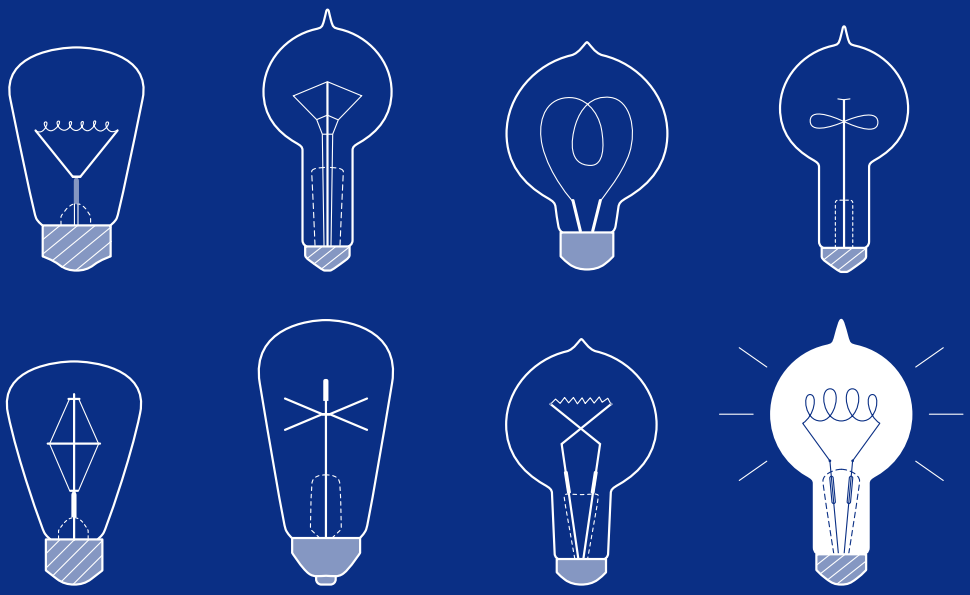
CHALLENGE CARDS



The inventor Thomas Edison once said success is 10% INSPIRATION AND 90% PERSPIRATION.

FOUNDATION JAMES DYSON

Using challenges like these, the James Dyson Foundation encourages young people to think differently and realise their engineering potential. You might make lots of mistakes trying to solve each task, but don't give up – and have fun.

CHALLENGE

01

SPAGHETTI BRIDGES

Isambard Kingdom Brunel was the genius behind the Great Western Railway – the series of tunnels and bridges connecting London with the South West and Wales. Through years of testing and exploration, he developed an expert understanding of the strengths and constraints of materials and the structural stability of different shapes.

BEAM BRIDGE

TRUSS BRIDGE

ARCH BRIDGE

CANTILEVER BRIDGE

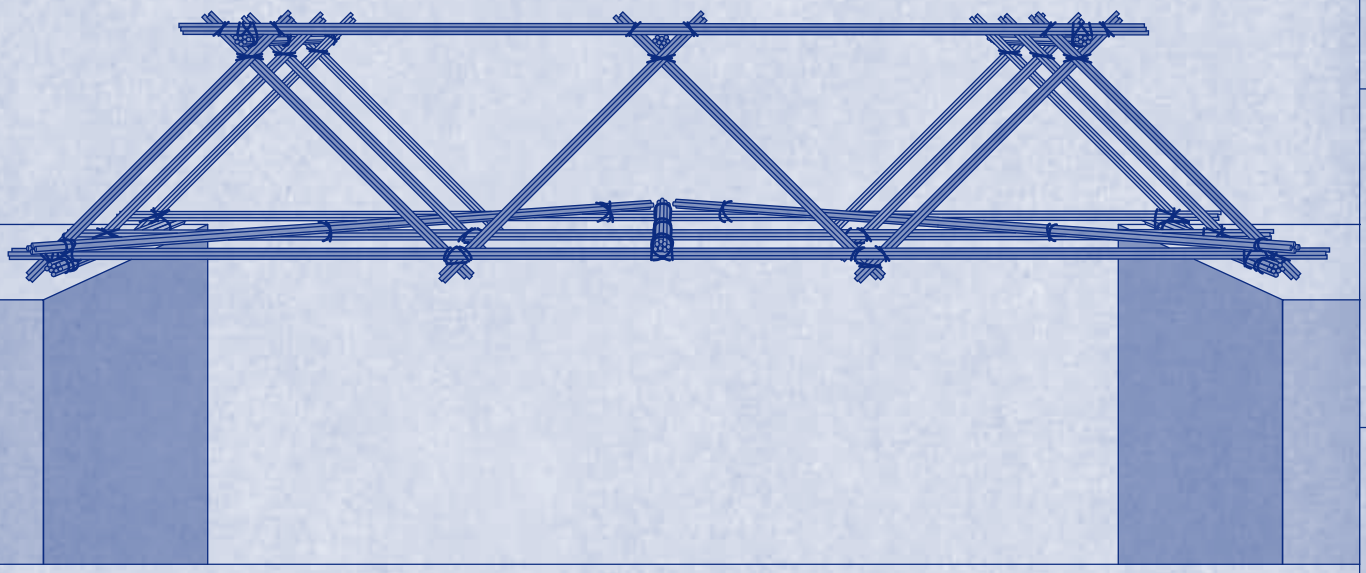
CABLE-STAYED BRIDGE

SUSPENSION BRIDGE

CONSTRUCT A BRIDGE OUT OF SPAGHETTI, STRONG ENOUGH TO SUPPORT A 250G BAG OF SUGAR.

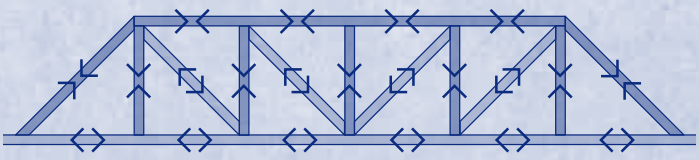
Materials

Spaghetti
Small elastic bands or bag ties
Sticky tape
Plenty of patience



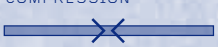
Snap. Snap. Start again.

Bridges manage two important forces: compression and tension – pushing and pulling. Too much of either and they buckle or snap. Be patient. Through trial and error, you'll become proficient with spaghetti: bracing strands together for strength; forming rigid shapes that absorb loads; and using elastic bands at junctions.



TENSION

COMPRESSION



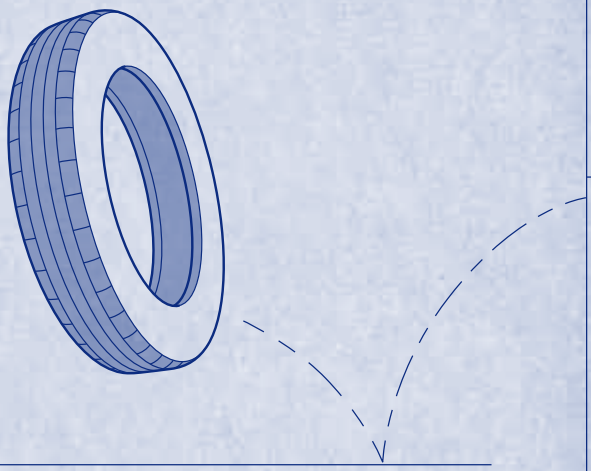
VISIT WWW.JAMESDYSONFOUNDATION.CO.UK/DRAWING
to see more spaghetti bridges, upload your engineering feats and download your bridge building certificate.

CHALLENGE

02

CHANGING STATES

Rubber is everywhere now. But in the early 1830s it was considered useless. It set hard in winter and melted in summer. Charles Goodyear spent nine years finding a solution. He mixed rubber with other substances; boiled it; covered it in acid. By chance he dropped a sulphur-covered sample on a hot stove – transforming it into a springy substance known today as vulcanised rubber.



HOW DO YOU CHANGE AN EGG'S PROPERTIES TO MAKE IT FIT IN A BOTTLE?

Materials

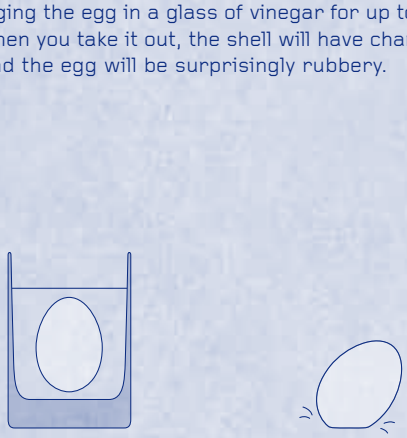
1 x small uncooked egg
1 x pan of boiling water (with adult supervision)
or 1 x glass of vinegar
1 x thick-necked bottle

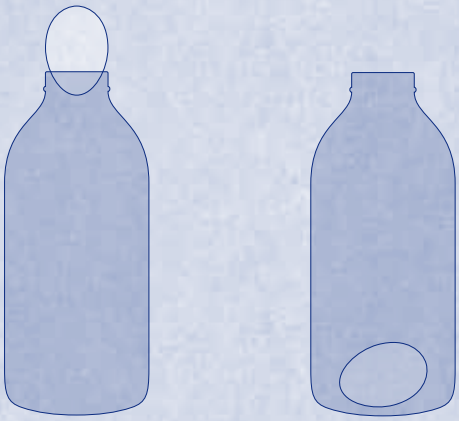
Changing the state of the egg:

Boil an egg in a pan of water for 10 minutes and carefully remove its shell.

Alternatively, for a more challenging approach, try submerging the egg in a glass of vinegar for up to two days. When you take it out, the shell will have changed state and the egg will be surprisingly rubbery.

Heat the bottle in hot water – use gloves (or a tea towel) when handling the hot bottle. Rest the egg on the neck. As the air inside the bottle cools, it contracts and sucks the egg down. Tip: try lubricating the egg with kitchen oil or washing up liquid.

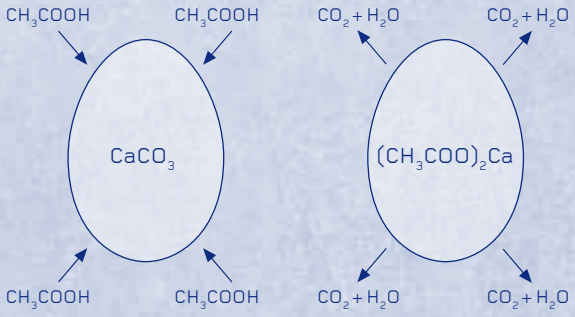




How it works

Eggs are rich in protein. When heat is applied, chemical bonds within the protein molecules are broken, and new bonds are formed between adjacent molecules. This creates a network of interconnected proteins which causes the egg to go hard.

Vinegar contains acetic acid (CH_3COOH) that dissolves the calcium carbonate ($CaCO_3$) shell but leaves behind the egg's springy membrane.



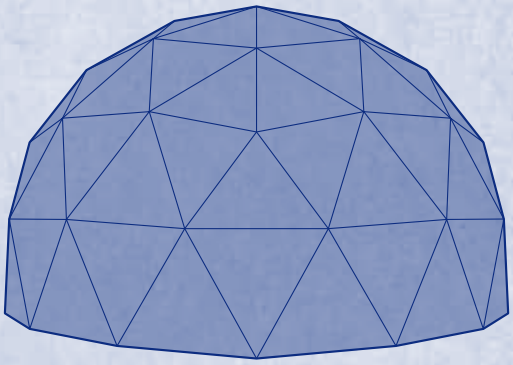
VISIT WWW.JAMESDYSONFOUNDATION.CO.UK/DRAWING to see more eggy experiments. You can also get a certificate for completing your experiments successfully.

CHALLENGE

03

GEODESIC DOME

Richard Buckminster Fuller studied beehives, fishing nets and other 'networks' to create the geodesic dome: lightweight, simple to build, yet incredibly rigid – ideal for the post WW2 housing shortage. Today, there are more than 300,000 around the world.



USING JELLY SWEETS AND COCKTAIL STICKS, MAKE YOUR OWN GEODESIC DOME.

Materials

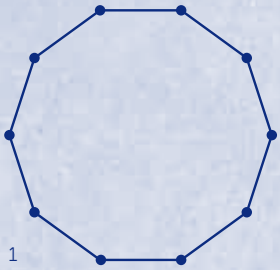
Cocktail sticks
Jelly sweets
Scissors (with adult supervision)

Follow the steps 1 to 6.

You'll need two different cocktail stick lengths: 35 at 60mm and 30 cut down to 54mm.

Key for cocktail stick lengths:

60mm
54mm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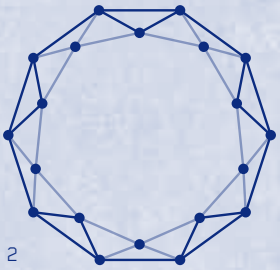
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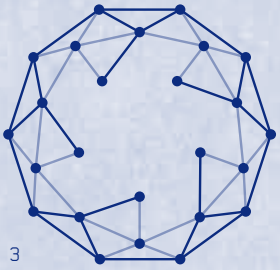
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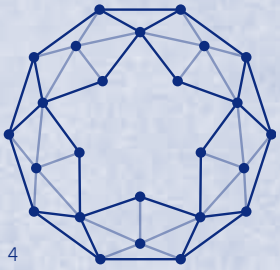
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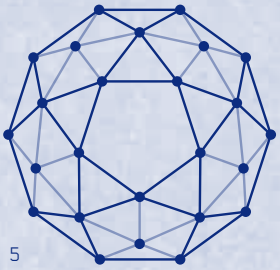
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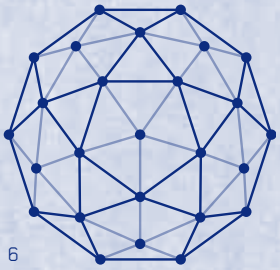
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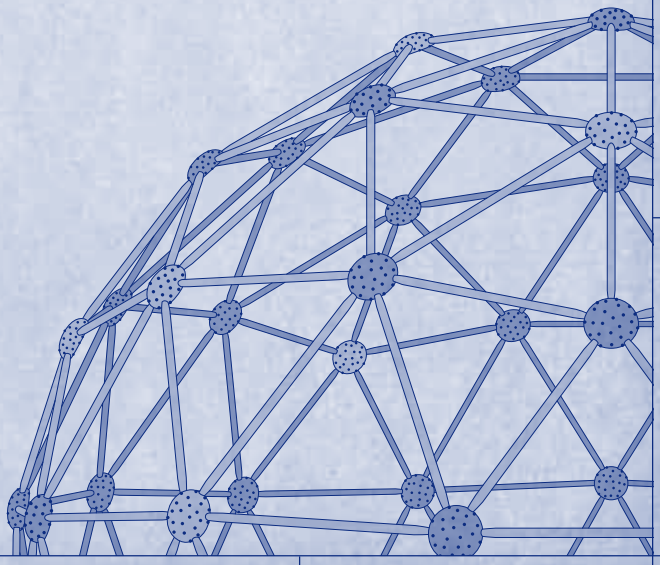
Why are geodesic domes so rigid?

Multiple, interlocked triangles form incredibly strong structures. To deform or buckle a triangle you have to compress or stretch the lengths of the sides, which is hard to do as they all support each other. Ideal for polar research stations and military bases.

Domes and more

Try making a bigger dome. More triangles means greater rigidity and a smoother curve. See what other structures you can make using cocktail sticks and jelly sweets.

VISIT WWW.JAMESDYSONFOUNDATION.CO.UK/DRAWING to see other geodesic domes, or upload your own structures. Once your dome is built, you can download a certificate.

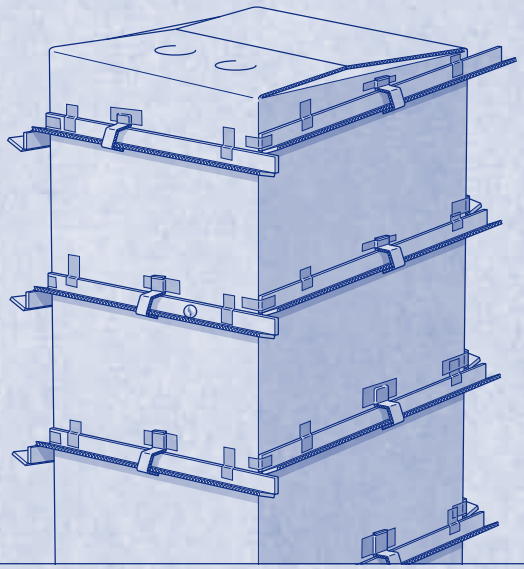


CHALLENGE

04

MARBLE RUN

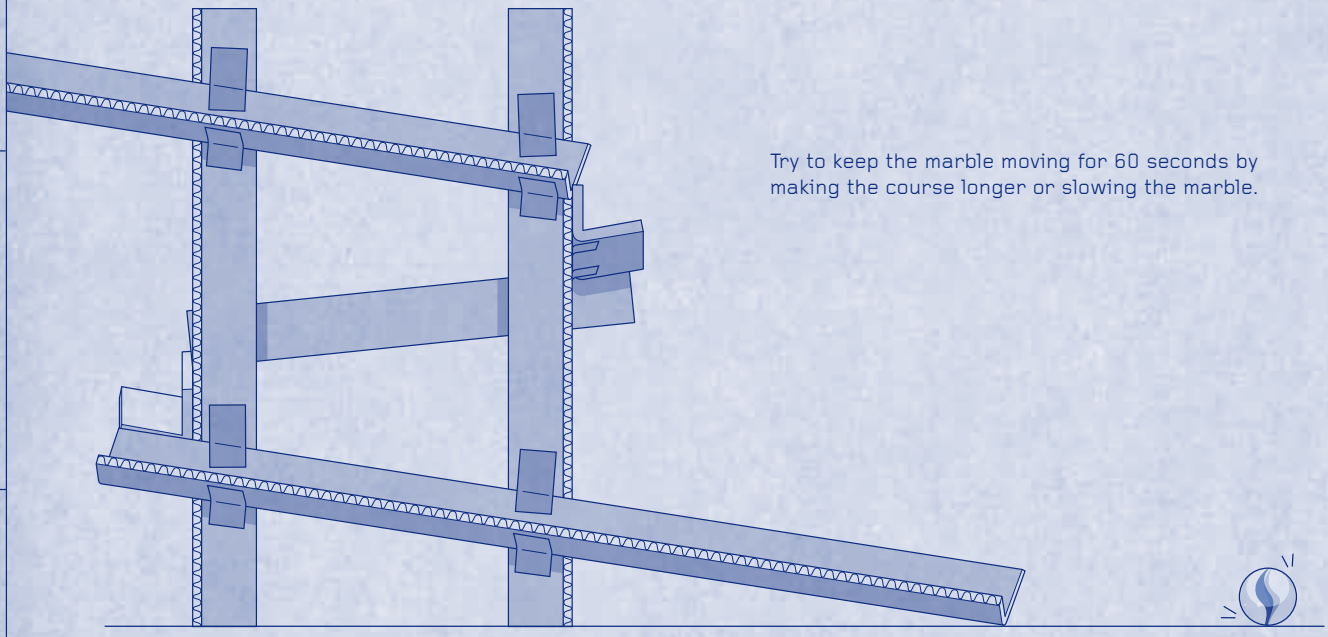
Cardboard is a useful material for Dyson engineers. It's pliable, easy to shape and ideal for prototyping and early structural testing. It's also recyclable.



USE YOUR VACUUM CLEANER BOX AND THE INTERNAL CARDBOARD STRUTS TO CREATE A MARBLE RUN.

Materials

Vacuum cleaner box (including inner struts)
Sticky tape
Marbles
Scissors (with adult supervision)

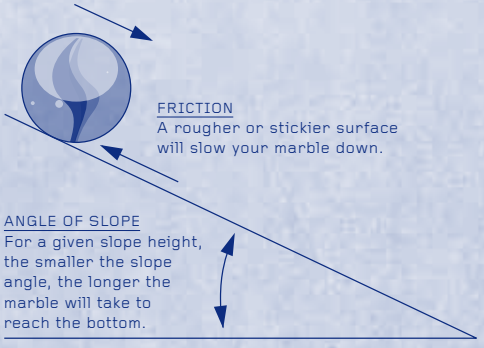


Try to keep the marble moving for 60 seconds by making the course longer or slowing the marble.

Marble run physics

To help you control the time your marble takes to run its course, you will need to consider the following:

POTENTIAL ENERGY = MASS X GRAVITY X HEIGHT
The heavier your marble, and higher your slope, the more energy your marble will have.



FRICTION
A rougher or stickier surface will slow your marble down.

ANGLE OF SLOPE
For a given slope height, the smaller the slope angle, the longer the marble will take to reach the bottom.

VISIT WWW.JAMESDYSONFOUNDATION.CO.UK/DRAWING to be inspired by other marble runs. You can also upload footage of your own and get a certificate for your efforts.