EXPERIMENT MANUAL

STRUCTURAL ENGINEERING

BRIDGES & SKYSCRAPERS

THAMES & KOSMOS

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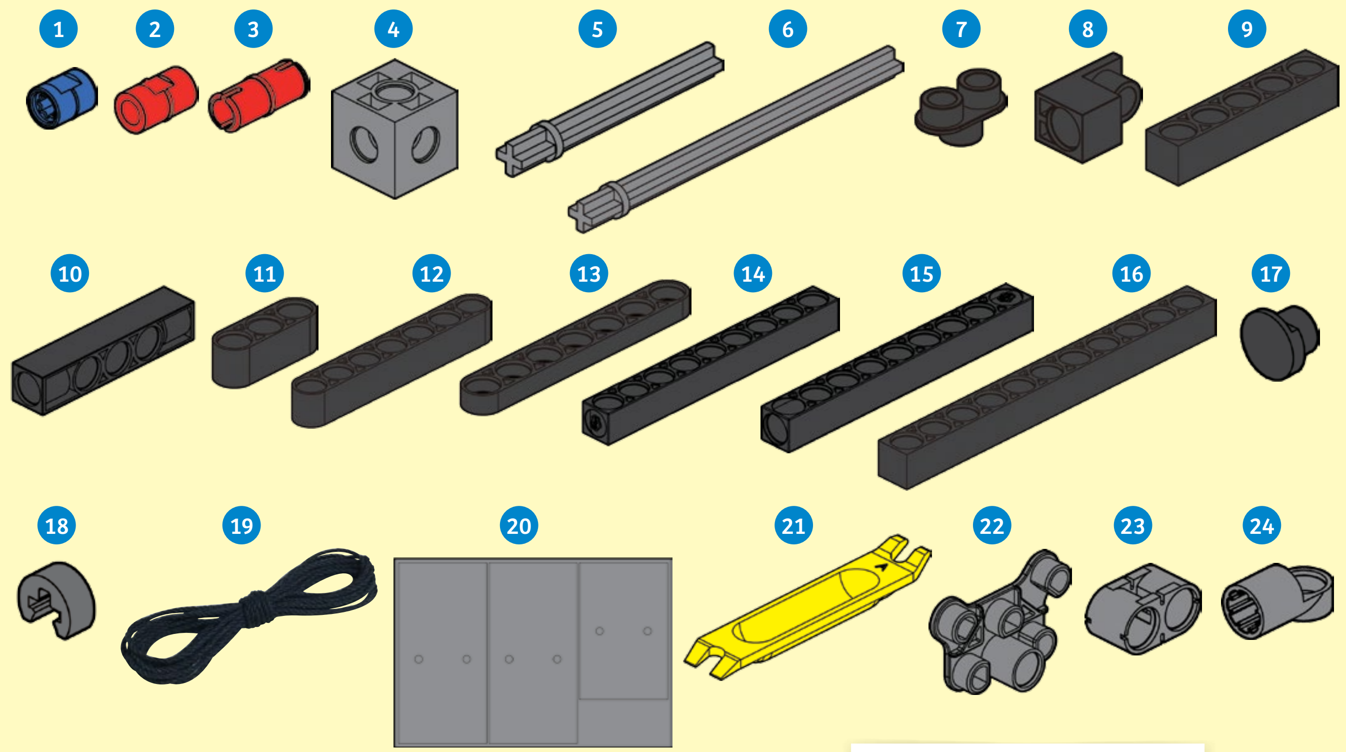
What's inside your experiment kit:



To build the models, you will also need:
scissors, ruler or measuring tape

Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
❍	1	Short anchor pin, blue	40	7344-W10-C2B
❍	2	Anchor pin, red	20	7061-W10-C1R
❍	3	Joint pin	32	1156-W10-A1R
❍	4	6-hole cube, gray	8	880-W10-N1S1
❍	5	60-mm axle rod	12	7413-W10-M1S
❍	6	100-mm axle rod	4	7413-W10-L2S
❍	7	Two-to-one converter	16	7061-W10-G1D
❍	8	90-degree converter Y, black	14	7061-W10-J2D
❍	9	5-hole rod, black	12	7413-W10-K2D
❍	10	5-hole cross rod	10	7413-W10-K3D
❍	11	3-hole wide rounded rod	2	7404-W10-C1D
❍	12	7-hole wide rounded rod	2	7404-W10-C2D
❍	13	7-hole flat rounded rod	2	7404-W10-C3D
❍	14	9-hole rod	24	7407-W10-C1D
❍	15	9-hole cross rod	13	7407-W10-C2D
❍	16	11-hole rod	11	7413-W10-P1D
❍	17	Short button pin	8	7061-W10-W1D
❍	18	Axle lock	9	3620-W10-A1D
❍	19	Black string, 400 cm	2	R39-W85-400D
❍	20	Die-cut plastic sheet	1	K41-7410
❍	21	Anchor pin lever	1	7061-W10-B1Y
❍	22	6-way connector	24	7410-W10-A1S
❍	23	String connector	24	7410-W10-B1S
❍	24	Axle rod connector	32	7410-W10-C1S

Cutting the string to length

You will need to cut the two 400-cm black strings to the following lengths. The specific lengths needed for each model are indicated in the assembly instructions for each model.

20 cm x 4

24 cm x 4

38 cm x 8

GOOD TO KNOW!
If you are missing any parts, please contact Thames & Kosmos customer service.

US: techsupport@thamesandkosmos.com
UK: techsupport@thamesandkosmos.co.uk

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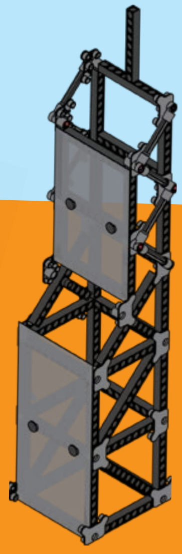

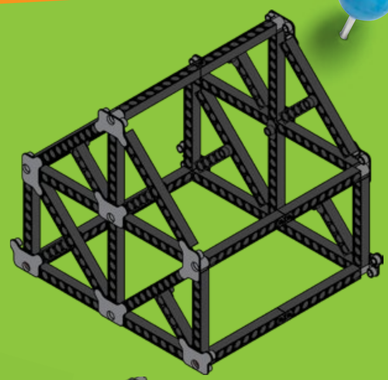

TIP!

At the top of each model assembly page, you will find a red bar:

››› It shows how difficult the model's assembly will be:

easy — medium — hard

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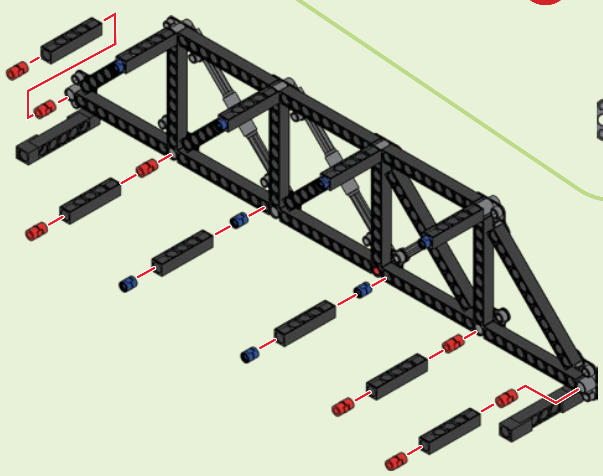

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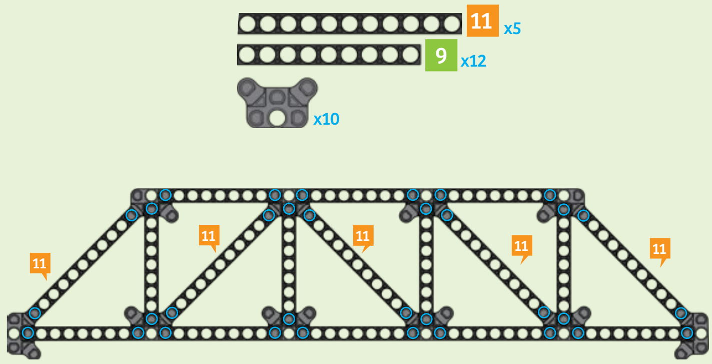

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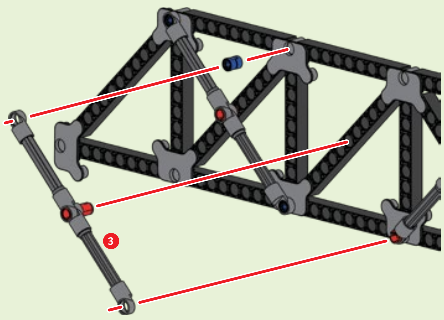

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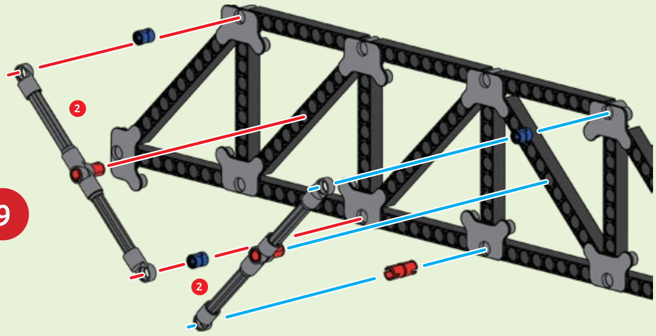

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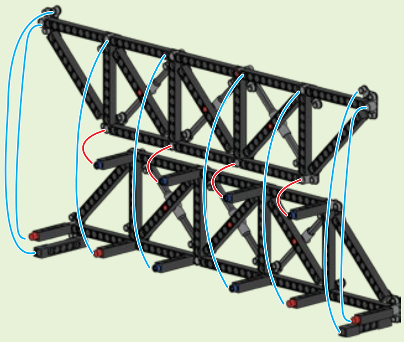

EXPERIMENT 9

Engineering constraints

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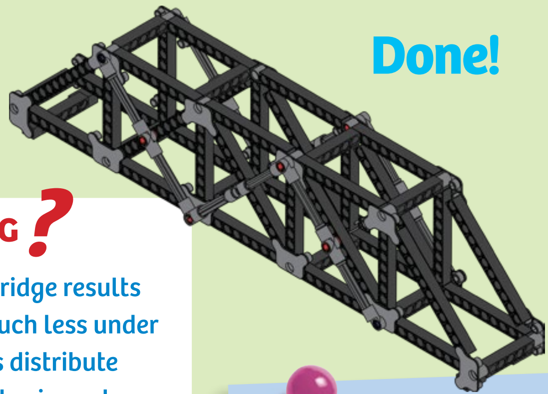


Done!

HERE'S HOW

Repeat Experiment 7. Compare the amount of deflection in the different bridges. Which bridge is the strongest?

A crucial task of an engineer is to identify and understand constraints in order to develop a solution. An engineer has to balance many different trade-offs. Some trade-offs an engineer may face include available resources, cost, productivity, time, quality, and safety.

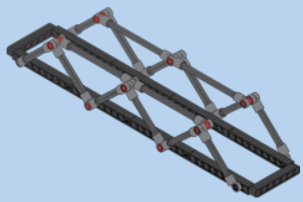
WHAT'S HAPPENING?

Adding the trusses to the bridge results in a bridge that deflects much less under the same load. The trusses distribute the forces through the bridge in such a way that the middle of the bridge deflects less. Some of the rods in the truss are under compression and some are under tension, and each rod and connection point is suitably strong to hold up to the forces acting on it.

Read about tension and compression on the next page.

BONUS EXPERIMENT

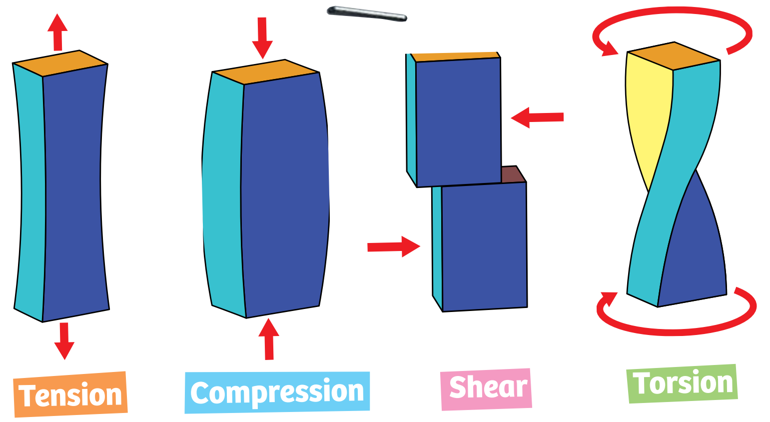
Can you build this alternate truss bridge?



CHECK IT OUT

Load

Another important part of designing a structure is understanding how **loads** affect a structure. Loads are forces, deformations, or accelerations that are applied to a structure or its parts.



Structural engineers often use four terms to describe how a load can affect a structure: tension, compression, shear, and torsion.

Tension is any force that pulls (or stretches) an object apart.

Compression is any force that pushes in on (or squeezes) an object.

Shear is a force that causes parallel internal surfaces within an object to slide past each other. (You will see an example of shear in the next experiment.)

Torsion is a force that causes the twisting of an object due to a moment.

DID YOU KNOW ...

... **toughened glass,** which is the glass used in smartphone screens, is strengthened by treating it with heat and chemicals to induce a state of compression in the outer surface of the glass and a state of tension inside the glass. This increases its ability to withstand external loads without breaking.

A structure, such as a building, is made up of many different parts such as walls, floors, beams, and ceilings. A structural engineer groups the parts of a building or structure into a small number of categories based on their physical behaviors. In this kit, we focus on understanding how **columns, beams, planes, trusses, catenaries, arches, cables,** and **shells** work in a structure.

Just as important as which structural elements are used in a building are the ways in which those structural elements are connected together. A building is designed to safely transfer its load through its structural elements to the ground. There are three common types of connections used in buildings: **rollers, pins,** and **fixed supports.**

For example, **roller supports** are commonly used at one end of bridges. This allows the bridge to move when it expands and contracts with changes in temperature.

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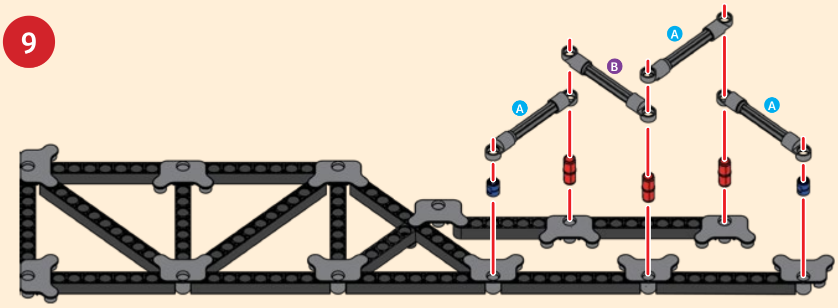

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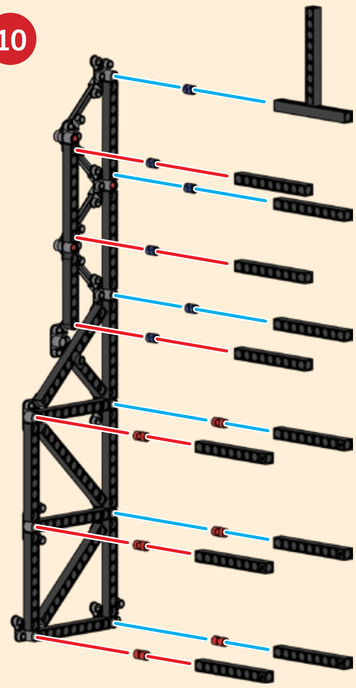

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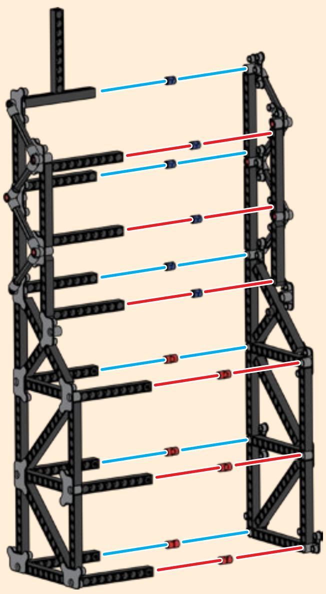

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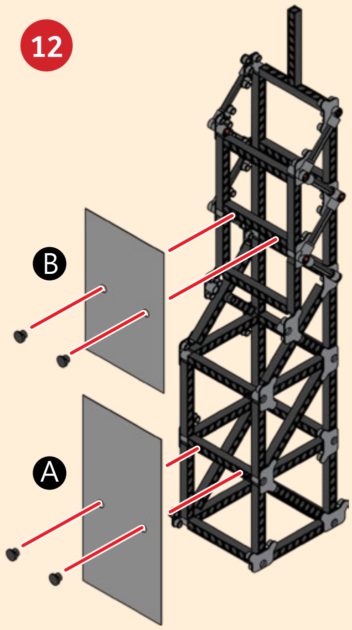

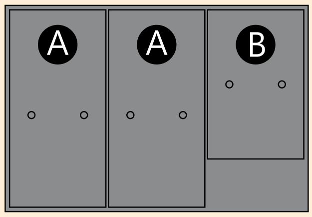

EXPERIMENT 14

Engineering Design Challenge: Skyscrapers

HERE'S HOW

Using only the materials in this kit, build the tallest skyscraper possible. The skyscraper must be able to remain standing on its own. You can make the challenge more difficult by adding other requirements, such as that the skyscraper must withstand the flow of air from a hair dryer, or the shaking of the table, or must hold a certain amount of weight.

Some engineering constraints relating to skyscrapers that you may need to consider in your design include the materials available, height, weight of the skyscraper and occupants, location, time, cost, and the strength and stability needed to resist loads such as earthquakes and wind.

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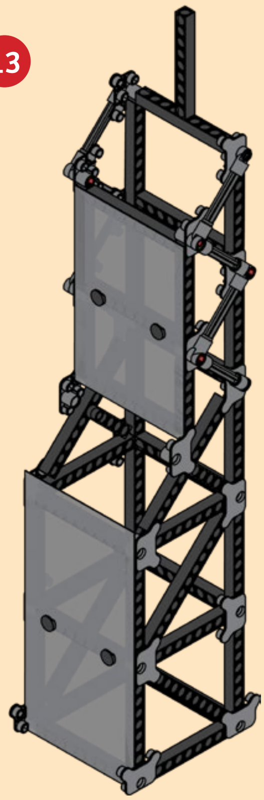

Done!