Vehicles

Lesson Plan

Vehicles

- Recommended level – KS1 & KS2
- Time taken – 4-6 hours
- Pupils to work individually or in pairs
- Expectation – to complete working vehicles

Skills and Learning

STEM Links

- **S**cience – gravity and friction, scientific enquiry, comparative and fair tests, everyday materials.
- **T**echnology – designing and making, using mechanisms (wheels, axles and bearings)
- **E**ngineering – design, build, test and improve products.
- **M**aths – measuring length, time, mass and angle, average speed.

Curriculum Learning Objectives – it is recommended to cover as many of these topics as possible prior to the exercise so that the pupils are reinforcing their knowledge and understanding, rather than meeting the topics for the first time.

Science: Working Scientifically

Pupils should be taught to:

- set up simple practical enquiries, comparative and fair tests
- take accurate measurements using standard units, using a range of equipment
- report on findings from enquiries

Science: Forces

Pupils should be taught to:

- explain that unsupported objects fall towards the earth because of the force of gravity
- identify the effects of friction that act between moving surfaces
- compare how things move on different surfaces

Design and Technology

Through a variety of creative and practical activities, pupils should be taught the knowledge, understanding and skills needed to engage in an iterative process of designing and making.

When designing and making, pupils should be taught to:

Design and Technology: Design

- design purposeful, functional, appealing products based on design criteria
- generate, develop, model and communicate their ideas

Design and Technology: Make

- select from and use a range of tools and equipment to perform practical tasks (for example cutting, shaping, joining and finishing)
- select from and use a wide range of materials and components according to their characteristics

Design and Technology: Evaluate

- evaluate their ideas and products against design criteria

Design and Technology: Technical knowledge

- understand and use mechanical systems in their products (for example wheels, axles and bearings)

Mathematics: Measurement

Pupils should be taught to:

- Measure lengths
- Compare duration of events
- Measure mass / weight
- Measure angles in degrees
- Calculate average speed

Resources

Parts included in class kit:

- Coloured corrugated cardboard sheet (2 packs of 15 sheets 500mm x 700mm)
- Cardboard boxes (30)
- Wooden wheels (100)
- Plastic wheels (100)
- Dowel (20 lengths of 60 cm)
- Jumbo striped paper straws (200)

Check you have received the correct contents in your class kit. Try pushing both the wooden and plastic wheels onto the dowel to check they fit tightly. (There can be a slight variation in the diameter of the dowel due to the wood's moisture content. If the wheels are difficult to fit you can sandpaper down the end of the dowel slightly, and if they are slightly loose on the dowel you can glue them on.) Check the dowel slides easily inside the straws. Please let TTS know if there are any problems as soon as possible.

Tools and consumables needed (not included):

- Ruler
- Pencil
- Large scissors
- Low melt glue gun and glue sticks (preferable) or double-sided foam tape (strong bond). **Note: High melt temperature glue guns should not be used by pupils, as they can cause nasty burns.**
- Ramp (if you don't have one you can use a length of plywood propped up on some books)
- Junior hacksaw and vice (or you could ask an adult to cut the axles to length using secateurs)
- Sandpaper
- Felt tip pens, decorations, materials to make passengers etc.
- Tape measure
- Stop watch
- Paint and paintbrushes (optional)
- Calculator (if calculating mean speed)
- Protractor (if measuring ramp angle)
- Weighing scales (if measuring weight)
- Plasticine to make passengers or pebbles (if adjusting weight)
- Old cardboard cereal boxes or A4 sheets of cardboard and transparent sticky tape (if making prototypes)
- Balloons or bicycle inner tube (if conducting the extension activity)
- Transparent plastic sheet e.g. tops of food containers for making windscreens (optional)
- A variety of smooth and rough surfaces, e.g. carpet, smooth floor, table cloth, blanket, bubble wrap

Associated resources:

- Vehicles Presentation
- Vehicles Worksheet
- How to make a Carnival Float Blog

Risk assessment

Conduct a risk assessment before undertaking the activity. Some suggestions for inclusion are given below:

Hazard: Pupils burning themselves with the glue guns.
Ways to reduce the risk: Warn the pupils of the dangers; don't switch them on until after the safety briefing; have a responsible adult supervising the glue guns; only use low melt temperature glue guns.

Hazard: Pupils cutting themselves with the junior hacksaws.
Ways to reduce the risk: Explain how to use the hacksaws safely; warn the pupils of the dangers; use only in combination with a vice or bench hook; ask an adult to cut the axles to length using secateurs instead of allowing the pupils to cut them.

Hazard: Pupils cutting themselves with the scissors.
Ways to reduce the risk: make the pupils aware of the dangers; explain how to use the scissors safely.

Vocabulary list

Axle – a central shaft for rotating wheels
Bearing – this retains the axle in position whilst allowing it to rotate
Gravitational potential energy – the energy which an object has due to its vertical position
Kinetic energy – the energy which an object has due to its motion
Rolling friction – the force resisting motion when an object rolls along a surface
Sliding friction – the force resisting motion when an object slides along a surface

Preparation Needed:

Build a sample vehicle to explore any pitfalls, and to demonstrate to the pupils what they will be making and how it works. Instructions for building a sample vehicle are given in the blog 'How to make a carnival float'.
You may want to suggest a theme for the vehicles; perhaps connected to a local event such as a carnival procession or a classic car rally, or moon buggies to support a topic on space, for example.

The vehicles should be tested down a ramp (or a sheet of plywood board propped up on some books), and the distance travelled after they leave the ramp can be measured. Pupils should come up with their own scientific enquiries. Here are some possible ideas:
How does the distance travelled vary with the weight of the vehicle?
How does the distance travelled vary with the initial height of the vehicle above the floor?
How does the distance travelled vary with the angle of the ramp?
How does the distance travelled vary with the material on the ramp, or on the floor? How does the average speed change with any of the above?

At the end you may want to select the most innovative, most functional and most appealing vehicle and the best scientific investigation, and decide on a winner for each category.

Avoiding pitfalls

It is a good idea to ask the pupils some leading questions before they embark on their designs, to help them avoid a number of common pitfalls. Show them the sample vehicle so that you can point out the issues. Suggested questions include:

1. What will happen if your wheels are touching your bodywork? (They will rub when they rotate, or may not be able to rotate at all.) How can you avoid this? (Make your straws longer so that the wheels can't touch the bodywork.)

2. If your wheels are jammed up hard against the ends of the straws what will happen? (They will rub and slow the vehicle down; that is why you need to leave a gap.)

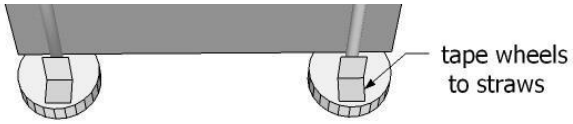
3. If your axles aren't parallel to one another what will happen? (This will slow the vehicle down.)

4. If your car bodywork design is too low at the front or back what could happen? (You need to leave enough cardboard at the front and back to make a robust box, or your vehicle could fall apart!)

5. If you are having passengers, make sure there is a way of getting them into the vehicle.

Extension activity

1. Place the vehicle on a smooth horizontal ramp.
2. Gradually increase the ramp angle until the vehicle starts to roll down the slope and record the angle.
3. Tape the insides of the wheels to the straws as shown below so they can't rotate.



4. Gradually increase the ramp angle until the vehicle starts to slide down the slope and record the angle.
5. Take slices of balloon or bicycle inner tube and stretch them over the wheels.
6. Gradually increase the ramp angle until the vehicle starts to slide down the slope and record the angle.

This activity demonstrates how much higher sliding friction is than rolling friction, and how much putting rubber tyres on vehicles improves the grip.
Instead of adding rubber tyres you could try changing the material of the ramp and gradually increasing the ramp angle until the vehicle starts to slide down, and discuss how this relates to driving safely under differing road conditions