

# TOWER WORKSHEET

## GETTING STARTED



**5-10m**

The tower build is a great way of learning about basic structural techniques in engineering.

You'll have to consider the strengths and weaknesses of the materials you have, before planning, designing and redesigning your structure to ensure your tower is stable.

Be sure to think about the foundations of your tower and how this will impact your final structure.

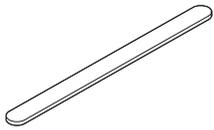
# VOCABULARY

**Free-standing** - A structure that remains upright on its own and is not attached to, or supported by, another structure.

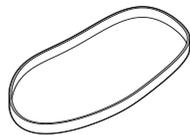
**Stability** - The ability to remain steady and not be likely to move or change without an external force.

**Structural** - Relating to, or forming part of, the structure of a building or other item.

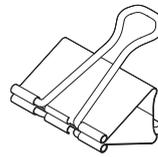
## EACH TEAM WILL NEED



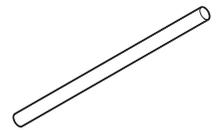
Lollipop Stick  
30



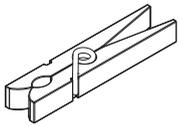
Elastic Band  
20



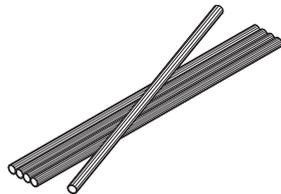
Bulldog Clip  
16



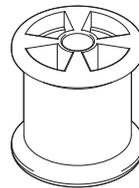
Wooden Dowel  
14



Clothes Peg  
10



Paper Straw  
10



Cotton Reel  
6



White Tac

# WARM-UP ACTIVITY



**10-15m**

## A

In teams, experiment with the supplies you have been given to see which combination of shapes and materials provide you with the most stability.

Try to assemble and connect some of these shapes to see which will give your structure the height that you'll need to win the competition. Don't forget to:

- Use your creativity - think of different types of structures that you've seen.
- Be open to suggestions - collaboration is key and can result in different ideas to make the best project.
- Communicate effectively - your ideas might help others think differently.
- Be flexible - remember engineering development is a process. Perseverance, time management, learning from mistakes and previous experiences are all key.

# MAIN CHALLENGE



**30-40m**

As a team, you are going to work together to build a structurally sound tower.

Firstly, you will discuss and design your tower before starting construction, but be open to the idea of redesigning aspects part way through your build. Think about using symmetry in your design as this will reduce weak points.

Using the materials provided, you must build the tallest and most stable structure in the room. The success of this will be judged on the tower's height and ability to hold a fixed weight.

Once completed and tested, there will be a class discussion about your findings.

## DID YOU KNOW?

The Burj Khalifa in Dubai currently holds the title of the world's tallest building at over 800 meters tall. By the end of 2021, this is expected to have been overtaken by The Jeddah Tower in Saudi Arabia which, will stand at 1km high!

# BUILDING YOUR TOWER

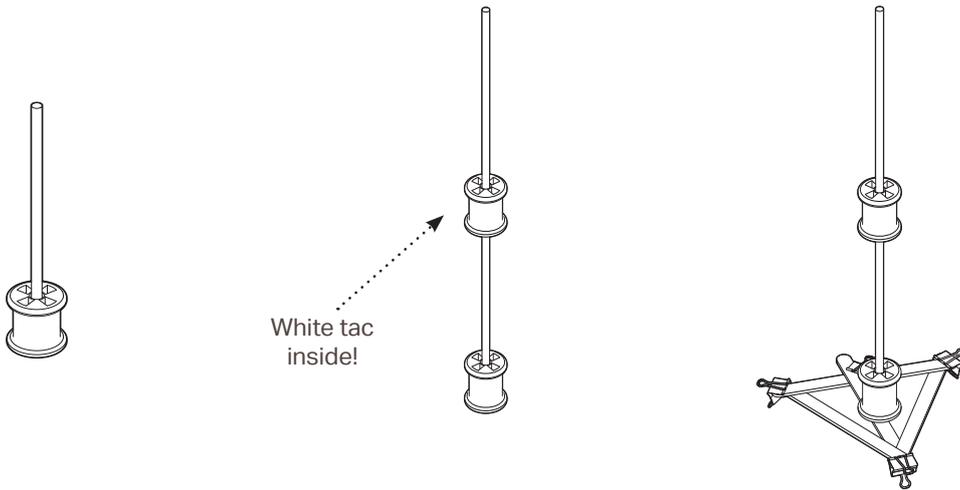
There are many ways to build a tower using the materials provided, but here are a few techniques you could use to get you started. Use your creativity to form innovative, load bearing structures!

## TECHNIQUES TO TRY

### DOWEL SUPPORT & BASES

Cotton reels act as excellent supports for vertical dowels and straws. These can be stacked several times, with the addition of some white tac, although it's quite likely after reaching a certain height your tower may topple.

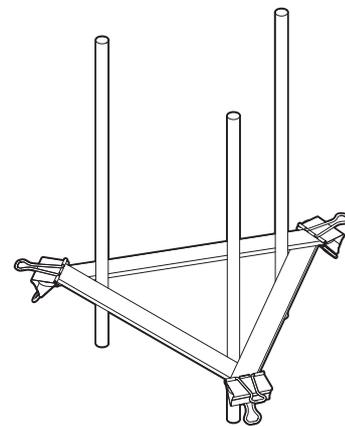
This is due to the centre of gravity acting outside of the footprint of your tower. A simple fix to this is to add a wide base to your tower, which might be attached using white tac, or bulldog clips. When attempting very tall towers, you may need to consider using a wider base as the tower grows!



### MULTIPLE STRUTS

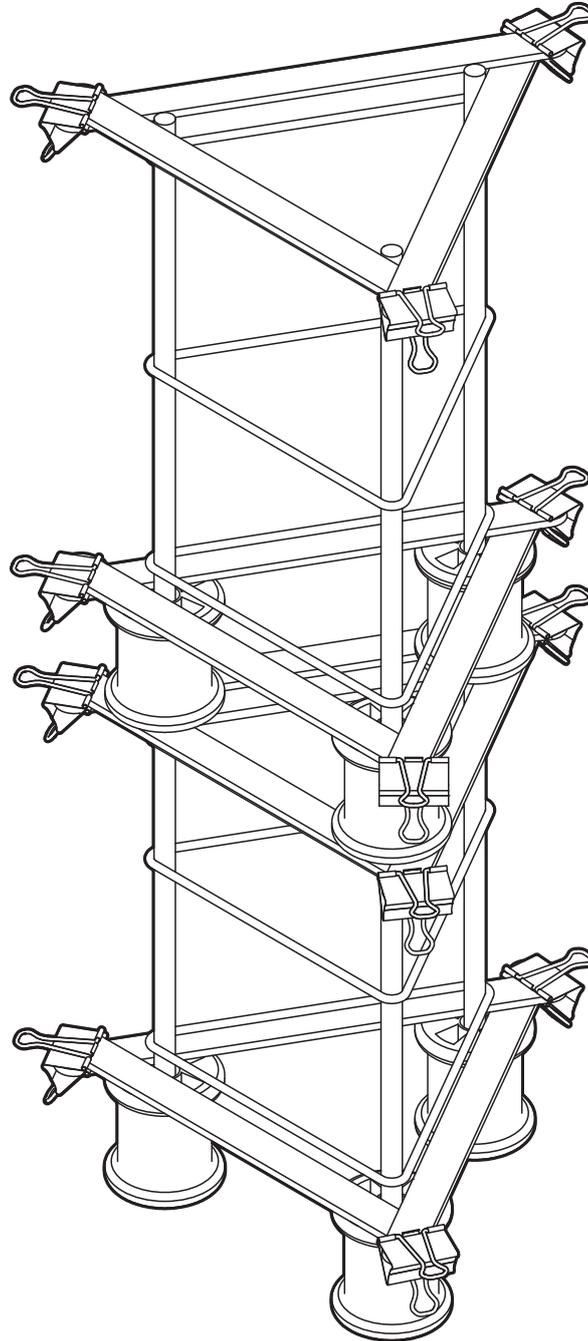
Try using lollipop sticks and bulldog clips as shown to the right to add multiple struts. This technique is great to ensure that your structure keeps its shape. It was used to make the base shown in the right-most image above. You can add white tac or cotton reels at the bottom to add stability.

Remember to make sure that the lollipop sticks overlap each other before you clip them!



# EXAMPLE TOWER

We have created a tower using the techniques described. However, there are many approaches you can take, and we encourage you to experiment. It is important to include a platform at the top of the tower to support a load. Now it's your turn!



## REMEMBER

Trusses and struts distribute forces throughout a structure. How could they be used to add stability to your load-bearing tower?

# TOWER

  
10-15m

## STABILITY

### KS1/2 PROOF OF CONCEPT

Try standing up with your legs out wide like a star. Is it easy to balance? Now, compare this to standing on one leg.

Which one did you think was more stable?

Simply put, when you have a wider base, it is easier to stand because you are more stable.

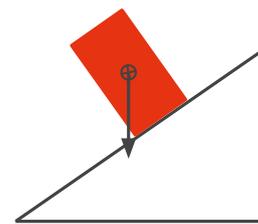
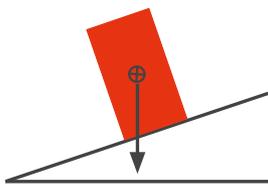


However, when your base is smaller and your top is off-balance, or non-symmetrical, it is harder to balance.

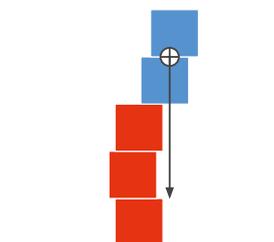
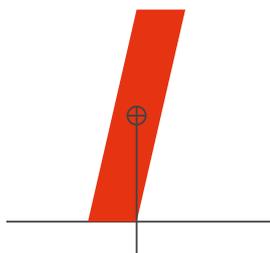
You can apply this knowledge to the towers you built to make your structure more stable.

### KS3/4 DEEPER LEARNING

The tipping angle is the point at which a force is sufficient to tip an object over. This is the point at which the force is acting right on the edge - or outside - of the contact area between an object and a plane. This is most clearly understood when looking at objects on inclined planes, but the same principle applies to towers on a flat surface. On the images below, the larger slope on the right would cause the tower to topple over.



The diagram below shows how the weight force could act on the corner or outside of the footprint even if only slightly, ultimately making the tower topple over. This could occur between sections of the tower, causing those blocks to fall off, or for the entire tower to collapse.



# QUIZ

  
**10-15m**

What does the term “Free-standing” mean in relation to building a tower?

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Why are trusses and struts used throughout the design process for a tower?

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What can bracing be used for?

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What does a wider base do for a tower?

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Why is stability important in a tower?

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# QUIZ

Where does a force have to act to make an object fall over?

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What kind of force is acting on the tower?

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What kind of engineering does tower building come under?

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Which tower is expected to be the tallest in the world by the end of 2021?

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Why is a symmetrical design important when building your tower?

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