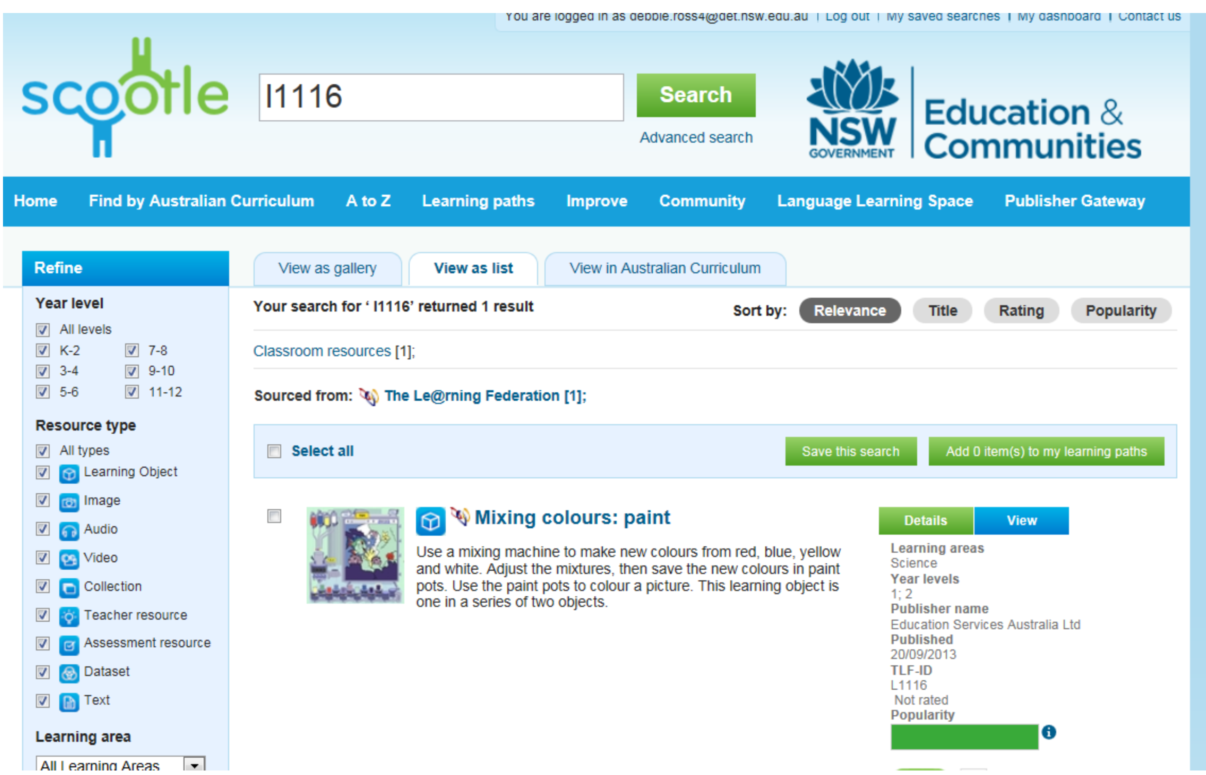
How to access Learning Objects

- Go to www.scootle.com.au
- Select **Login**
- Select **Education & Communities** icon on right hand side
- Search using reference number from learning object eg. L1116



Catalogue of digital curriculum resources

2011

Contents

Introduction

This catalogue contains details about the Science: Energy and change digital curriculum resources made available by The Learning Federation (TLF) to all schools in Australia and New Zealand. The content supports and enhances students' understanding of key scientific concepts in a range of contexts for the P–12 years.

The content includes:

- hundreds of interactive learning and assessment objects
- a large and diverse range of digitised items such as images, film clips, maps, songs, posters and documents, all with detailed teachers' notes.

Learning and assessment objects

The learning and assessment objects are based on current research findings in Science education and pedagogy. The objects foster skills, such as scientific inquiry, data interpretation, analysis and synthesis, that are transferable to daily life and to offline learning opportunities.

The objects promote scientific literacy and are organised around scientific concepts with real-life applications for students. They contain open-ended investigative tasks, tools, activities and processes that enable students to engage in 'real' science experiences and to construct and test their own scientific understandings.

Many of the objects also provide meaningful models, simulations and demonstrations of scientific concepts and practices. These objects provide teachers and students with experiences that are not universally available because, for example, they require expensive equipment or occur over extended periods of time.

Other objects are short activities that allow students to explore and practise a range of scientific concepts and skills.

Learning objects are generally published in series and some are also aggregated into single, larger learning objects. Aggregated learning objects are identified with the symbol.

An asterisk (*) on the series title indicates that not all the learning objects in that series have been released. The remaining learning objects will be released progressively.

Some learning objects contain non-TLF content. See the acknowledgements and conditions of use in the learning objects for details.

Digital resources

A remarkable range of digitised items licensed from leading Australian and New Zealand cultural and scientific institutions is also available. These items include:

- audio files of interviews, broadcasts and speeches
- clips from documentaries, newsreels, television programs and feature films
- photographs, paintings, line drawings, maps and documents
- units of work featuring teacher resources, student activities and multimedia presentations centred on specific topics.

With each item, TLF supplies an educational value statement comprising a description and contextual information that enriches the value of the asset for the teacher.

This catalogue contains a representative sample of digital resources licensed from TLF's partner institutions useful for the Science: Energy and change strand.

Themes

This catalogue also includes examples of how teachers can draw on the extensive range of content to create thematic collections to challenge and engage students.

Other catalogues

You can download catalogues for each of the Science strands at:
www.ndlrn.edu.au

A comprehensive Index of Science digital curriculum resources is also available for download.

Accessing and viewing the content

Government and non-government education authorities in each Australian state and territory and in New Zealand have responsibility for facilitating access to the pool of digital content. Full details about how to access the content, including the necessary technical and software requirements for viewing it, can be found at:

www.ndlrn.edu.au

Learning objects

Let's make it go series (Years P–1)

Students examine what it is that 'powers' everyday objects in everyday environments.

Features include:

- an introduction to the concepts of energy sources and energy consumers
- a reward for student success in the form of making the animated machine 'go'
- random generation of machines and devices, which supports repeated use.

Students:

- link forms of energy to common machines or energy uses
- explore different forms of energy available in residential and park environments.

Let's make it go: at the park
L847 – Years P–1

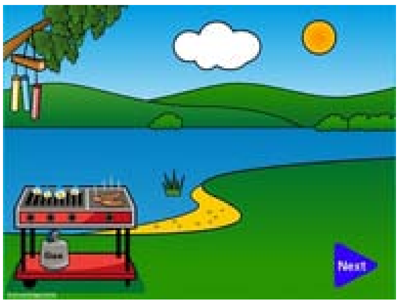
Students use the park environment and objects easily associated with this environment, such as barbecues, boats and sprinklers.

Let's make it go: backyard
L953 – Years P–1

Students use a home backyard and objects easily associated with this environment, such as a drill, chimes, mower and family car.

Let's make it go: in the kitchen
L954 – Years P–1

Students use the kitchen and objects easily associated with this environment, such as a dishwasher, oven, refrigerator and radio.



Let's make it go
L955 – Years P–1

This is an aggregated learning object combining the above three learning objects.

Mixing colours series (Years P–2)

Students experiment with mixing primary colours to create new colours to paint predefined pictures.

Features include:

- three levels of difficulty in each learning object
- an option to print completed pictures showing the proportions of primary colours used to make each colour.

Students:

- are able to add different volumes of paints to create colours that they can then use.

Mixing colours: paint
L1116 – Years P–2

Students use the mixing machine to mix primary colours to form different colours. Students can then select from a range of pictures and paint using the colours they have created.

Mixing colours: match
L1117 – Years P–2

Students select a picture and use the mixing machine to create colours to match those in the selected picture. They then paint a replica of their selection.

Mixing colours
L686 – Years P–2

This is an aggregated learning object combining the two other learning objects.

Pushing and pulling series (Years P–3)

Students experiment with force and mass by using non-standard labour units (in the form of monkeys) to help move recently arrived animals to the zoo.

Features include:

- animals of various sizes and masses, requiring students to apply different amounts of force to succeed.

Students:

- investigate the meaning of 'push' and 'pull' forces
- move animals across a bridge either by pushing or pulling with 'monkey power'
- apply a force to move an object that is at rest and identify the minimum force needed to move a range of weights.

Pushing and pulling: push or pull?
L1120 – Years P–1

Students discover the difference between 'push' and 'pull' as they are asked to move four small animals of similar mass across the bridge using 'monkey power'.

Pushing and pulling: how much force?
L1121 – Years P–2

The animals to be moved are of different sizes and therefore different masses. To move them will require different amounts of force. Students need to move the animals using the correct number of monkeys – too few and the cart can't be moved, while too many monkeys leads to a crash!

Pushing and pulling: zoo move
L1122 – Years P–3

Students are limited to a finite pool of monkeys to move the animals. Using too many monkeys will crash the cart and there won't be enough left to get all the animals across.

Pushing and pulling: assessment
L7879 – Years 1–2

Students investigate and then predict the amount of force required to move a range of animals of various masses.

Pushing and pulling
L700 – Years P–3

This is an aggregated learning object combining the three other learning objects.

Make it go: assessment series (Years P–6)

Students show their understanding of energy and what makes things work.

Features include:

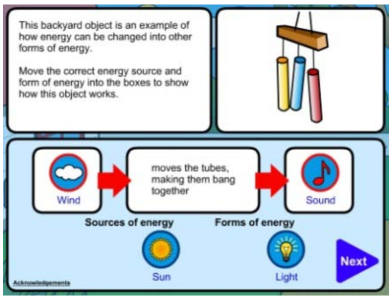
- structured tasks to assess students' understanding of energy and what makes things work
- a printable report of each student's performance.

Students:

- match an object to its use
- link forms of energy to common machines or energy uses
- identify properties of energy.

Make it go: energy source: assessment
L9842 – Years P–2

Students match a machine to its use and identify what makes it go. They answer true/false questions to show what they know about types of energy.



Make it go: energy change: assessment
L9843 – Years 3–6

Students complete a flow chart to show energy changes by identifying the energy source and the energy output of machines.

Energy from the sun series (Years 3–5)

Students explore the use of solar energy for cooking.

Features include:

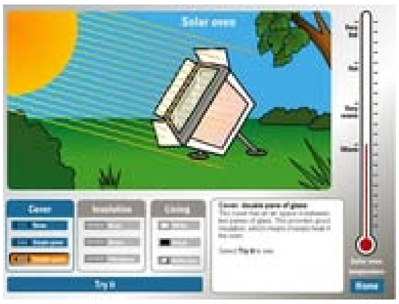
- different design variables for a solar cooker (shape, direction and surface) and a solar oven (cover, insulation and lining).

Students:

- recognise that the Sun is a source of renewable energy
- identify surfaces that will absorb or reflect heat
- compare heat retention and insulation properties of a range of materials and container covers
- compare the concentration of solar energy captured using a range of orientations and the concavity of surfaces
- compare the results of different simulations to determine the best design for a solar cooker and solar oven.

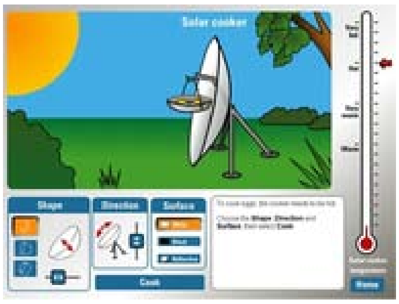
Energy from the Sun: design a solar cooker
L1140 – Years 3–5

Students design a solar cooker by selecting various characteristics for its shape, direction and surface. They can test each of the variables to determine the heat generated by the cooker when powered by the Sun.



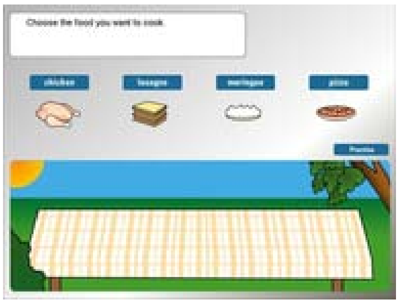
Energy from the Sun: design a solar oven
L1141 – Years 3–5

Students design a solar oven by selecting various characteristics for its cover, insulation and lining. They can test each of the variables to determine the heat generated by the oven when powered by the sun.



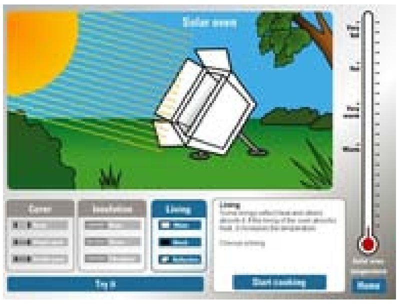
Energy from the Sun: design a solar cooker and start cooking
L848 – Years 3–5

Students cook food in a solar cooker. By selecting the design settings for the cooker, students are able to find the best temperature needed to cook food such as soup, chicken or fish.



Energy from the Sun: design a solar oven and start cooking
L1142 – Years 3–5

Students cook food in a solar oven. By selecting the design settings for the oven, students are able to find the best temperature needed to cook food such as chicken, pizza or lasagne.



Energy from the Sun
L956 – Years 3–5

This is an aggregated learning object combining the above four learning objects.

Sound: thunderstorms (Years 3–6)

Using the context of thunder and lightning, students discover that sound and light travel at different speeds.

Features include:

- an introduction to the concepts of the speed of sound and the speed of light
- an interactive stopwatch to help students to measure and record elapsed time
- multiple-choice questions to test understanding of key concepts.

Students:

- identify that light travels much faster than sound
- establish that the time delay between lightning and thunder is a guide to how far away a lightning strike occurs
- relate the speed of sound to the distance travelled by thunder before it is heard by an observer.

Sound: thunderstorms
L2537 – Years 3–6

Students experiment with lightning and thunder and use a simple method of estimating the speed that sound travels through the air. Students use a stopwatch to take measurements and then, using the data they collect, make estimations of the speed the sound is travelling.

Sound series (Years 3–6)

Students discover basic concepts relating to sound and vibration. Students discover that musical instruments have different variables that affect the sound they produce.

Features include:

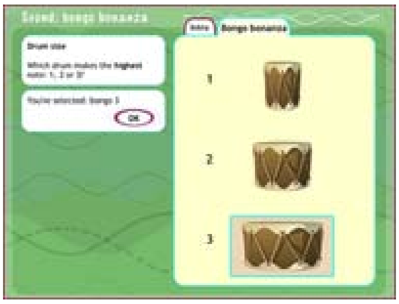
- a demonstration of how a range of sounds is generated by musical instruments
- virtual percussion, stringed and wind instruments
- a demonstration of the concept that the faster an object vibrates, the higher the note it will produce
- multiple-choice questions to test understanding of key concepts.

Students:

- explore how sounds are made by vibrating objects
- identify variables affecting the pitch of sounds made by musical instruments
- adjust variables to produce a musical note of a given pitch.

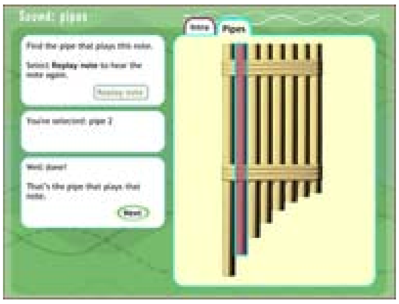
Sound: strings
L2538 – Years 3–6

Using a stringed guitar instrument, students investigate the impact of different variables such as string thickness and tension. Frets are also introduced to demonstrate how shortening the string can change a note.



Sound: bongo bonanza
L2539 – Years 3–6

Using a bongo drum, students investigate the impact of different variables, such as drum size and skin tension, on the resultant sound.



Sound: pipes
L2540 – Years 3–6

Using pan pipes, students investigate the impact of different variables, such as pipe length and width, on the resultant note played.

Sound
L2536 – Years 3–6

This is an aggregated learning object combining the above three learning objects.

Steady ships series (Years 3–6)

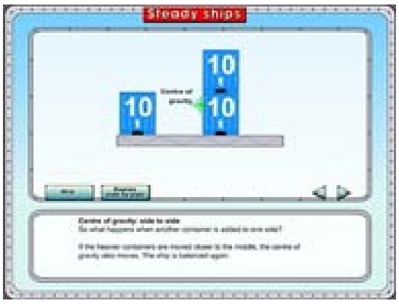
Students explore the concept of stability and the science of the centre of gravity. Using the context of a cargo ship, students are asked to load containers so that weight is distributed evenly and the centre of gravity is low. Most importantly, the centre of gravity must not move outside the base of boat when the ship sails.

Features include:

- introductions to the concepts of stability, balance and centre of gravity
- an interactive model of a ship which demonstrates centre of gravity and balance
- feedback after the stability of a loaded ship is tested in rough seas.

Students:

- identify the centre of gravity of an object as an indicator of its stability
- arrange a group of weights to maximise stability
- identify factors that affect stability such as total mass and distribution of mass.



Steady ships: load similar weights
L1495 – Years 3–6

Using the ship loading metaphor, students are provided with cargo items of similar weight at this foundation level.

Steady ships: load different weights
L1496 – Years 3–6

Steady ships: load different weights further challenges students by introducing greater variations in the cargo items that the students need to load.

Steady ships: add similar weights
L1498 – Years 3–6

Students have new elements (a car, yacht or truck) which have an unknown weight, so they must carefully analyse the weights that they are adding to best balance the ship. In this learning object, students are provided similar weights to help scaffold into more difficult examples in the more complex learning objects.

Steady ships: add different weights
L1499 – Years 3–6

Students are challenged with unknown elements (a car, yacht or truck). However, this learning object uses cargo boxes of greater weight variance to challenge students.

Steady ships
L1494 – Years 3–6

This is a single aggregated learning object combining the above four learning objects.

Electromagnetism series (Years 3–8)

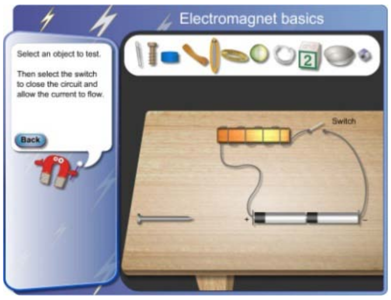
Students explore the magnetic fields of electromagnets. They investigate their representation by field lines, their effects on materials and the factors that influence their strength.

Features include:

- descriptions of the components of an electromagnet and its operating circuit
- virtual testing of a variety of objects to determine whether they are attracted to an electromagnet
- field diagrams for electromagnets of several different strengths.

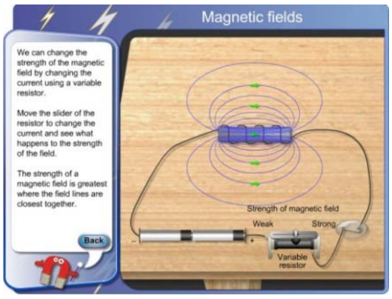
Students:

- identify the parts of an electromagnet and its accompanying circuit, and explain their functions
- use an electromagnet to identify substances that are affected by magnetic fields
- construct magnetic field diagrams for an electromagnet
- describe the relationship between field strength, current and the spacing of field lines.



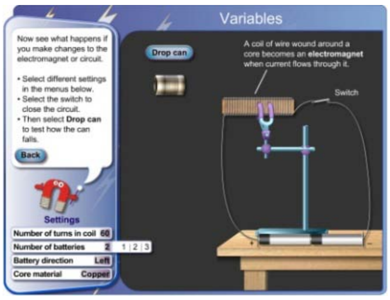
Electromagnetism: electromagnet basics
L10714 – Years 3–6

Students explore the parts of an electromagnet circuit. They test objects made of different materials to find out whether they are affected by magnetic fields



Electromagnetism: magnetic fields
L10715 – Years 5–8

Students investigate the magnetic field surrounding an electromagnet. They use a compass to find the direction of the field at different places and see how field lines can be used to map the field's strength and direction.



Electromagnetism: variables
L10716 – Years 3–6

Students investigate how the strength of an electromagnet can be changed. They alter the number of batteries, the number of turns in the coil and the core material of the electromagnet, then observe the effect.

Energy chains series (Years 4–8)

Students explore fuel, energy and energy converters.

Features include:

- authentic photographs
- descriptions of the function of energy converters in a variety of systems for generating electricity
- options to save and print the energy chains constructed.

Students:

- arrange energy sources and converters into a logical chain to deliver electrical energy
- review the energy chain they constructed.

Energy chains: build an energy chain
L2353 – Years 4–6

Students build an energy chain for a coal-fired power station. They find out about fuel and how the energy converters work. Students examine the type of energy change that happens in each converter. They arrange converters into the correct sequence so that the energy in fuel can be delivered as electricity.

Energy chains: make electricity
L2354 – Years 4–6

Students build up to six energy chains that produce electricity. They select from different energy sources and choose energy converters to match.

Energy chains: side effects
L2355 – Years 4–6

Students build energy chains that make electricity and examine the waste products and side effects that occur with each converter. For example, they find out the environmental effects of using water to generate electricity in hydroelectric systems.

Energy chains: power up!
L2356 – Years 5–8

Students build energy chains to power appliances and vehicles. They find out about energy sources and about how energy converters work, then select the energy converters that suit each source and vehicle.

Energy chains: energy use
L2357 – Years 7–8

Students select energy sources and energy converters to build energy chains to power appliances and vehicles. They examine how each energy converter in a chain loses some energy and reduces the energy available for use.

This series contains non-TLF content. See Acknowledgements in the learning objects.

Jet force series (Years 4–6)

Students use a frictionless disc to investigate the results of applying a force to an object. The disc has several slots on its back to which jet forces can be attached by students who then shoot for goal.

Features include:

- vector diagrams to assist students to determine the number of forces and the position they must go in to achieve success.

Students:

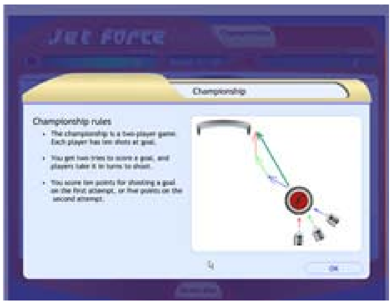
- investigate the direction of movement of an object when a force is applied to it
- apply multiple forces to an object to propel it in a given direction on a flat surface.

Jet force: training
L1113 – Years 4–6

In this series, students are awarded points based on their success at shooting goals. Before beginning anything, some training is always helpful. Students begin by applying just one force to the disc, in the correct slot, to get the disc in the goal. Once they have that mastered, they move on to using two, and finally three, forces to get the disc into the goal.

Jet force: match
L1114 – Years 4–6

Students are awarded points based on their success at shooting goals. If they apply the correct number of forces to the disk in the correct place, a goal, plus points, is guaranteed. If they miss the goal, those points dwindle.



Jet force: championship
L1115 – Years 4–6

Students challenge a friend to see who is best able to combine forces and score a goal.

Jet force
L685 – Years 4–6

This is an aggregated learning object combining the three other learning objects.

Energy-efficient house series (Years 4–6)

Students take on the role of a designer selecting the types of materials to use in the construction of houses in different climatic regions in order to make them energy-efficient. Through this interaction, students identify materials and design factors that maximise the energy efficiency of a building in a given climate.

Features include:

- a model to allow the design parameters of a house to be changed in order to achieve the most energy-efficient design
- an introduction to the six star rating system for energy efficiency
- a range of insulation materials, building design elements and climates
- data displayed in column graphs.

Students:

- explore how climate influences the energy efficiency of a building
- explore how a range of materials and design factors affect the energy efficiency of a building
- identify materials and design factors that will maximise the energy efficiency of a building in a given climate
- identify materials and design factors that will maximise the cost efficiency of energy-saving measures for a building in a given climate
- interpret data relating to costs and energy efficiency.

Energy-efficient house: information
L1148 – Years 4–6

Students are provided with information that will help them make energy-efficient choices in the design and construction of a house. This includes information about air leaks (from gaps under doors and windows), the types of insulation used for walls and ceilings, and the impact of double-glazing windows.

Energy-efficient house: explore design
L1149 – Years 4–6

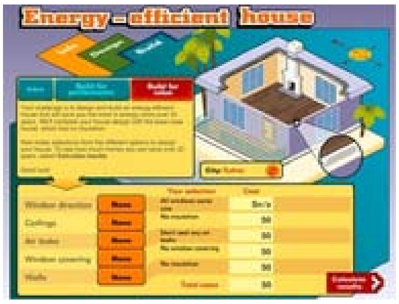
Students decide in which city they wish to build a house. They then make choices about the type of insulation materials, window coverings and window directions that should be used in the construction of their house. They are then able to test the energy efficiency of the house.

Energy-efficient house: build for performance
L1150 – Years 4–6

Students are challenged to build the most energy-efficient house they can. The house they build will be given an energy efficiency rating comparing it to a house that has no insulation. Students will need to consider such things as window direction, the types of window coverings to use and what types of materials to build walls from.

Energy-efficient house: build for value
L1151 – Years 4–6

Students are challenged to build an energy-efficient house that will save them the most in energy costs over 20 years. Each choice students make (for example, the type of insulation) will be displayed with an associated cost. The costs are totalled and the house costs are compared to the costs of a house that has no insulation.



Energy-efficient house
L895 – Years 4–6

This is an aggregated learning object combining the above four learning objects.

Matter and evaporation series (Years 5–6)

Students experiment with the transformation of water to gain an understanding of the relationship between temperature, molecular speed and states of matter.

Features include:

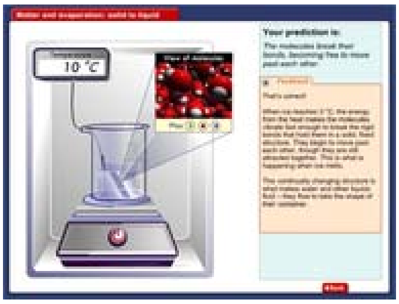
- virtual experiments to demonstrate the relationships between temperature and molecular speed
- feedback on the accuracy of students' predictions
- simulations that are accessible for further observation after feedback has been given.

Students:

- explore relationships between temperature, molecular speed and states of matter
- describe the changes in molecular structure that accompany changes in state from solid to liquid and from liquid to gas
- predict the outcome of each investigation, and then examine those outcomes at a molecular level .

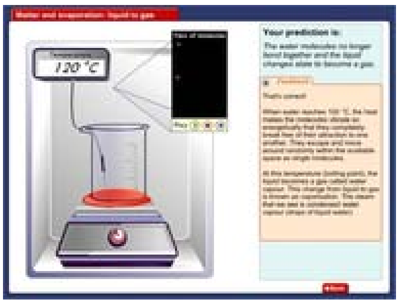
Matter and evaporation: below zero
L1491 – Years 5–6

By heating ice to -1°C in a virtual experiment, students discover the relationship between temperature and the molecular speed of ice. They discover that, as the temperature rises, the ice molecules vibrate faster, but that they remain bonded together as a solid.



Matter and evaporation: solid to liquid
L1492 – Years 5–6

By heating ice to +10°C in a virtual experiment, students discover the relationship between temperature and the molecular speed of ice. They discover that when the temperature reaches 0°C, the molecules vibrate so fast that they break their solid structure bond and ice starts to melt.



Matter and evaporation: liquid to gas
L1493 – Years 5–6

Students discover the relationship between temperature, change of state and the molecular speed of water. Students discover that, as the temperature reaches boiling point, the molecules vibrate so fast that they completely break free and float around. At this point the water changes state to become a gas.

Matter and evaporation
L1490 – Years 5–6

This is an aggregated learning object combining the above three learning objects.

Matter: assessment series (Years 5–9)

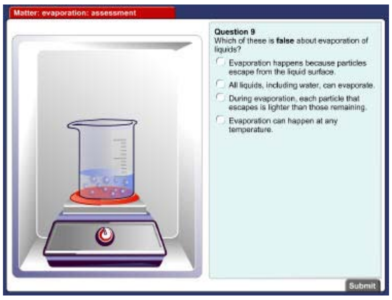
Students show their understanding of the particle model by relating particle-level animations to observable physical changes.

Features include:

- multiple-choice questions requiring students to provide reasons for their answers
- model answers for students to compare their reasoning against
- a printable report of the student's performance.

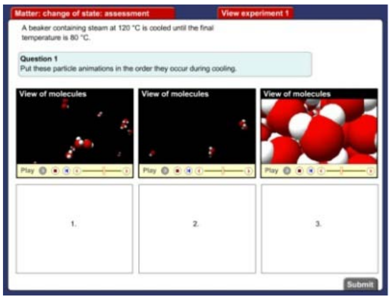
Students:

- identify melting and boiling points of water
- use the particle model of matter to explain phenomena related to temperature and phase changes
- identify that temperature remains constant until a change of state is complete
- relate particle energy during temperature and phase changes to energy flows at the macro level.



Matter: evaporation: assessment
L9956 – Years 5–7

Students look at particle-level animations and relate them to the observable physical changes. They answer five multiple-choice questions and give reasons for each of their answers.



Matter: change of state: assessment
L9957 – Years 8–9

Students demonstrate their understanding of the particle model by explaining temperature changes, changes of state and energy flows. They look at particle-level animations and relate them to the observable physical changes.

Making music series (Years 5–6)

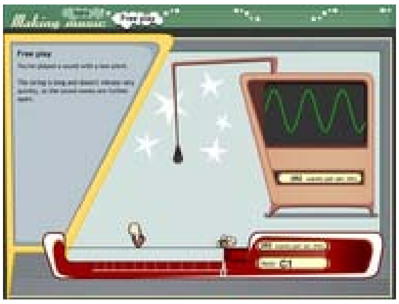
Students discover the science behind sound. They pluck a virtual stringed instrument and 'see' the sound waves that are made on a simplified oscilloscope. They have the opportunity to explore freely as well as the challenge of matching sounds or tunes.

Features include:

- an oscilloscope model that allows students to view sound waves
- a recording feature that enables students to compose simple tunes
- pattern matching activities that include three skill levels, progressively increasing in difficulty
- random generation of sounds and tunes that supports repeated use
- playback and print facilities.

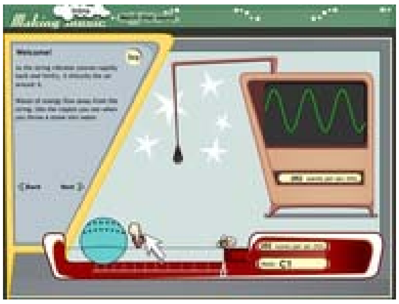
Students:

- explore how sounds are caused by vibrating objects
- compare musical notes with soundwave patterns and predict one from the other
- identify and produce sounds of a given pitch and assemble them into known tunes or new compositions.



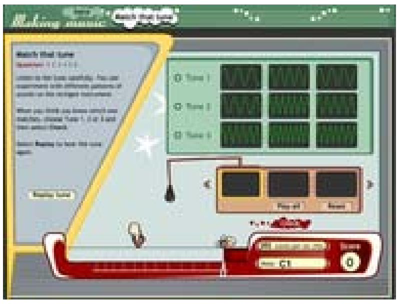
Making music: free play
L1193 – Years 5–6

Students step through a clearly explained introduction to the science of sound and then experiment with the virtual stringed instrument. Students explore the relationships between string length, musical pitch and wave frequency. They are able to change the length of the string and 'see' the results.



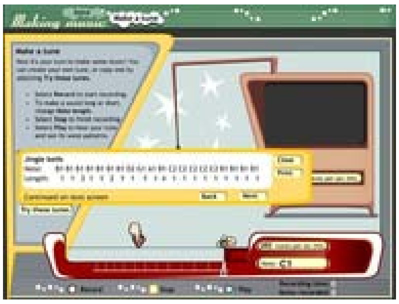
Making music: match that sound
L1194 – Years 5–6

Students are challenged to listen to a sound, look at the wave pattern it makes on the oscilloscope and then see if they can make the same sound on the stringed instrument. There are three levels of difficulty in this learning object and, as students progress, they have fewer chances to get the correct answer.



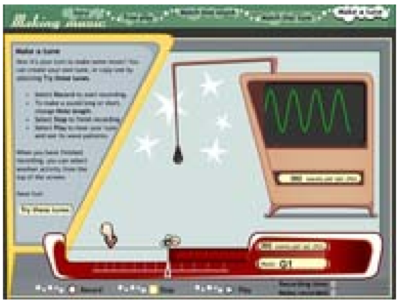
Making music: match that tune
L1195 – Years 5–6

Students are challenged to analyse and then identify tunes made up of three individual sounds displayed on an oscilloscope. Students then select the sound wave pattern that matches the tune. To help them in their selection, students are able to experiment with patterns of sounds on the stringed instrument.



Making music: make a tune
L1196 – Years 5–6

Students are able to record a tune of their own choice, making long and short sounds on the stringed instrument by changing the note length. They are then able to play back the tune and see the wave patterns they have made. Students are also able to copy tunes such as 'Row, row, row your boat' and 'Jingle bells'.



Making music
L1192 – Years 5–6

This is an aggregated learning object combining the four other learning objects.

Optics and images series (Years 5–6)

Students experiment with lenses and mirrors, discovering how images are reflected, magnified and projected. Students choose between two hypotheses as they start each investigation.

Features include:

- simulations to show image formation by flat and curved mirrors and lenses
- facilities to enable students to vary the shape of mirrors and lenses, and vary distances and sizes of objects
- a facility to allow student to predict the outcome of an experiment.

Students:

- use light ray diagrams to locate images formed by mirrors and lenses
- position lenses and mirrors to produce images larger or smaller than an actual object
- distinguish between real and virtual images
- choose between two hypotheses in each investigation.

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Optics and images: plane mirrors
L1487 – Years 5–6

Students change the position and size of an object and see the results of the image reflection in a mirror. Through experimentation, they are able to see the effect this has on the position and size of the virtual (reflected) image. They are also able to see the corresponding light ray and virtual light rays. As a result of this interaction, they are able to see that the virtual image always appears to be the same distance from the mirror as the object.

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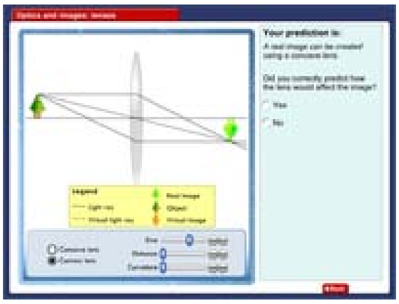
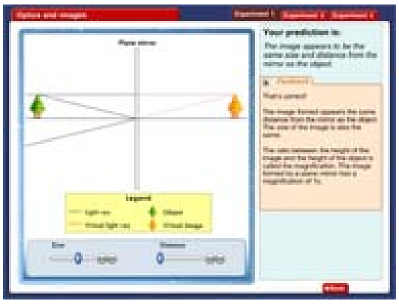
Optics and images: curved mirrors
L1488 – Years 5–6

Students change the curvature of a convex mirror. Through experimentation, students are able to see the effect this has on the size of the virtual image that is reflected in the convex mirror. They are also able to see the corresponding light rays and virtual (reflected) light rays. As a result of this interaction, they are able to see that an image changes size depending on the type of mirror.



Optics and images: lenses
L1489 – Years 5–6

Students are able to explore what happens to an image when it passes through different lenses. They choose a convex or concave lens and then manipulate its curvature. Through experimentation, students see that a real image can be created using a convex lens and this image can be projected onto a screen.



Optics and images
L1483 – Years 5–6

This is an aggregated learning object combining the above three learning objects.

This series contains non-TLF content. See Acknowledgements in the learning objects.

Optics and images series (ESL) (Years 5–6)

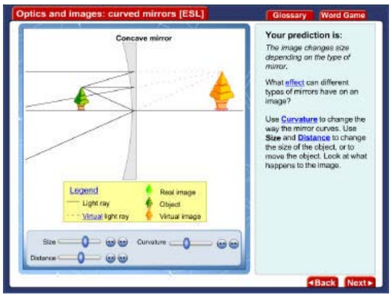
Students explore the effect of shape, distance and curvature of mirrors on the images formed.

Features include:

- modified language for English as a Second Language users
- a glossary of terms used in the activity
- simulations of how images are formed
- a cloze exercise on scientific method and the vocabulary used in science reports.

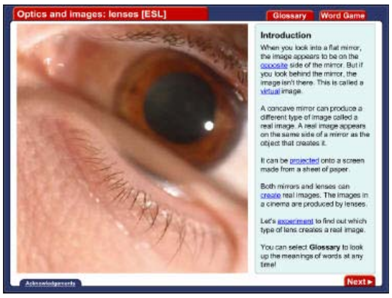
Students:

- vary the shape of mirrors and vary distances and sizes of objects to investigate effects on the size and nature of images produced
- choose between two hypotheses, and assess whether their choice was correct.



Optics and images: curved mirrors [ESL]
L10194 – Years 5–6

Students position lenses and mirrors to change the direction of light rays and produce images. They predict the properties of a reflection produced by a mirror according to its shape – flat, concave or convex – and explore how the distance of an object from a mirror affects the image produced.



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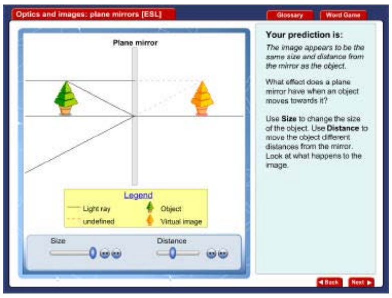
Optics and images: lenses [ESL]
L10195 – Years 5–6

Students position lenses to change the direction of light rays and produce images. They predict the properties of an image produced by a lens according to its shape – concave or convex? – and explore how the curvature of a lens affects focal length and images produced.



Optics and images: plane mirrors [ESL]
L10193 – Years 5–6

Students position an object and a flat mirror to reflect light rays and produce images. They predict the size and position of the reflection produced.

This series contains non-TLF content. See Acknowledgements in the learning objects.

Light and reflection series (Years 5–6)

Students explore the concepts of light and reflection in a range of different contexts.

Features include:

- illustrations to show that light always travels in a straight line
- more than one visual perspective for light experiments
- a series of tasks that progressively increase in difficulty.

Students:

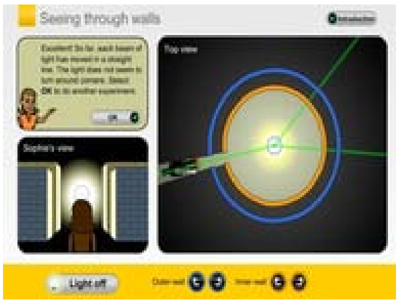
- combine simple shapes to cast a shadow having a complex shape
- relate the size of a shadow to the proximity of an object to a light source
- explore angles of incidence and reflection using plane mirrors
- predict the direction in which light will be reflected by fixed mirrors.

Light and reflection: light rays: seeing through walls
L4604 – Years 5–6

Students rotate concentric walls until gaps in the walls are aligned and light can travel out to an observer. Through a series of increasingly complex tasks, students record that light always travels in a straight line.

Light and reflection: light rays: shadow animals
L4605 – Years 5–6

Students select from a range of shapes and then position the shape between a light source and a screen to match a shadow animal. Through a series of tasks that progressively increase in difficulty, students understand that light travels in a straight line and that a shadow is caused when light is partially blocked.

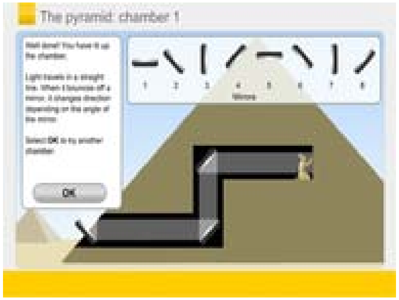


Light and reflection: light rays
L2041 – Years 5–6

This is an aggregated learning object combining *Light and reflection: light rays: seeing through walls* and *Light and reflection: light rays: shadow animals*.

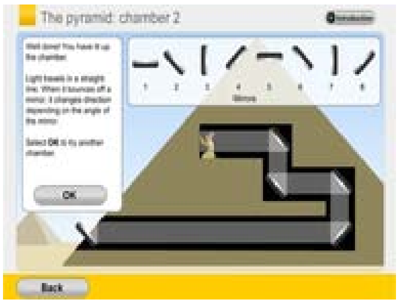
Light and reflection: using mirrors: the forest
L4153 – Years 5–6

Using the light from the headlights of his truck, students help Denis find animals at night by positioning a mirror to direct the beam of light. They must correctly position the mirror to reflect light at a suitable angle. Students are able to vary the angle of the mirror, then must predict which fixed mirror will achieve the desired angle. From this experimentation, students determine that light always travels in a straight line.



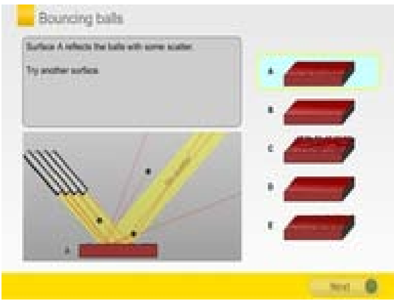
Light and reflection: using mirrors: the pyramid
L4155 – Years 5–6

Students light the way for a scribe to see inside a pyramid by correctly predicting and positioning mirrors that will reflect a beam of sunlight at a suitable angle. Through this exploration, and a series of tasks that increase in difficulty, students notice that the light always travels in a straight line, and gain an understanding of the way in which light is reflected by plane mirrors.



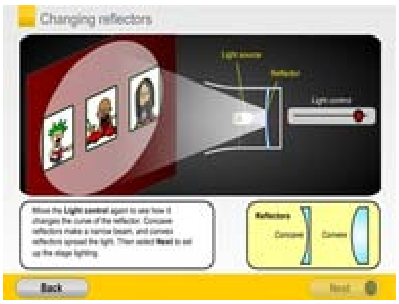
Light and reflection: using mirrors
L2042 – Years 5–6

This is an aggregated learning object combining *Light and reflection: using mirrors: the forest* and *Light and reflection: using mirrors: the pyramid*.



Light and reflection: reflecting off surfaces
L2043 – Years 5–6

Students observe the way in which balls bounce in different directions and order the surfaces in increasing roughness. They discover that the amount of scatter can be used as an indicator of how rough the surface is. Using this knowledge, students then observe light reflecting off surfaces of varying roughness. They infer the roughness of that surface based on the amount of light scatter.



Light and reflection: under the spotlight
L2044 – Years 5–6

Initially students observe that the shape of a reflector – concave, flat or convex – alters a reflected beam of light. By tracing individual light rays, the link between angle of incidence and angle of reflection is demonstrated, with the application of this to stage lighting being illustrated. In the final activity, students have to follow a simplified lighting diagram to set the stage lights as a rock group plays.

Pulleys series (Years 5–8)

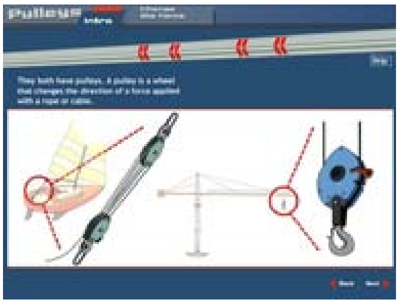
Students explore the relationship between mass, force, distance and work. The setting for this series is a warehouse where the students are helping workers lift crates onto a truck.

Features include:

- descriptions of common devices that use pulleys
- an explanation of the principle that a pulley makes it easier to lift loads by changing the direction of a force
- an introduction to common units used for measuring mass (kilograms) and force (newtons)
- quizzes to test students' understanding of mechanical concepts
- random generation of worker strengths (newtons) to support repeated use
- a data table in which students' efforts are recorded.

Students:

- solve lifting problems in a warehouse scenario using combinations of force and pulley numbers
- analyse data tables to work out mathematical relationships between load mass, the number of pulleys, force, the distance rope is pulled and work done
- note that pulleys change the direction of an applied force, and that the more pulleys used, the greater the load that can be lifted with a given force
- note that the amount of work needed to lift an object is constant and the greater the load, the more work is required to lift it.



Pulleys: change the force
L1199 – Years 5–8

Students assess the weight of each crate and then determine how much force (ie how many workers) is needed to lift the crate.

Pulleys: add more pulleys
L1200 – Years 5–8

Students assess the weight of each crate and then determine the minimum number of pulleys needed for the workers to lift the crate.

Pulleys: lifting challenge
L1201 – Years 5–8

Students assess the weight of each crate and use different strategies to lift the crates. Sometimes they must change the number of pulleys, sometimes the force (number of workers) and sometimes both.

Pulleys
L1198 – Years 5–8

This is an aggregated learning object combining the three other learning objects.

Additive colour series (Years 5–8)

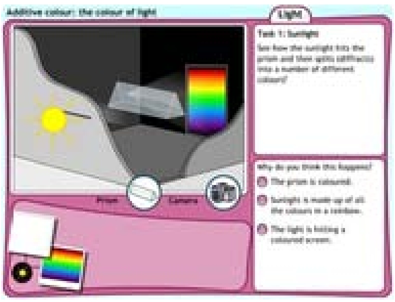
Students explore the different mixture of colours emitted by a range of light sources and the range of colours produced by combining different ratios of the three primary additive colours.

Features include:

- a screen capture mechanism for comparing light sources, visible spectrum components and the result of mixing colours
- examples of the different mixtures of colours emitted by a range of light sources
- multiple-choice questions to test understanding of key concepts.

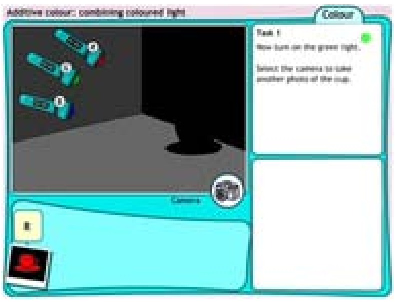
Students:

- identify that white light is made up of coloured light (the rainbow colours)
- identify colour differences between sunlight and light from artificial sources
- explore the range of colours produced by combining different ratios of the three primary additive colours
- predict the result when additive colours are mixed.



Additive colour: the colour of light
L2542 – Years 5–8

Students use a variety of light sources and take pictures of the resultant spectrum so that a comparison can be made. The learning object introduces the concept that white light is made up of many colours.



Additive colour: combining coloured light
L2543 – Years 5–8

Students use the three main colour light sources in different combinations to examine their effect on white. Students are also asked to consider some of the technologies that might use additive light.

Additive colour
L2541 – Years 5–8

This is an aggregated learning object combining the two other learning objects.

Subtractive colour series (Years 5–8)

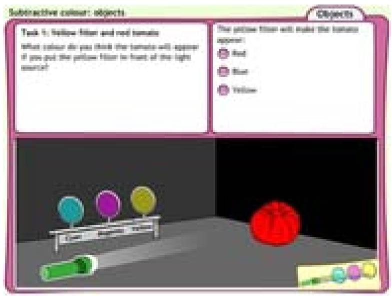
Students investigate how white light is made up of coloured light and how coloured filters selectively absorb colours.

Features include:

- a demonstration to show that the apparent colour of an object depends on its reflective properties and the colours of light that reach it
- illustrations of the colours produced by subtracting different ratios of the three primary colours
- illustrations to show that coloured filters selectively absorb colours
- a screen capture mechanism for comparing the results of filtering colours
- multiple-choice questions to test understanding of key concepts.

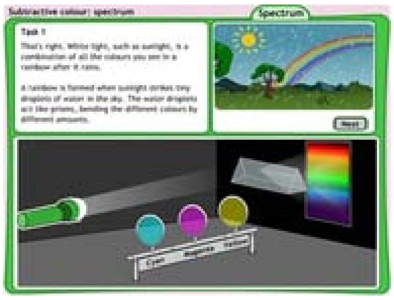
Students:

- note that white light is made up of coloured light (the rainbow colours)
- note that coloured filters selectively absorb colours
- note that the three primary subtractive colours are magenta, cyan and yellow
- predict the result when subtractive colours are filtered onto coloured objects
- explore the range of colours produced by combining different ratios of the three primary subtractive colours.



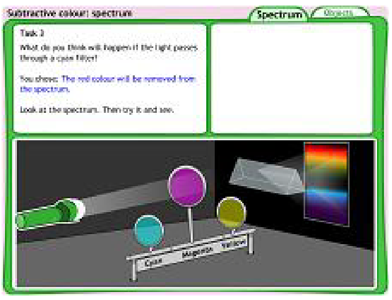
Subtractive colour: objects
L2780 – Years 5–8

Students predict and explore how the colours in white light can be split, absorbed and reflected by shining a white light through coloured filters (magenta, yellow and cyan) and a glass prism. Then, using multiple combinations of the filters, they investigate how filters absorb some colours and let others pass through.



Subtractive colour: spectrum
L2544 – Years 5–8

Students use different combinations of filters to absorb primary colours so they do not shine onto a given object. They then investigate what combinations of filters might be used to change a white object into a different colour. Students are also asked to consider some of the technologies that might use subtractive colours.



Subtractive colour
L2545 – Years 5–8

This is an aggregated learning object combining the two other learning objects.

Air pressure series (Years 5–9)

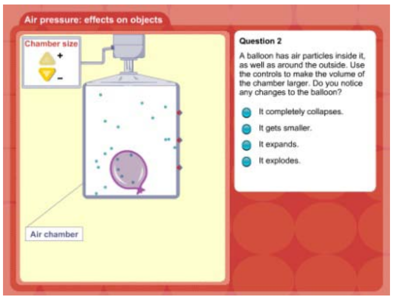
Students interact with a particle-model simulation of a sample of gas trapped in a chamber. They investigate the effects of temperature and volume changes, as well as particle numbers, on gas pressure.

Features include:

- an interactive particle model of a gas trapped in an air chamber
- quantitative data that illustrates Boyle's Law and the relationship between pressure and the number of particles
- a series of multiple-choice questions requiring students to observe changes and make predictions
- structured feedback to student responses.

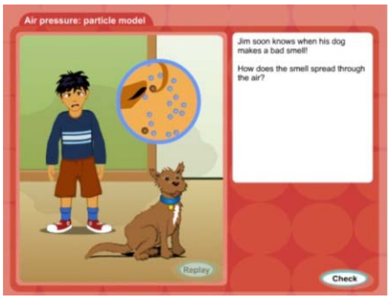
Students:

- describe the particle nature of gases, including the characteristics of the particle motion
- use the particle model to interpret observed changes in gas pressure
- predict the effects of changes in volume, temperature and/or particle numbers on the pressure of a gas in an air chamber



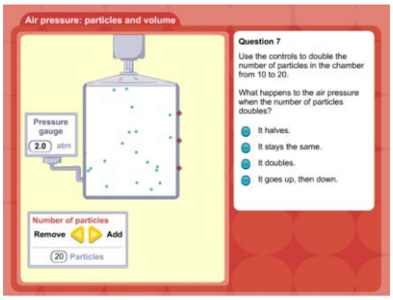
Air pressure: effects on objects
L10383 – Years 6–9

Students experiment with gas trapped in an air chamber. They observe and make predictions about the effects of changing the chamber volume, or the number of gas particles, on some common objects placed inside, such as a balloon.



Air pressure: particle model
L10380 – Years 5–8

Students investigate the speed and collisions of air particles in an air chamber. They watch what happens to the particles as the temperature changes and observe how this affects the properties of the gas.

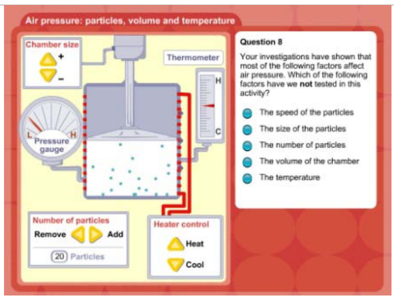


Air pressure: particles and volume
L10381 – Years 6–9

Students change the size of an air chamber, add or remove gas and notice how the gas pressure changes. They then control the pressure by balancing the volume of the chamber with the number of gas particles in it.

Air pressure: particles, volume and temperature
L10382 – Years 10–12

Students make and test predictions about the behaviour of gas trapped in an air chamber. They change the size of the chamber, the temperature or the number of gas particles and notice how the gas pressure changes.



Sport shoes series (Years 6–7)

Students investigate the concept of ground reaction force, both through the practical example of sports shoes and from the perspective of a sports scientist.

Features include:

- simulations of lab-testing procedures and data measurement, including the use of impact-testing machines
- descriptions of how impact forces can be cushioned
- characteristics of sports shoes that determine how well they are suited to forces exerted in typical use.
- tables for students to record experimental results.

Students:

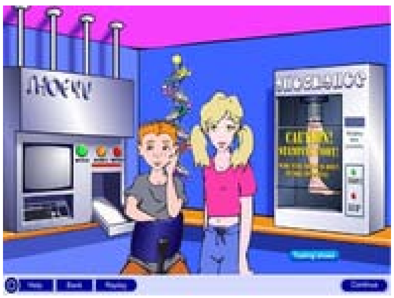
- make predictions
- collect and analyse data
- construct shoes for different purposes to their preferred design.

Sports shoes: sole support
L491 – Years 6–7

Students experience the outcome of two forces colliding. Sports shoes are used to demonstrate that the impact from the ground reaction force can be measured and managed through an understanding of the components of sports shoes and their purpose.

Sports shoes: sole support [no spoken instructions]
L780 – Years 6–7

Students experience the outcome of two forces colliding. Sports shoes are used to demonstrate that the impact from the ground reaction force can be measured and managed through an understanding of the components of sports shoes and their purpose.



Sports shoes: shoe4u
L492 – Years 6–7

Students experiment with the design of shoes for different sports, taking into account the requirements of particular sports and the properties of the shoe components.

Sports shoes: shoe4u [no spoken instructions]
L781 – Years 6–7

Students experiment with the design of shoes for different sports, taking into account the requirements of particular sports and the properties of the shoe components.

Light and colour: assessment series (Years 7–8)

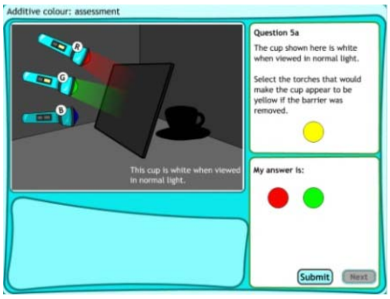
Students demonstrate their understanding of the light spectrum.

Features include:

- structured tasks to assess students' understanding that light is made up of coloured light (spectrum)
- model answers for students to compare their reasoning against
- a printable report of each student's performance.

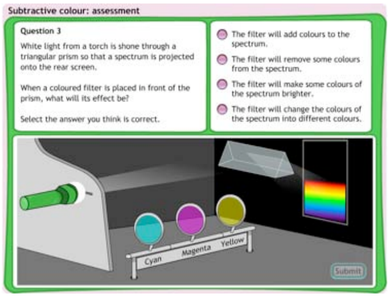
Students:

- identify that a triangular prism can separate the colours of white light into a spectrum
- predict the result when additive colours are mixed and subtractive colours are filtered onto coloured objects
- provide reasons for their answers to multiple-choice questions
- relate the colour of an object to the reflection and absorption of different colours.



Additive colour: assessment
L10324 – Years 7–8

Students are assessed on their understanding of coloured light, including the effect of shining a beam of light through a prism, mixing light and shining different coloured light on objects. They identify that the three additive primary colours are red, green and blue.



Subtractive colour: assessment
L10325 – Years 7–8

Students demonstrate their understanding of the effect of filters on white light. They predict the effect of adding different coloured filters to white light and identify that coloured filters selectively absorb colours.

Interpreting changes of state series* (Years 7–8)

Students explore the three main states of matter, as well as changes of state, by viewing changes in water at the physical and particle level as the water is heated and cooled.

Features include:

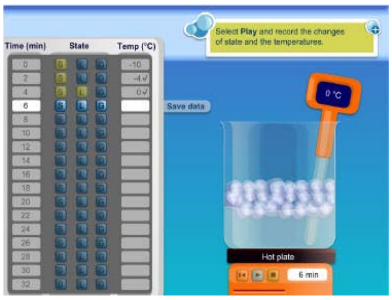
- physical and particle-level animations showing water as it changes state between its solid, liquid and gas forms
- options to print the data tables, graphs and summaries describing the changes in water when it is heated or cooled
- additional extension questions as an optional printout.

Students:

- are introduced to both the reasons behind changes in properties as substances change state and the unique properties of water through multiple-choice questions
- conduct a virtual experiment in which they heat water, and then record, graph and interpret the observed changes
- record and graph changes over time as water is heated, and predict the graph that will be obtained if water is cooled
- interpret and explain the shape of the temperature-time graphs obtained when water is heated and cooled.

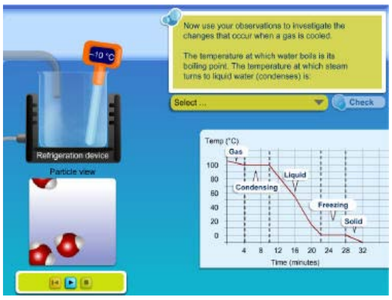
Interpreting changes of state
L9122 – Years 7–8

Students observe the behaviour of water particles during heating and cooling and explain properties of solid, liquid and gaseous water, and the processes involved in changing state, in terms of kinetic theory.



Interpreting changes of state: heating
L9128 – Years 7–8

Students explore how particle theory and the kinetic theory of matter can be used to explain properties of water and the physical changes that occur when it is heated.



Interpreting changes of state: cooling
L9129 – Years 7–8

Students observe the behaviour of water particles during cooling and explain properties of solid, liquid and gaseous water, and the processes involved in changing state, in terms of kinetic theory.

Wild ride series (Years 6–7)

Students investigate some of the physical forces involved in riding a bicycle. They investigate scientific principles and then test these principles in simulated bike-race time trials.

Features include:

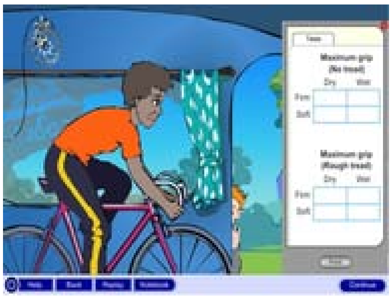
- test results and feedback
- variables such as wheel size, tyre pressure, tread and gears
- simulations of computer modelling procedures and data measurement
- printable tables for students to record experimental results.

Students:

- relate cycling performance to forces which vary according to wheel size, tyre pressure and tread
- investigate how gears affect operational efficiency in simple machines such as bicycles
- optimise performance in a timed race scenario.

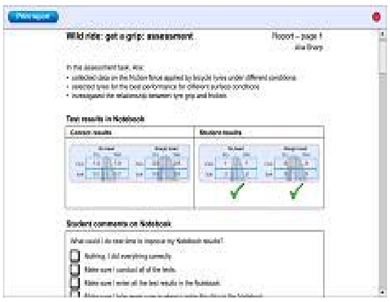
Wild ride: get a grip
L477 – Years 6–7

Students investigate the role of friction in the performance of bicycle tyres. They test how the type of tread affects grip and speed, and choose tyres best suited to various track and weather conditions in simulated bike-race time trials. A printable notebook function also allows students to record their observations.



Wild ride: get a grip [no spoken instructions]
L478 – Years 6–7

Students investigate the role of friction in the performance of bicycle tyres. They test how the type of tread affects grip and speed, and choose tyres best suited to various track and weather conditions in simulated bike-race time trials. A printable notebook function also allows students to record their observations.



Wild ride: get a grip: assessment
L7969 – Years 7–9

Assesses students' ability to conduct a test, collect data and make predictions. It also assesses their understanding of how friction affects bicycle tyre performance. Includes a printable report.

Wild ride: get a grip: assessment: teacher guide
R9714

Wild ride: on a roll
L479 – Years 6–7

Students investigate the role of physical forces in how bicycle wheels work. They test how wheel size, tyre pressure, tread and load affect rolling resistance, and choose wheels best suited to various track and weather conditions in simulated bike-race time trials.

Wild ride: on a roll [no spoken instructions]
L480 – Years 6–7

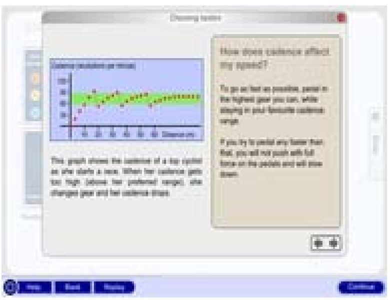
Students investigate the role of physical forces in how bicycle wheels work. They test how wheel size, tyre pressure, tread and load affect rolling resistance, and choose wheels best suited to various track and weather conditions in simulated bike-race time trials.

Wild ride: in top gear
L481 – Years 6–7

Students investigate how gears work and why you need them to ride a bicycle efficiently. They test how cog size affects speed and energy efficiency, and choose gears best suited to various track and weather conditions in bike-race time trials.

Wild ride: in top gear [no spoken instructions]
L482 – Years 6–7

Students investigate how gears work and why you need them to ride a bicycle efficiently. They test how cog size affects speed and energy efficiency, and choose gears best suited to various track and weather conditions in bike-race time trials.



Wild ride: race day
L483 – Years 6–7

It's race day. In order to get the fastest possible time, students select bike type, colour, wheel size, tyre tread and gear set and determine tactics to suit the race track and weather conditions.

Wild ride: race day [no spoken instructions]
L484 – Years 6–7

It's race day. In order to get the fastest possible time, students select bike type, colour, wheel size, tyre tread and gear set and determine tactics to suit the race track and weather conditions.

Wild ride: race day: assessment
L7968 – Years 7–9

Students are assessed on their ability to optimise the performance of a bike for racing.

Wild ride: race day: assessment: teacher guide
R9715

Wild ride: in top gear and *Wild ride: on a roll* contain non-TLF content. See Acknowledgements in the learning objects.

Accelerate series (Years 7–10)

Students take on the role of an interplanetary cargo craft pilot in the year 2084 to explore the concepts of speed and acceleration.

Features include:

- the introduction of SI units for velocity, acceleration, force and mass
- velocity-versus-time-line graphs, in which the slope of the line indicates acceleration
- an option to print a table of results.

Students:

- explore the relationships between acceleration, force, mass and friction
- distinguish between the concepts of speed and acceleration
- apply Newton's second law of motion to work out the force needed to produce the acceleration needed in a series of challenges
- analyse number patterns in data tables to verify Newton's second law of motion
- predict how the motion of an object is affected by changes in forces applied, including friction and the mass of the object
- interpret velocity-versus-time-line graphs.

Accelerate: force
L1189 – Years 7–10

Students control the craft's force settings in order to maintain constant acceleration as they fly through space.

Accelerate: mass
L1190 – Years 7–10

Students control the craft's force settings in order to maintain constant acceleration. When students take on cargo, the mass of the craft changes and they must adjust the force accordingly.

Accelerate: friction
L1191 – Years 7–10

Students control the craft's force settings in order to maintain constant acceleration. They must adjust the force when the craft is affected by 'drag' (friction) as they pass through a cloud of gas.

Accelerate
L1188 – Years 7–10

This is an aggregated learning object combining the three other learning objects in a sequence.

Changes of state series (Years 7–11)

Students explore the three main states of matter, as well as changes of state, when two substances, water and iodine, are heated and cooled. They view the changes at both the physical and particle levels and are introduced to the reasons behind them.

Features include:

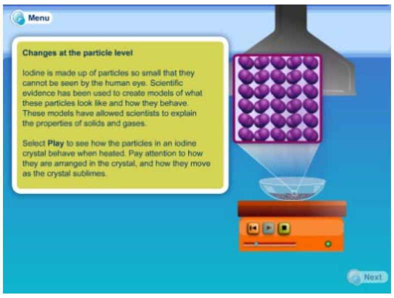
- opportunities for students to observe changes of state such as sublimation and reverse sublimation both at the physical level and the particle level
- animations showing different states and the processes that occur as matter changes state
- options to print diagrams of the experimental set-ups used and summaries about the changes of state and the behaviour of the particles
- additional extension questions as an optional printout.

Students:

- explain that changes of state occur when heat energy is added to, or removed from, a substance
- identify that changes of state – melting and freezing, evaporation and condensation, and sublimation and reverse sublimation – are reversible physical changes
- explain that, unlike water, iodine will directly change from solid to gas and vice versa
- describe the properties of solids, liquids and gases in terms of how the particles move or pack together.

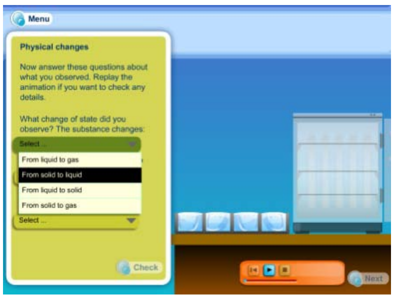
Changes of state: liquid to gas
L9127 – Years 7–11

Students investigate liquid water and explore how physical changes of state can be brought about by supplying heat energy to liquid water and then removing it. They observe the changes of state at both the physical and particle levels, and explain the different properties of liquids and gases in terms of their particle movement.



Changes of state: solid to gas
L9126 – Years 7–11

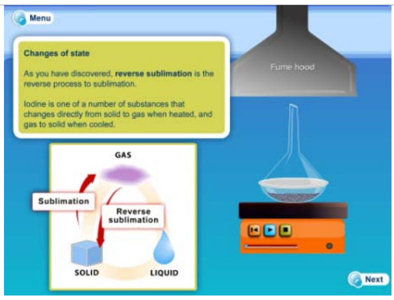
Students investigate iodine and explore how physical changes of state can be brought about by supplying heat energy to the substance and then removing it. They observe the changes of state at both the physical and particle levels, and explain the different properties of solids and gases in terms of their particle movement.



Changes of state: solid to liquid
L9124 – Years 7–11

Students investigate ice and explore how physical changes of state can be brought about by supplying heat energy to the substance and then removing it. They observe the changes of state at both the physical and particle levels, and explain the different properties of solids and liquids in terms of their particle movement.

Changes of state
L10431 – Years 7–11



Students explore how physical changes of state can be brought about by supplying heat energy to, or removing heat energy from, different substances such as iodine crystals or ice cubes. This learning object is a combination of three objects in the same series.

Optics and prisms series (Years 8–10)

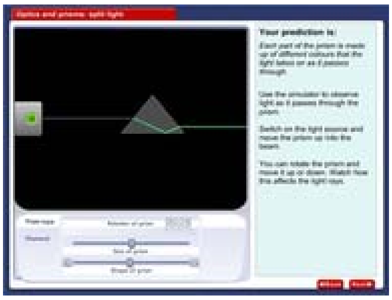
Students explore the principles of refraction and dispersion of light through interactions with an animated model of a prism and a white light source.

Features include:

- an introduction to the principles of refraction, dispersion, total internal refraction of light and the absorption of light by filters
- a simulation of white light dispersing as it passes through a triangular prism
- facilities to allow the prism to be rotated and have its size and shape changed
- the ability to access simulations for further investigation after feedback has been given
- a facility to allow students to predict the outcome of an experiment.

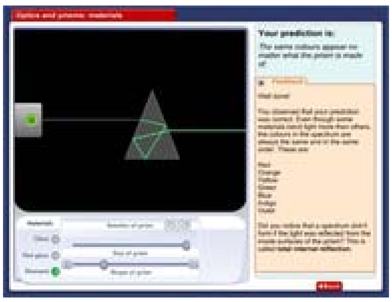
Students:

- use a triangular prism to split white light into the visible spectrum
- compare the dispersion produced by prisms of different materials
- manipulate the position, orientation, composition, size and shape of prisms to observe how these affect the light rays
- choose between two hypotheses as they start each investigation.



Optics and prisms: split light
L1480 – Years 8–10

Students are challenged to determine where the spectrum of colours that appear when white light is split comes from. Through manipulating the prism, students discover that each of the colours that make up the white light bend at a different angle when they pass through the prism.

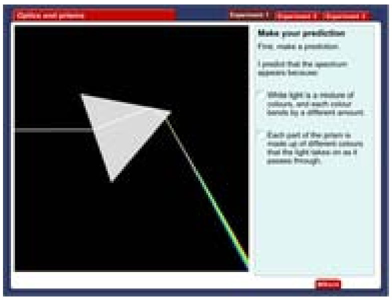


Optics and prisms: materials
L1481 – Years 8–10

Students are challenged to determine whether the colour spectrum that appears when white light is split will be the same if the prism is made of a different material. Students choose whether the prism is made of glass, flint glass or diamond and discover that the same colours appear no matter which material the prism is made from.

Optics and prisms: coloured light
L1482 – Years 8–10

Students are challenged to determine what effect a coloured light source has on the colours that result from splitting white light. Students place different coloured filters in front of the white light then manipulate the prism to observe the effects on the colour spectrum.



Optics and prisms
L1479 – Years 8–10

This is an aggregated learning object combining the three other learning objects.

Glide series (Years 9–10)

Students investigate the physical forces involved in hang-gliding.

Features include:

- interactive controls allowing students to manage the test flight
- feedback is given on the success of decisions made.

Students:

- modify a hang-glider's wingspan and camber shape and alter the weight of the pilot
- test the glider's ability to fly successfully
- understand the principles of physics that enable unpowered flight
- explore how various atmospheric and geographic conditions affect unpowered flight
- select the physical dimensions of a hang-glider that will optimise its flight performance.

Glide: meet the instructor
L392 – Years 9–10

Students interview a hang-gliding instructor to discover why she likes to hang-glide, what hang-gliders are made from, how they fly and how to take off, steer and stay up in the air.

Glide: meet the instructor [no spoken instructions]
L659 – Years 9–10

Students interview a hang-gliding instructor to discover why she likes to hang-glide, what hang-gliders are made from, how they fly and how to take off, steer and stay up in the air.

Glide: customise your hang-glider
L394 – Years 9–10

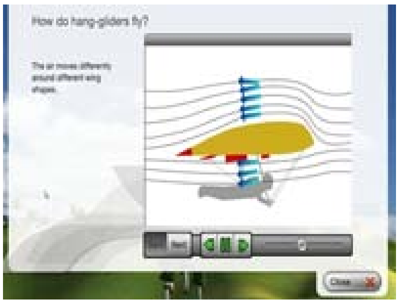
Students customise and test a hang-glider. They select the pilot's weight, choose the correct wingspan for this weight, modify the camber shape and test for peak performance.

Glide: customise your hang-glider [no spoken instructions]
L660 – Years 9–10

Students customise and test a hang-glider. They select the pilot's weight, choose the correct wingspan for this weight, modify the camber shape and test for peak performance.

Glide: take a flight
L395 – Years 9–10

Students take their hang-glider on a test flight and fly it to a target zone. They can control the flight direction, roll and angle of attack. The altimeter shows height above sea level and the variometer indicates the climb or descent rate. Feedback is given on the success of their attempts.



Glide: take a flight [no spoken instructions]
L661 – Years 9–10

Students take their hang-glider on a test flight and fly it to a target zone. They can control the flight direction, roll and angle of attack. The altimeter shows height above sea level and the variometer indicates the climb or descent rate. Feedback is given on the success of their attempts.

Glide: an interactive guide to hang-gliding
L396 – Years 9–10

This is an aggregated learning object combining the three other learning objects in a sequence.

Glide: an interactive guide to hang-gliding [no spoken instructions]
L658 – Years 9–10

This is an aggregated learning object combining the three other learning objects in a sequence.

Glide: meet the instructor and *Glide: an interactive guide to hang-gliding* contain non-TLF content. See Acknowledgements in the learning objects.

Isotopes and radiation series (Years 9–10)

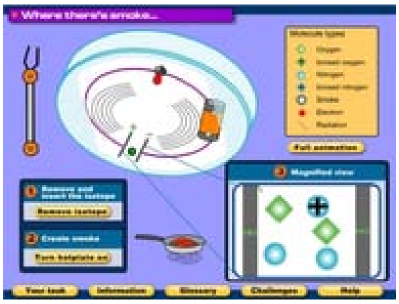
Students explore smoke, isotopes and radiation.

Features include:

- activities, information and questions.

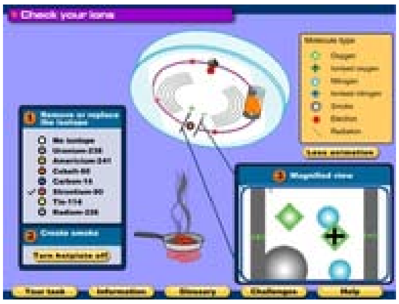
Students:

- explore the operation of a smoke detector, including the role of radioactive isotopes
- identify isotopes that are suitable for use in a smoke detector
- assess the types of radiation emitted by a range of isotopes
- explore factors that influence the absorption of radiation.



Where there's smoke
L44 – Years 9–10

Students explore how a smoke detector operates in a home-safety scenario. A circuit diagram illustrates the role of an isotope in ionising the air within a circuit gap.



Check your ions
L46 – Years 9–10

This learning object extends the activities contained in *Where there's smoke*. Students test a range of isotopes for their suitability in the smoke detector.

The alpha, beta, gamma of radiation
L45 – Years 9–10

Students participate in a simulation of a radiation laboratory in which a Geiger counter is used to measure the alpha, beta and gamma radiation from a range of isotopes. Students test the absorption effects of various materials on the radiation emission levels.

Nuclear power series (Years 9–10)

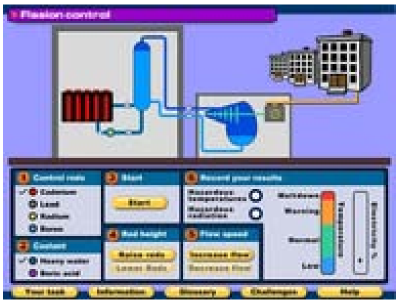
Students explore various aspects of nuclear energy.

Features include:

- simulations of how nuclear reactors work
- further information and questions for all activities.

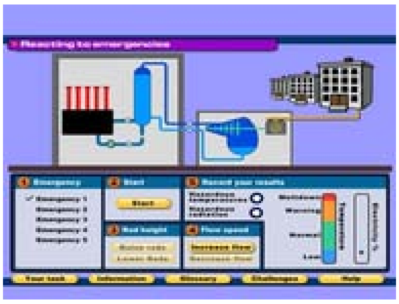
Students:

- regulate cooling and fission activity in a nuclear power station
- explore how nuclear energy can be converted into electrical energy.



Fission control
L47 – Years 9–10

Students first answer questions about how nuclear reactors work then proceed to operate simulated controls for a nuclear power reactor with the variables: fuel type, coolant type, coolant flow and position of control rods. The aim is to generate electricity without causing a meltdown.



Reacting to emergencies
L48 – Years 9–10

Students operate simulated controls for a nuclear power reactor. They regulate coolant flow and position of control rods as they respond to mechanical failures and other emergencies. The aim is to ensure a safe operation while avoiding a meltdown.

Wind power series (Years 9–10)

Students explore the conversion of wind energy into electricity.

Features include:

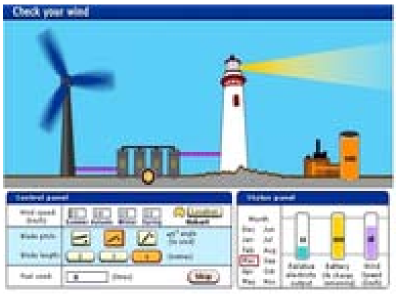
- two simulations to test wind generators
- options to look up further information and answer questions

Students:

- maximise a windmill's power output and energy efficiency at a range of wind speeds
- explore the design of wind-powered generators.

It's not just wind
L49 – Years 9–10

Students test design settings for a windmill that is to generate electric power for an island lighthouse. They set the angle and pitch of the windmill blades to suit wind speed for each season. They try to maximise the energy efficiency of the windmill operation while minimising the back-up use of diesel fuel for power generation. They predict and test the setting that results in the minimum use of fuel over one year.



Check your wind
L50 – Years 9–10

Check your wind extends the activities contained in *It's not just wind*. Students are asked to determine the best locations in Australia and New Zealand for locating wind generators.

Speed and direction series (Years 9–10)

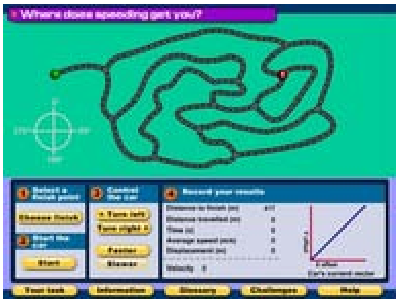
Students explore the relationships between distance, time and speed.

Features include:

- simulated vehicles to explore relationships between: angles, speed, distance and time
- further information and questions for all activities.

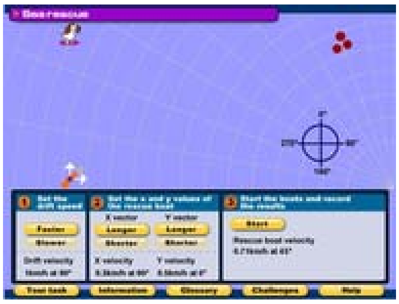
Students:

- analyse the relative motion of objects by using vectors
- relate the components of a vector to its magnitude and direction
- explore relationships between scalar quantities and vectors.



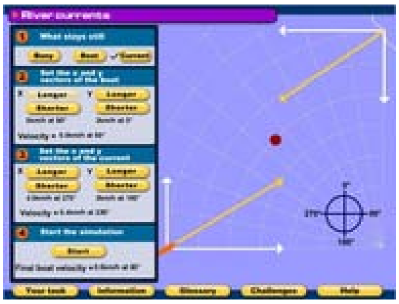
Where does speeding get you?
L53 – Years 9–10

Students steer a rally car around a track, adjusting speed and direction. They can view a continuous readout of: distance travelled, time taken, speed, velocity, displacement angle and direction. Students record their results for each test run. They then explore the relationship between scalar and vector values.



Sea rescue
L54 – Years 9–10

Students attempt to save a dog on a drifting boat before it collides with rocks by adjusting the course and speed of a rescue boat. Students explore relationships between angles, speed, distance and time, and learn how to express speed and direction as vector values.



River currents
L55 – Years 9–10

Students direct a motorboat to moor beside a buoy in a river, adjusting boat speed and direction to allow for water current. They use trigonometry to calculate the relationships between angles, speed, distance and time. This is an advanced test of their knowledge of vectors. Challenge questions extend these principles to a road setting.

Speed and distance series (Years 9–10)

Students explore the physics of motion.

Features include:

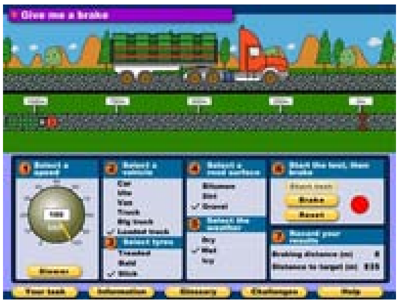
- further information and questions about driving
- simulated vehicles to explore relationships between braking, stopping distances and friction

Students:

- compare how braking distance is related to driving speed, vehicle mass, tyres and road conditions
- demonstrate that reaction time contributes to total stopping distance.

It's a drag
L51 – Years 9–10

Students explore how a range of variables (vehicle speed, vehicle type, road surface type, weather conditions and tyre tread) affect the stopping distance of a vehicle when the brakes are applied.



Give me a brake
L52 – Years 9–10

Give me a brake extends the activities in *It's a drag*. Students predict and test how different vehicles and road conditions affect the length of a skid.

Vision and lenses series (Years 9–10)

Students explore the basic relationships between several optical variables.

Features include:

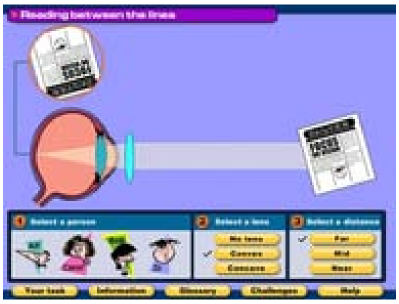
- optical devices to test applications
- options to look up further information and answer questions.

Students:

- investigate how to focus a simple telescope
- investigate how focal lengths and the separation of lenses in a telescope influence the sharpness and magnification of images
- identify human vision problems by exploring focal distances and lens shapes
- identify the shape of lens needed to correct common vision problems.

Far out lenses
L56 – Years 9–10

Students build a simple telescope for looking at the moon using two convex lenses. They adjust the focal lengths of the lenses and compare results in the viewfinder. They explore basic relationships between several variables such as focal length, position of objective lens, convexity, image inversion and lens size.



Reading between the lines
L57 – Years 9–10

Students test the vision of four virtual people to diagnose common vision problems: myopia, hyperopia and presbyopia. They compare the effects of corrective lenses on reading at different distances and determine which lens type corrects which vision problem.

Seeing with sound series (Years 9–10)

Students experiment with and explore aspects of sound using a range of highly interactive tools.

Features include:

- a sophisticated, interactive sound simulation tool with a range of settings, including frequency, wavelength and amplitude
- graphic displays of information for student interpretation
- an introduction to sound as waves of energy caused by objects vibrating and causing particles to vibrate

Students:

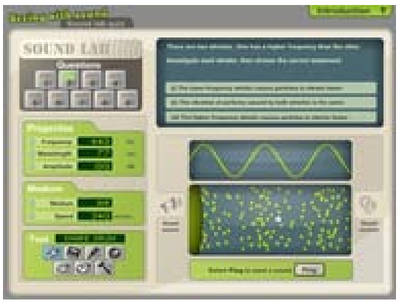
- use a wave model to explain the behaviour of sound
- view diagrams and simulate sound wave variations in a range of mediums
- interpret data to determine the location, speed and distance to an object using 'sound producers' and sound sensors
- test the effects of varying sound wavelength, amplitude, frequency and medium density
- recognise that sound travels faster in denser mediums.

Seeing with sound: sound lab tool
L1301 – Years 9–10

Students change variables such as frequency, wavelength and amplitude, as well as varying speed and changing the medium the sound is travelling through. Once students have chosen their settings, they are able to test the results and see a representation of the sound in a traditional sine wave form, as well as in a particle representation.

Seeing with sound: sound lab tour
L1302 – Years 9–10

Students are introduced to wave and particle model representations of sound and are able to use them to answer questions about the relationship between waveform, wavelength, frequency and other properties of sound. Students are also able to draw upon additional information about frequency, wavelength and amplitude.



Seeing with sound: sound lab quiz
L1303 – Years 9–10

Students are 'quizzed' on their understanding of sound. Students are presented with information about a range of items such as drums, a hammer, a tuning fork and a sonar device. The properties (frequency, wavelength and amplitude) of each can be displayed, along with the sound wave that they. Based on this information, students are asked a series of questions.

Seeing with sound: echo lab
L1304 – Years 9–10

Students are introduced to the concept of echo-location works. They are then able to interact with a simulator to test how an echo can be used to measure distance. They use the tool to time how long it takes to hear an echo and then answer a series of questions based on their observations.

Seeing with sound: Doppler lab
L1305 – Years 9–10

Students are introduced to the concept that sound waves can be used to locate things that are not visible to the human eye. Using a simulator tool, students investigate how the Doppler Effect uses an echo to work out how fast things are moving. Students then answer a series of questions based on their observations.

Seeing with sound
L1306 – Years 9–10

This is an aggregated learning object combining the five other learning objects.

Optics and refraction series (Years 9–10)

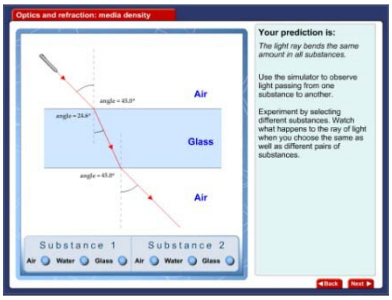
Students manipulate light rays, noting the different ways the light rays travel through air, glass and water.

Features include:

- an animated model that shows refraction of light rays at various interfaces
- the ability to access simulations for further investigation after feedback has been given
- a facility to allow students to predict the outcome of an experiment.

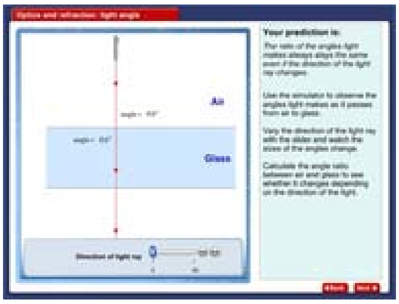
Students:

- identify that light rays change direction when they pass from one medium to another
- predict the angle of refraction as light passes from one medium to another
- demonstrate that as the incident angle of light rays changes, the angle of refraction also changes
- align different combinations of media to observe refraction of light at boundaries
- choose between two hypotheses as they start each investigation.



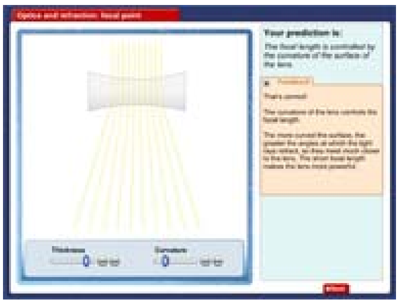
Optics and refraction: different substances
L1476 – Years 9–10

Students look at light rays travelling through air, glass and water. They notice how light bends as it enters a new substance and explore how the angle of refraction is affected by the nature of the substance and by the curvature at the boundary between substances.



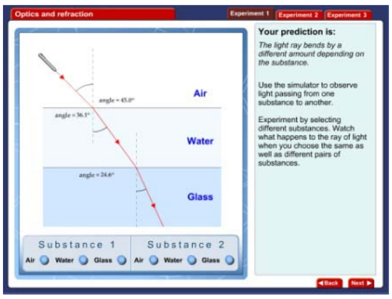
Optics and refraction: light angle
L1477 – Years 9–10

Students are introduced to the concept of refraction and use the animated model to see the changes in direction of a light ray as it passes through air and then glass. They are able to see that the ratio of the angles the light makes always stays the same, even if the direction of the light ray changes.



Optics and refraction: focal point
L1478 – Years 9–10

Students are introduced to the concept of focal length and experiment with changing both the thickness and the curvature of a lens. As a result of this interaction they are able to see that the distance from the lens to the point of focus, ie the focal length, is controlled by the thickness of the lens.



Optics and refraction
L1475 – Years 9–10

This is an aggregated learning object combining the three other learning objects.

Optics and refraction series (ESL) (Years 9–10)

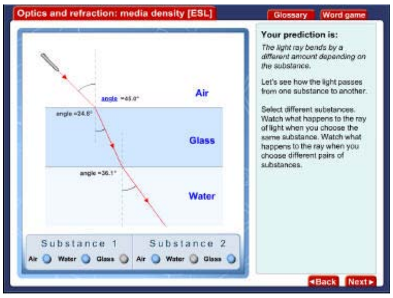
Students investigate refraction and lenses by engaging with a simulation showing light rays travelling through air, glass and water.

Features include:

- simulations showing the behaviour of light rays
- modified language for English as a Second Language users
- a glossary of terms used in the activity
- a cloze exercise about images that gives students practice with present-tense verbs in an information text.

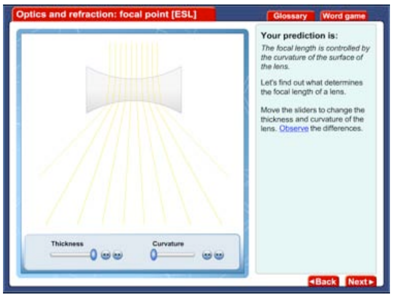
Students:

- choose between two hypotheses and consult experimental data to decide if their prediction
- identify that light rays change direction when they pass through air, glass and water
- demonstrate that the focal length of a lens is related to the curvature of its surfaces.



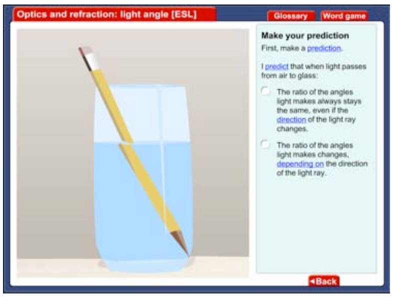
Optics and refraction: different substances [ESL]
L10384 – Years 9–10

Students look at light rays travelling through air, glass and water. They notice how light bends as it passes from one substance to another and explore how the angle of refraction is affected by the nature of the substances.



Optics and refraction: focal point [ESL]
L10386 – Years 9–10

Students look at how light rays behave when they pass through a lens. They notice how light converges after it leaves the lens and examine how the curvature and thickness of a lens affect focal length.



Optics and refraction: light angle [ESL]
L10385 – Years 9–10

Students look at light rays travelling through air and glass. They notice how light bends as it passes from one substance to another and try to predict whether the ratio of the angles of light will change if the direction of the light ray changes.

Exploring atoms series (Years 9–10)

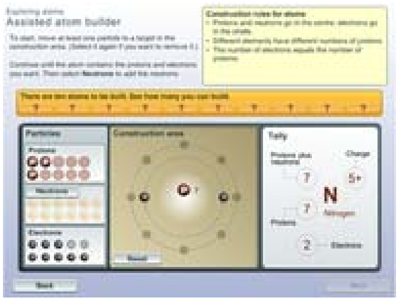
Students construct authentic atom and ion models of the first ten elements by assembling the required protons, neutrons and electrons.

Features include:

- an introduction to subatomic particles and the internal structure of atoms
- an introduction to isotopes and nuclear symbols
- a look at how atoms and ions differ in their internal structure
- an illustration of the shell and 'electron cloud' models of the atom
- a tool to build authentic models of atoms and ions of the first ten elements
- an 'atom bingo' game.

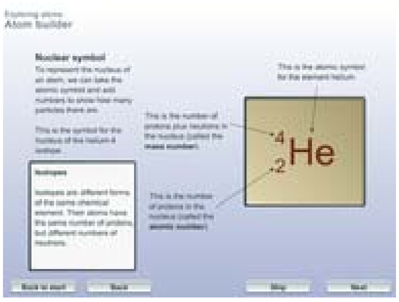
Students:

- explore sub-atomic particles and how they combine to form atoms
- assemble atoms from protons, neutrons and electrons
- distinguish between atoms and ions
- interpret nuclear and ionic symbols.



Exploring atoms: assisted atom builder
L2563 – Years 9–10

Students compare different ways of modelling atoms and use nuclear symbols to represent different isotopes. Students also dynamically build atoms by combining protons, neutrons and electrons using an interactive tool. In this learning object, the neutrons are added automatically.



Exploring atoms: atom builder
L2564 – Years 9–10

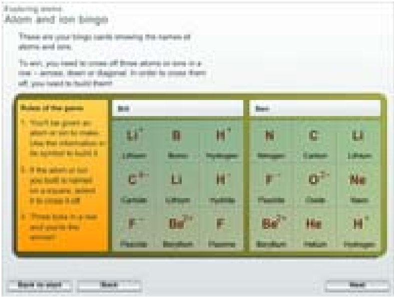
Students compare different ways of modelling atoms and use nuclear symbols to represent different isotopes. Students also build atoms by combining protons, neutrons and electrons using an on-screen tool.

Exploring atoms: ion builder
L2565 – Years 9–10

Students compare different ways of modelling atoms and ions and use nuclear symbols to represent different isotopes. Students also build atoms and ions by combining protons, neutrons and electrons using an on-screen tool.

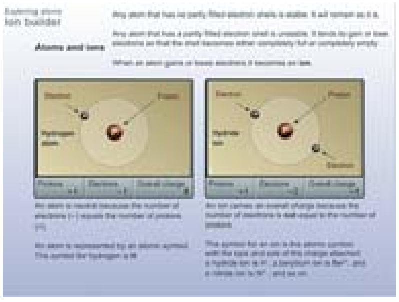
Exploring atoms: atom bingo
L2566 – Years 9–10

Students compare different ways of modelling atoms and use nuclear symbols to represent different isotopes. Students then play bingo, where each player (up to two) has a bingo card of atoms to build by combining protons, neutrons and electrons using an on-screen tool.



Exploring atoms: atom and ion bingo
L3124 – Years 9–10

Students compare different ways of modelling atoms and ions and use nuclear symbols to represent different isotopes. Students then play a form of bingo in which each player (up to two) has a bingo card of atoms and ions to build by combining protons, neutrons and electrons using an on-screen tool.



Exploring atoms
L3125 – Years 9–10

This is an aggregated learning object combining *Exploring atoms: atom builder*, *Exploring atoms: ion builder* and *Exploring atoms: atom and ion bingo*.

Resistors series (Years 9–10)

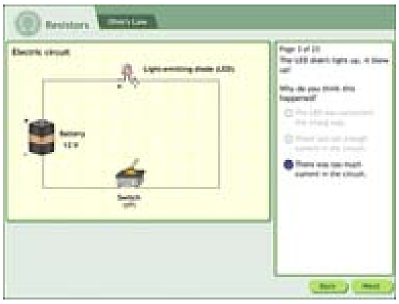
Students use circuits to examine simple electronics.

Features include:

- a simulation of electric circuits and measurements to establish mathematical relationships between resistance, voltage and current
- an introduction to resistance, voltage, current, resistors, power supplies, meters, switches, voltage dividers, potentiometers, transistors and circuit symbols
- multiple-choice questions to test understanding of key concepts.

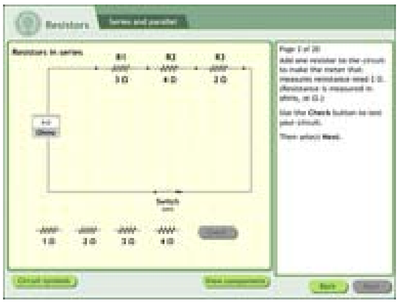
Students:

- investigate current flows in electric circuits
- analyse relationships between voltages, currents and resistance in electric circuits
- investigate series and parallel combinations of resistors
- investigate how resistors, potentiometers and transistors can regulate voltages in electric circuits.



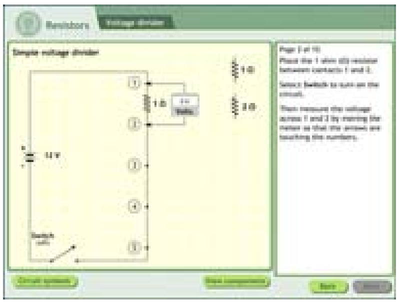
Resistors: Ohm's Law
L3824 – Years 9–10

Students control the current in an electrical circuit by varying the voltage and resistance within the circuit. Various circuit components are introduced, such as meters, switches and batteries, which are all represented by circuit symbols. After measuring voltages and currents within the circuit, students discover how they are related by Ohm's Law, and use this law to predict currents in further circuits.



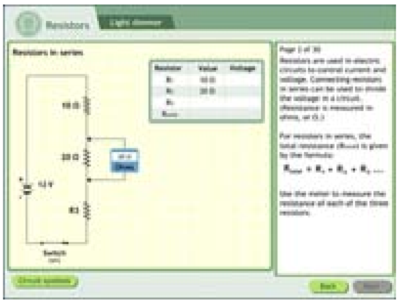
Resistors: series and parallel
L3825 – Years 9–10

Students combine resistors in different ways to give new values of resistance (for example, by connecting them in a series or in parallel, or a mixture of both) and from there establish the rules for calculating the total resistance of the circuit. Finally, in problems of increasing difficulty, students must combine resistors to provide a specific resistance. The learning object introduces resistors, power supplies, meters and switches, as well as circuit symbols for each them, with users able to switch the display from a 'real world' to a 'circuit symbol' view at will.



Resistors: voltage divider
L3826 – Years 9–10

Students use resistors to divide the voltage from a battery. By arranging resistors correctly they are able to obtain small voltages from larger ones. Students predict the voltage across any resistor in a circuit before measuring that voltage for resistors placed in series. Students then solve a number of problems that require resistors to be combined in order to achieve specified outcomes.



Resistors: light dimmer
L3827 – Years 9–10

Students build a light dimmer circuit using resistors and a transistor. They prevent components from burning out and investigate the operation of a transistor and a potentiometer.

Resistors
L3823 – Years 9–10

This is an aggregated learning object combining the four other learning objects in a sequence.

These learning objects were developed as part of the Intelligent Learning Objects project made possible through an Australian Research Council grant. Research, prototyping and production by the University of Melbourne's Victorian College of the Arts. Additional research by Queensland University of Technology's Education and Creative Industries faculties.

Logic gates series (Years 9–10)

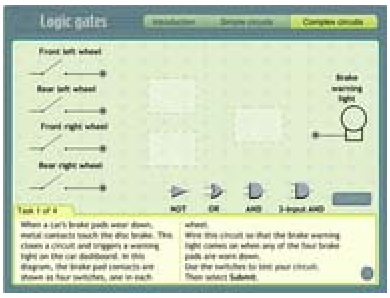
Students explore the concept of 'gates' and the way they can be used and combined in electronic control systems.

Features include:

- illustrations of the operation of AND, OR and NOT logic gates
- automatically generated truth tables that appear when combinations are entered
- a tool to build virtual circuits using logic gates to monitor and control both simple and complex electrical systems
- multiple-choice questions to test understanding of key concepts.

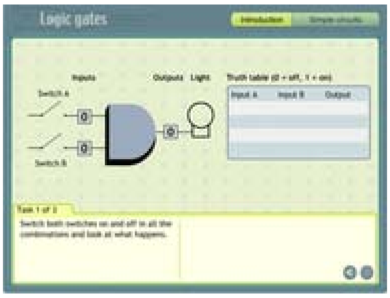
Students:

- investigate the action of AND, OR and NOT gates
- construct truth tables for logic gates
- build circuits controlled by logic gates
- combine logic gates to achieve outcomes not available from single gates
- combine logic gates to construct circuits which monitor and control electrical systems.



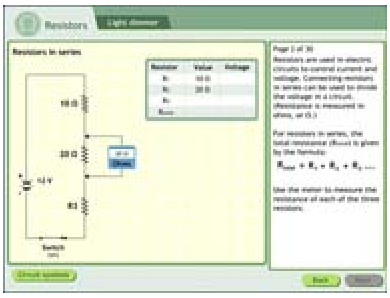
Logic gates: introduction
L3829 – Years 9–10

Students explore AND, OR and NOT gates to discover the way in which they function, with truth tables automatically constructed to show the various results. From there, students explore how different combinations of switches can give different outcomes to construct basic logic circuits to control a hedge trimmer, a hallway light, and a watering system.



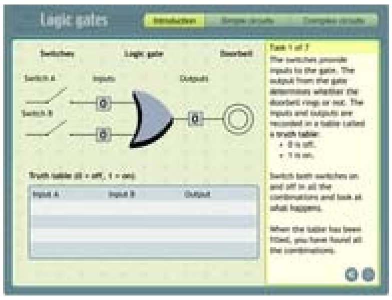
Logic gates: simple circuits
L3830 – Years 9–10

Students build virtual circuits of increasing complexity using AND, OR and NOT logic gates singly in most instances and in combination to control different devices, including a street light, a burglar alarm and fire sprinkler systems.



Logic gates: complex circuits
L3831 – Years 9–10

Students build virtual circuits of increasing complexity using AND, OR and NOT logic gates in combination to monitor and control four complex systems.



Logic gates
L3828 – Years 9–10

This is an aggregated learning object combining the three other learning objects in a sequence.

These learning objects were developed as part of the Intelligent Learning Objects project made possible through an Australian Research Council grant. Research, prototyping and production by the University of Melbourne's Victorian College of the Arts. Additional research by Queensland University of Technology's Education and Creative Industries faculties.

Wave Maker series (Years 9–10)

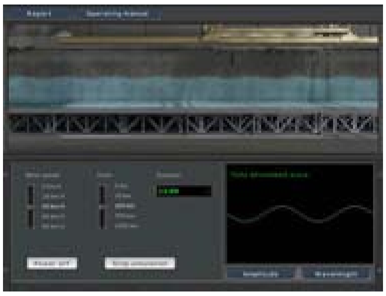
Students explore different aspects of waves, including their formation, the energy they carry and their interaction with the coast.

Features include:

- a simulated wave tank and wind generator to investigate the formation of ocean waves
- descriptions of properties of waves such as amplitude, wavelength and frequency
- an option to print students' reports.

Students:

- simulate the formation of ocean waves by the wind to produce fully developed swell in a wave tank
- analyse experimental data to find relationships
- report their conclusions.

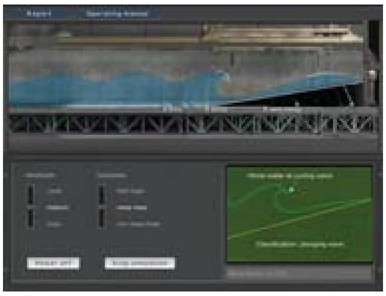


Wave Maker: making waves
L3820 – Years 9–10

Students experiment to find how the speed, duration and fetch of the wind affect the production of waves and the relationships between wind speed, amplitude, and wavelength of fully developed swell.

Wave Maker: wave power
L3821 – Years 9–10

Students measure the power carried by the waves and experiment to find how the power depends on the amplitude and wavelength of the waves.



Wave Maker: breaking waves
L3822 – Years 9–10

Students investigate the types of wave break and find the best conditions for creating surfing waves based on properties such as amplitude and the slope of a beach.

These learning objects were developed as part of the Intelligent Learning Objects project made possible through an Australian Research Council grant. Research, prototyping and production by the University of Melbourne's Victorian College of the Arts. Additional research by Queensland University of Technology's Education and Creative Industries faculties.

Radioactive decay series (Years 10–12)

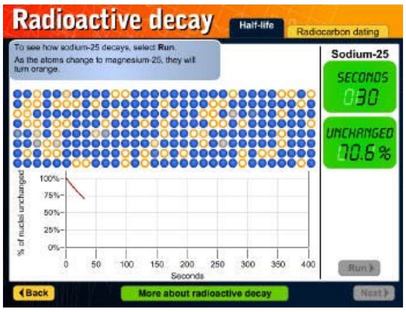
Students make predictions and analyse graphs resulting from the decay of an array of radioactive atoms in order to determine their half-life. They apply their understanding of the method of radiocarbon dating to establish the age of various organic remains.

Features include:

- an introduction to the concept of radioactive half-life and its measurement
- animations showing the nuclear changes that occur during radioactive decay
- interactive graphs to assist in analysing radioactive decay and identifying half-lives
- word-completion exercises to confirm student understanding.

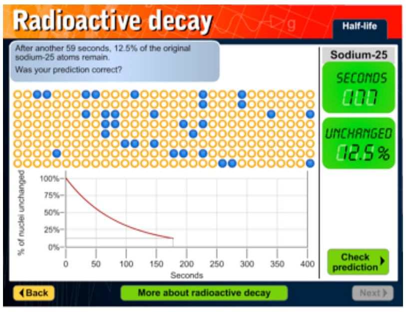
Students:

- describe the changes occurring in nuclei during alpha and beta decay
- describe the nature of alpha and beta radiation
- explain the meaning of 'half-life'
- calculate radioactive half-lives from decay data.



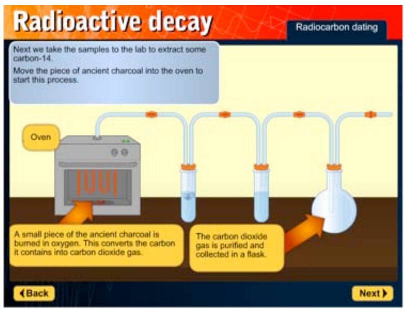
Radioactive decay
L8031 – Years 10–12

This learning object combines the other two objects in the series.



Radioactive decay: half life
L8032 – Years 10–12

Students watch radioactive decay happen at the sub-atomic level. They make predictions and analyse graphs resulting from the decay of an array of radioactive atoms in order to determine the half-life of the element.



Radioactive decay: radiocarbon dating
L8033 – Years 10–12

Students use radiocarbon dating to find and compare the ages of ancient remains. They convert organic samples to gas and use a Geiger counter to measure radioactivity. They use calculations and radioactive decay graphs to estimate the age of the samples.

This series contains non-TLF content. See Acknowledgements in the learning objects.

Galvanic cells series (Years 11–12)

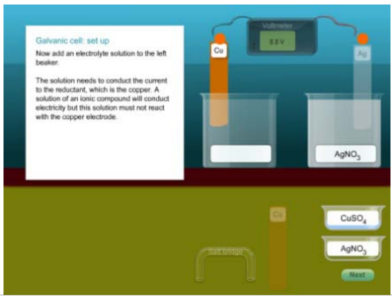
Students find out about the design of galvanic cells. They set up different galvanic cells and observe the cell reactions. Students analyse galvanic cells to deduce the relative positions of a number of metals in the electrochemical series.

Features include:

- opportunities for students to set up galvanic cells of different levels of difficulty
- animations of cell reactions at the physical and particle level
- options to print diagrams of the galvanic cells, the experiment set-up and the student's responses to questions about cells
- additional extension questions as an optional printout.

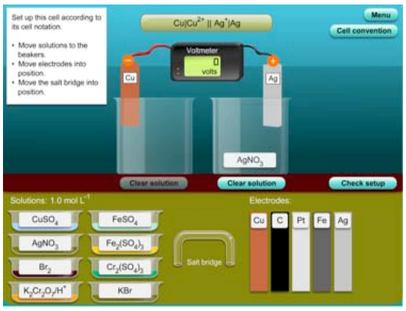
Students:

- identify the direction of electron flow and the polarity of the electrodes in sample galvanic cells
- observe the reactions at the anode and cathode at both the physical level and the particle level, and determine the half-equations for these reactions
- interpret test results from sample galvanic cells and place the half-equations for the metals tested into their correct order in the electrochemical series
- record and explain their observations of changes occurring in galvanic cells.



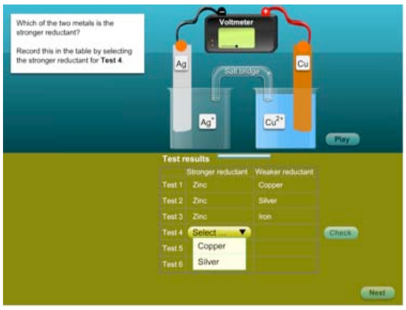
Galvanic cells: cell design
L8883 – Years 11–12

Students set up and observe the spontaneous redox reaction that occurs between copper metal and silver nitrate solution when they are in direct contact. They find out how this reaction can be used to generate an electric current and set up the galvanic cell that utilises this reaction.



Galvanic cells: cell reactions
L8884 – Years 11–12

Students set up different galvanic cells as specified in given conventional cell notations. They find out the type of reaction that can be used in a galvanic cell, the energy change that occurs and how to interpret conventional cell notation. For each cell, they observe the reactions at the anode and cathode at both the physical level and the particle level.



Galvanic cells: electrochemical series
L8885 – Years 11–12

Students view six galvanic cells built from six different combinations of half-cells of copper, zinc, iron and silver. They observe how the voltmeter needle moves when the circuit is complete, and deduce the direction of electron flow in the external circuit and the polarity of the electrodes. They then deduce and record which of the two metals in each cell is the stronger reductant and hence the order of the half-equations in the electrochemical series for the four metals tested.

Electrolytic cells series (Years 11–12)

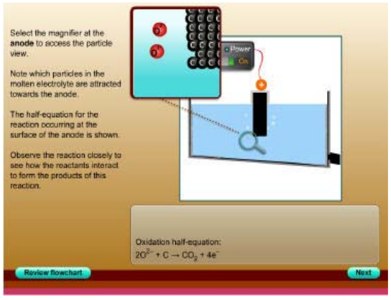
Students find out about the design of electrolytic cells and the reason behind the design. They observe and explain cell reactions, and predict cell reactions using the electrochemical series. They look at the key steps involved in the large-scale production of aluminium and chrome-plating, the reasons for these steps and the design principles behind the commercial electrolytic cells used in these processes.

Features include:

- animations showing the cell reactions at the physical and particle level
- images of commercial electroplating cells in action
- options to print information about the different electrolytic cells investigated
- additional extension questions as an optional printout.

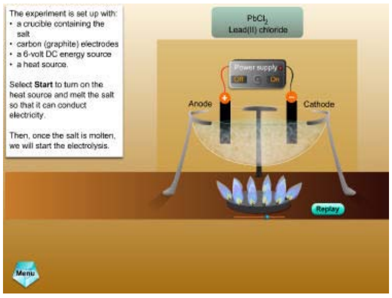
Students:

- explain key features in the design of electroplating cells
- observe and explain what happens at the particle level in electroplating cells
- determine the nature of the process occurring at each electrode of a particular cell, and the half-equations and the equation for the net cell reaction
- deduce the species to be preferentially discharged at specific electrodes
- predict cell reactions using the electrochemical series.



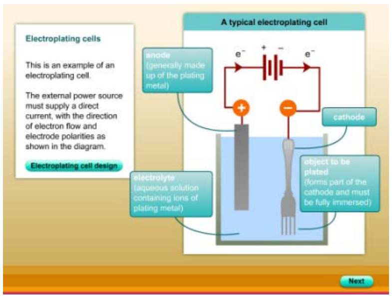
Electrolytic cells: aluminium extraction
L8886 – Years 11–12

Students explore the production of aluminium, its uses and its waste products. They look closely at the cell, observe the reactions at the anode and cathode at both the physical level and the particle level, and determine the equation for the net cell reaction.



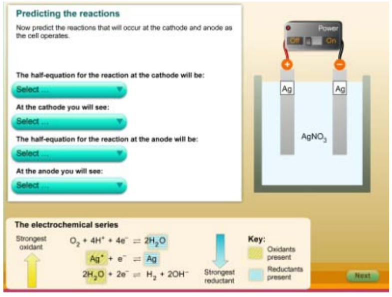
Electrolytic cells: molten salts
L8887 – Years 11–12

Students investigate the electrolysis of three molten salts in electrolytic cells where there is only one oxidant and one reductant present. They observe reactions at the anode and cathode at both the physical level and the particle level, and determine the half-equations and the equation for the net cell reaction.



Electrolytic cells: electroplating
L8888 – Years 11–12

Students investigate electroplating cells. They explore the design of a typical cell and discover the purpose of the various stages in commercial chrome-plating. Then they observe the physical and particle processes in an operating chrome-plating cell and deduce the half-equations for the anode and cathode reactions.



Electrolytic cells: aqueous solutions
L8889 – Years 11–12

Students use the electrochemical series to identify the strongest oxidant and reductant in an electrolytic cell containing an aqueous electrolyte solution. They predict the physical reactions and half-equations at the anode and cathode for different cells then observe the reactions to confirm their predictions.

This series contains non-TLF content. See Acknowledgements in the learning objects.

Content from other sources

How is the melting of ice affected by heat? (Years 3–4)

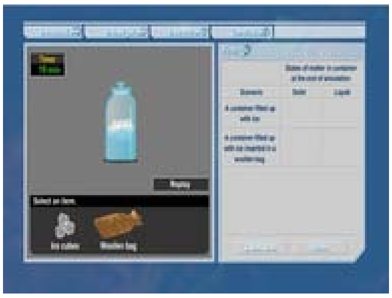
This is a short interactive task that allows students to investigate how heat affects the melting process of ice.

Features include:

- simulations of the melting of ice with and without insulation of the container
- a data table to record results
- test questions whose answers indicate a conclusion
- an option to print the conclusion questions for classroom use.

Students:

- examine the effect of a thermal insulator on the melting of ice
- predict the state of ice with and without thermal insulation
- explain thermal insulation in terms of the absorption and loss of heat.



How is the melting of ice affected by heat?
L7576 – Years 3–4

Students place ice cubes into a container and time how long they take to melt. They repeat the experiment with the container wrapped in a woollen bag and observe the difference in the state of the ice after the given time.

Does sound require a medium to carry its vibrations? (Years 3–4)

This is a short digital activity that enables students to investigate one of the conditions required for sound waves to travel.

Features include:

- audio support to simulate the effect of air being pumped out of a jar enclosing the sound source
- a concluding question to test students' understanding of the findings.

Students:

- investigate whether sound can travel in a vacuum by conducting an experiment with a sealed jar and an alarm clock
- identify the conditions required for sound waves to travel
- evaluate evidence to show that sound requires a medium for its vibrations transmission.

Does sound require a medium to carry its vibrations?
L7567 – Years 3–4

Students place a ringing alarm clock under a jar and pump out all the air. They listen to find out if sound can travel in a vacuum.

Light series (Years 3–8)

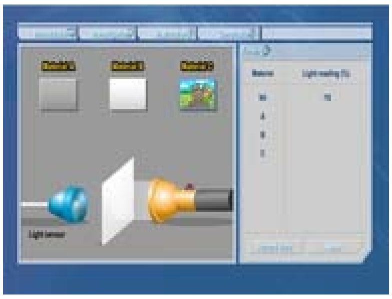
Students are introduced to various aspects of light energy.

Features include:

- a data table to record results
- test questions to assess students' understanding.

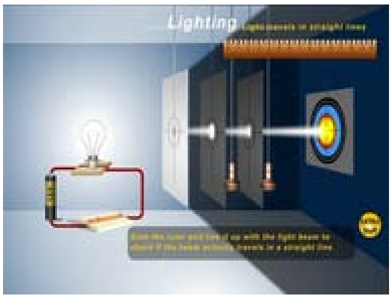
Students:

- explore the functions and components of light energy
- predict the effect of changes in light conditions.



Amount of light passing through a material
L7575 – Years 3–4

Students examine the transparency of three different materials by shining light through them and recording the results. They then answer a set of questions related to the experiment they have conducted.

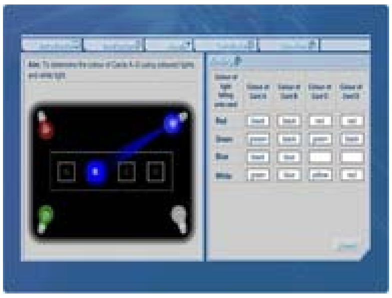


Lighting: light travels in straight lines
L3061 – Years 5–8

Students use a model to verify that light rays travel in straight lines.

Lighting: assemble the spotlight
L3062 – Years 5–8

Students explore the function of spotlight components, including reflectors, lenses and light filters. Lighting information and suggestions for some additional activities are contained in extra notes.



Colour of objects
L7562 – Years 7–8

Students predict and test the ability of coloured objects to reflect different components of white light. They shine different coloured lights on four darkened boxes and record the resulting colour. Using their results, they identify the colour of each box, then answer a series of questions about light reflection and the colour of objects.

Flexibility of different shoes (Years 5–6)

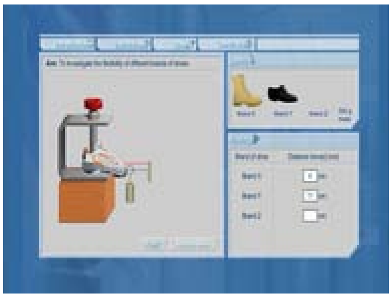
This is a short digital activity that enables students to test the flexibility of three different types of shoes by applying force to the toes.

Features include:

- test simulations of the flexibility of three types of shoes using a hanging mass
- a facility to record results in a data table
- a reset button to support repeated experiments.

Students:

- predict the flexibility of three different shoe brands by applying a known force
- identify the flexibility of three different shoe materials
- explain flexibility as a property of matter.



Flexibility of different shoes
L7564 – Years 5–6

Students select a shoe then apply a force to the toe. They use a ruler to measure how far each shoe has moved then compare the results.

Electrical circuits series (Years 5–8)

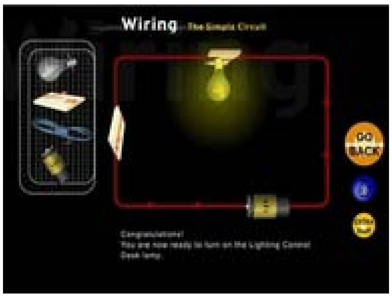
These are short digital activities which introduce students to electrical circuits, currents, conductivity and circuit diagrams.

Features include:

- pictorial or symbolic views of the circuits.

Students:

- add components to complete a circuit
- see how circuits can be modelled by water flow
- record their results in a table and answer a set of questions related to their experiment.

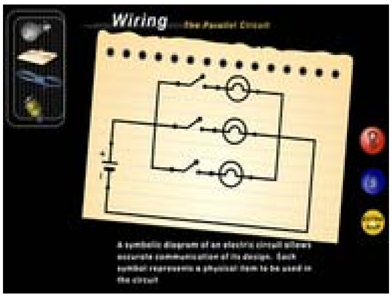


Wiring: the simple circuit
L3058 – Years 5–8

Students create a simple circuit using wire, a gate, a battery and a globe.

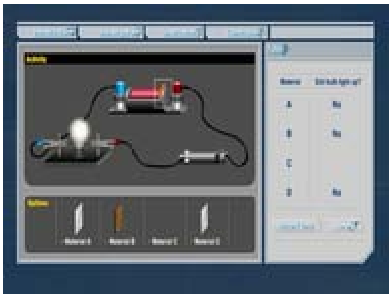
Wiring: the series circuit
L3059 – Years 5–8

Students explore the effects of switches and breaks in the circuit by opening and closing switches and replacing a globe in a series circuit to complete a circuit.



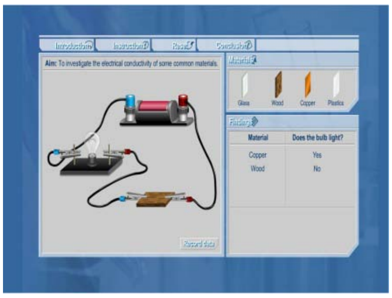
Wiring: the parallel circuit
L3060 – Years 5–8

Students verify that current flow in each branch of a parallel circuit is independent of the other branches by opening and closing the switches in each branch of the circuit.



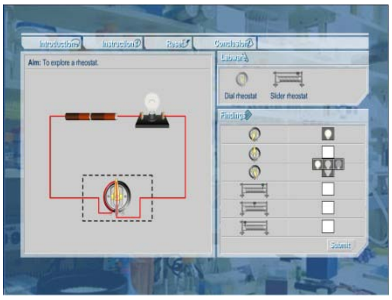
Conductors and insulators in circuits
L7578 – Years 5–6

Students examine electrical conductors and electrical insulators. Students test for electrical conductivity by inserting each different material into the contact point in the electric circuit and noting which ones make the light globe glow. The data can also be viewed in graph form.



Electrical conductivity
L7560 – Years 7–8

Students test the electrical conductivity of four different materials: glass, wood, copper and plastic. Students connect each item into an electric circuit then observe the light bulb to see whether the material has acted as an electrical conductor.



How a rheostat works
L7563 – Years 7–8

Students find out how a rheostat may be used to control the current in an electric circuit. Students connect and adjust a dial rheostat and a slider rheostat on an electric circuit. They record the brightness of the circuit light bulb resulting from different settings of the rheostat.

Electrifying concert series (Years 5–8)

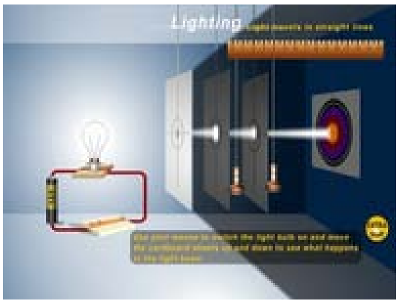
Students set up wiring and stage lighting for a rock band.

Features include:

- multiple-choice questions about electrical circuits
- examples of how the colour of an object is affected by the colour of the ambient light
- a water flow analogy to explain the operation of electric circuits
- everyday applications of circuits and optical instruments
- an introduction to electrical circuits, circuit diagrams, lighting and optics.

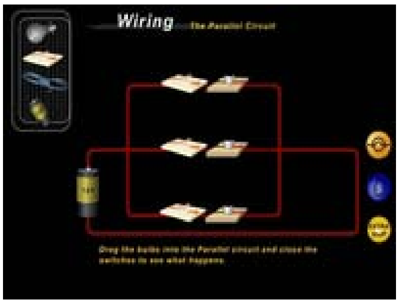
Students:

- align apertures to verify that light travels in straight lines
- manipulate a spotlight to test the effects of lenses and light filters
- manipulate models of electrical circuits
- distinguish between types of electrical circuits: simple, series and parallel
- use a model to verify that light rays travel in straight lines
- explore the function of spotlight components, including reflectors, lenses and light filters
- interpret circuit symbols and diagrams.



Electrifying concert: lighting
L3056 – Years 5–8

Students use a model to verify that light rays travel in straight lines. They also explore the function of spotlight components, including reflectors, lenses and light filters.



Electrifying concert: wiring
L3057 – Years 5–8

Students distinguish between types of electrical circuits: simple, series and parallel. They control current flows in circuits by manipulating components such as switches, batteries and light globes. Students see how circuits can be modelled by water flow.

Electrifying concert
L3055 – Years 5–8

This is an aggregated learning object combining the two other learning objects in a sequence.

Electromagnets (Years 7–8)

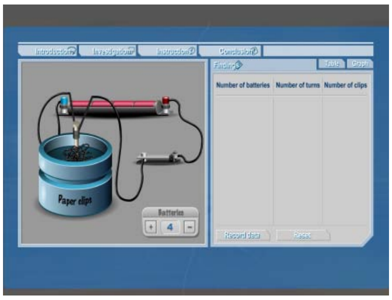
These are short interactive tasks that introduce students to electromagnets and allow them to explore the relationship between the magnetism of an electromagnet and electrical currents and circuits.

Features include:

- a data table to record results and graphical representations of the data
- a set of questions related to the experiment.

Students:

- test the strength of the electromagnet by observing the number of paperclips it picks up
- vary the number of batteries or turns of wire to determine the resulting changes in battery strength.



How does the number of batteries affect the strength of an electromagnet?
L7566 – Years 7–8

Students vary the number of batteries which connect to an electromagnet in order to test changes in the magnet's strength.

How does the number of turns of the wire affect the strength of an electromagnet?
L7565 – Years 7–8

Students vary the number of turns of wire around the magnet then test changes in the magnet's strength.

Measuring time using a pendulum (Years 7–8)

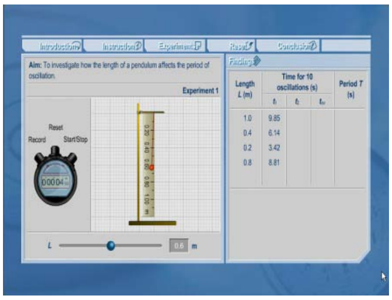
This is a short digital activity that enables students to experiment with a simple pendulum to determine how the length of the pendulum and the mass of the bob affect the period of its swing.

Features include:

- simulations of a swinging pendulum whose length or bob mass can be changed in separate experiments
- test questions to guide students in making their conclusions
- a virtual stopwatch to measure the period
- measurements recorded in a data table.

Students:

- relate factors influencing the period of a pendulum's swing
- identify how a pendulum's length affects its period of oscillation
- relate how the mass of the pendulum's bob affects the period of oscillation
- appreciate the importance of repeating measurements to attain valid scientific data
- draw conclusions from experimental data.



Measuring time using a pendulum
L7559 – Years 7–8

Students set the length of the pendulum and use a stopwatch to time 10 oscillations. They record the results then repeat the process for different lengths. Students repeat the experiment, this time changing the mass of the pendulum's bob each time. A virtual stopwatch is provided to record time.

The Bunsen flame (Years 7–8)

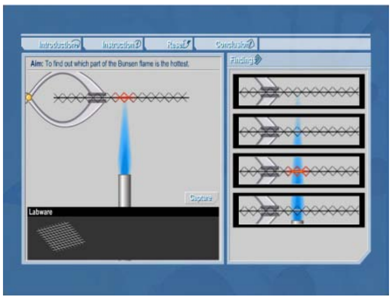
This is a short digital activity that enables students to explore which part of a Bunsen burner flame is hottest and which part is coolest.

Features include:

- an image-capture facility to build a record of observations
- an explanation of the relationship between the temperature of hot objects and the colour of light emitted
- two test questions whose answers indicate a conclusion
- dynamic generation of the experiment to support repeated use.

Students:

- identify the hottest and coolest parts of a Bunsen burner flame
- interpret the results to judge the hottest and coolest regions of the flame
- judge the relative temperature of hot objects by observing the colour of light they emit
- appreciate the relationship between the relative temperature of wire gauze and the colour of light it emits.



The Bunsen flame
L7558 – Years 7–8

Students place wire gauze over four different parts of the flame. Students judge the relative temperature of the flame by observing the colour of the gauze shown in the experiment. They capture and analyse the test images.

EagleCat: gears (Years 7–10)

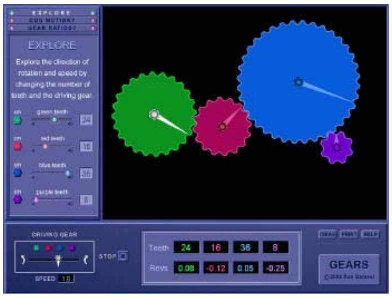
Students explore the relationships between cog size, speed, the direction of motion and gear ratios.

Features include:

- animations to show the concept of gear ratios
- animations to illustrate the concept of a driving gear
- ideas for further investigation and practical applications
- an option to print gear combinations and their settings, as well as question screens
- a 'Help' feature to optimise student interaction.

Students:

- interpret the relationship between gear size and revolutions per minute
- interpret the effect of direction of cog rotation on an interlocking cog
- analyse the direction of motion in different cogs for up to four cogs
- interpret the effect of a driving gear on interlocking cogs.



EagleCat: gears
L10085 – Years 7–10

Students explore the relationships between cog size, speed, direction of motion and gear ratios by changing the settings on four interlocking cogs.

EagleCat: reflect (Years 7–10)

Students observe the relationship between the angle of incidence and the angle of reflection by manipulating variables.

Features include:

- realistic experiments requiring students to test an hypothesis that is false
- an opportunity for students to apply their spatial and numerical understanding of the relationship between the angle of incidence and the angle of reflection.

Students:

- explore the angle of reflection of light
- test an hypothesis about the angle of reflection and the angle of the reflective surface
- determine the angle of reflection by observing different light sources.

EagleCat: reflect
L10079 – Years 7–10

Students manipulate the angle of incidence and the angle of a reflective mirror to test the hypothesis that 'the angle of reflection is equal to the angle of incidence only when the mirror is at zero degrees'.

Electron configuration (Years 11–12)

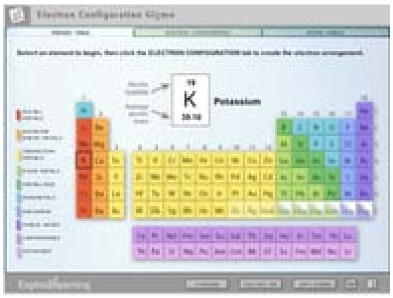
Students create electron configurations for any element in the periodic table.

Features include:

- a graphical representation of the relationship between atomic number and atomic radius
- a printable exploration guide to assist students with creating orbital diagrams and analysing atomic radii
- an option to copy and print the activity screen
- an extension activity on using the diagonal rule to create orbital diagrams for elements later in the periodic table
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- check configurations they have composed and provides explanations when a student's theoretically correct answer differs from an element's actual configuration
- investigate the Aufbau principle, the Pauli Exclusion Principle and Hund's rule.



Physical science: electron configuration
L8995 – Years 11–12

Students use orbital diagrams to create electron configurations for elements in the periodic table. They can also discover the relationship between electron configuration and atomic radius.

Photoelectric effect (Years 11–12)

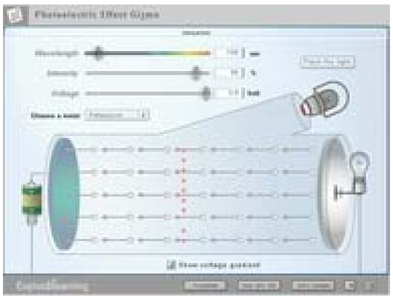
Students explore Einstein's explanation for the photoelectric effect by investigating the effect of light on various metal surfaces.

Features include:

- a tool to test three different metal surfaces, and a voltage gradient measuring tool
- a printable exploration guide that assists students to perform tests, collect data and form hypotheses
- an option to copy and print the activity screen
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- see that the frequency, not the intensity, of light is what determines whether electrons are emitted from metal surfaces when struck by light
- simulate experiments and gather data that can be used to replicate Einstein's explanation for the photoelectric effect
- follow the reasoning of Einstein in explaining the results which helped lay the foundation of quantum physics.



Physical science: photoelectric effect
L8993 – Years 11–12

Students investigate the photoelectric effect by varying the wavelength and intensity of light striking three different metal surfaces, and then measuring the energy of the electrons emitted.

Density laboratory (Years 11–12)

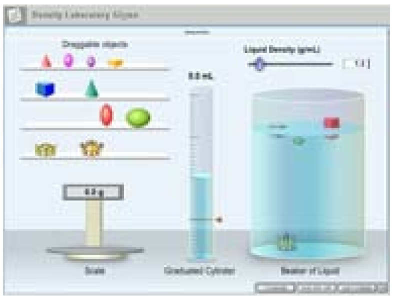
Students use a scale and graduated cylinder to investigate the mass and volume of objects.

Features include:

- an option to copy and print the activity screen
- a printable exploration guide to assist students with collecting data, performing tests and forming hypotheses about density
- real-world scenarios to introduce the science being investigated
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- carry out the measurements required to calculate the density of solids.



Physical science: density laboratory
L8862 – Years 11–12

Students carry out the measurements required to calculate the density of solids. They adjust the density of liquid in a beaker to see how this affects which items will float. Students calculate the densities of three crowns and find out which one is made of pure gold.

Nuclear decay (Years 11–12)

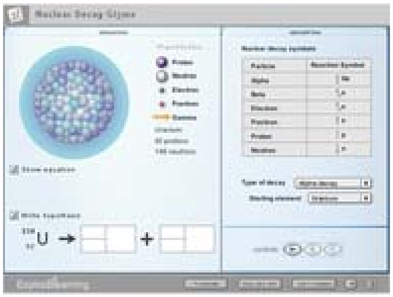
Students explore four different types of nuclear decay (alpha decay, beta decay, positron emission and electron capture) and generate hypotheses predicting particles emitted and the daughter nuclei of the decay.

Features include:

- feedback on each equation attempted
- an option to copy and print the activity screen
- a printable exploration guide to assist students with performing experiments, writing hypotheses and checking nuclear equations
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- predict outcomes for different types of decay by composing nuclear equations.



Physical science: nuclear decay
L8992 – Years 11–12

Students observe simulations of different types of nuclear decay affecting atoms of different elements. They use the atomic numbers and mass numbers of the atoms to predict various outcomes of the decay.

Roller coaster physics (Years 11–12)

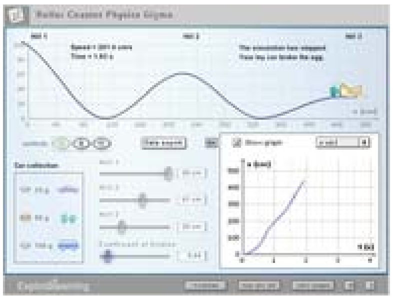
Students explore the law of conservation of energy through the journey of a vehicle moving along a track.

Features include:

- access to 14 graphs plotting variables of motion, including potential, kinetic and total energies, as well as position, velocity and acceleration
- a printable exploration guide to assist students with performing experiments and collecting and analysing data
- an option to copy and print the activity screen
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- vary the mass and initial elevation of the object, together with the heights of hills and coefficient of friction.



Physical science: roller coaster physics
L8985 – Years 11–12

Students design their own roller-coaster track for toy cars. They can change the cars, the heights of the hills and the track's friction. Students monitor the position, speed and energy of the cars via graphs and try to prevent the cars from breaking an egg at the end of the track.

Orbital motion: Kepler's Laws (Years 11–12)

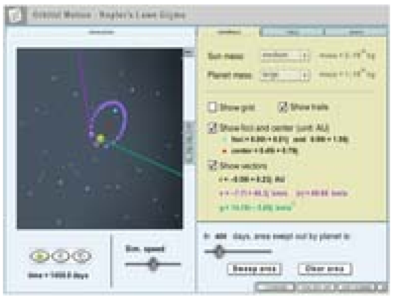
Students apply Kepler's Laws of planetary motion to orbiting bodies. They conduct controlled experiments and apply mathematical formulas to investigate the relationships between orbital period and radius.

Features include:

- a printable exploration guide to help students set up simulations of planetary orbits and apply mathematical formulas to test theories
- an option to copy and print the activity screen
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- investigate the orbit of a planet around a star
- change the size of a planet, its speed of orbiting and its distance from the Sun
- discover how variables change the shape and period of orbit
- record data in a table and in graphs and use their observations to discover the fundamental relationships within the solar system known as Kepler's Laws.



Physical science: orbital motion: Kepler's Laws
L9005 Years 11–12

Students vary the mass, initial velocity and separation of orbiting bodies to demonstrate the laws of planetary motion known as Kepler's Laws.

Fan cart physics (Years 11–12)

Students explore the relationship between force, mass, acceleration and velocity by adjusting the mass of a cart and the forces acting on it.

Features include:

- a printable exploration guide to assist students with performing tests and forming hypotheses from graphs and tabulated data
- real-world scenarios to introduce the science being investigated
- five summative multiple-choice assessment questions with printable results and explanations of correct answers
- an option to copy and print the activity screen.

Students:

- plot graphs of displacement, velocity and acceleration-versus-time as the motion proceeds
- arrange forces in reinforcing or opposing configurations.

Physical science: fan cart physics
L8984 – Years 11–12

Students experiment with the effects of force and mass on acceleration by loading fans and blocks onto a cart. They also monitor displacement, velocity and acceleration as the cart moves.

Freefall laboratory (Years 11–12)

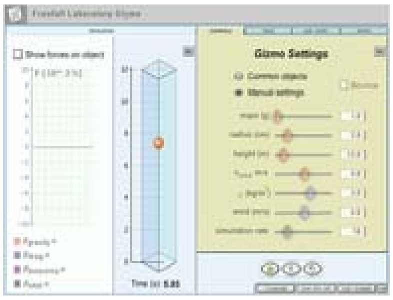
Students investigate the motion of falling objects, accounting for gravity, drag and buoyancy.

Features include:

- zoomed-in views of graphs so that overall patterns or small variations may be examined closely
- an option to copy and print the activity screen
- a printable exploration guide to assist students with performing tests and forming hypotheses about the behaviour of falling objects
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- analyse data and interpret graphs to discover relationships between variables.



Physical science: freefall laboratory
L8981 – Years 11–12

Students select from a list of common objects, and vary conditions such as height and air resistance to investigate the motion of falling objects. They measure acceleration due to gravity, and discover the factors influencing terminal velocity.

Refraction (Years 11–12)

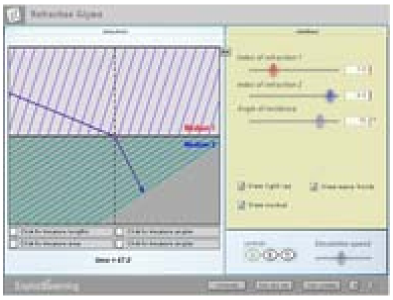
Students conduct controlled experiments on refraction and tabulate the data collected. Students then apply the trigonometric formula known as Snell's Law to the data collected.

Features include:

- views of both rays and wavefronts
- an extension activity on measuring the frequency and wavelength of light waves in different mediums
- five summative multiple-choice assessment questions with printable results and explanations of correct answers
- a printable exploration guide to assist students to perform tests, collect and analyse data and apply mathematical formulas
- an option to copy and print the activity screen.

Students:

- investigate how light refracts when it passes from one medium to another, for example from air to water
- vary the angle of incidence and refractive indices of different mediums and discover the relationship known as Snell's Law.



Physical science: refraction
L9002 – Years 11–12

Students investigate the relationship between the indexes of refraction in two mediums and the angles of incidence and refraction known as Snell's Law.

Boyle's Law and Charles's Law (Years 11–12)

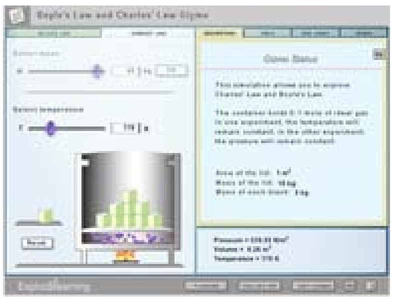
Students investigate Boyle's Law by varying the pressure of a gas sample at constant temperature. Students investigate Charles's Law by varying the temperature of a gas sample at constant pressure.

Features include:

- an exploration guide
- an option to copy and print the activity screen
- data displayed in table and graphic form
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- investigate the effects of pressure and temperature changes on the volume of a sealed gas sample
- discover the relationships known as Boyle's Law and Charles's Law.



Physical science: Boyle's Law and Charles's Law
L8988 – Years 11–12

Using an animated particle-model simulation, students vary the pressure and temperature of a gas sample to explore the effects of temperature and temperature changes.

Bohr model (Years 11–12)

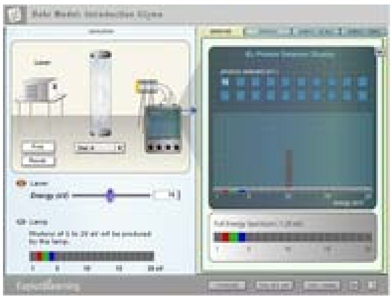
Students use a Bohr model to explain atomic spectra and calculate atomic energy levels from spectral data.

Features include:

- an exploration guide
- an option to copy and print the activity screen
- data displayed in table and graphic form
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- fire photons to determine the spectrum of a gas and observe how an absorbed photon changes the orbit of an electron, and how a photon is emitted from an excited electron
- discover why the atoms of the gases absorb only very specific photons and find out how the spectrum of an atom reveals its electron orbitals and energy levels.



Physical science: Bohr model: introduction
L8994 – Years 11–12

Students experiment with three hypothetical gases and two 'mystery' gases to show how absorption of photons promotes electrons through energy levels and the emission of photons as they return to ground state.

Hearing: frequency and volume (Years 11–12)

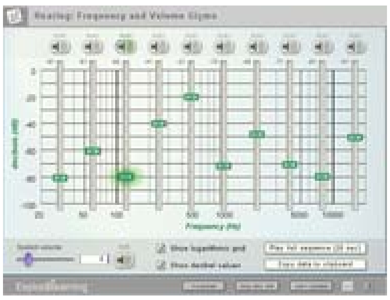
Students generate and interpret equal-loudness curves and compare human hearing thresholds at different frequencies.

Features include:

- a printable exploration guide to assist students with collecting, comparing and analysing data
- five summative multiple-choice assessment questions with printable results and explanations of correct answers
- real-world phenomena to introduce the scientific content being investigated
- an option to copy and print the activity screen.

Students:

- investigate how well they can hear sounds of different frequencies at different decibel levels
- find their threshold of audibility at low, medium and high frequencies
- build an equal-loudness curve by setting the decibel level for different frequencies at the same perceived loudness.



Physical science: hearing: frequency and volume
L8997 – Years 11–12

Students construct a personal equal-loudness curve and threshold of audibility. They demonstrate that perceived loudness and hearing thresholds differ for sounds of different frequencies.

Circuits (Years 11–12)

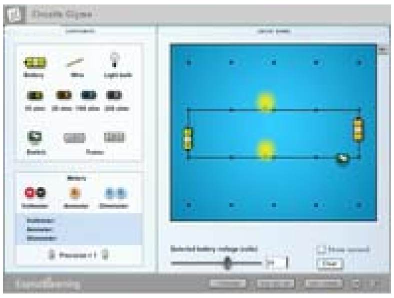
Students build and explore a variety of circuits and measure the voltage, resistance and current in the circuits.

Features include:

- an exploration guide
- an option to copy and print the activity screen
- data displayed in table and graphic form
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- build electric circuits using batteries, light bulbs, resistors and other components
- use various meters to measure voltage, current and resistance
- differentiate between series and parallel circuits.



Physical science: circuits
L8983 – Years 11–12

Students vary the battery's electromagnetic field and simulate a large variety of direct current circuits using batteries, light bulbs, resistors, switches, fuses and meters.

Shoot the monkey (Years 11–12)

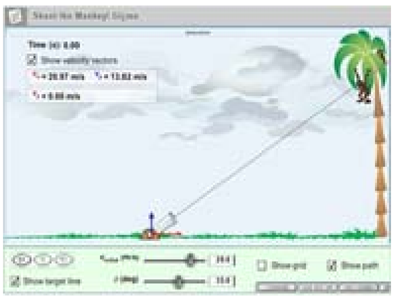
Students apply trigonometric formulas to calculate initial horizontal and vertical velocity of a projectile to fire a banana at a monkey.

Features include:

- a printable exploration guide to assist students to perform tests, form hypotheses and apply mathematical formulas
- an extension activity on projectile physics equations
- five summative multiple-choice assessment questions with printable results and explanations of correct answers.

Students:

- use a cannon to fire a banana at a monkey in a tree (the monkey drops at the instant the cannon is fired)
- adjust the cannon's position, launch angle and initial velocity of the banana until the monkey catches the banana
- demonstrate that the vertical and horizontal components of a projectile's motion are independent and that all objects moving freely under gravity have the same acceleration.



Physical science: shoot the monkey
L9006 – Years 11–12

Students demonstrate the mathematical relationships between projectile velocity and freefall velocity using a cannon to shoot a banana at a monkey. Features an option to copy and print the activity screen.

Collision theory (Years 11–12)

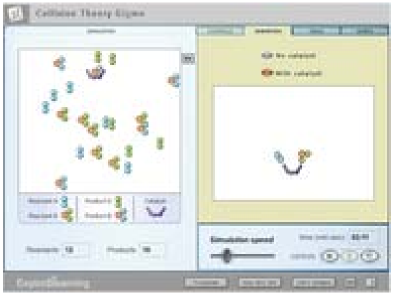
Students use collision theory to interpret and predict changes in rates of chemical reactions, and then interpret concentration time graphs for chemical reactions.

Features include:

- tables and concentration time graphs to records data allowing students to calculate the half-life of reactions
- five summative multiple-choice assessment questions with printable results and explanations of correct answers
- an option to copy and print the activity screen.

Students:

- explore methods of changing the rate of a chemical reaction, vary the temperature or concentration of a reactant, or add a catalyst
- observe the effects on molecular collisions and monitor the progress of the reaction using tables and graphs
- simulate a binary chemical reaction and watch its progress
- are able to vary reactant concentration, surface area, catalyst concentration and temperature.



Physical science: collision theory
L9001 – Years 11–12

Students explore methods of changing the rate of a chemical reaction. They vary the temperature or concentration of a reactant, or add a catalyst and observe the effects on molecular collisions and monitor the progress of the reaction using tables and graphs.

Digital resources

australianscreen online

Created by the Australian Film Commission and now managed by the National Film and Sound Archive, *australianscreen* online (ASO) is an innovative website with more than 2,000 moving-image clips from Australian feature films, documentaries, newsreels, short films, home movies and animations. As the education partner in this major project, TLF has selected hundreds of clips and provided accompanying teachers' notes.

TLF ID: R8891

Backs to the Blast, an Australian Nuclear Story, 1981: Power of the atom
This clip shows black-and-white newsreel footage of a nuclear test at Maralinga, South Australia, in the 1950s, and includes comments from people exposed to radioactive fallout from the test. A former serviceman reports that he was instructed to shield his eyes against the flash that accompanied the blast, while an Indigenous woman describes seeing what appeared to be smoke coming through the trees overhead that left behind a residue of grey-black dust.

TLF ID: R7731

Metric Motoring, 1974: What you need to know
This is a television advertisement that explains the numerical conversions required to understand the new road signs being introduced as part of Australia's change from imperial measures to the metric system. The Commonwealth Constitution of 1901 gave the federal government the power to make laws in respect of weights and measures. In 1947, Australia signed the Metre Convention, making metric units legal for use in Australia. In 1970, the *Metric Conversion Act* was passed, allowing the metric system to become the sole system of measurement.

TLF ID: R8909

Landline – Ethanol Special, 2006: 'Clean, green and healthier'
This clip shows the health risks of petrol- and diesel-driven vehicle fuel exhausts within a context of advocating the biofuels ethanol and biodiesel. Graphic images of particles superimposed on exhaust fumes reinforce the health message. Scenes of Sydney smog and people in crowded streets close to traffic are then interspersed with Professor Ray Kearney speaking about the research into the health dangers of fuel exhausts.

TLF ID: R8908

Activities of the Royal Aero Club of South Australia, c1935: A flight in a Tiger Moth
This silent black-and-white clip shows a Tiger Moth plane in action in the 1930s. The Tiger Moth is only a small aircraft – 7.29 m long, 2.68 m high, with an unfolded span of 8.94 m about the same dimensions as a modern double garage – but its size made it ideal for training. It couldn't fly very far (about 485 km), climb very high (4,145 m) or travel very fast (175 km/h) but, as seen in the clip, flying in it was an exhilarating experience.

Images courtesy of *australianscreen* online.

CSIRO

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency. TLF makes available hundreds of CSIRO's scientific still and moving images in the pool of digital curriculum content.

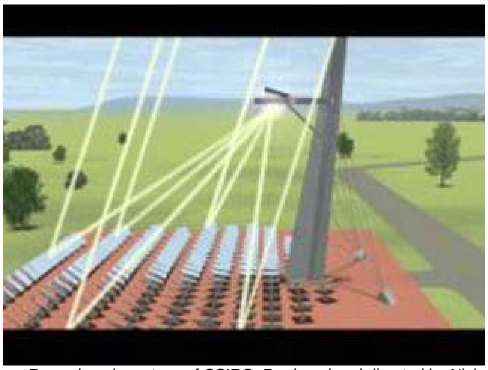
TLF ID: R9756

Harvesting energy from vibrations
This is a clip about converting energy carried by vibrations into electricity. It shows a voltmeter and scientists looking at data on a computer as they capture energy from vibrations. Vibrations are a form of energy that can be turned into electricity. Potential sources include vibrations from traffic on heavy bridges, heavy machinery, floors in high traffic public areas, household appliances, train tracks and earthquakes.


Reproduced courtesy of CSIRO. Produced and directed by Nick Pitsas.

TLF ID: R9661

High-concentration solar tower array
This clip describes how a high-concentration solar array works. The clip shows the arrangement of mirrors at Australia's first high-concentration solar array at the CSIRO National Solar Energy Centre (NSEC) in Newcastle, New South Wales. It shows a molecular-level three-dimensional animation explaining how SolarGas is produced in a chemical reaction.


Reproduced courtesy of CSIRO. Produced and directed by Nick Pitsas, CSIRO.

TLF ID: R9754

Saving energy with smart agents
This shows how information systems known as smart agents can manage energy consumption by evening out the power usage in residential buildings. The smart agents shown here are devices that use artificial intelligence software to manage energy peaks. The agents communicate with each other to monitor and match electricity consumption and generation. This means energy can be managed more efficiently, which reduces the frequency of costly blackouts caused by excessive demand at peak times.


Reproduced courtesy of CSIRO. Produced and directed by Nick Pitsas, CSIRO.

Getty Images

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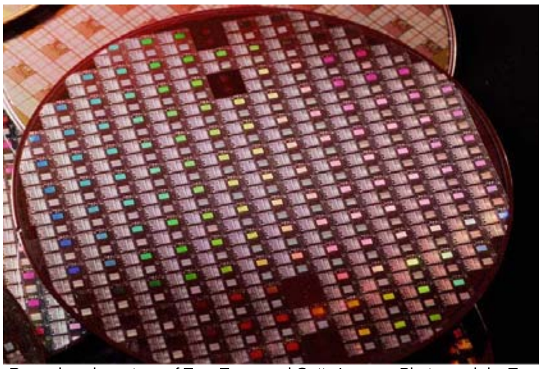
TLF ID: R8311

An innovative solar energy panel
This solar panel contains a layer of nanocrystals, or quantum dots, of copper-indium-gallium-diselenide (CIGS). The panel is being twisted to display its high flexibility. Standard electricity towers can be seen in the background.

Reproduced courtesy of Mark Thiessen and Getty Images. Photograph by Mark Thiessen.

TLF ID: R8443

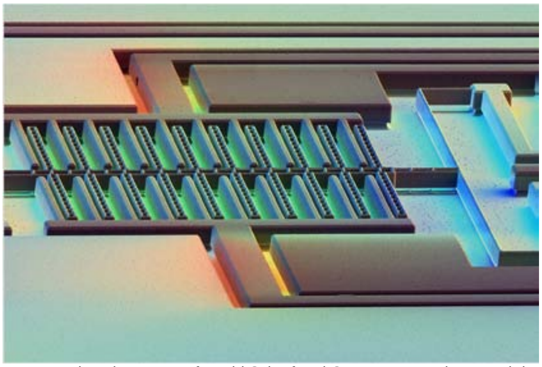
An etched semiconductor wafer
This shows a silicon wafer containing many small integrated circuits. Each rectangle corresponds to an individual integrated circuit or silicon chip.



Reproduced courtesy of Tom Tracy and Getty Images. Photograph by Tom Tracy.

TLF ID: R8431

MEMS accelerometer device
This shows a micrograph of a microelectromechanical systems (MEMS) accelerometer device. MEMS are very small devices that integrate mechanical systems with electronics. The image is about 1,200 times actual size.



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Museum Victoria

Museum Victoria is responsible for Victoria's scientific and cultural collections. TLF has licensed many digitised items from the Museum's science, Indigenous, history and technology collections for inclusion in the pool of digital curriculum content.

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TLF ID: R6368

Penny-farthing bicycle, c1888

This is a penny-farthing, or high-wheel bicycle, built in Melbourne by H Bassett and Co in the late 1880s. Called 'The Victory', it has a 142-cm diameter front wheel and a smaller rear wheel, both with solid rubber tyres. The following is an image from the educational value statement provided by TLF for this resource.

Penny-farthing bicycle, c1888

Acknowledgements

Credits	Reproduced courtesy of Museum Victoria
Creator	H Bassett and Co, manufacturer, c1888 Benjamin Healley, photographer
Identifiers	Museum Victoria image number MN 11439 Museum Victoria object registration number ST 016415 TLF resource R6368
Source	Museum Victoria, http://www.museum.vic.gov.au/

Description

This is a penny-farthing, or high-wheel bicycle, built in Melbourne by H Bassett and Co in the late 1880s. Called 'The Victory', it has a 142-cm diameter front wheel and a smaller rear wheel, both with solid rubber tyres. The pedals are fixed directly to the axle of the front wheel. The leather seat sits on a 'cradle spring' mounted on a frame formed from a length of steel tubing. Under the seat is a metal plate (not visible) with the inscription 'MBC' (Melbourne Bicycle Club). The metal handlebars are high on the frame above the front wheel. Attached to the handlebars is a lever to operate a 'spoon brake' pushing a scalloped piece of iron down onto the front wheel. The bike weighs 21 kg.

Educational value

- Penny-farthings were a type of bicycle popular in Europe and other parts of the world in the 1870s and 1880s, before they were replaced by chain-driven 'safety bicycles' that resemble the bicycles still in use today. Penny-farthings had a large-diameter front wheel and a smaller rear wheel and were named after the English coins, the relatively large penny, and the much smaller farthing, worth quarter of a penny.
- Because they had no gears, the front wheels of penny-farthings were made large to achieve greater speed (and distance) with each revolution of the pedals. The cyclist had to ride almost on top of the front wheel, making it difficult to mount, and impossible to stop safely without first leaping off the bicycle, because the rider's feet could not touch the ground.
- This penny-farthing, known as 'The Victory', was made in Elizabeth Street Melbourne by H Bassett and Co, a company that assembled a bike on special order using parts imported from England. In the 1860s Australia had an active local industry making 'boneshakers', a type of early bicycle with an iron frame and wooden wheels, but the frames of penny-farthings required lightweight, high-strength, tapered steel tubing that was not made in Australia at the time.
- 'The Victory' was owned by a prominent member of the Melbourne Bicycle Club, George William Burston (1859-1924), who used this bike when he and a fellow club member, Harry Stokes, set off from Melbourne on a 'world tour' by bicycle in November 1889. It took the pair ten months to reach London, having cycled an estimated 16,000 km of the way through parts of Australia, Asia and Europe, travelling the rest of the way on steam ships. Their biggest distance travelled in a day was 212 km across northern India.
- Burston and Stokes were among the first Australians to make a journey to Europe mostly overland. Their serialised adventures were followed at home in The Australasian newspaper, and in 1890 Burston published a book called 'Round about the world on bicycles: the pleasure tour of G. W. Burston and H. R. Stokes'. On their return, they told fellow Bicycle Club members the worst roads they saw anywhere in the world were those in Australia at that time.
- Although their adventure took place before Federation, the Victorian-born Burston and Stokes believed they made their tour as representatives of Australia with one newspaper report quoting Burston as saying that because of the degree of public interest in the tour, he felt as though he was setting off as an Australian who must acquit himself well, and Burston's book makes frequent references to them being Australians.
- The Melbourne Bicycle Club, founded in 1878 staged regular racing events on penny-farthings, and in 1887 it inaugurated what is now the oldest and most distinguished track cycling race in Australia, the 'Austral'. Initially staged on grass at the Melbourne Cricket Ground over a distance of 3 miles (4,800 m), this annual race involved penny-farthings until 1893 when it became a 'safety bicycle' race.

Reproduced courtesy of Museum Victoria. Photograph by Benjamin Healley.

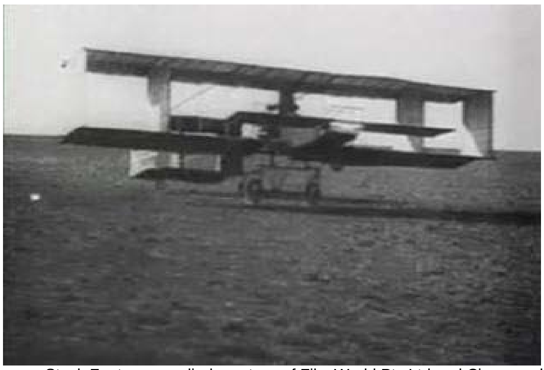
National Film and Sound Archive

The National Film and Sound Archive holds more than one million audiovisual items dating from the 1890s to the present day. Newsreels, songs, home-movie footage and early silent-era films that document aspects of the Australian experience are represented within the collection. TLF has licensed hundreds of items for inclusion in the pool of digital curriculum content.

Refer to the Index of Science digital curriculum content for a complete list of items available for science. You can use the search options in your educational jurisdiction's gateway to TLF to view the content.

TLF ID: R4394

Houdini first to fly, 1910
The excerpt shows the US magician and escape artist Harry Houdini (1874–1926) making what was officially recognised as the first controlled powered flight of an airplane in Australia in his Voisin biplane at Diggers Rest near Melbourne.



Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Fox Movietone (Australia).

TLF ID: R5697

'Integrated circuits: South Australia', 1970 – asset 1
This clip first explains what an integrated circuit is and then shows workers producing integrated circuits at the Philips factory in South Australia, interspersed with views of H D Huyer, chairman of Philips, showing dignitaries around the factory.

Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Cinesound Productions.

TLF ID: R6598

'Colour TV in the making', 1974 – part 1 of 3
This colour newsreel from 1974 alerts Australian audiences to the upcoming introduction of colour television in March 1975. Australians adopted colour television faster than anyone else in the world, with almost 80 per cent of homes owning a colour television set within five years of its introduction.

Reproduced courtesy of National Film and Sound Archive. Produced by Cinesound Movietone Productions.

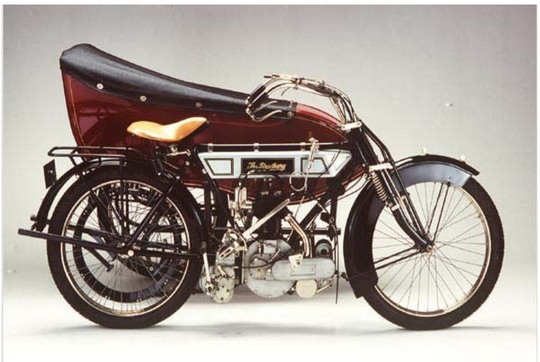
Powerhouse Museum

Powerhouse Museum holds a unique and diverse collection of more than 385,000 items that span history, science, technology, design, industry, decorative arts, music, transport and space exploration. TLF has licensed hundreds of these items for inclusion in the pool of digital curriculum content.

Refer to the Index of Science digital curriculum content for a complete list of images available for science. You can use the search options in your educational jurisdiction's gateway to TLF to view the content.

TLF ID: R6327

Bradbury motorcycle and sidecar, c1916
This is a motorcycle and sidecar built around 1916 by Bradbury and Co in Oldham, England. Measuring 1.2 m (height) x 1.5 m (width) x 2.2 m (length), it is powered by a 3.5 horsepower, single cylinder, 554 cc engine and has a three-speed gear box.



Reproduced courtesy of Powerhouse Museum.

TLF ID: R6170

John Logie Baird's televisor, c1930
The televisor is an important artefact in the development of television, having been made by John Logie Baird, one of television's pioneers. This is the home receiver that picked up the first commercial television images when, in 1927, Baird transmitted the first long-distance television signal over 700 km of telephone line.

Reproduced courtesy of Powerhouse Museum.

TLF ID: R5593

Solahart water heater – asset 1
These photographs depict water heaters that use the energy of the Sun. Cold water is drawn into the pipes in the solar collectors, which are positioned at an angle to best catch the warm rays of the Sun. The hot water rises into the storage cylinder and is then available for use. Water in the tank cools down after some time and goes through the cycle again.

With permission of Solahart Industries Pty Ltd.

University of New South Wales

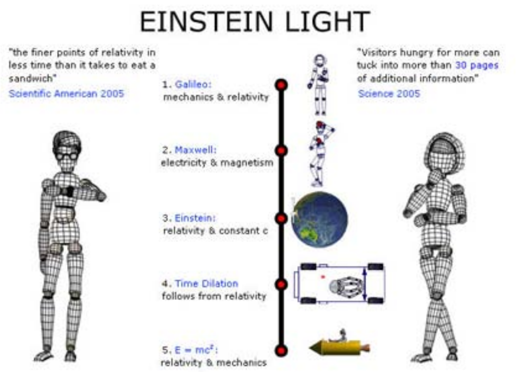
The Physclips project by the School of Physics, University of New South Wales is a multimedia introduction to areas of physics. It provides learning and reference tools for upper secondary and university students as well as resources for teachers.

TLF ID: R11214

Einsteinlight: a simple introduction to relativity

This 'Physclip' explores the basic ideas of Einstein's special theory of relativity. This resource contains film clips, animations and background material examining the following ideas:

- Galileo: mechanics and relativity
- Maxwell: electricity and magnetism
- Einstein: relativity and constant *c*
- time dilation follows from relativity
- mass-energy equivalence: relativity and mechanics
- beyond relativity.



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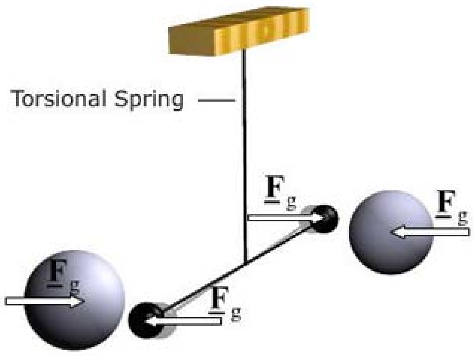
TLF ID: R11213

Gravity

In this resource, students learn how to calculate the orbits of planets and satellites, how to use the conservation of mechanical energy to find the escape velocity for a rocket and how to calculate the sizes of black holes. This 'Physclip' examines:

- Newton's law of universal gravitation
- Cavendish's experiment
- acceleration of falling objects
- gravitational potential energy
- escape velocity and black holes
- Kepler's laws and universal gravitation
- orbits and energy.



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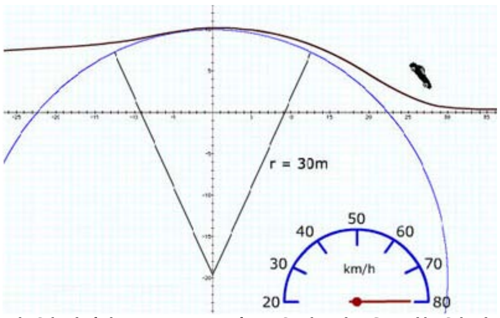
TLF ID: R11204

Circular motion

In this 'Physclip', students follow the derivation of equations to describe angular velocity and centripetal acceleration. This resource consists of a video in four sections with a supporting web page containing explanations and further examples. It looks at:

- uniform circular motion and acceleration
- angular velocity
- centripetal acceleration
- an example of circular motion.



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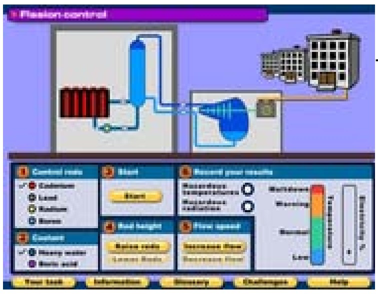
Themes

Nuclear power (Years 6–10)

This collection of digital curriculum content provides opportunities for students to learn about nuclear power generation, including its early development and potential uses in Australia, and some contentious issues surrounding it.



TLF ID: L47

Fission control
Students explore how nuclear energy can be converted into electrical energy using an interactive simulation set in a nuclear power station. They operate controls for a simulated nuclear reactor and answer questions about how nuclear reactors work. They need to adjust the fuel type, position of control rods, coolant type and flow speed to generate electricity without causing a meltdown.

Image courtesy of *australianscreen* online.

TLF ID: R7203

Public Enemy Number One, 1981: 'A warning to the world'
This clip shows scenes of the Japanese city of Hiroshima in 1945, shortly after the atomic bomb was dropped. Doctors at a hospital are shown treating patients, whose radiation injuries are graphically depicted. The bomb used at Hiroshima was a uranium weapon with a particularly high ionising radiation yield, which is very damaging to the human body.

Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Cinesound Productions.

TLF ID: R5268

'Atomic age comes to town', 1957 – asset 1
This is an excerpt from a 1957 *Cinesound review* newsreel showing some of the exhibits at a 1957 industrial trade fair in Sydney. With the development of nuclear reactor principles and the atom bomb during the Second World War, it was thought that uranium-based atomic (nuclear) technology would be able to provide the entire world's energy needs. This excerpt thus reflects the world's enthusiasm in the 1950s for the perceived benefits of the so-called 'atomic age'.

Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Cinesound Productions.

TLF ID: R5285

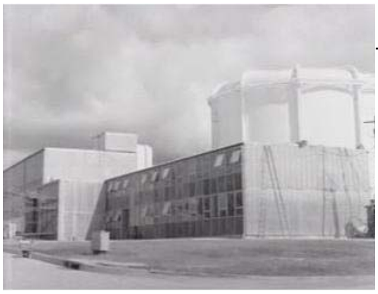
'Atomic age comes to town', 1957 – asset 2
This second excerpt shows a model of the world's first commercial nuclear power station, Calder Hall. Built at Sellafield, West Cumbria, in England, Calder Hall was opened in 1956 and continued to operate until 2003, making it the longest operating reactor in the world. Although it did supply electricity to the national grid, Calder Hall's primary purpose until 1964 was to produce weapons-grade plutonium, an indication of the importance placed on atomic weapons in the age of the Cold War.

Image courtesy of *australianscreen* online.

TLF ID: R8891

Backs to the Blast, an Australian Nuclear Story, 1981: Power of the atom

This clip shows newsreel footage of a nuclear test at Maralinga, South Australia, in the 1950s, and includes comments from people exposed to radioactive fallout from the test.



Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Cinesound Productions.

TLF ID: R5290

Menzies opens Australia's first nuclear reactor, 1958 – asset 1

This clip reveals something of the original purpose of Australia's first nuclear reactor and of Australia's national pride at joining the atomic community. Prime Minister Menzies explains to the media and dignitaries how Australia's energy needs will be met in the future.

Stock Footage supplied courtesy of Film World Pty Ltd and Cinesound Movietone Productions. Produced by Cinesound Productions.

TLF ID: R5291

Menzies opens Australia's first nuclear reactor, 1958 – asset 2

This clip illustrates a reactor that was constructed primarily to produce 'radioactive isotopes for use in medicine, science and industry'. One of the other original functions of the reactor was to test materials to be used in the construction of future reactors, but with changing social and political attitudes toward using nuclear reactors for the production of electricity, plans for building these reactors were dropped and the function was not developed.

Reproduced courtesy of Time Life Pictures/Getty Images. Photograph by Time and Life Pictures.

TLF ID: R8400

Satellite photograph of Chernobyl after nuclear accident, 1986

This satellite photograph was taken from 644 km above the Earth's surface and shows the Chernobyl nuclear power plant in the then USSR, three days after a catastrophic accident at the plant. The red colour indicates areas of high radiation. The accident released massive amounts of radiation and was caused by flawed reactor design and poorly trained staff. The plant had no containment structures, was highly unstable when power was reduced and used dangerously reactive graphite tips on the fuel rods.