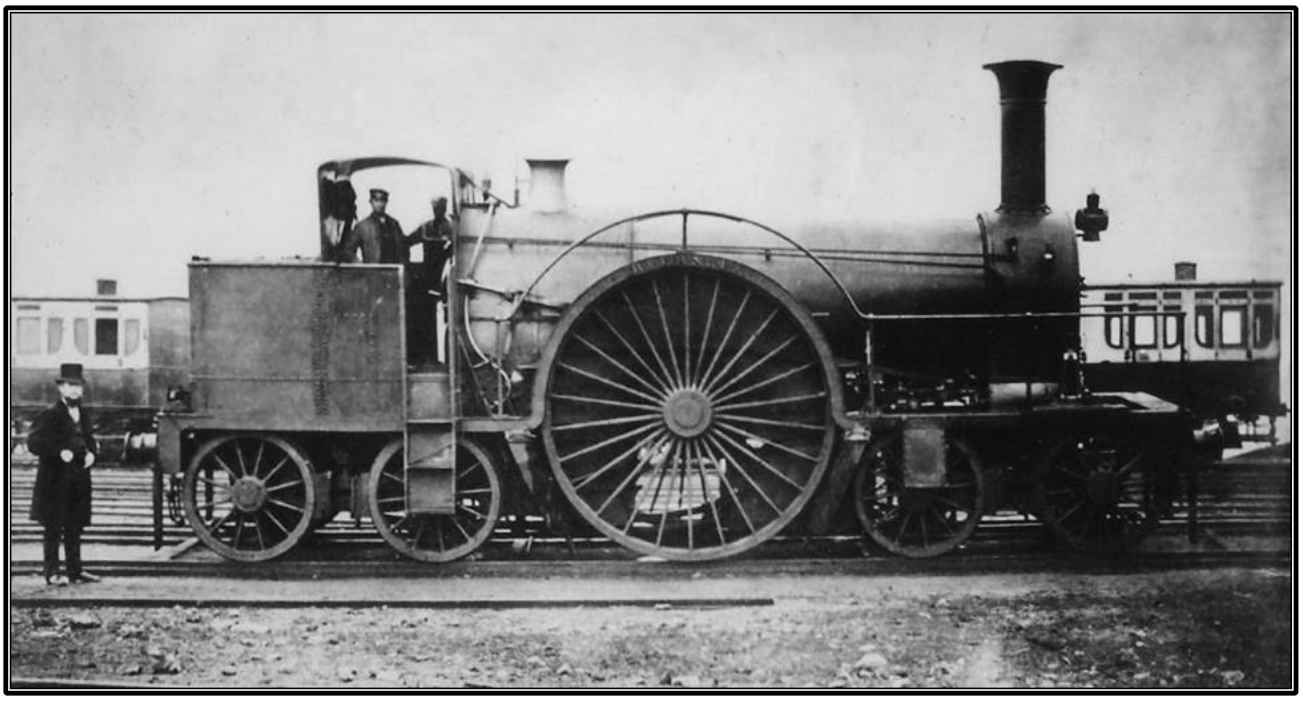
WSRHT Gauge Museum Education Service

KS2 STEM Investigation:

Brunel's Broad Gauge Challenge



Lesson Pack for Schools

Thank you for choosing to download our STEM challenge pack. Please read the following information through thoroughly as, in addition to the resources provided here, there are several further resources required for this session that you will need to provide in advance. We hope you and your class enjoy the challenge!

Background Information

The Great Western Railway was designed by famous Victorian engineer Isambard Kingdom Brunel to carry passengers from London to Bristol. The West Somerset Railway is an extension of that line, linking the market town of Taunton to the seaside at Minehead. In his original design, Brunel intended both the GWR and the WSR to run as a broad-gauge railway.

The 'Gauge' of a railway refers to the width of the rails that the trains run on. A broad-gauge railway, therefore, has much wider tracks than a standard gauge railway. Brunel chose broad-gauge for three main reasons:

- The broader tracks meant that locomotives could run faster, making them more efficient.
- They also offered a smoother ride, giving GWR passengers a much more comfortable journey.
- The broader base made the trains much safer, with less potential for derailing.

Unfortunately, the rest of the UK's railways had been designed as standard gauge, which meant that transferring rolling stock from one to the other was just too complicated. Even though Brunel's design was better, it was decided that converting the rest of the country to broad-gauge was both too expensive and too time consuming, so it was decided that the GWR had to change to standard gauge.

Remarkably, the transition took just two days. After careful preparation, the Great Western Railway managed the switch in a weekend. It sent its last broad-gauge train out from London Paddington on a Friday evening and by Monday morning, was running entirely on standard gauge.

Brunel's Broad Gauge Challenge

The following STEM investigation consists of two different challenges. The first is a maths-based investigation, while the second consists of a design and make challenge followed by a science investigation. The PowerPoint provided is designed to walk you and your class through the session step by step and we strongly advise you to read it through carefully before completing with your class. There are also several resources that you will need to prepare in advance.

Challenge 1: Maths Investigation

The challenge cards for this task come in three different levels and get progressively harder. Ideally, the children would pick their own level. If you have children working below KS2 level, you could encourage them to use non-standard units of measurement to complete the task (see KS1 challenge cards)

Resources Needed:

- A roll of masking or electrical tape to lay out 'rails'
- Tape measures
- Copies of the maths task cards
- A way for children to record their answers/discoveries

Before the lesson, mark out two sets of 'rails' in the space where you plan to deliver the session. One should have a width of 143.5cm – this represents the standard gauge, while the other should have a width of 167.6cm – this represents the broad gauge.

Challenge 2: Design and Make/Science Challenge

Resources Needed:

- Each 'team' will need
    - 2 straws
    - 8 bottle tops
    - 4 skewers
    - 1 wide and 1 narrow piece of card
    - 2 cut-out train shapes
    - Scissors and tape
    - A copy of the science task card
    - A STEM record sheet and/or other method of recording ideas/results
- For the science investigation, you will need a small, sloped ramp for the children to test their models on and a set of tape measures.

The level of support that you give to the children during the design and make task is entirely up to you. For a greater challenge, you could leave out the task cards and encourage the children to work out for themselves how to build the two train models.

Please note that the science task cards come in two reading levels.

Spicy Maths Challenge

Can you find the difference between broad gauge and standard gauge?

Use a tape measure to measure the two tracks in centimetres.

Make sure you measure accurately.

Now compare both measurements. How much wider is the broad gauge track than the standard one?

Broad Gauge	
Standard Gauge	?

Hot Maths Challenge

Can you find the difference between broad gauge and standard gauge?

First you need to measure the two tracks.
Gauge is traditionally measured in inches.

Now convert your measurements from inches into centimetres by multiplying them by 2.5

Now compare both measurements. How much wider is the broad-gauge track than the standard one?

Broad Gauge	
Standard Gauge	?

Volcanic Maths Challenge

Can you find the difference between broad gauge and standard gauge?

Gauge is traditionally measured in feet and inches.

Using these, find the width of each with your measuring tape.

You will need to convert your measurement into inches.
There are 12 inches in one foot.

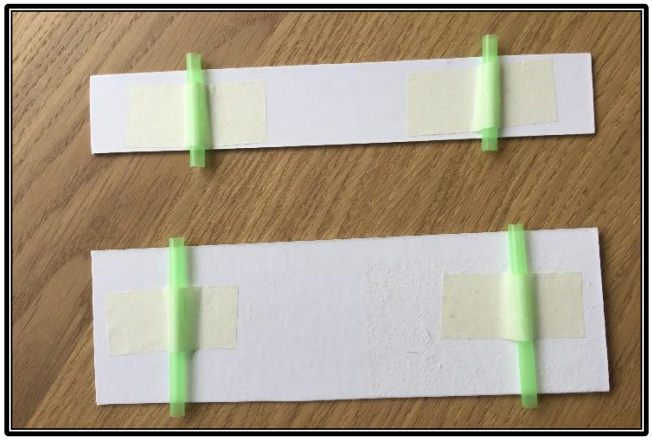
Now convert your inches into centimetres by multiplying by 2.54

Compare both measurements. How much wider is the broad-gauge track than the standard one?

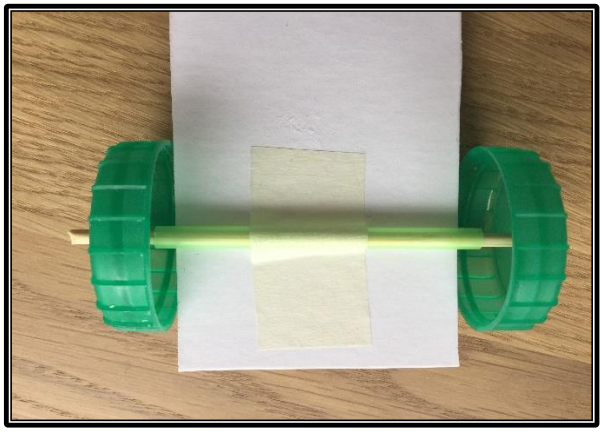
Science Investigation: Build your Trains

You will need:

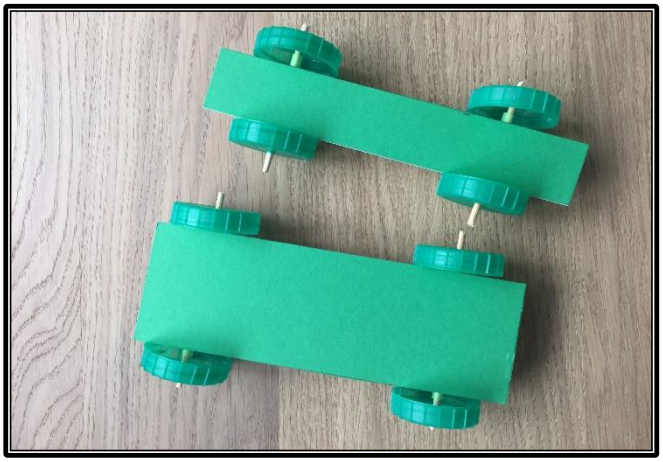
- 2 straws
- 8 bottle tops
- 4 skewers
- 1 wide and 1 narrow piece of card
- 2 train shapes



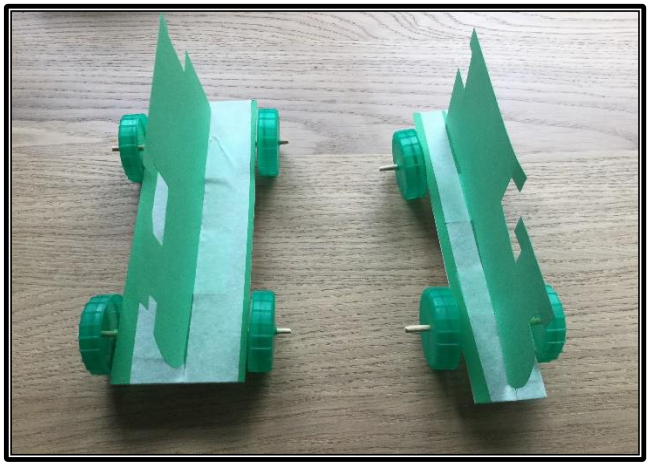
Stick the straws to the bottom of the two pieces of cardboard and trim.



Thread a skewer through each straw and put two bottle top wheels on each end.



Turn your wagons the right way up and test your wheels. They should turn easily.

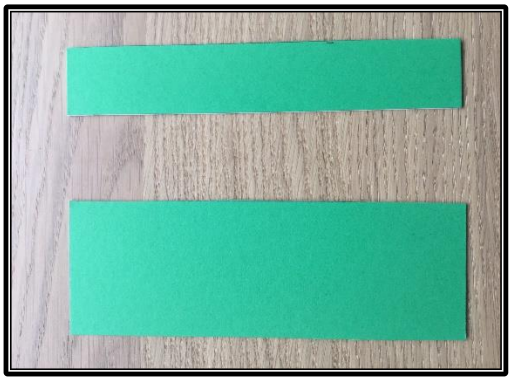


Stick your train shapes onto your wagons. Now you are ready to go!

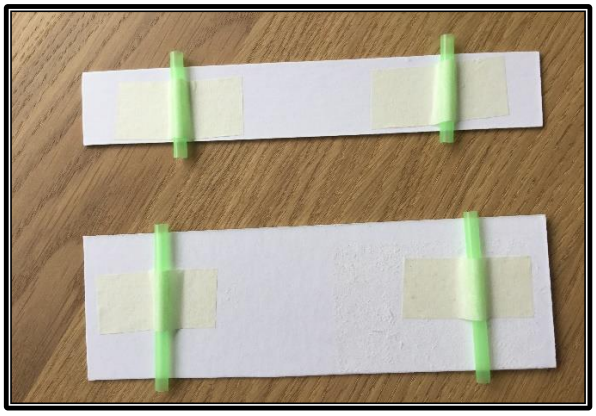
Science Investigation: Build your Trains

You will need:

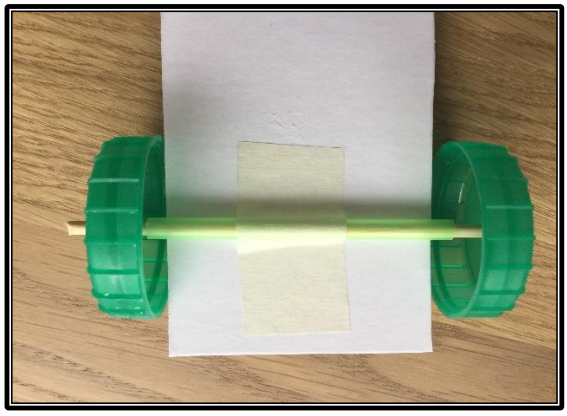
- 2 straws
- 8 bottle tops
- 4 skewers
- 1 wide and 1 narrow piece of card
- 2 train shapes



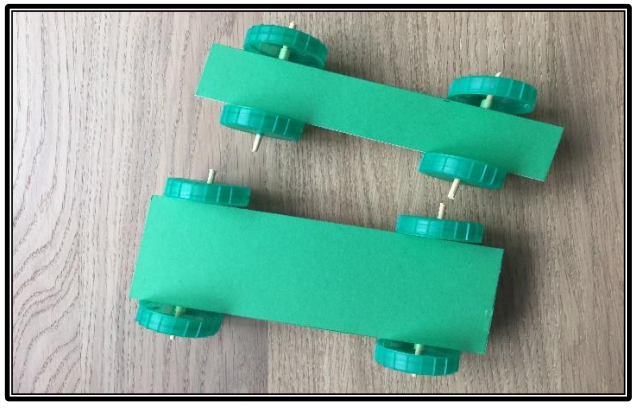
Measure your card. You will need one piece 6cm wide and one piece 3cm wide.



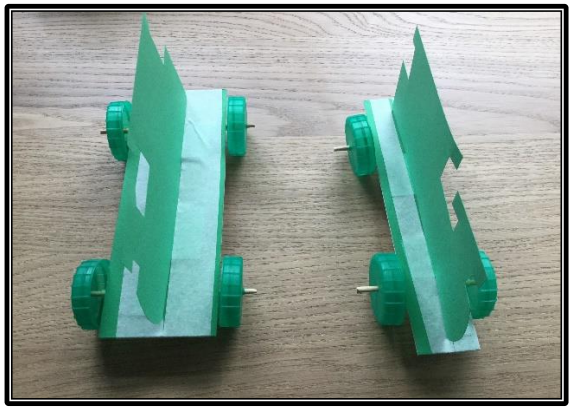
Create axles by sticking the straws to the base of each piece of card. Trim to size.



Thread the pointy end of your skewer through one of your bottle tops, then through the straw. Attach the second bottle top to the other end of the skewer and trim.



Turn your wagons the right way up and test your wheels. They should turn easily. If they don't, you may need to loosen the wheels a little.



Stick your train shapes onto your wagons. Now you are ready to conduct your experiment.

STEM Challenge

Today my challenge is _____

What problem do I need to solve?

What supplies will I use?

What is my plan?

What went really well?

What did not work for me?

Name _____ Date _____