

The Exhibition

Interactive Exhibits

EX-1 Rocket

Description: This exhibit allows the student to launch some actual working rockets!

The rockets are in the form of upturned plastic bottles that are propelled skyward along vertical wires by compressed air escaping from their lower nozzles.

Science behind exhibit: Air pressure in the filled bottle rocket is higher than in the room around it. As the rocket is launched, trapped air is allowed to rapidly escape from the base of the rocket. Newton's third law of motion states: For every action there is an equal and opposite reaction. The bottle applies a net downward force on the air to push it from the bottle, and the air applies a net upward force on the bottle. The bottle returns to the ground again under the action of gravity.



Pulse Rocket

Description: The object of this exhibit is to use magnetic repulsion to “launch” and then “safely land” a rocket.

The level of success (or failure) of the mission is governed by the correct timing of the button pressing process and is displayed at the end of the mission.

Science behind exhibit: Pressing the launch button sends an intense pulse of alternating current (AC) electricity through the coil surrounding an iron core. This generates a strong (and changing) magnetic field in the coil. The changing magnetic field passes through the ring ‘rocket’ and induces powerful eddy currents, which, in turn, produce another magnetic field. The two magnetic fields force the ring to fly skyward!



Pressing the ‘landing’ button at the right time creates a weaker magnetic repulsion pulse that prevents the rocket from crashing upon landing.

Hover Table

Description: Air flowing through holes in the table allows various discs to float above the table surface and gently bump into each other.

Science behind exhibit: When discs collide, their resulting motion depends on numerous factors – how fast and in what direction they were initially moving, how big they were, and whether or not a ‘bouncy’ (elastic) collision took place.

In general, the speed and direction of larger discs change less than smaller discs after colliding with each other. This is because large objects have more momentum than small objects.



Bernoulli Blower

Description: A ball floats in the air stream of a hose at the front of the exhibit. If the air stream is slightly deflected to the side, the ball can be suspended in space off to the side or made to pass through several hoops on top of the exhibit. If the ball is pulled slowly out of the stream of air when vertical, a force is felt trying to pull the ball back into the air stream.

Science behind exhibit: When the ball is suspended in the air stream, the air flowing upward hits the bottom of the ball and slows down. This creates a region of high-pressure air, which holds the ball up against the pull of gravity.

When the ball is partly pulled out of the air stream, air rushes around the inner side of the ball. The fast moving air creates a region of low pressure on that side of the ball. The higher pressure of the still air on the outer side of the ball pushes it back into the air stream, even when the blower is tilted at a slight angle.

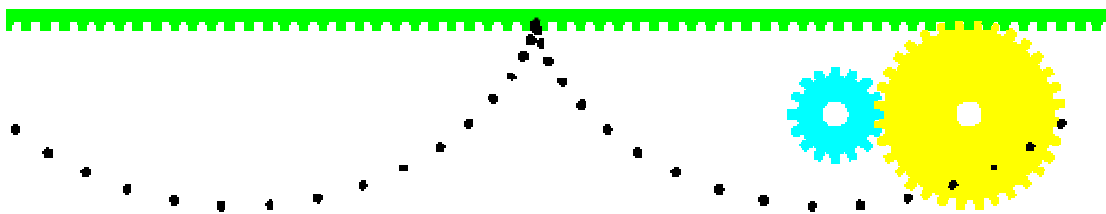


Cycloid

Description: The student allows balls to roll down three different (but fixed) pathways to equivalent finish spots. One pathway is the shortest, another is the steepest, and the third, along a track known as the cycloid (which is neither the shortest, nor the steepest) proves to be the fastest of the three!



Science behind exhibit: The cycloid is the path of a point on the rim of a circle rolling along a straight line or, as shown below, a circular gear rolling along a toothed rack. The straight-line (shortest) path allows the ball to slowly build up speed. The steepest path allows speed to quickly build up but involves the longest distance. The cycloid is the best compromise between slope and distance thereby enabling the shortest travel times.



Vortex

The main function of this info-pod is to provide explanations of several aspects of vortices. One segment explores the concept that the speed of the vortex is fastest near its centre and slower towards the edge. Another looks at how smaller vortices (eddy currents) often form at the edges of larger swirling motion. A third segment describes several different types of vortices.



Whirlpool Vortex

Description: Students are able to control a large whirlpool and directly observe (from the side) changes in its behaviour.

Science behind exhibit: This exhibit is a giant version of the whirlpool that forms in a bath or sink when the water is draining out. The vortex forms because the 'downdraft' created in the water begins to rotate and gather speed.

Several factors contribute to the funnel shape of the whirlpool: Gravity acts downward trying to maintain an overall flat surface on the water. 'Inertial tendency' from the rotation (sometimes described as the fictitious 'centrifugal' force) acts outwards, causing the spinning water to build up towards the sides. Water pressure is the other major factor. It increases rapidly with water depth. This pushes the water back towards the central spin axis with ever increasing force as a function of depth in the water column.



Gravity Well

Description: Students observe what happens when a ball starts to roll around the edge of the hyperbolic well.

Science behind exhibit: Gravity wells of this type are designed so that the ball acts like planets orbiting the Sun. Planets closer to the Sun have a faster orbit than those further away. This means that the ball moves faster as it gets closer to the centre. Friction removes some of the energy of the rolling ball causing it to drop down into the gravity well. When the ball drops into the well, some of its gravitational potential energy is converted into kinetic energy. This increases the speed of the ball.



Eddy Currents

Description: This exhibit allows students to create and observe various vortex and peripheral eddy patterns.

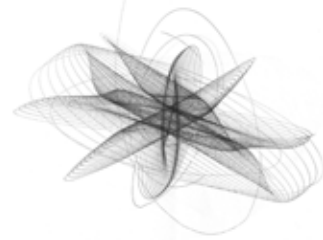
Science behind exhibit: Eddies form whenever water currents are redirected for some reason. For example, eddies often form behind rocks in rapidly flowing rivers. Behind the rock, the water current is slowed, and this causes the water to circle around and form an eddy. In this exhibit, the eddy current patterns creep into the overall swirling vortex pattern primarily because of frictional effects between the moving fluid and the container.



Lissajou Figures

Description: A projected laser show, of varying patterns, is the main feature of this exhibit. Students use control knobs to adjust the frequencies of two signals, each of which is causing a speaker to vibrate. Mirrors connected to the speakers respond to the vibrations and cause laser light that strikes them to form a pattern on a wall behind the exhibit.

Science behind exhibit: When the frequencies of vibration of the two speakers are the same, a circle is produced. When the two frequencies are multiples of each other, simple patterns emerge (eg. a 'figure 8' occurs when one frequency is twice the other one). At other times, complicated patterns occur.



Lightning Tube

Description: In this exhibit, students interact with streaks of lightning contained within a long glass tube. Placing a hand on the outside of the tube causes the lightning streaks to concentrate their movements under the hand.

Science behind exhibit: The lightning tube is similar to a large neon tube but the gases and power supply are different. The lightning tube contains a mixture of the inert gases neon, krypton and xenon as well as traces of other gases. Passing an electric current (a flow of electrons) excites the gas atoms and causes them to ionise and glow in thin streams of light. Gases at higher pressures are used with high voltages (10,000 V) to produce the bright filaments of light. Placing a hand on the tube allows small amounts of current to flow away at that point. This causes the lightning streaks to follow pathways under the hand.



Guitar String

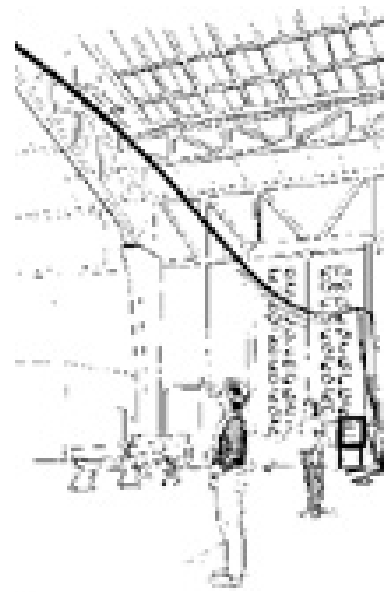
Description: A long piece of rope stretches horizontally between two supports. By pulling on the rope at one end, students can make waves in the rope.

Science behind exhibit: Upon reaching an end, each travelling wave becomes inverted (i.e. upward if it was previously downward, and downward if it was previously upward).

Two waves on the rope, moving in opposite directions, pass through each other with the resulting combined wave shape being the addition of their individual wave shapes. In this case, waves of similar wave orientation add 'constructively' whereas those of opposite orientation add 'destructively'.

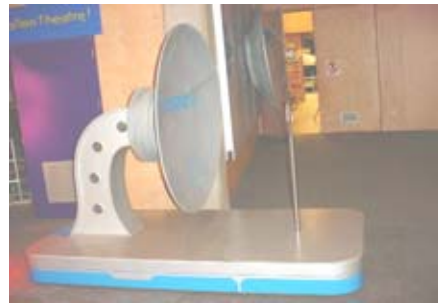
When the rope is pulled repeatedly and consistently at certain rates the 'travelling' waves are replaced by 'standing' waves that resemble vibrations seen on a guitar string (hence the exhibit name). The fundamental mode of vibration (a wave maximum at the centre and points of no displacement (nodal points) at either end of the rope) occurs at the lowest vibration rate.

At twice that vibration rate, two wave maxima are present with three nodal points occurring (one at each rope end and one in between the two maxima). This vibration is known as the 'first overtone' of the fundamental mode. Likewise, three times the fundamental vibration rate produces the 'second overtone' with three maxima and four nodal points (one at either end and two between the three maxima) and so on.



Whisper Dishes

Description: Whisper Dishes consist of two large parabolic reflectors. These are set far apart and facing each other so that they act as a pair of sound-reflecting 'mirrors'. Two students situate themselves at approximately the focal point for each reflector. The sound coming from each reflector is focused at this point. Each student can then clearly hear the other's voice.



Science behind exhibit: The parabolic shape of each dish causes sound waves from different specific directions in the listening field of the dish to become focussed at slightly different spots in the region directly in front of the dish.

The indicated spot (where the speaker's / listener's head is placed) causes sound from the speaker to be defocused at one dish into parallel waves that travel through the air until they strike the other dish. There they are refocussed onto the listener's ear.

The focussing of many sound waves from primarily only one source (the speaker at the other dish) causes great amplification of those sounds to occur in comparison to other background sounds in the room.

Tubular Resonance

Description: This exhibit makes use of a horizontal, clear Perspex tube, which is partially filled with polystyrene beads.

Sound from a speaker housed at one end of the tube causes polystyrene beads to form 'vertical clusters' along the tube. The bead clusters may be moved to various sections of the tube by adjusting the frequency of the sound coming from the speaker. Frequency variation from tens to hundreds of hertz is possible.



Science behind exhibit: This exhibit graphically demonstrates resonant frequencies in a tube.

This exhibit contains a sine wave generator (of variable frequency) connected via an amplifier to a powerful speaker in the tube. Vibrating the speaker at one of the resonant frequencies causes significant air pressure differentials to occur along the length of the tube. The polystyrene beads (coated with graphite so they do not stick together by electrostatic charge) are light enough that these pressure differentials force the beads to group together at particular spots (producing standing wave patterns) within the tube.

Resonance occurs at the frequencies where the beads form these standing waves.

Robot BUZZ

Description: This 'robot' is actually a Remotely Controlled Operating Vehicle (ROV) that the student controls by pushing buttons on the control panel.

Radio signals sent from the control panel cause the robot to start moving, change direction, stop, and emit half a dozen pre-recorded sounds from built in speakers.

To further enhance the experience, the student is able to see what it is that the robot is 'looking' at via returning signals (from a camera in the robot's head) that are displayed on a screen at the control panel.



Mission Control

This small open theatrette provides seating for students to view a DVD about the launch of the Space Shuttle and views of the Earth from space.



Source: NASA

Additional Exhibits

Objects from Museum Victoria collections have been added to the *Sci-Quest* exhibition while it is at Scienceworks. A petrol/electric hybrid car, the *Honda Insight*, is also on display.

Collection Cases

These showcases contain objects from the Museum Victoria Heritage Collection. An adjacent TV monitor shows video footage of some of the objects being operated.

- **Attwood's Gravity Machine** (1950s)
This device was used in physics classrooms to calculate the constant acceleration that is due to gravity. The two weights are of different mass, and students measured their velocity after they were released.
- **Models of rockets** (1950s)
These models are of the American *Aerobee* and *Skyrocket D-588* rockets. Rockets use the energy from burning fuel to create thrust and travel into the atmosphere. The *Skyrocket D-588* was the first aircraft to fly at twice the speed of sound.
- **Model of CC-2 Hovercraft** (~1962)
Hovercrafts float on a cushion of air that is created by large fans. The first passenger hovercrafts started operating in 1963.
- **Topo the Robot** (1984)
'Topo' could be programmed to roll forward, deliver items on a tray and to talk and sing. It was controlled by infrared communications from an Apple 11E computer.
- **Walking toys** (1960s to present)
These homemade and cereal box toys move by gravity. They waddle down a slope or are pulled along by a weight hanging over the edge of the table.
The walking toys are owned by a Scienceworks staff member.



Chaotic Pendulum

A normal pendulum consists of a free swinging arm with a weight attached to the end. As it swings to and fro, its action is quite predictable.

This pendulum has a second free-swinging arm attached to the end of a normal pendulum. Its behaviour is chaotic. It can suddenly change direction or alter its speed unexpectedly.

Hybrid Car

Insight is a petrol-electric hybrid car. It has two engines – a petrol engine, and an electric engine. The electric engine assists the petrol engine when accelerating from a standstill, and when the car is stopped at a red light.

Power for the electric motor is stored in a battery. The battery is charged when the driver brakes – the electric motor becomes a generator, converting the kinetic energy of the car's forward momentum into electrical energy that is stored in the battery. This system is known as *re-generative braking*. It is important to note that the battery is not charged from mains power via a power point!

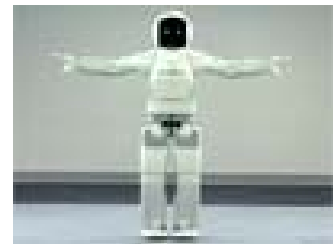
When the *Insight* comes to a complete stop the petrol engine automatically switches off. The car's lights, radio and heating/cooling then run on the electric motor.

Thanks to the hybrid system and the light, aerodynamic body, the *Insight* uses only one third of the petrol that a normal car uses.

(Information provided by Honda Australia.)

ASIMO robot footage

Video footage of ASIMO, the Honda robot, is shown on a monitor adjacent to the hybrid car. Similar footage can be viewed at: <http://asimo.honda.com/asimotv/>



School Robot Display

This showcase displays robots and animatronic models that have been made by local schools. The accompanying video footage shows their construction and operation.