle with abstract designs

Step 1: Insert a Tourus shape, rotate and make it thicker.
Step 2: Insert a roof at the bottom of torus shape and make it as Hole.



Step 3: Group the objects so that it forms a 3/4th ring shape.
Step 4: Insert a hexagon shape, use duplicate option to make lots of them as shown below.
Step 5: Place the hexagon shapes on top of the ring and make them into holes. Group, all the objects to get the final shape.

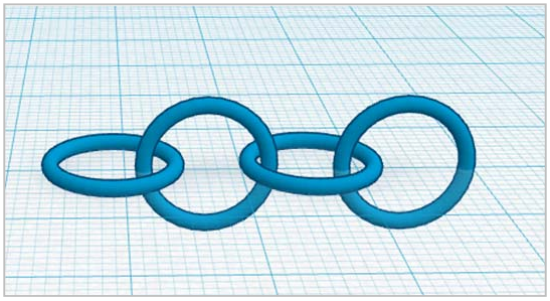




Note - Use different shapes to get more abstract designs instead of Hexagon shape.

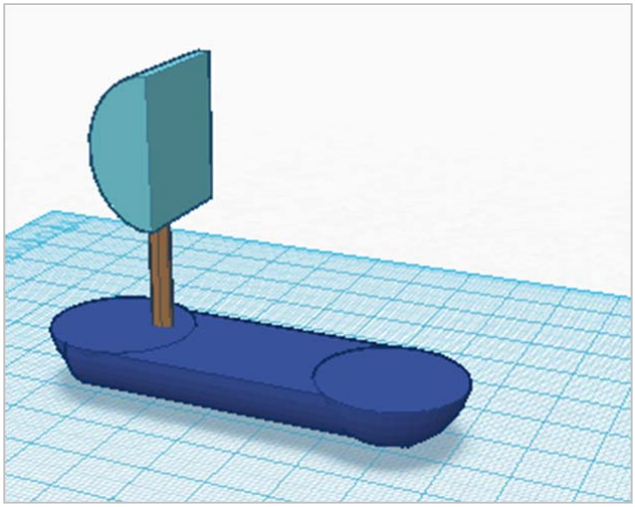
Assignment

1) Create a chain



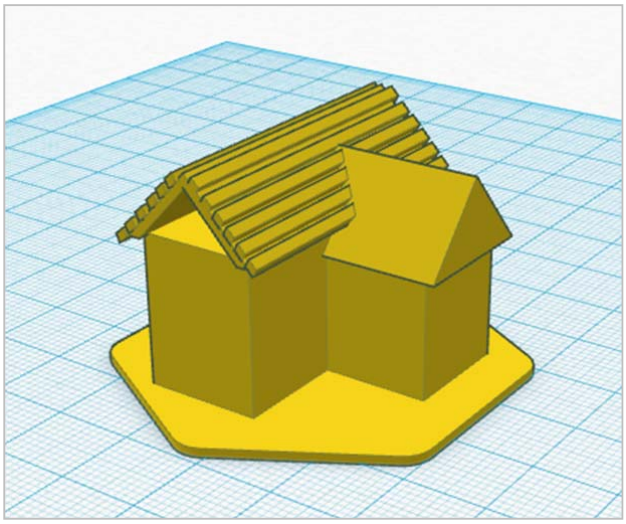
Hint – Use Torus thin, duplicate, rotate to achieve the shape.

2) Design a 3D Boat



Hint – Use a square – extend width. Insert spheres on both the side edges. Use Holes and Group to cut and then place the hexagon and half round rotated on the top.

3) Design a 3D House with tile roof



Hint – Use Square, Roof, Duplicate, Group to achieve the shape

Exercise

Q.I Select the correct option

1) Which of the following options can be used to create a hollow object?
   a) Hole
   b) Scale
   c) Align
   d) Move

2) Observe the Figures given below. Which of the following options should be used to get the result shown in Figure 2?

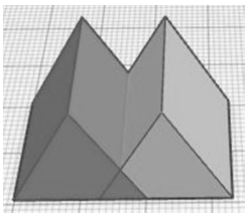


Figure 1

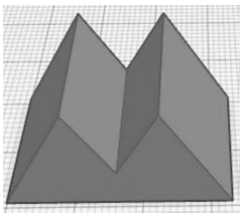


Figure 2

a) Group
b) Align
c) Ungroup
d) Copy

3) Which option will Neha choose if she has to turn over the box horizontally?
a) Align
b) Flip
c) Group
d) Ungroup

Q.II Read the following statements carefully and state whether they are true or false.

1) We can use the right mouse button on the workplane to have a 360^0 view of the object in Tinkercad.
2) The white corner handle of an object can be used only to increase or decrease the width and height of the object.
3) The filament used for 3D printing is made up of metal.
4) To select multiple objects in Tinkercad, we can also use Shift+Enter from the keyboard.
5) Objects when grouped together get changed to the same colour. One can use a multicolor option to change the color of the objects as given before.

Q.III Write the use of the following elements of Tinkercad in short.

a) 
b) 
c) 
d) 
e) 
f) 

Q.IV Do as directed

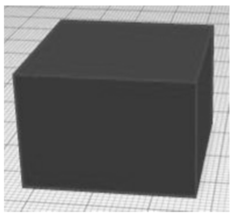
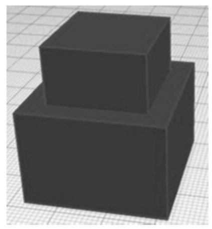
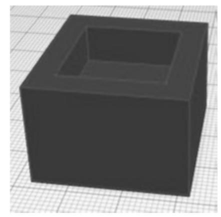
1) Observe and fill in the blanks the steps given below to create a flower using a heart shape.
Step 1: Insert a heart on the workplane. Reduce the height to 7mm.

Step 2: Press ____________ and use rotate handlers to rotate the new object to 45 degree.

Step 3: Now keep pressing Ctrl + D, You will see that at every _____________ degrees angle a new flower petal is placed and the heart flower is ready.

Step 4: Select ___________ option to combine all the petals together to show as one object and add a torus shape on top.

2) Rearrange the steps followed to create the hollow object as shown below.

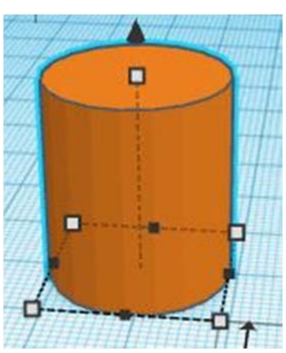
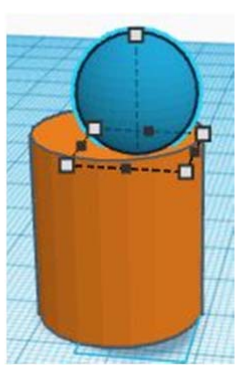
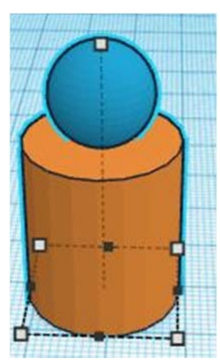
Step: Lift the smaller box above the larger box using the triangle holder. Click ‘Hole’ option and group both the objects.

Step: Press Shift key and reduce the size of the box proportionally.

Step: Insert the box on the workplane. : Press Ctrl + D and duplicate the box.

Q.V Answer the following

1) Priya wants to create a house in Tinkercad. She added a rectangle on the workplane. How she can add a roof on top of the rectangle.
2) How can we change the height and width of an object in equal proportion?
3) Mention the keyboard shortcuts to perform the following in Tinkercad.
   a) Scaling the object uniformly.
   b) Rotate the object with angles 45^0, 90^0 and 180^0.
   c) Duplicate object
4) Neha added a cylinder on a workplane and then added a sphere on top. Write down the steps she will have to follow to align these objects.

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