

# **SPEED**

SCIENCE IN MOTION



**SCHOOL AND VISITOR GUIDE**

DESIGNED AND PRODUCED BY

**scitech**

PERTH • AUSTRALIA

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# The exhibition

Designed, developed and built by Scitech in Perth, Western Australia, the ***SPEED: Science in Motion*** exhibition investigates the technology of Formula One auto racing, from physics and engineering to human endurance and biology. Taking the form of a race track complete with pit lane, workshop and physical testing environments, ***SPEED: Science in Motion*** is designed to unravel the cutting edge science and technology behind motor sports. Visitors will be challenged by exciting, hands-on exhibits and displays that explore the fascinating science of speed. ***SPEED: Science in Motion*** will both question and entertain, inform and delight in an enthralling look at all aspects of speed and the science that has lifted auto racing into the highest echelons of modern technology.



## Key messages

- **Machines are complex systems where each part must interact with all others in the right way for the machine to work.**
- **The laws of physics affects how humans and machines work.**
- **Physical fitness is important for race car drivers. Their bodies and brains are running at a peak of efficiency whilst racing.**

## Exhibit description

### A The race track

#### Formula One Car >>>

A full-scale replica Formula One car creates an immersive environment for visitors and is an excellent "scene-setter".

The full-scale F1 racing car complete with dynamic race backdrop also provides excellent promotional opportunities.



#### Science links

- Complex machines

#### <<< Pit Stop

Experience the thrill of being in the pit crew and trying to perform a wheel change in double-quick time! Can you do a 10-second pit stop like the F1 crews? This exhibit can 'pit' individuals against one another or can be done as a team activity to see how well the team works together.



#### Science links

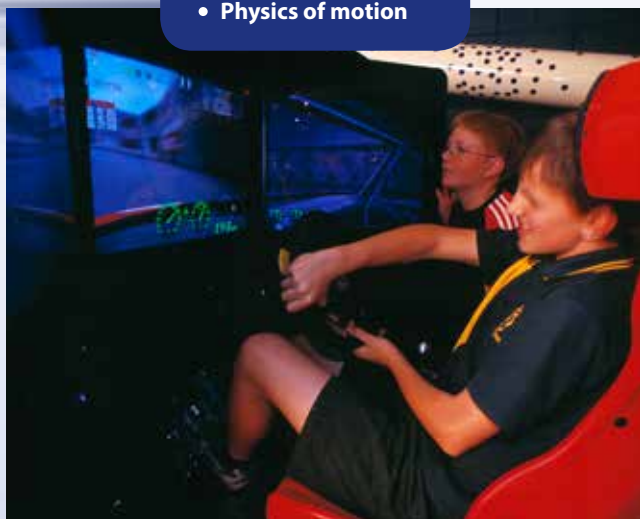
- Biology – reaction time
- Simple and complex machines





### Science links

- Forces
- Physics of motion



### ▲ Race Simulator

Feel like you're really driving fast in the race car simulator. With steering control, gears, accelerator and brakes it will be just like driving a real car. This simulator has three screens giving a virtual racing experience that is hard to beat.



### ▲ Pedal Car Racing

Don't let the children have all the fun! Pedal the 'racing cars' to see just how competitive you are. Feel the adrenalin pump as the lights change to green and then pedal hard to beat your opponent or score the fastest lap for the day.



### Science links

- Forces
- Physics of motion

This exhibit pitches one visitor against another in a computer-based competition to see who can pedal the fastest. The visitors sit in 'racing cars' and take their position on the start line. At the drop of the flag they must pedal as fast as possible to be the first to complete a lap of the track.



## B The fitness testing area



### Fit to Race?

Test your heart rate to see if you have the general fitness required to withstand the stresses of hours on the track. Take the step challenge and see how your rate changes under stressful conditions.



#### Science links

- Circulatory system



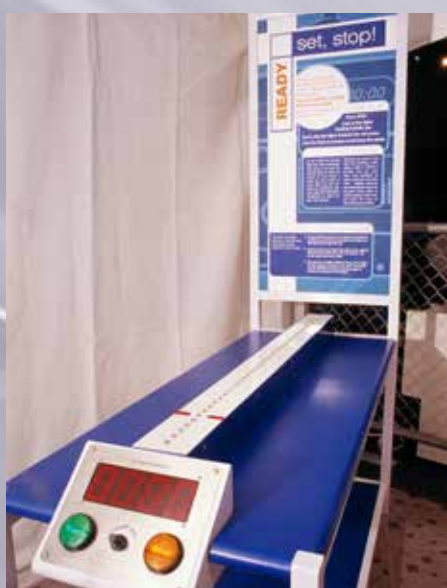
### Eyes on Everything

Flashing lights are used on a large board, which tests peripheral vision, reaction speed, coordination, and concentration. The visitor stands facing a large panel, eyes fixed in the centre. As each button is randomly lit, the visitor must tap them. When the flashing lights have all been turned off, a digital readout shows the average time taken to tap each light off and the cumulative total.



#### Science links

- Biology - reaction times



### Ready, Set, Stop!

Visitors test their reflexes by simulating the braking speed required in Formula One racing. The visitor sits in front of a 1.5 metre bar that has lights that travel at speeds from 5 to 40km/hr. The visitor hits a button when the light reaches the mark near the end of the bar. Visitors can vary the speed of the traveling light to compare the effect that this has on their reflex accuracy.



#### Science links

- Biology - reaction times





### Science links

- Parts of the brain
- Short term and long term memory



### ▲ Perform Under Pressure

A cross is marked out on the floor, giving four points and a central spot marked out as 'home', which the visitor stands on. A display gives random instructions as to which direction to move in. After each directional move, the visitor has to move back to the home position before progressing onto the next direction. Instructions may be front-back-left-right but not always in the same sequence. In each case, the visitor must remember the sequence given, and remember to travel back to the 'home' base position in between while at all times trying to complete the task in the shortest possible time.

The visitor can test their memory at 'novice', 'amateur' and 'pro' skill levels.



## C The workshop



### Build an Engine

See the workings of a multi-cylinder cut away engine. A computer-animated display accompanying this exhibit will explain the different engine types and how they work. You will be able to 'build' an engine on-screen and see how a simple 4-stroke combustion engine works.

Information is also provided about different types of engines including Formula One and a 2-stroke engine.



#### Science links

- Physics of motion
- Energy transfer
- Engineering



#### Science links

- Aerodynamics
- Engineering

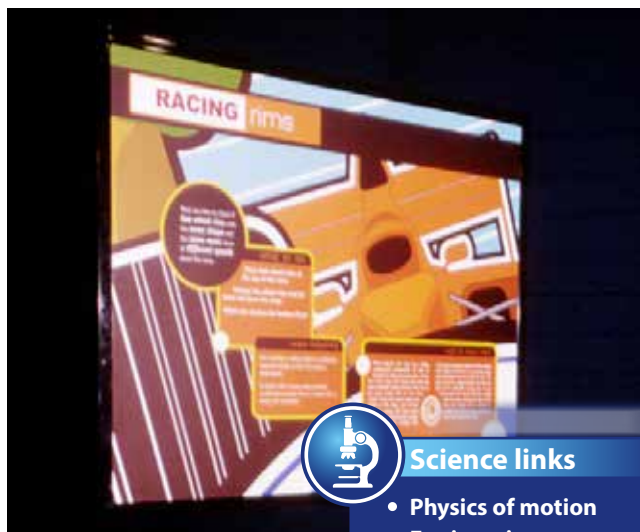
### Downforce & Drag



Racing cars are low-slung, therefore air travels fast through the narrow space between the body and the ground. This reduces the pressure beneath the car and pulls it firmly

downwards, improving its road-holding. There is also an aerofoil, shaped like an upside-down aircraft wing, mounted on the rear of the car to increase the downward force. At 200km/hour a F1 car could drive on the ceiling because of all the force created by its 'wings' and body shape. Select from various car configurations and test them in a wind tunnel to learn about turbulence, drag and aerofoils. Then design the best racing car for different styled racing circuits. Results of the testing and the car's performance on a particular track are explained on a computer screen.





#### Science links

- Physics of motion
- Engineering

### ▲ Racing Rims

Two cylinders that look the same may roll down a hill at different rates. Two objects with the same shape and the same mass may behave differently when they roll down a hill.

How quickly an object accelerates depends partly on how its mass is distributed. A cylinder with a heavy hub accelerates more quickly than a cylinder with a heavy rim.

Visitors place both 'rims' at the top of the ramp and release them allowing them to roll down the ramp. The rim with the mass closer to the center will always reach the bottom first.



#### Science links

- Friction
- Newton's laws of motion

### ▲ Collisions

A large air table similar to an air hockey game is exhibited.

The air table is equipped with pucks of differing masses, and launchers that enable the visitor to set up collisions between the pucks. The visitor learns about inertia, friction and collisions through interactive play with the exhibit.

## ✓ Giant Ball Bearing

Build and try out a simple ball bearing. See how the balls enable the bearing to rotate freely. Visitors construct the ball bearing seat and then can sit on it and see how the bearings reduce friction allowing it to swivel.



### Science links

- Friction
- Engineering

## ✓ What's the Diff?

Ever wonder what a car differential is for? Ever thought that to turn a corner a car's inside and outside wheels have to turn at different speeds? Have a twist of the differential to see how the gears work to allow the wheels to turn at different speeds while still supplying drive to them.



### Science links

- Simple machines

## ✓ Gear Change

Why do cars have gearboxes? How can you make a shaft turn faster or supply more torque? Learn about this as you assemble different gear trains on the Gear Change exhibit. Then compare what you have built to the insides of a see-through real car gearbox.



### Science links

- Simple machines
- Energy transfer



## ✓ Further but Faster

Roll two balls down two different shaped tracks – one straight, the other curved. Both travel the same vertical distance. Which one gets to the bottom first? Intuitively you would think the shortest distance (the straight track) would be the fastest, but acceleration is important too. The curved track accelerates the ball more quickly and it arrives at the end first. This exhibit focuses on teaching participants the conversion of potential into kinetic energy.



### Science links

- Physics of motion
- Energy transfer

## ✓ Tyre Tread

Learn about what different tyre tread patterns are for. What tyre would you choose for a particular purpose? You wouldn't think tyre design was so important, but it can have a dramatic effect on the performance of a car. The plate is etched with different tread patterns including dry and wet conditions for racing and general purpose tyres. Visitors can take a rubbing of the choices of tyre tread patterns with the supplied paper and crayons. They can then keep the rubbing..

A cut-away tyre will show the various components that make up a vehicle tyre.



### Science links

- Tyre tread pattern
- Physics and engineering

## Lower primary sample worksheet

Have you ever wondered what it would be like to be a race car driver? Take a look around the exhibition to experience it for yourself. To complete the worksheet, find each pictured exhibit and have a go, then answer the questions. You might need to read the graphics panels or use your problem solving skills.

### Further but faster

1. Which track makes the ball go fastest? \_\_\_\_\_

\_\_\_\_\_

### Gear change

2. When you connect a big gear to a small gear and then spin them, which gear turns the fastest? \_\_\_\_\_

\_\_\_\_\_

### Giant ball bearings

3. What do the ball bearings do? \_\_\_\_\_

\_\_\_\_\_

4. Name one machine where it would be good to use ball bearings to make it move easier. \_\_\_\_\_

\_\_\_\_\_

### Downforce and drag

5. Why are racing cars low to the ground? \_\_\_\_\_

\_\_\_\_\_

### Ready, set, stop

6. Why do race car drivers need good reflexes? \_\_\_\_\_

\_\_\_\_\_

### Fit to race?

7. What does the circulatory system do? \_\_\_\_\_

\_\_\_\_\_

8. What is something you do that makes your heart beat faster? \_\_\_\_\_

\_\_\_\_\_

### Whole exhibition

9. Find the following simple machines and write down which exhibit you found them in.

• Wheel \_\_\_\_\_

• Cog \_\_\_\_\_

• Ramp \_\_\_\_\_

• Screw \_\_\_\_\_

• Lever \_\_\_\_\_





## Lower primary answer key

### Further but faster

1. Which track makes the ball go fastest? *The curved track*

### Gear change

2. When you connect a big gear to a small gear and then spin them, which gear turns the fastest? *The small gear.*

### Giant ball bearings

3. What do the ball bearings do? *They make the seat spin more easily.*
4. Name one machine where it would be good to use ball bearings to make it move easier. *Student may name any machine with moving parts, e.g. bicycle, car, washing machine.*

### Downforce and drag

5. Why are racing cars low to the ground? *It makes them more stable.*

### Ready, set, stop

6. Why do race car drivers need good reflexes? *Because they are going very fast so they don't have much time to react.*

### Fit to race?

7. What does the circulatory system do? *It pumps blood around the body.*

8. What is something you do that makes your heart beat faster? *Students may name any aerobic activity such as running or skipping. They may also name other stressful situations such as feeling nervous.*

### Whole exhibition

9. Find the following simple machines and write down which exhibit you found them in.

- Wheel - *all the exhibits in the Racetrack section, plus most in the Workshop section.*
- Cog - *Gear Change, What's the Diff. NB – a cog is really just a special kind of wheel.*
- Ramp – *Further but Faster, Racing Rims*
- Screw – *Pit Stop*
- Lever – *What's the Diff*

*NB – Children may find these simple machines in an exhibit not listed here. As long as they are able to point the simple machine out and they are correct this is fine.*



## Upper primary sample worksheet

Have you ever wondered what it would be like to be a race car driver? Take a look around the Speed exhibition to experience it for yourself. To complete the worksheet, find each pictured exhibit and have a go, then answer the questions. You might need to read the graphics panels to find the answers or use your problem solving skills.

### Tyre tread

1. Why do tyres have tread? \_\_\_\_\_

\_\_\_\_\_

### Further but faster

2. Which track makes the ball go fastest? \_\_\_\_\_

\_\_\_\_\_

3. Why do you think this is? \_\_\_\_\_

\_\_\_\_\_

### Gear change

4. When you connect a big gear to a small gear and then spin them, which gear turns the fastest? \_\_\_\_\_

\_\_\_\_\_

5. What happens to the direction of the second wheel? \_\_\_\_\_

\_\_\_\_\_

6. Why do cars use gears? \_\_\_\_\_

\_\_\_\_\_

### Giant ball bearings

7. Why do the ball bearings make the seat turn easier? \_\_\_\_\_

\_\_\_\_\_

8. Name one other way of reducing friction between moving parts. \_\_\_\_\_

\_\_\_\_\_

### Downforce and drag

9. What is an aerofoil and why do racing cars have them? \_\_\_\_\_

\_\_\_\_\_

### Fit to race

10. What does the circulatory system do? \_\_\_\_\_

\_\_\_\_\_

11. Why does your heart speed up when you are under stress? \_\_\_\_\_

\_\_\_\_\_



## Upper primary answer key

### Tyre tread

1. Why do tyres have tread? To provide more traction and stop cars slipping on the ground.

### Further but faster

2. Which track makes the ball go fastest? The curved track.
3. Why do you think this is? The steeper start to the curved track makes the ball speed up faster.

### Gear change

4. When you connect a big gear to a small gear and then spin them, which gear turns the fastest? The small gear turns faster.

Bonus: because the small gear has less teeth.

5. What happens to the direction of the second wheel? It turns the opposite way to the first wheel.

6. Why do cars use gears? The engine has to spin very fast but the wheels need to spin slower. The gears go in between the engine and the wheels to decrease the rotations per minute.

### Giant ball bearings

7. Why do the ball bearings make the seat turn easier? They spin.
8. Name one other way of reducing friction between moving parts. Possible answers: Oil or grease, more slippery surfaces, slippery powder...

### Downforce and drag

9. What is an aerofoil and why do racing cars have them?  
It is the shape of a wing or blade which is aerodynamic.  
They help the car push down into the road so that they can turn corners at high speeds with more stability.

### Fit to race

10. What does the circulatory system do? It pumps blood, nutrients, and oxygen through the body.
11. Why does your heart speed up when you are under stress?  
To provide extra oxygen to your body.



## Post-visit classroom activities

### Momentum and collisions

Investigate how objects move when they come to a sudden stop. You can use this as a physics lesson and also to discuss road safety with your students.

#### Materials (For each group)

- A piece of cardboard (to use as a ramp)
- Toy car
- Coins of different values or washers of different size and weights
- Thin wooden blocks or books (2 per group)

#### Activity instructions

1. Find a smooth flat surface on either a table or on the floor.
2. With the first wooden block, prop up the cardboard to make a ramp at an angle of about 30 degrees to the desk surface or floor.
3. Place the second wooden block about 10cm in front of the bottom of the cardboard slope. *The second wooden block should be of lesser thickness than the toy car that is being used so that it does not impede the movement of the coin from the car's roof.*
4. Place the toy car at the top of the ramp with a coin on the roof of the car.
5. Let the car roll down the ramp and collide with the second block.

#### Extend

- Change the slope of the ramp and repeat the activity. Does the slope of the ramp affect the distance the coin will travel after impact?
- Vary the distance the block is placed from the end of the ramp. Does this affect the distance the coin travels after impact?

### Friction investigation

Investigate which kinds of surfaces have more friction, and why we might prefer different surfaces for different purposes.

#### Materials (For each group)

- Toy cars
- Wooden ramp (about 1m long)
- Wooden blocks or books to rest ramp on
- Different materials to place on the ramp surface to alter ramp friction e.g. carpet, aluminium foil, rubber, foam, bubble wrap
- Sticky tape
- Stopwatch

#### Activity Instructions

1. Find a smooth flat surface on either a table or on the floor.
2. Using a wooden block, prop up the ramp to make a slope at an angle of about 30 degrees to the desk surface or floor. For the first test, use the ramp with an unaltered surface.
3. Place a car at the top of the ramp and then release it. Measure the time it takes for the car to reach the bottom of the ramp. Record the time taken in a table.
4. Cover the ramp surface with one of the materials to be tested and fasten it in place with sticky tape. Replace the car and repeat the test with the altered ramp surface. Record the time on the worksheet.
5. Repeat the activity with the other surface materials on the ramp. Which has the most friction?

#### Discuss

- How could you use different surfaces for different purposes? What surface would you use if you wanted to travel fast? What surface could you use to slow a fast-moving object (such as arrester beds used to stop trucks)?
- For any given surface, what modifications could be made to reduce friction?



## Inertia investigation

Is it easy for objects to begin moving? Investigate the effect that mass and weight have on inertia.

### Materials

- Toy truck or car (needs an area to allow weights to be added to it)
- String
- Pencil
- Milk carton (or small, strong plastic bag)
- Masses (to add weight to the truck or car)
- Marbles

### Activity Instructions

1. Find a smooth flat surface on a table.
2. Cut a milk carton in half and fasten it to a toy truck using a piece of string about one metre long. Alternately, if you are using a small plastic bag, tie the string around one side of the bag so that the neck is open and marbles can be added to the bag.
3. Place the truck on the table and let the carton hang over the edge. You can use a pencil taped on the edge of the table to provide a surface for the string to pass over.
4. Slowly add marbles one at a time to the half milk carton until the truck begins to move. Record the number of marbles that were used.
5. Add more weights to the truck and repeat the activity. Record the number of marbles required to move the truck this time. Repeat this process as many times as you like with different weights added to the truck. Which truck required the least and which the most number of marbles to get it moving?

### Discuss

- What modifications could you make to the truck to allow it to overcome inertia and get moving faster?
- Present a list of objects and ask students to rank them from least to most inertia, eg car, ball, train, table, paperclip.

## Egg driver safety

How do people in fast moving vehicles keep safe? Have children design a container which can keep a raw egg safe from an impact.

### Materials (for each group)

- Raw and hard-boiled eggs (one of each per pair or group)
- Milk cartons
- Scissors
- Sticky tape
- Craft glue
- Construction materials (eg cardboard, paper, foam, bubble wrap, aluminium foil, cotton wool, rubber bands, straws, balloons, icy-pole sticks, polystyrene foam, corrugated cardboard, etc)

### Activity instructions

1. Present students with a range of construction materials. Using these, students are to design and construct a package that will allow an egg to survive a fall from a set height. Emphasise to the students that the eggs must be able to be easily inserted into and removed from the package.

The whole activity can be completed in an afternoon or be carried out over a number of days, depending upon student age, ability and purpose of the exercise.

2. When construction is completed, test each of the packages by placing the egg inside and dropping it from desk height on to a hard floor surface. (Tip: if you want to avoid a mess, get students to place the raw eggs used for the tests in small snap-seal bags).

### Discuss

- What sorts of designs seemed to work best?
- What safety features are in your car or on your bicycle to keep you safe?

## Simple machines

Identify some simple machines, then have a look at a more complex machine to see if you can find how all the simple machines fit together.

### Materials

You will need several examples of the six simple machines:

- **Lever:** a board or bar that rests on a turning point. A fulcrum is the turning point of a lever. *Examples: seesaw, hammer, crowbar*
- **Inclined plane:** flat surface that is higher on one end. *Examples: ramp, slide, path up a hill*
- **Wheel and Axle:** an axle is a rod that goes through the wheel. This lets the wheel turn. *Examples: tyres, cogs, doorknobs*
- **Screw:** simple machine made from another simple machine. It is actually an inclined plane that winds around a nail. *Examples: jar lids, light bulbs, drill bit*
- **Wedge:** made up of 2 inclined planes. These planes meet and form a sharp edge that can split things apart. *Examples: nail, fork, knife, axe heads.*
- **Pulley:** made up of a wheel and rope. The rope fits on the groove of the wheel. One end of the rope is attached to a load and the other end can be pulled by a person. *Examples: flag poles, clotheslines*

You will also need a couple of examples of a more complex machine made up of several simple machines, for example a bicycle or wheelbarrow.

### Activity instructions

1. Introduce the six types of simple machine. Then have the students classify the objects you brought in, either as a class or in pairs or groups. Discuss the way some are used and why they are classified the way they are. E.g. a hammer forms a part of a lever with your arm to provide the force to drive in a nail.
2. Have students brainstorm ways of putting the simple machines together and how these new machines could be used.
3. Bring out your one or two complex machines and, as a class, try to identify all the simple machines and how they work together.

### Extend

- Look at simple machines in the body – for example, arms, legs and jaws are levers, while teeth are wedges.
- Have children use their knowledge of simple machines to solve a series of mechanical problems in groups (e.g. transporting a marble from one end of the desk to the other).







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