



# Bugatti Trust - Wheel Materials

Testing materials to see which material is the most suitable for a wheel

**Subject(s):** Engineering, Maths

**Approx time:** 55 – 70 minutes

**Key words / Topics:**

- > Test rig
- > Testing
- > Rotation
- > Force
- > Mass
- > Speed
- > Acceleration
- > Materials
- > Properties
- > Wheel

## Stay safe

Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:

- ensuring that any equipment used for this activity is in good working condition
- behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others

Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠

## Suggested Learning Outcomes

- > To understand how material testing is used by engineers
- > To be able to test various materials i.e. wood, metal and plastic to see how they perform as a wheel.
- > To be able to record the results and calculate the speed of a disc

## Introduction

This is one of a set of resources designed to allow learners to develop their knowledge and skills in Design & Technology, Engineering and Mathematics. This resource has been developed with the support of the Bugatti Trust and focuses on testing materials to see which material is the most suitable for a wheel using Engineering and Math's skills.

## Purpose of this activity

In this activity learners will test various discs made from different materials to see how they perform as a wheel.

This activity could be used as a main lesson activity to teach learners about the physical properties of materials or approaches to testing in the context of practical applications. It could also be used as part of an introduction to the practical use of numeracy within engineering.





## Activity

### Introduction (5-10 minutes)

Teacher to explain that learners are going to conduct a materials testing activity focused on car wheels, explaining that the focus will be on the central structure of the wheel.

Teacher to explain how materials testing is used by engineers to make decisions when selecting the materials to be used for racing car wheels. Teacher to explain who Ettore Bugatti was and how making cars more lightweight gave him the most successful racing cars.

### Material testing activity (20 – 30 minutes)

Teacher to demonstrate how to assemble and use the test rig.

- > Test pieces - learners to draw arrows on the discs and use a ruler to check the dimensions. Discs should be 140 mm diameter with a 10 mm diameter central hole.
- > Making a test rig - learners to set up their test rigs using metal pipe/bar and either clamp it to a fixed object, e.g. a desk, or use a vice. Then add some masking tape to the bar to support the disc.
- > Testing - within a group, one learner to hold the disc steady and attach a weight with masking tape. Another learner should be ready with a stopwatch, who then counts down 3-2-1 for the timing to start and the disc to be released. ⚠ Another learner should count the rotations and be ready to video in slow-motion if required.
- > Recording results – learners to record the results on the worksheet. Teacher to explain how to calculate the circumference of the disc to allow learners to work out of speed at the edge. Learners then to calculate the speed of the discs.

### Plenary (5-10 minutes)

Learners discuss their results and share how successful each test on the material disc was. Which material would be the most suitable for a wheel? Why?

## Teacher notes

The activity is most effectively carried out in small groups.

### Introduction

The class could be asked what properties they think are important for the wheel and why. Distinctions should be drawn between the rim and any associated tire.

### Materials testing activity

Test pieces: the teacher may wish to prepare the material testing discs, prior to the lesson, to ensure the discs are all the same size. Discs should be made from sheet, such as plywood or hardboard, acrylic plastic and at least one metal, such as mild steel or aluminum. The discs should be thick enough to be rigid; for example, 3-5 mm for the timber-based, 1-3 mm for a rigid polymer and 1 mm for the metal. Care should be taken to ensure that there are no burrs – for example, the central hole and outer edge could be smoothed with wet and dry paper or similar. In particular, burrs or sharp edges in the central hole may affect the test results.

Making a test rig - for safety, keep the test rig at a low height to ensure that the weight does not have to fall far. Use a bucket or other plastic container to catch the weight.

Testing – teacher to demonstrate how to set up the testing rig and how to attach the weight to the disc using masking tape, then show how to let go of the disc and catch the weight safely in a container. For comparability, the point of connection of the weight should be in the same position relative to the edge of the disc each time. The weight should drop off each time when it reaches the lowest point during the first rotation.

If learners find it difficult to see the arrow on the disc and to count the rotations, use a camera and video in slow-motion.

Recording results – The energy provided by the fall of the weight is the same for all discs; this means that the results should show that the lighter the disc, the greater the speed and the more the number of rotations. Learners could investigate this further by weighing discs, followed by producing graphs relating mass to speed (or number of rotations). Learners could consider why different thicknesses may be needed for different materials.

If the expected trend is not observed, the most likely cause is friction – this may be a result of burrs or sharp edges cutting against the bar.





## Differentiation

### Basic

- > Provide pre-prepared discs.
- > Set up the test rigs in advance.
- > To help learners work out speed learners to watch BBC Bitesize: Speed:  
<https://www.bbc.co.uk/bitesize/topics/z4brd2p/articles/zw9qwnb>

### Extension

- > Carry out tests using different weights and materials, to determine how these affect the results.
- > Calculate the force exerted on the discs.

### Resources

- > Discs of material, 140 mm diameter with a 10 mm central hole; for example, steel, aluminum, acrylic, plywood
- > Metal bar or pipe, 8-10 mm diameter
- > G clamps or vices
- > Masking tape
- > Weights – various, 250 g to 1 kg
- > Stopwatch
- > Calculators
- > Rulers and writing implements
- > Optional: scales to weigh the discs

### Required files



- Presentation Bugatti wheel
- Worksheet Bugatti wheel

### Additional websites

- > YouTube: Evolution of Bugatti; Part 1: <https://www.youtube.com/watch?v=869o7z1X2B0>
- > YouTube: Evolution of Bugatti; Part 2: <https://www.youtube.com/watch?v=Yku4aSTZuAw>
- > BBC Bitesize: Force and Newton's Second Law: <https://www.bbc.co.uk/bitesize/guides/zjbhjhv/revision/7>
- > BBC Bitesize: Speed: <https://www.bbc.co.uk/bitesize/topics/z4brd2p/articles/zw9qwnb>

### Related activities (to build a full lesson)

#### Starters (Options)

- > Watch the video YouTube: Evolution of Bugatti; Part 1:  
<https://www.youtube.com/watch?v=869o7z1X2B0>

#### Plenary

- > Learners to discuss their results and share how successful each test on the material disc was. Which material would be the most suitable for a wheel? Why?

### The Engineering Context



Engineers conduct materials testing in many sectors of engineering. For example, sports cars must complete a roll test to ensure the roof does not collapse. Engineers will therefore test strong and lightweight roof materials to find the most suitable material to survive the roll test.





## Curriculum links

### England: National Curriculum Science

#### KS3 – Motion and forces

- > speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time)
- > forces measured in newtons, measurements of stretch or compression as force is changed

### Scotland: Curriculum

#### Maths

#### Time

MNU 3-10a

- > Applies knowledge of the relationship between speed, distance and time to find each of the three variables.

### Northern Ireland Curriculum

#### Science and technology: Science

- > forces and energy transfer

### Wales: National Curriculum

#### Maths

#### Understanding measuring skills

- > make links between speed, distance and time
- > understand and use a variety of compound measures, including speed

## Assessment opportunities

- > Formal teacher assessment of the materials testing activities.

