

## ***Engineering report: Straw water tower challenge.***

The challenge is to make a free-standing tower which can support a ballast which is a golf ball which is at least 10cm above the ground using 8 – 10 drinking straws, 20cm of masking tape and can support a golf ball for an extended period of time. Also, you had to make a report/portfolio which outlined the task, and the engineering steps you used.

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## ***Introduction***

### ***what the task is about:***

The task is to build a water tower out of straws which can hold a golf ball above 10cm/100mm and needs to be built out of eight or less cocktail paper straws and only using 20cm/200mm of tape to build the tower.

### ***what is the problem:***

The problem is being able to build a tower with limited materials and being able to hold a golf ball above 10cm for an extended period. Another problem was not being able to secure the tower to the ground which would've given it more stability and strength.

### ***the aim of the project:***

The aim of the project is to hold a golf ball 100mm above the ground and be able to support the ball for an extended period.

### ***purpose of the report:***

The purpose of the report is to make a portfolio of the project and record pictures, sketches and all the engineering processes into one place and to record and reflect on the straw water tower project with both positives and negative reflections. To reflect on the straw tower and provide information and reflect on the tower.

### ***review earlier work/research/products (using proper referencing):***

In previous works we discovered the stability and how to make towers which contributed massively to this project, also in the catapult we learnt how to engineer strong structures which could absorb the catapult arm, this contributed to the water tower because we need to build a structurally sound tower that has a great centre of gravity and can support a ballast. In the research part of the project there were many water towers but all included lots of straws and went massively above 10cm, so you had to get creative and make an innovative design.

### ***outline method of approach:***

The method of how I approached this task, I designed a tower that was consistently made of triangles and braces which had the best outcomes when holding a ball. Also, in the preliminary sketches I tried designing towers that were consistent and that were made of triangles, which provide good stability and strength. The method of how I approached building the tower was reflecting off the designs incorporating them and making a better design out of all the sketches. Also, I tried being very conservative with materials and not needing more tape or straws.

***outline the scope and limitations of the project:***

The project was about to build a water tower out of cocktail straws and 200mm of marking tape, my first water tower took inspiration from the previous paper tower challenge where I made a tripod stand which the golf ball would sit on, because the legs would slip out I braced them to prevent the tower from falling over. The limitations of this design were because all of the legs would meet in the middle of the tower creating a cradle for the ball to sit in, this design when above 10cm which was good, but you had to balance the ball perfectly for the tower to be functional. This tower was also built in 4 straws and all 20cm of tape provided and weighed 14grams.

On the second design I incorporated the first design creating 2 big triangles either side of the tower and trussed at the top for connection, support and a place to put the ball, this design was very accurate and functional because you could position each triangle to give more support, and it was very stable and held the ball above 10cm. The design has very little to no limitations which was good. The overall limitations of the whole project were that you were only allowed to eight or less cocktail paper straws and 20cm of tape which was difficult because the pieces need to be placed accurately and small so that there was tape for later. This tower was built of 6 straws, and all tape provided this tower weighed 15 grams.

# Main body

## Methodology

The method I used to assemble the final straw water tower I took 2 straws, laid them out with the tops of the straws touching then I cut another straw into 2, I used 1 half to brace the bottom, creating a large triangle that is used as pillars to support the ballast, then I replicated that design of the triangle pillars using another 2 straws is well as the other half. Then this triangle will be mirrored to the other side of the water tower. Then I took my last straw cutting it into 2, which will provide connection between both triangle pieces and acts as a spot to place the golf ball or ballast. I connected theses half straws 10mm from the top so I could use the tops of the triangles as railings to support the ballast from falling off.

## Material list

The materials need to complete this project were:

8 cocktail paper straws: 6mm x 123mm

20cm/200mm of masking tape

A ruler for measuring the water tower

Golf ball or similar, to be placed on tower

## Evidence of research (images of existing designs)



The 1<sup>st</sup> image shows a water tower holding a can of beans. This Straw Water tower shows excellent height and strength, this tower is braced in the middle then extends upwards and is braced again providing a spot for the beans to sit on. The 2<sup>nd</sup> image shows a straw water tower which is similar to my designs with the bracing between the pillars and the bracing on the top which provides a spot for the ball to be placed in, the bracing provides the tower from sipping out and also provides good stability. The 3<sup>rd</sup> image shows a tower which has a large amount of bracing around and inside the tower which provides extra strength, this tower also has a similar cradle on the top which acts as a place to put the ball or ballast onto.



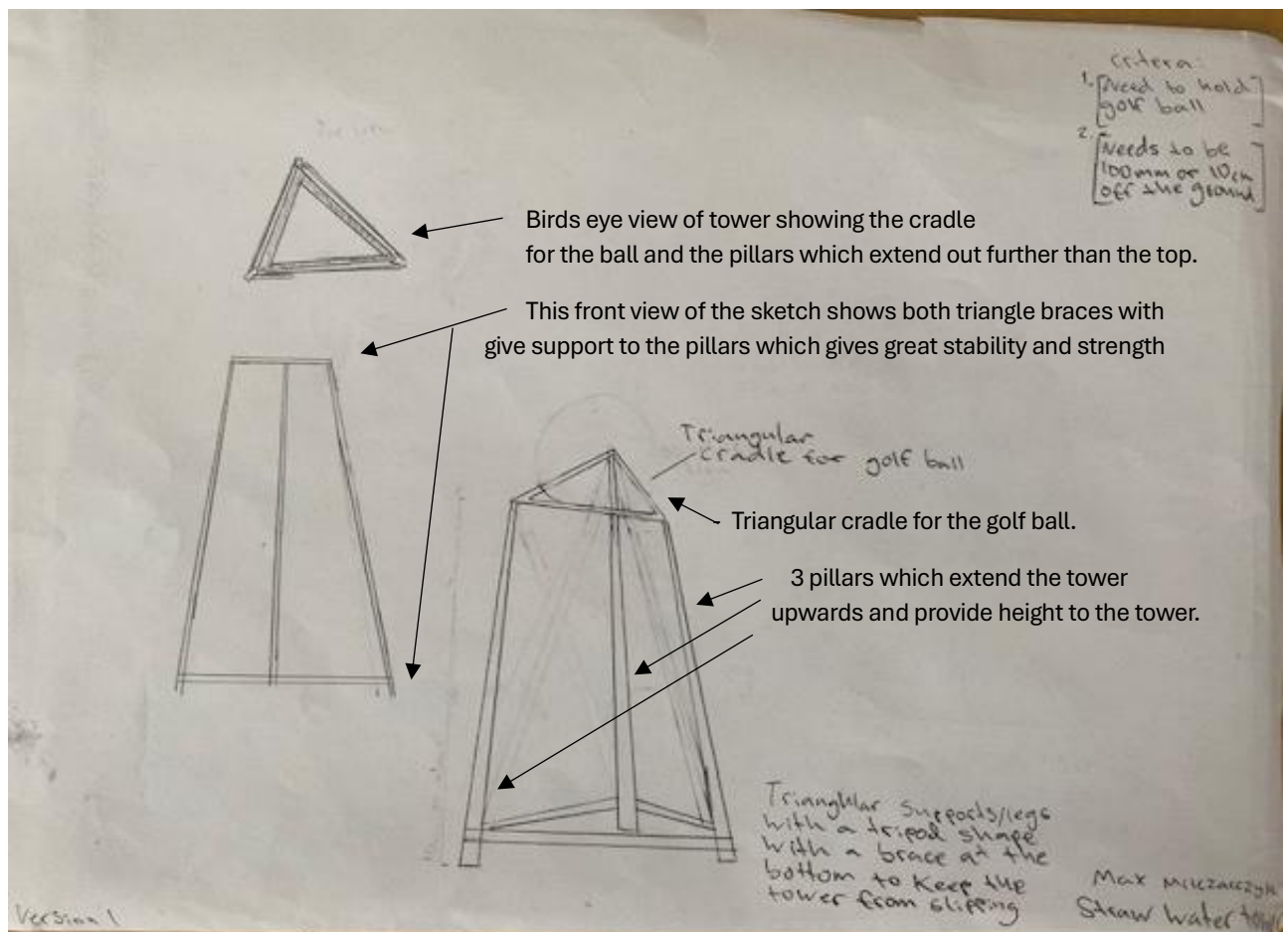


Pictures of completed design and other straw water tower.

## Main body - Sketches in advance of building. 1 of 2

### Labelled preliminary sketches of initial ideas – alternative preliminary sketch 1

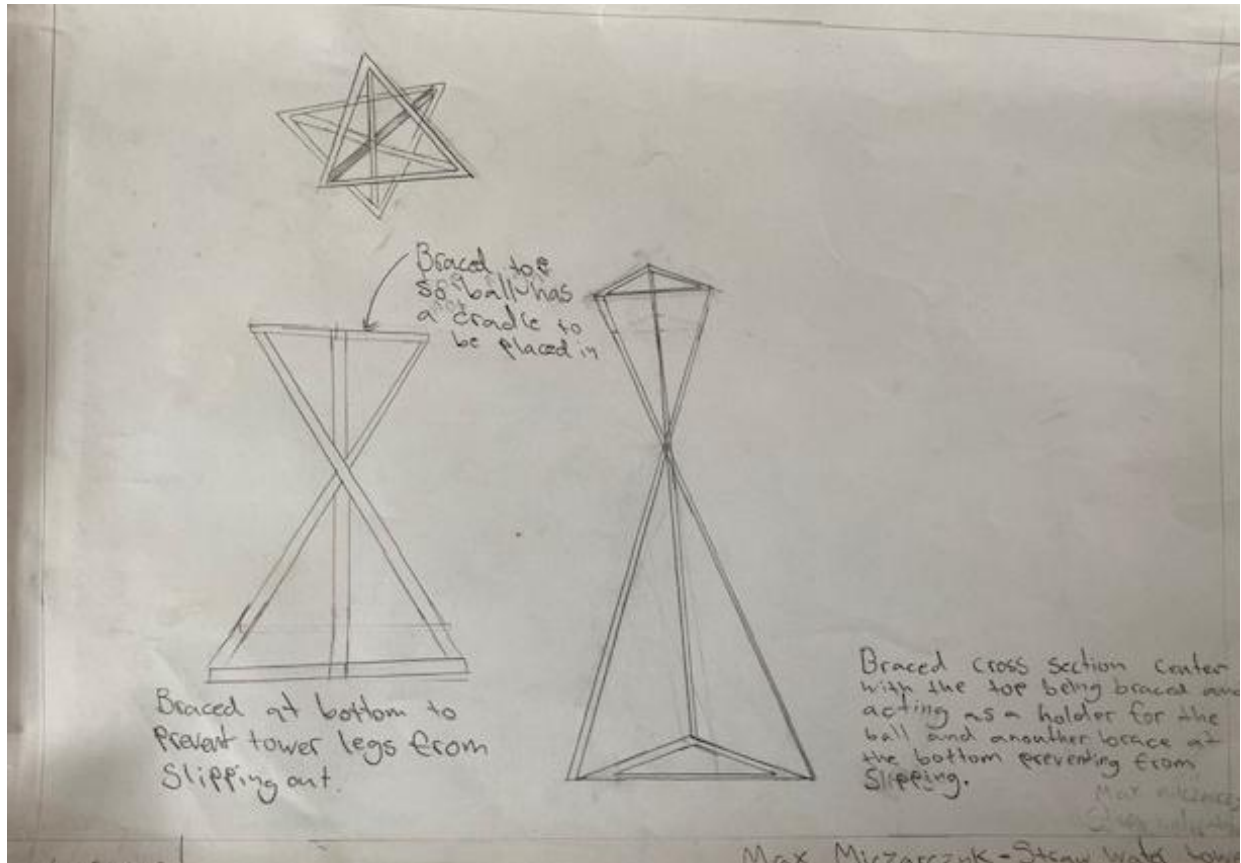
I came up with a water tower that was similar to the paper tower, because of the paper towers success. I made a design that was similar but imitated some of the other design features. This water tower sketch is braced from both top and bottom to provide stability and the top brace acts as a cradle for the ball. This tower consisted of 2 triangle braces with supported the 3 pillars.



## **Main body – Sketches in advance of building. 2 of 2**

### **Labelled preliminary sketches of initial ideas - alternative preliminary sketch 2**

This sketch had a crossed section in the middle of the tower to provide an extra point for connection and also another point of strength, this design was very similar to design 1 consisting of the 2 triangle braces and the 3 pillars which extend downwards. This design also took the braces which are great from preventing the pillars from slipping out.

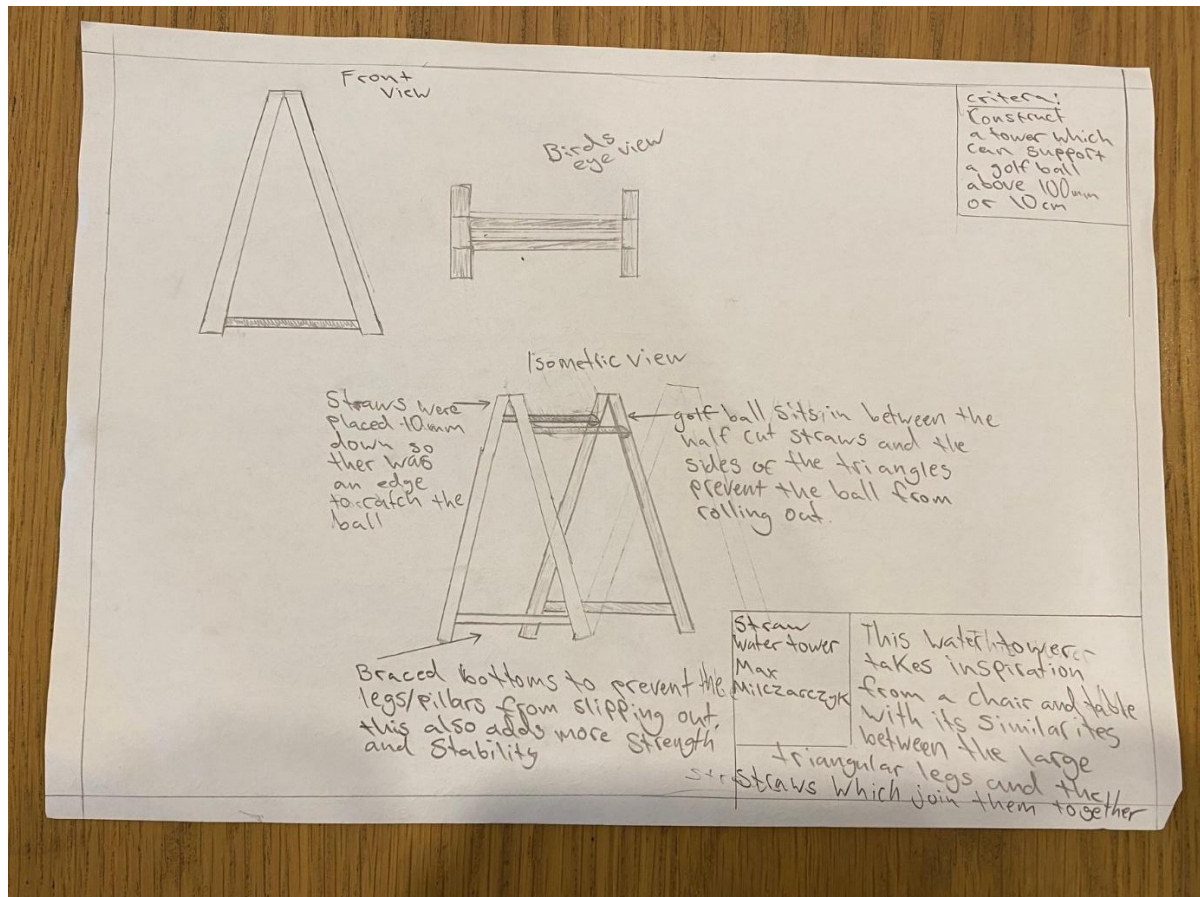


**Labelled preliminary sketches of finished straw water towers on next page. Pg 7.**

## Main body – Finished Product sketch. 1 of 2

### Labelled preliminary sketches of finished straw water towers

This is the finished product of the straw water tower, this design was an innovative design that incorporated 2 large triangles connected with a half cut straw joining them to become one tower, this connection allowed the ball to be placed giving a large cradle to support the ball, these cut straws were placed 10mm down as the side of the triangle pillars gave an edge for the golf ball not to roll off. This design took inspiration from tables and chairs which have a large area for the ballast and 2 large triangle pillars. This design was very successful as it had great stability and strength.



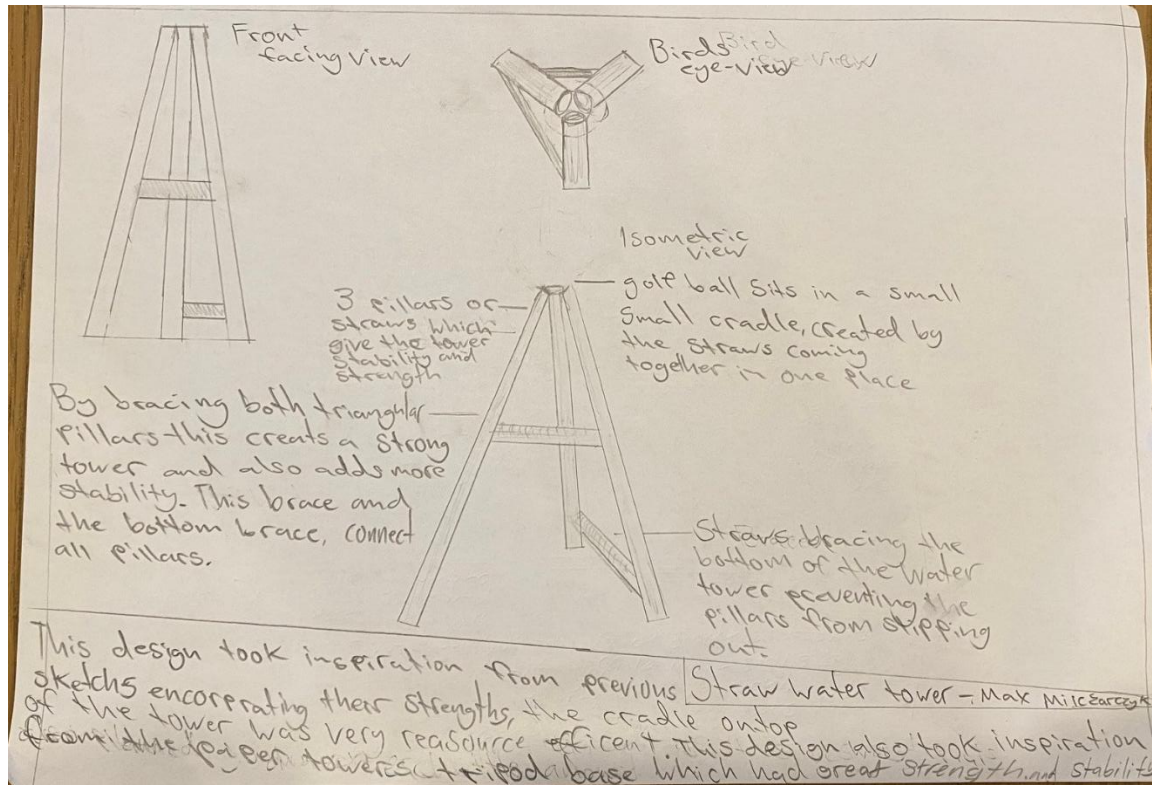
Labelled preliminary sketches of other finished straw water tower on next page: Pg 9.



## Main body – Finished Product sketch .2 of 2

### Labelled preliminary sketches of other finished straw water towers

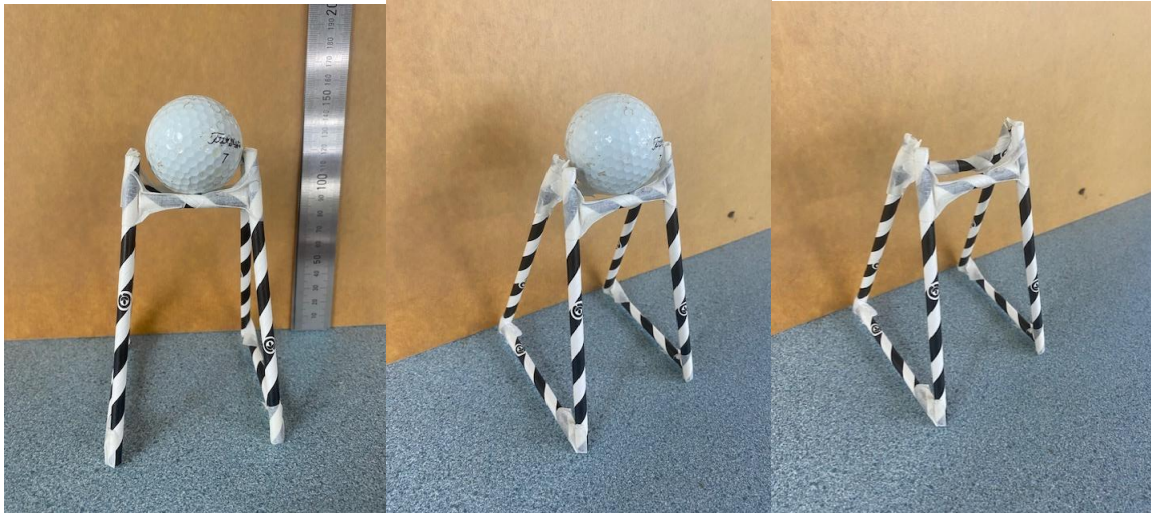
This design took inspiration from the previous paper tower project with its tripod base that had great stability and strength this design of the 3 pillars with braces was very effective as it



## ***Main body***

### ***Evidence of completion (Cropped photo of completed project)***

*Images of final completed straw water tower:*




*Images of other straw water tower:*



***Procedure recount – Finished product on next page Pg. 10***


### Procedure recount – Finished product

<p><b>Insert Image below</b></p>	<p><b>Write below an evaluation of design 1</b>, with respect to what you see as positive (works well), what is negative (does not work well) and what you would like to a change in version 2 to improve your overall design.</p>
	<p><i>What worked well, with design 1 was that this water tower had great stability and strength due to the large triangles and the straws supports connecting the triangles. This design was also very effective at holding the ball and not letting it roll off the sides due to the straws being placed lower, so it created a railing for the ball. What was also very positive about this design was the brace between both the pillars on the left side and right side which held the tower in shape and prevented it from slipping out. This tower also weighed 15g because of using less straws and tape. Also I only used 6 straws making this design.</i></p> <p><i>What didn't work well, I believe that this design had very little to no negative aspects, but this towers main issue was the base of the triangular pillars was unsupported and a tiny bit flimsy, this was due to no bracing the bottom.</i></p> <p><i>What I could've improved, I could've improved the base with the leftover straws as I only used 6. I could've used the last 2 straws to reinforce the base adding more strength and stability to the water tower also by making the triangular pillars more spread apart this would give the tower even more stability.</i></p>
<p><b>Procedure recount</b></p>	<p>In the space provided below, provide a procedure recount of how you made your Straw water tower. Remember to include the correct names of materials, equipment and techniques used. Seek advice from your teacher if you need help.</p>
	<p>The method I used to assemble the final straw water tower I took 2 cocktail straws, laid them out with the tops of the straws touching , taping them together with masking tape, then I made a brace to connect the large triangles. I cut another cocktail straw into halves, I used a half to brace the bottom taping the brace to both pillars, creating a large triangle that is used as pillars to support the ballast, then I replicated that design of the triangle pillars using another 2 cocktail straws as well as the other half. Then this triangle will be mirrored to the other side of the water tower. Then I took my last straw cutting it into halves, which will provide connection between both triangle pieces and acts as a spot to place the golf ball or ballast. I connected theses half straws 10mm from the top so I could use the tops of the triangles as railings to support the ballast from falling off.</p>
<p><b>Challenge reflection</b></p>	<p>Consider the process of designing, making and testing your water tower (the design process). What worked well for you? What did you have difficulty with? What would you do differently next time? Are there other materials you could have used and why?</p>
	<p>What worked well for me, was being able to create a cradle for the ball and being able to accurately get the same outcome with the tower supporting the ball, this was due to the large triangles being able to support the ballast and the straws connecting the triangles together. What also worked well for me was being able to create the triangles that support the weight of the golf ball. What I had difficulty with, I wasn't really faced with to many challenges however next time I would change the supports on the bottom, allowing the tower to hold more weight with more stability. Some other materials I would've used are paddle pop sticks and hot glue as the paddle pop sticks can support more weight and give</p>



better stability and strength and the hot glue would add a better connection and strength in the joints where the paddle pop sticks meet.

### Procedure recount – Other straw water tower

<p><b>Insert Image below</b></p>	<p><b>Write below an evaluation of design 1</b>, with respect to what you see as positive (works well), what is negative (does not work well) and what you would like to change in version 2 to improve your overall design.</p>
	<p><i>What worked well</i>, what worked well with this straw water tower was the number of resources I used, this tower was created out of 4 cocktail straws and most of the tape provided, this tower also had great stability with its braced pillars, also because the straws were angled higher then the other water tower this one held the ball higher. This tower also had simple construction which made fast construction. This tower also weighed 14grams lighter than the other tower and was only constructed of 4 straws.</p> <p><i>What was negative</i>, this tower has a lot of negatives especially if it was scaled to real life sizes there would be problems with the ballast sitting on the top. The main issues with this tower where you had to perfectly balance the ball on top of the tower for it to stay in the cradle also the tower wasn't braced at the back which problems with base stability.</p> <p><i>What would I improve</i>, I would improve this tower by making a small triangle that would be placed on the top which would hold the ball accurately and connected it by using my remaining tape also I would brace the back of the water tower as it isn't braced and bracing it would provide more stability and strength to the tower.</p>
<p><b>Procedure recount</b></p>	<p>In the space provided below, provide a procedure recount of how you made your Straw water tower. Remember to include the correct names of materials, equipment and techniques used. Seek advice from your teacher if you need help.</p>
	<p>How I made this tower I made this tower by constructing 2 cocktail straws being laid out with the tops touching, I taped the tops to keep them in place then I cut a cocktail straw into halves and used that as a brace on the lower part of the connected pillars taping the brace to each pillar using masking tape, then I took my final straw stood up the other triangle and attached the straw using masking tape making sure all tops were together making a small cradle then I took my final half and added it half way up the pillars so that is provided a larger base and finally taped the brace in place.</p>
<p><b>Challenge reflection</b></p>	<p>Consider the process of designing, making and testing your water tower (the design process). What worked well for you? What did you have difficulty with? What would you do differently next time? Are there other materials you could have used and why?</p>
	<p>What worked well, what worked well in this design, when the ball was successfully balanced this tower was very effective, but the ball could be knocked off easily, what was the most effective was the use of materials, being conservative of the straws making an effective tower out of 4 cocktail straws, what also worked well was the bracing between the pillars which provided strength and added stability to the tower.</p>

What did I have difficulty with, I had a few problems with the design with the balancing of the golf ball on the top and the positioning the pillars so that the stability could be at its full potential I also had problems with the leg not being extended enough the tower would fall over.

What would I do differently next time, next time I would add another brace to the back of the water tower which provides more stability and strength to the tower, I would also create a small triangular cradle which would be placed on the top to hold the ball better.

Other materials I could've used and why, some other materials I could've used are paddle pop sticks and hot glue as well as timber dowel, timber dowel is great for modelling and building, timber dowl also provides good strength. Hot glue also provides a fast strong method of attaching also it stronger then masking tape, paddle pop sticks also provide a stronger and alternative material.



## ***Conclusions:***

### ***Reference to the original aims of the project***

The aim of the project was to create a tower of 8 or less cocktail paper straws which can hold a golf ball indefinitely and to create the tower only using 20cm of tape. The tower also had to hold the golf ball above 10cm or 100mm above the ground and without the golf ball falling off, the tower cannot be secured to the ground, must be freestanding. The other aim was to create a portfolio of the project which reflected main ideas, procedure recount and sketches of the project also including a title page, table of contents, main body, conclusions and reflections.

### ***The context and significance of the information***

The context and significance of the information is that I successfully built a tower which can hold a ball above 100mm above the ground without the ball falling and if scaled up to real life sizes this tower would be very successful for holding 3 times its weight because a golf ball weighs 46grams and my tower only weighed 15. The significance of the information also shows a detailed report with depth and understanding of the topic.

### ***The applications of the results***

This water tower is applicable to the real world because it able to successfully hold more than 3 times its weight indefinitely and be able to hold the ballast above 100mm.

### ***Acknowledgment of the limitations of the findings***

The limitations of finding were that this tower could've been stronger and more stable if there was a braced added at the bottom of the tower between both pillars also because the tower is a bit flimsy now this adds less stability.

### ***Clear and concise summary of the key findings or information in the report.***

The findings showed out of both towers that I constructed the final design with the large cradle was more effective and stronger than the other tower which had a small cradle and small bracing because the final tower had a large spot of the ball to sit also the sides prevented the ball from falling off also this tower distributed the weight better then the other tower because the other tower had a small pillar base and it was difficult to place the ball as the cradle was small and you needed to balance the ball perfectly also in the rest of the report the sketches and images of existing towers and straw towers can support this because most water towers have large base width which provides good stability and strength. In other existing designs people have created most of them consistently have a lot of bracing which gives even better strength to the tower.

## **References:**

- I would like to keep the existing design.
- Upgrading the parts like the triangles which aren't braced and if we would add more stability and strength.
- Use different materials to see the other outcomes that the tower preforms
- Create different alternative innovation alternatives or use the existing design
- Have more time, this provides mor planning and building time
- Pushing myself to engineer a tower which can go even higher
- Hopefully engineer a tower which can hold even more than 3 times its weight when scaled up.