# PHYSICS
## EDUCATIONAL SOFTWARES
## (CD ROMs, Videos, DVDs)

- Intermediate Simulations
- Introductory Simulations
- Exploring Simulations Series
- Interactive Physics™
- Physical Science Course

(주)동원오디오비쥬얼
www.dongwonav.co.kr

# Multimedia Science Simulations
# Intermediate Physics Series

**MSS Simulation Series**는
-다음과 같은 어렵고 이해하기 힘든 개념들의 쉬운 이해를 돕는다.
(What happens inside a mass spectrometer, how well pigments absorb different light wavelengths 등등)
-위험하고 많은 비용이 들어가는 실험들의 수행　　-방법보다는 결과와 성과에 집중하도록 도와줌
-보다 다양한 방법으로 실험을 수행할 수 있도록 함.　　-실험결과물에 대한 그래프를 자동적으로 얻을 수 있음.
-실험상 보이지 않은 것까지 보여짐(e.g. how the molecules are moving);
-실험상의 어려운 개념을 설명할 수 있고 원리와 과정을 생생하게 이해하도록 함.
-학생들로 하여금 시각적인 학습을 선호하게 하고 각각의 개념을 이해하는데 새로운 통로를 제공케 함.
-Site License 제품: 지정된 한 학교내에서 사용자 제한없이 사용가능(Network 또는 Stand Alone)

## 26 interactive resources to support your teaching of physics

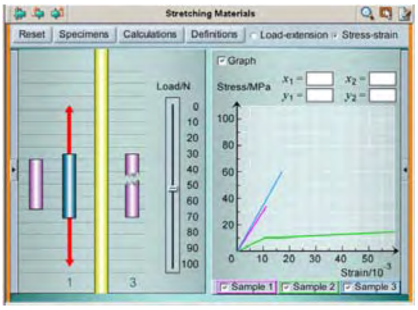
Excellent teaching tools for whole class learning, these multimedia simulations can help make the invisible - visible. The accompanying lessons encourage independent thought and allow students to observe, explore and interact.

**26 Physics Simulation Tools**
Perfect for high school and
college level physics classes

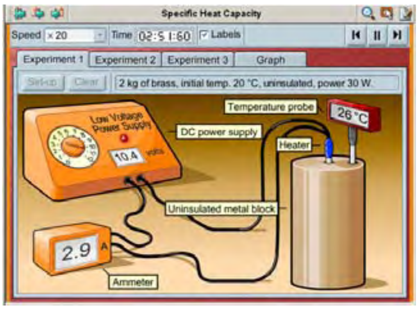
- **Capacitors**
- **Combining Waves**
- **DC Electricity**
- **Dynamics I**
- **Dynamics II**
- **Electric Fields**
- **Electromagnetic Induction**
- **Electromagnetism**
- **General Physics**
- **Gravitational Fields**
- **Kinematics**
- **Kinetic Theory of Matter**
- **Light**
- **Materials**
- **Mechanical Energy**
- **Motion in a Circle**
- **Nuclear Atom**
- **Oscillations**
- **Quantum Phenomena**
- **Radioactivity**
- **Scalars & Vectors**
- **Statics**
- **Thermal Physics**
- **Vehicles: Forces & Safety**
- **Wave Behavior**
- **Work and Energy**

## *Lecture Enhancement Tools*

Use the lesson ***Stretching Materials***, from the intermediate topic ***Materials***, to explore a range of specimens. Eliminate tedious, repetitive graphing and calculating.
Use our comprehensive database of nuclides in the topic ***Nuclear Atom*** to generate a binding energy graph



## *Independent Student Exploration*

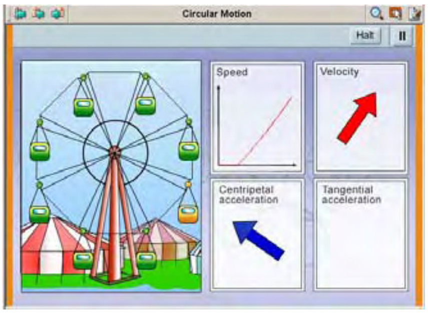


2 kg of brass, initial temp. 20 °C, uninsulated, power 30 W.

Once students have investigated a metal block, they can use the lesson ***Specific Heat Capacity***, from the ***Thermal Physics*** topic, to learn how to reduce the errors in such an experiment

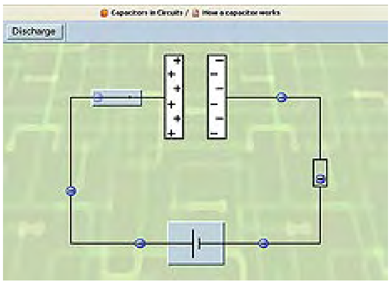
## *Flexible Learning Environment*

Students can perform experiments safely and easily, while recording results using the onscreen worksheets. Exporting data from the programs allows the user to conduct data manipulation and plotting. This integrates a wide range of skills and can help satisfy labs and hands-on learning requirements.



## 1. Capacitors

**Objectives** - After completing these activities, students should:



- Define capacitance and the farad.
- Recall and use C = Q/V.
- Recall and use W = ½QV for the energy stored in a charged capacitor.
- Use the formula 1/CT = 1/C1 + 1/C2 for capacitors in series.
- Use the formula CT = C1 + C2 for capacitors in parallel.
- Describe the discharge of a capacitor through a resistor.
- Interpret and produce graphs showing the variation with time of potential difference, charge stored and current flowing during the discharge of a capacitor.
- Recall the equation τ = CR for the time constant of the capacitor and resistor circuit.
- Explain the practical importance of the time constant for capacitor discharge.
- Use the equations Q = Q0e–t/CR, V = V0e–t/CR and I = I0e–t/CR for the charge, potential difference and current for a discharging capacitor.
- Use the equations Q = Q0(1 – e–t/CR), V = V0(1 – e–t/CR) and I = I0e–t/CR for charging a capacitor.

### Lesson: Capacitors in Circuits

This lesson introduces students to a new electrical component: the capacitor.

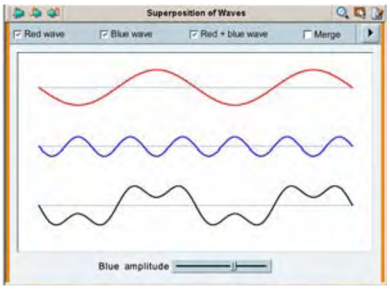
Capacitors can store an electric charge and then be made to release it at a later time. Capacitors are different from other electrical components you may be familiar with because they cause the electrical quantities in a circuit, such as current and potential difference, to change with time. This makes them essential for electronic circuits used for timing, for producing oscillations, and where the frequency of a signal is important, such as in the tuning circuit in a radio.

### Lesson: Charging and Discharging Capacitors

This lesson explores how electrical quantities associated with a capacitor in a circuit vary with time. Capacitors consist of two conducting plates with an insulator (or dielectric) between them, and they can store an electric charge and release it at a later time. Specifically, capacitors cause the electrical quantities in a circuit, such as current and potential difference, to change with time. Being able to control the rate of variation of these quantities is a vital part of using capacitors in electronic circuits.

## 2. Combining Waves

**Objectives** - After completing these activities, students should:



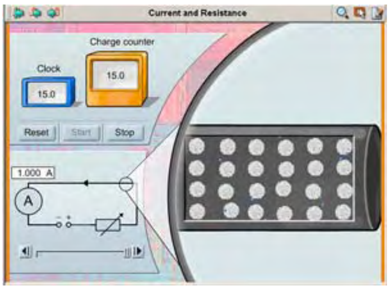
- Explain and use the principle of superposition to add waves.
- Explain the formation of standing waves, and identify nodes and antinodes.
- Describe experiments which demonstrate standing waves in stretched strings and in air tubes or columns.
- Describe experiments with a ripple tank that show: a) water waves diffracting through wide and narrow gaps; and b) two-source interference of water waves.
- Explain the meaning of the terms 'diffraction', 'interference' and 'path difference'.
- Show how the wavelength ë, source separation a and distance to a cross-section D affect the separation x of reinforcements in a two-source interference pattern.
- Recall and use the equation x = ëD/a for two-source interference.

### Lesson: Superposition of Waves

The activities start with the graphical addition of waves using the principle of superposition. This is done for waves moving in the same direction and for those moving in opposite directions, where standing waves are formed. Experiments on standing waves in a stretched string, an open and closed air tube and an air column are simulated. Dynamic ripple tank pictures show the diffraction and interference of water waves. An interactive analysis of two-source interference patterns is carried out to explain how the pattern is formed and how its shape can be changed. The concept of path difference and the equation that relates the parameters in two-source interference are developed.

## 3. DC Electricity

**Objectives** - After completing these activities, students should:



- Distinguish between electron flow and conventional current.
- Express current as I = ÄQ/Ät.
- Use the equation I = nAev.
- Express potential difference as V = W/Q.
- Express power as P = VI.
- Use the equation W = VIt for energy transferred in an electric circuit.
- Distinguish between ohmic and non-ohmic conductors.
- Use the formula R = ñl/A.
- Recognize and use the circuit symbols for - single cell, combinations of cells, d.c. power supply, lamp, switch, ammeter, voltmeter, resistor, variable resistor, thermistor, light-dependent resistor (LDR), semiconductor diode, light-emitting diode (LED).
- State that a power supply or cell may have an internal resistance (r), and recognise that the internal resistance behaves as a resistor in series with the supply.
- Distinguish between terminal potential difference and electromotive force for a power supply with internal resistance.
- State and use the equation E = V + Ir.
- State Kirchhoff's laws.
- Use the principle of Kirchhoff's laws to make predictions about currents and potential differences in circuits.
- State and use the formula for calculating the total resistance for resistors in series (RT = R1 + R2 + R3).
- State and use the formula for calculating the total resistance for resistors in parallel (1/RT = 1/R1 + 1/R2 + 1/R3). Explain how the potential difference of a supply can be reduced using a potential divider circuit.

### Lesson: Current and Resistance

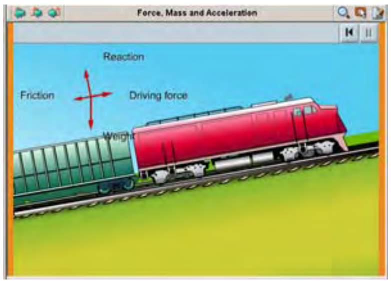
In this lesson students investigate electrical quantities and components. The majority of the lesson uses a simulation of an electric circuit. The simulation allows a series or parallel circuit to be selected and a range of different power supplies, components and measuring instruments to be used. Three more specialized simulations are also provided. The first of these illustrates electrons in a wire and how their behavior relates to current flow; the second shows a circuit with a laboratory or mains supply connected to a lamp or cooker, and is used to demonstrate energy transfer in simple circuits; and the third is an experiment in which the length, material and diameter of a wire can be measured, which shows how the shape and material of a conductor affect its resistance.

### Lesson: Electromotive Force and Kirchloff's Laws

This lesson makes extensive use of an interactive circuit simulation to communicate concepts regarding components in circuits. Working with this simulation can enable students to become fully conversant with circuit symbols. Students are also guided in using the simulation to investigate the behavior of a power supply in a circuit in terms of its e.m.f. and internal resistance. The rules that describe the behavior of currents and potential difference in circuits (Kirchhoff's laws) are stated and demonstrated.

## 4. Dynamics I

**Objectives** - After completing these activities, students should:



- Outline the relationship between speed, velocity, acceleration and force for various combinations of forces.
- Explain what is meant by 'resultant force' and understand its relationship to acceleration. Give the meaning of 'acceleration'.
- Explain how variations in forces and masses can affect acceleration both in situations where friction is operating and in those when it is not.
- Describe the effect of frictional force on motion.
- Understand the relationship between speed, velocity, acceleration and force for various combinations of forces.
- Know what is meant by 'resultant force' and understand its relationship to acceleration.
- Know the meaning of 'acceleration'.
- Be able to explain how variations in forces and masses can affect acceleration both in situations where friction is operating and when it is not.
- Understand the effect of frictional force on motion.
- Be able to state each of Newton 's laws of motion.
- Be able to define, recall and use (linear) momentum as the product of mass and velocity.
- Be able to define force as the rate of change of momentum, and use this definition in situations where mass is constant.
- State the principle of conservation of momentum.
- Use the principle of conservation of momentum in simple applications, including elastic and inelastic interactions between two bodies in one dimension, and separation of an initially stationary body into two parts.

### Lesson: Force, Mass and Acceleration

These activities provide animated screens that present opportunities to investigate forces that act and the sort of motion which will result in a range of scenarios. They provide an interactive means of studying practical examples of the physical principles that are expressed in Newton 's first and second laws, rather than concentrating on formal statements. The activities also provide practice in the use of the laws to analyse motion.

### Lesson: Newton's Laws of Motion

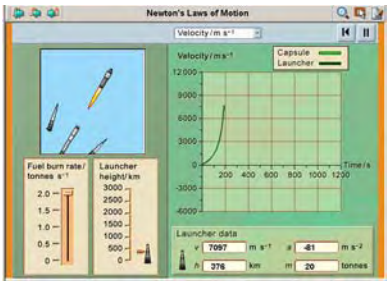
Detailed definitions of Newton 's laws of motion are given and a number of different interactive scenarios are then presented to explore the practical implications of each law.

### Lesson: Vertical Motion

These activities allow momentum to be examined. Interactive screens with animated graphics enable students to explore collisions and explosions involving two toy trucks. Students can manipulate mass, velocity, elasticity and energy to investigate how altering these variables affects the results. In this way, they can obtain a solid qualitative grasp of how bodies collide. Studying the values of momentum and kinetic energy extends this to a quantitative understanding, which allows the outcome of an event to be predicted mathematically.

## 5. Dynamics I I

**Objectives** - After completing these activities, students should:



v 7097 m s⁻¹ a -81 m s⁻²
h 376 km m 20 tonnes

- State each of Newton's laws of motion.
- Define, recall and use (linear) momentum as the product of mass and velocity.
- Define force as the rate of change of momentum, and use this definition in situations where mass is constant.
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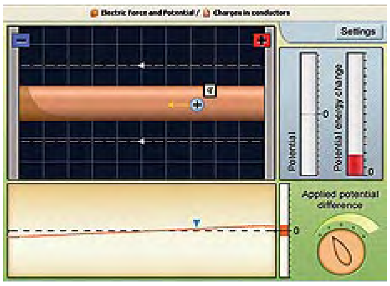
## 6. Electric Fields

**Objectives** - After completing these activities, students should:



- Explain that the force acting on a charged body in a field depends on the charge and on the properties of the field.
- Explain that the work done when a body moves at constant speed in a field in a

vacuum is equal to the change in potential energy, and depends on the size of the charge and on the properties of the field.

- Distinguish between uniform and radial fields using field-strength vectors and field lines.
- Use field strength and potential as properties of points in a field and relate them to, and distinguish them from, force and work done.
- Apply the concept of potential gradient to the prediction of force and motion.

**Lesson: Electric Force and Potential**

In this lesson Students will learn about electric fields. Gravitational fields make a good starting point for thinking about electric fields.

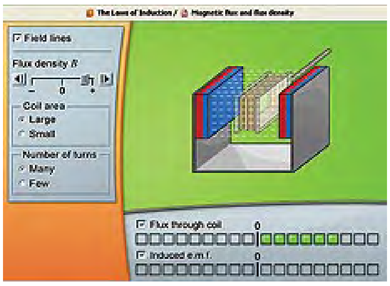
Look around the room you are in – a mass at any point in the room will experience gravitational force. There is gravitational potential energy (GPE) associated with the mass. Now imagine that you move the mass. You could move it across the room or you could take it in a spacecraft far from the Earth. At its new location the mass can still experience force and there will still be GPE, though these won't necessarily be the same as before.

You can go further than describing force and energy for a particular mass. Ideas can be developed, like gravitational field strength g, that allow you to predict what will happen at different points in different fields, even before you introduce a particular mass into the situation.

In an electric field, it is not a body with mass but a body with charge that experiences force and is involved in energy changes. However there are very similar principles that also allow you to predict behaviour. Ideas about electric fields can help you to make valuable predictions about what will happen to charges in different scenarios, whether in the vacuum of a television or electron microscope, or inside a conductor.

## 7. Electromagnetic Inducation

**Objectives** - After completing these activites, students should:



- Explain magnetic flux and the weber.
- Recall the equation $\Phi = BA$ relating flux, flux density and area in a magnetic field.
- Demonstrate an understanding of the concept of flux linkage for a coil and state that it is $N\Phi$.
- Explain that an electromotive force (e.m.f.) can only be induced in a conductor when the magnetic flux near it changes.
- Discuss the laws of Faraday and Lenz and their conclusions about electromagnetic induction.
- Recall expressions for the induced e.m.f. in terms of the rate of change of flux and the rate of change of flux linkage.
- Explain how a wire cutting lines of magnetic force generates an electromotive force.
- Calculate the size of the e.m.f. induced in a moving wire cutting lines of force.
- Use Fleming's right-hand rule to predict the direction of the induced e.m.f. in a wire moved through a magnetic field.

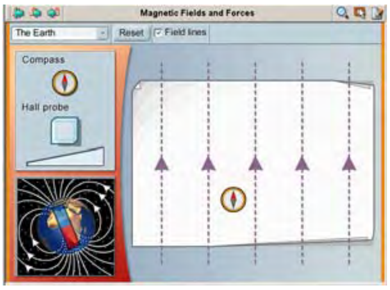
**Lesson: Laws of Induction**

Conductors like wires or coils have a magnetic field around them when they carry an electric current. A wire carrying a current in the magnetic field of a magnet experiences a force, and this principle is used in the electric motors in items like drills or washing machines.

If an electric motor is removed from its electricity supply and spun by hand it also generates electricity. This principle is used in bicycle dynamos to generate electricity on a small scale, and in power stations to generate electricity on a large scale. In a generator a magnet is rotated near a coil, or vice versa.

## 8. Electromagnetism

**Objectives** - After completing these activities, students should:



- Sketch the magnetic field patterns caused by a current in a long straight wire, a flat coil and a long coil, and state where the magnetic fields are the strongest.
- Recall the right-hand grip rule for finding the direction of the magnetic field near a straight conducting wire.
- Work out the polarity of the ends of conducting coils of wire.
- Explain that a force may act on a straight current-carrying conductor placed in a magnetic field, and that the direction of the force is given by Fleming's left-hand rule.
- Describe a method for measuring the force on a conductor in a magnetic field.
- Recall and use the equation $F = BIl$ for the force on a conductor in a magnetic field.
- Define magnetic flux density and its unit, the tesla.
- Explain how a Hall probe can be used to measure the strength of a magnetic field.
- Explain how two parallel current-carrying wires can attract or repel each other, and use Fleming's left-hand rule to predict the direction of the force between them.
- Explain how the phenomenon of the force between two current-carrying conductors can be used to define the ampere of current.
- Explain that a force may act on a straight, current-carrying conductor placed in a magnetic field, and that the direction of the force is given by Fleming's left-hand rule.
- Describe a method for measuring the force on a conductor in a magnetic field.
- Recall and use the equation $F = BIl$ for the force on a conducting straight wire perpendicular to a magnetic field.
- Define magnetic flux density and its unit, the tesla.
- State that the force on a conducting wire in a magnetic field is greatest when it is at 90° to the lines of force, and zero when it is parallel to the lines of force.
- all and use the equation $F = BIl \sin$ è for the force on a conducting straight wire inclined at an angle è to a magnetic field.
- Recognize that a stream of moving charged particles is equivalent to an electric current, and explain that a force in a direction perpendicular to the stream will act on the particles when they are in a magnetic field.
- Recall and use the equation $F = BQv$ for the force acting on a moving charged particle in a magnetic field.
- Explain that the force on a moving charged particle in a magnetic field can provide the centripetal force and

acceleration needed to make the particle follow a circular path.

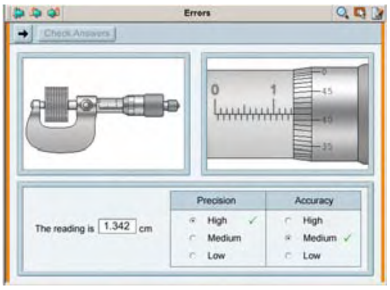
- Explain how the parameters of particle mass, velocity and charge, as well as the flux density of the magnetic field, affect the radius of the path followed by the particles.
- Relate the force F = BQv acting on the moving particle to the required centripetal force F = mv2/r needed for it to follow a circular path.

**Lesson: Magnetic Fields and Forces**
In this lesson simulated plotting compasses and a Hall probe are used to investigate the magnetic fields of permanent magnets and electromagnets. The force that acts on a straight conducting wire in a magnetic field is investigated qualitatively and quantitatively.

**Lesson: Magnetic Forces on Moving Charges**
In this lesson the force that acts on a straight conducting wire in a uniform magnetic field is investigated qualitatively and quantitatively. One method of measuring the force on the wire is shown and the formula F = BIl sin è is developed. Students then investigate a stream of charged particles entering a magnetic field. The equation F = BQv is introduced to give the force on each moving charge that makes it change direction. The effect of changing these parameters can then be explored.

## 9. General Physics

**Objectives** - After completing these activities, students should:



The reading is 1.342 cm

| Precision | Accuracy |
|---|---|
| ● High ✓ | ○ High |
| ○ Medium | ● Medium ✓ |
| ○ Low | ○ Low |

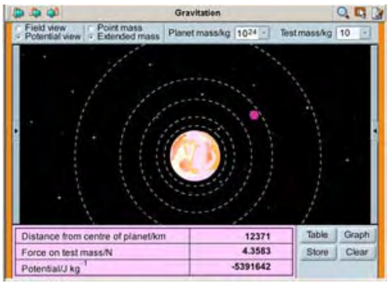
- Recognize that there is uncertainty or possible error in every measurement.
- Recognize that different instruments or techniques can provide measurements with different precisions, and quote values with a number of significant figures to match the precision of the measurement.
- Distinguish between precision and accuracy.
- Calculate percentage errors.
- Distinguish between random and systematic error, and explain how good experimental technique can potentially reduce random error and eliminate systematic error.
- Recognize that uncertainty or error in measurement limits the validity of the conclusions that can be made from investigations.
- Distinguish between quantities and units, and between unit names and abbreviations.
- Recognize that most units students will use are part of the Système Internationale (SI).
- List the seven base quantities and their specific base units.
- Recognize that all quantities other than the seven base quantities are derived quantities, and all units other than the seven base units are derived units.
- Relate some derived units to the equivalent combinations of base units.

**Lesson: Errors**
These activities provide opportunities to practise measurement, to explore precision and uncertainty, to consider and take action on sources of random and systematic error, and to examine the importance of uncertainty, expressed in terms of 'error', in drawing conclusions from data.

**Lesson: Units**
These activities use interactive tables and an engaging ‘snap' game to help students learn the correct units for physical quantities in calculations and measurements within practical work.

## 10. Gravitational Fields

**Objectives** - After completing these activities, students should:



○ Field view ● Potential view ○ Point mass ● Extended mass Planet mass/kg $10^{24}$ Test mass/kg 10

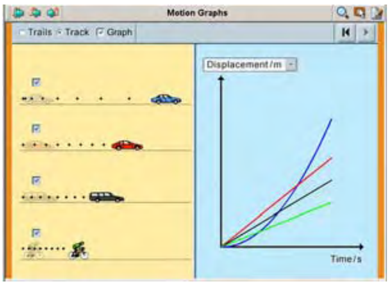
| Distance from centre of planet/km | 12371 |
|---|---|
| Force on test mass/N | 4.3583 |
| Potential/J $kg^{-1}$ | -5391642 |

- State the equation for gravitational force between two objects.
- Explain the meaning of 'gravitational field strength'.
- State the equation for gravitational field strength.
- Describe how gravitational field strength varies with distance from an object.
- State the equation for gravitational potential.
- Describe how gravitational potential varies with distance.
- Describe the gravitational field strength and variation in potential energy close to the surface of the Earth.
- Relate gravitational and centripetal force in order to make calculations of the behaviour of objects in circular orbits.

**Lesson: Gravitation**
In these activities diagrams can be manipulated in order to explore the variation of gravitational field and potential around the Earth and close to its surface. The behavior of an object in orbit around the Earth is also investigated – the orbital velocity, radius and period of an animated rocket can be varied and then the rocket launched, enabling the effect of the selections to be viewed.

## 11. Kinematics

**Objectives** - After completing these activities, students should:



- Use graphical methods to represent distance travelled, displacement, speed, velocity and acceleration.
- Find the distance travelled by calculating the area under a speed-time graph.
- Use the slope of a displacement-time graph to find velocity and the slope of a distance-time graph to find speed.
- Use the slope of a velocity-time graph to find acceleration.
- Explain how the four equations of motion are derived from the definitions of average velocity and acceleration.
  Solve problems using equations of motion.
- Qualitatively describe the motion of an object falling or being projected vertically in terms of displacement, velocity, acceleration and force.
- Calculate displacement and velocity at any given time for an object falling or being projected vertically.

- Calculate the time needed to reach any given point for an object falling or being projected vertically.
- Qualitatively describe the motion of objects projected horizontally and at an angle to the horizontal, in terms of displacement, velocity, acceleration and force.
- Calculate horizontal and vertical displacement and velocity for objects projected horizontally.
- Calculate horizontal and vertical displacement and velocity for objects projected at an angle.

### Lesson: Motion Graphs

These activities allow motion to be visualised in different ways. Vehicles move across the screen, showing uniform and accelerated motion. Their motion can be recorded as a pattern of dots (as produced by ticker-timers) and as graphs.

### Lesson: Equations of Motion

The activities explain derivations, provide worked examples that can be stepped through, and supply problems to solve with model answers so that working can be compared.

### Lesson: Vertical Motion

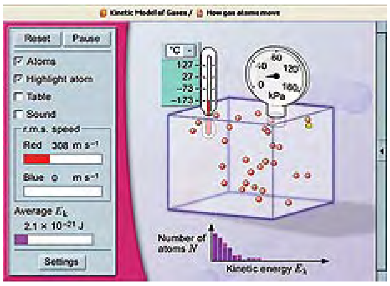
These activities use interactive animations to model the motion of objects falling or being projected vertically upwards and acted on by gravity only. Various features of the model can be controlled and a wide range of display options may be selected, providing access to information about displacement, velocity, acceleration and force at different times during the motion. Vectors and graphs of the motion can be displayed, and appropriate versions of the equations of motion for the scenario can be investigated.

### Lesson: Projectile Motion

These activities investigate the projection of objects. The paths of projected balls and cannonballs are explored through animated simulations in which the speed of projection can be controlled, images showing how motion changes can be displayed, and vectors, graphs and formulae relevant to the motion selected can also be viewed. These features allow students to observe how each quantity of the motion varies and to relate the quantities to each other to see why that variation occurs. The animations allow students to make calculations of the motion and compare their answers with the motion as shown in the simulation.

## 12. Kinetic Theory of Matter

**Objectives** - After completing these activities, students should:



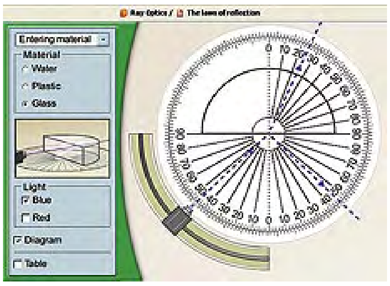
- Describe how the particles of a gas move, according to the kinetic model of matter.
- Outline the phenomenon of Brownian motion, and explain it in terms of the kinetic model.
- State how the pressure of a gas depends on its volume, and relate this to the kinetic model.
- State how the pressure of a gas depends on the number of particles present, and relate this to the kinetic model.
- State how the pressure of a gas depends on its absolute temperature, and relate this to the kinetic model.
- State how the absolute temperature of a gas relates to the average kinetic energy of its particles.

### Lesson: Kinetic Model of Gases

The gas laws relate the pressure, volume and temperature of a gas. They were discovered by careful experimentation.
But can the origin of these laws be explained by looking at the behaviour of the particles of which a gas is made?
That is what the kinetic model of a gas attempts to do

## 13. Light

**Objectives** - After completing these activities, students should:



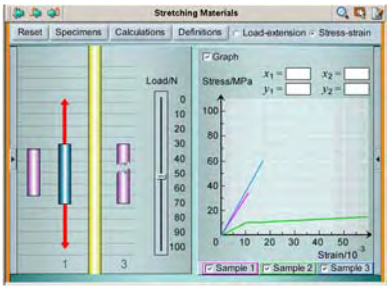
- Recall the laws of reflection and refraction of light.
- Define the refractive index of a material in terms of the velocity of light in a vacuum and in the material.
- Use Snell's law to relate the refractive index to the sines of the angles made by a ray as it passes into a material.
- Define the term 'critical angle' and describe the part this plays in total internal reflection.
- Relate the critical angle to the refractive index for a material.
- Describe how light can be deviated or dispersed by a triangular prism.
- Explain how a prism can be used to reflect light instead of using a mirror.
- Describe how total internal reflection is used in the transmission of light along an optical fibre.
- Demonstrate an awareness of the problems caused by the multipath dispersion of light passing through an optical fibre.

### Lesson: Ray Optics

In 1666 Isaac Newton sent sunlight through a triangular prism and saw the light split up into all the colours of the rainbow. When the sun is behind you and it shines on rain falling in front of you, you see a rainbow. The setting sun looks red and the sky looks blue. A diamond sparkles more than a piece of glass of the same shape. All these phenomena are due to the reflection and refraction of light. tical instruments such as telescopes, binoculars and cameras use lenses and mirrors to refract and reflect light so that images of objects of interest can be seen and recorded.

## 14. Materials

**Objectives** - After completing these activities, students should:



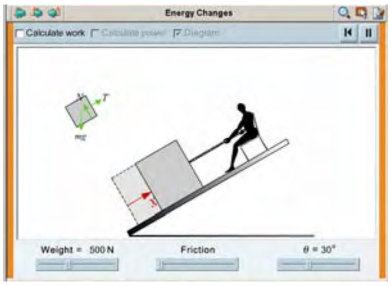
- Interpret load-extension and stress-strain graphs for brittle and ductile materials.
- Calculate stress and strain.
- Deduce strain energy, ultimate tensile stress and the Young modulus from graphs.
- Distinguish between the elastic and plastic deformation of a material, and relate these to the brittle and ductile behavior of materials.

**Lesson: Stretching Materials**

These activities utilize a 'virtual laboratory' in which experiments can be carried out on a variety of materials. The laboratory provides a selection of metal, glass and polymer specimens, to which tensile forces are applied. The corresponding load–extension and stress–strain graphs are displayed, and a calculation panel is given to aid calculations of strain energy and the Young modulus.

## 15. Mechanical Energy

**Objectives** - After completing these activities, students should:



- Describe the concept of work in terms of the product of force and displacement in the direction of the force.
- Recognize the joule as the unit of work.
- Use the equation W = Fx, where F is a constant force along the direction of motion.
- Recall and use the equations for kinetic energy (Ek = ½mv2) and change in gravitational potential energy (ÄEp = mgÄh).
- Relate power to work done and time taken.
- Recall and use the equation W = Pt.

**Lesson: Work, Energy & Power**

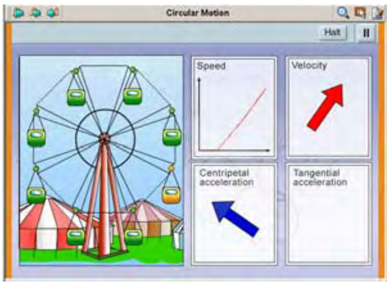
These activities explore two scenarios, lifting objects vertically and pushing or pulling an object up a slope. For vertical lifting, the load and height can be varied. For movement up a slope, friction can be introduced and the angle of the slope can also be varied. Through the four activities an understanding of the concepts of work done, kinetic energy, potential energy and power is developed.

**Lesson: Rotational Equilibrium Plus**

These activities explore the concepts of doing work and the conservation of energy. They examine changes in potential energy and kinetic energy, including the effect of friction. A variable animation of a load moved by a force shows how a force transfers energy when it does work, and these ideas are then applied to the motion of a roller coaster car.

## 16. Motion in a Circle

**Objectives** - After completing these activities, students should:



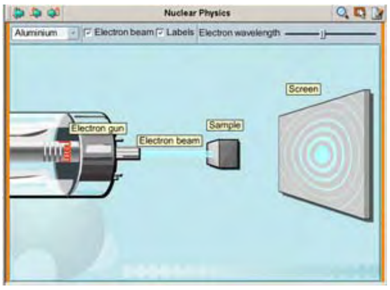
- Distinguish between speed and velocity.
- Explain why an object undergoing uniform circular motion has both a constant speed and an acceleration.
- Use the formulae for centripetal acceleration and force.
- Use radians to express angles.
- Use angular velocity ù in formulae for centripetal acceleration and force.

**Lesson: Circular Motion**

These activities use a wide range of animated scenarios, including a washing machine, a train, a Ferris wheel and a snail, to investigate how speed, velocity, acceleration and force change for an object moving in a circle. The use of radians in angle measurement is explored and angular velocity and acceleration is introduced. The formulae for centripetal acceleration and force are introduced, and opportunities are provided to practice using these formulas.

## 17. Nuclear Physics

**Objectives** - After completing these activities, students should:



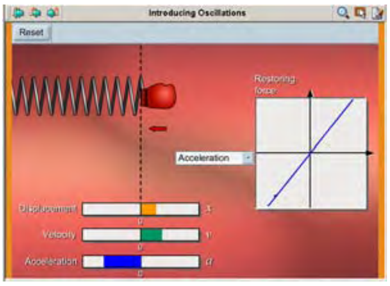
- Explain the evidence for the existence of nuclei.
- Describe how diffraction of electron beams provides an indication of nuclear size.
- Explain the importance of proton and neutron numbers to nuclear charge, mass and identity.
- Recognize that an isotope is a form of a specified element and a nuclide is any species of given nuclear structure.
- Recognize that of all possible proton and neutron combinations there is a range of stabilities, most potential nuclides being highly unstable and a relatively small number being stable.
- Describe mass defect and binding energy, and explain their association.
- Explain that fusion and fission involve an increase in the binding energy per nucleon.

**Lesson: Nuclear Physics**

Beginning with a brief review of some of the evidence for the existence of atoms, the lesson uses clear diagrams and animations to illustrate the evidence for nuclei themselves, for their different sizes, and for the existence of isotopes. Simulations are provided that enable students to ‘construct' nuclei by selecting proton and neutron numbers. Furthermore, these nuclei can be tested so that students can explore nuclear stability as well as the issues of mass and energy, and hence the processes of fusion and fission.

## 18. Oscillations

**Objectives** - After completing these activities, students should:



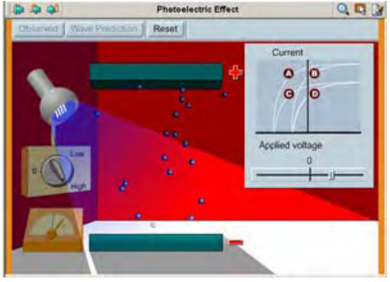
- Compare the effect of a constant force with that of a restoring force that is proportional to displacement.
- Compare, in general terms, the variation with time of key variables - force, acceleration, velocity and displacement - during simple harmonic motion.
- Predict the shape of an acceleration-time graph from a displacement-time graph for simple harmonic motion.
- Predict the shape of a velocity-time graph by applying a knowledge of gradient of a displacement-time graph.
- Define amplitude, frequency and period and state the relationship between period and frequency.
- Describe the cyclic nature of oscillation.
- Describe the relationships between displacement and time: x = A sin 2pft and x = A cos 2pft.

### Lesson: Introducing Oscillations

These activities enable the behaviors of key variables of force, acceleration, velocity and displacement under the action of a restoring force to be compared with those in a simpler motion. The patterns of variation with time of the key variables are explored. The foundations of the mathematical representation of cyclic behavior are established, leading to relationships between displacement and time. Interactive and animated graphics are used to illustrate these patterns and relationships.

## 19. Quantum Phenomena

**Objectives** - After completing these activities, students should:



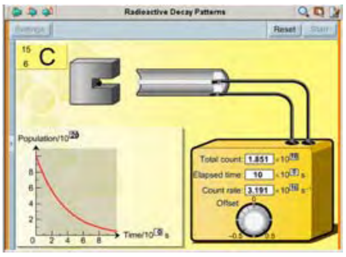
- Describe the photoelectric effect in terms of emission of electrons.
- Relate observed patterns of photocell current and applied voltage to electron behavior and, in particular, to relate photocell stopping voltage to the maximum kinetic energy of electron emission.
- Describe the effects of varying the intensity of light and appreciate that observed behavior is not as predicted by wave theory.
- Describe the effects of varying the frequency of light, and its relationship with the maximum kinetic energy of emitted electrons.
- Describe the hypothesis that light transfers energy in separate quanta, carried by separate photons, and that the energy carried by each photon is related to its frequency.
- Recognize that the hypothesis leads to the equation Esupplied = hf - ö, and that experimental test of this equation supports the hypothesis.
- Consider wave and particle models of light.

### Lesson: Photoelectric Effect

The photoelectric effect encompasses many of the defining features of science: experimental evidence that undermines an established theory, new hypotheses that at first seem strange but are supported by observation, visual presentation of data and relationships, and the importance of modeling. The activities deal with each of these, using dynamic models of electron emission and electron acceleration by applied voltage. Through these the activities explore and explain the effects of variation of intensity and frequency of light, both on directly observable current and voltage and on modeled electron behavior. The activities go on to reveal how the quantum hypothesis can account for behavior where wave theory fails, and so to show that two models are needed to describe the behavior of light.

## 20. Radioactivity

**Objectives** - After completing these activities, students should:



Total count: 1.851
Elapsed time: 10
Count rate: 3.191

- Eliminate the effect of background count from radioactive measurements.
- Describe radioactivity in terms of emission accompanied by nuclear change or 'decay', nucleus by nucleus, and recognize that the randomness of decays within a sample arises from the unpredictable time of decay of any individual nucleus.
- Apply standard form to timescales of radioactive change for a wide range of nuclides.
- Explain that a detection system responds to a proportion of individual emissions from a sample of radioactive nuclide, and that count rate is therefore a proportion of the activity A of the sample.
- Equate the activity A of a sample of radioactive nuclide to the size of the rate of change of the population of undecayed nuclei.
- Interpret exponential decay curves and relate the activity A of a sample of a radioactive nuclide to the population of undecayed nuclei N, and hence understand the significance of the decay constant.
- Relate half-life to exponential decay curves and to decay constant.
- Eliminate the effect of background radiation from radioactive measurements.
- Apply standard form to timescales of radioactive change for a wide range of nuclides.
- Identify radiation as alpha, beta-minus, beta-plus or gamma from the observation of penetrative and electrical behavior.
- Relate the classification of radiation types, as alpha, beta-minus, beta-plus and gamma, to observed patterns of penetrating properties and behavior in electric fields.
- Describe radiation in terms of particles, including photons. Apply the conservation of mass number and atomic number (charge number) to the completion of nuclear change 'equations'.

### Lesson: Radioactive Decay Patterns

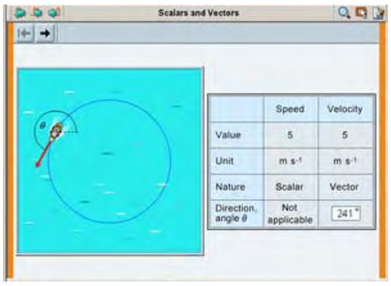
This lesson is based around a detailed interactive simulation of a GM tube, nuclide sample holder and counter unit that relates to a real laboratory arrangement but allows a much wider range of activities than is possible in a laboratory. This offers enormous scope for working with issues of radioactive counting. For example, the ability to vary the effective time of measurements of counts and count rates within very wide limits allows comparative work on radioactive nuclides with widely varying half-lives. The randomness of the decay process is actively illustrated, and exponential decay curves for count rate, activity and population of undecayed nuclei can be explored and compared.

### Lesson: Radioactive Emissions

A detailed interactive simulation is provided of a GM tube, nuclide sample holder and counter unit, which enables the behavior of different kinds of radiation to be explored. The simulation allows students to distinguish alpha, beta and gamma radiations by making use of the different penetration properties in metals and in air. The behavior of radioactive emissions in electric fields can also be investigated and the two types of beta emission are introduced. Nuclear structures and the nuclear changes accompanying the different types of emission are explored, and students are provided with an opportunity to practice applying conservation rules in completing nuclear change equations.

## 21. Scalars & Vectors

**Objectives** - After completing these activities, students should:



|  | Speed | Velocity |
|---|---|---|
| Value | 5 | 5 |
| Unit | m s-1 | m s-1 |
| Nature | Scalar | Vector |
| Direction, angle θ | Not applicable | 241° |

- Distinguish between vector and scalar quantities.
- Calculate pairs of perpendicular components of a vector.
- Add pairs of vectors in one and two dimensions.

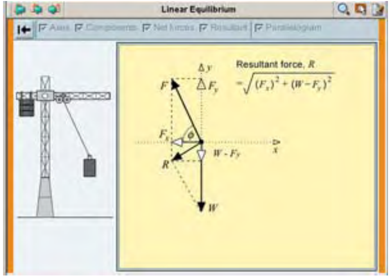
### Lesson: Scalars & Vectors

These activities use various animations of a boat moving across water to introduce the concept of vectors. Initially vectors are compared with scalar quantities to highlight the distinctions. Later the animations are used to show the components of vectors, and equation boxes are provided to give opportunities to practise calculations with vector components and pairs of vectors.

**Activity 1: Scalars and vectors**
**Activity 2: Components of Vectors**
**Activity 3: Adding vectors**

## 22. Statics

**Objectives** - After completing these activities, students should:



- Recognize systems of pairs of forces which are in equilibrium and pairs which are not.
- Use the condition for linear equilibrium to consider the behavior of systems of forces.
- Construct triangles and other polygons of forces and use them to determine whether a system is in equilibrium.
- Consider multiple forces acting on a body, applying both the condition for linear equilibrium and the condition for rotational equilibrium.
- Use the condition for rotational equilibrium, whether presented in words or in mathematical form.
- Apply the condition for rotational equilibrium to generate and consider equations that are useful for predicting whether bodies remain static.

### Lesson: Linear Equilibrium

These activities use different examples of suspended loads to consider linear equilibrium and non-equilibrium. Systems of two, three or more forces are considered to introduce and apply the condition for linear equilibrium. Finally, concepts of linear equilibrium and rotational equilibrium are brought together.

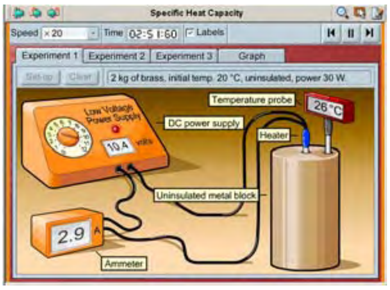
### Lesson: Rotational Equilibrium Plus

These are ‘plus' activities because they assume an existing good knowledge of rotational equilibrium and go beyond the academic requirements for most 16–18 year olds.

Students are likely to be competent at solving problems in which the clockwise moment of one force is balanced by the anticlockwise moment of another. These activities look at more complex situations involving three or more forces. A detailed consideration of the condition for rotational equilibrium in the context of a ladder, a typical static body subject to several forces, is provided. Couples are also introduced through this context. An alternative context is then used so that the application of the condition for rotational equilibrium can be seen, and the opportunity to work with some general principles of equations and graphs is provided.

## 23. Thermal Physics

**Objectives** - After completing these activities, students should:



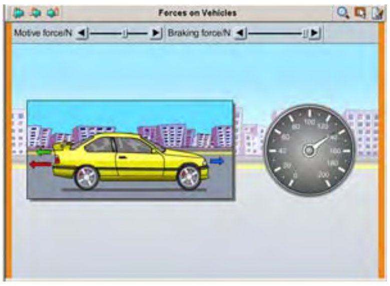
- Define 'specific heat capacity'.
- Calculate specific heat capacity given data for power, time, mass and temperature rise.
- Describe an electrical method for measuring the specific heat capacity of a metal.
- Explain how random and systematic errors will affect the results of an experiment using an electrical method to measure the specific heat capacity of a metal.
- Discuss ways of reducing or eliminating errors in an experiment using an electrical method to measure the specific heat capacity of a metal.

### Lesson: Specific Heat Capacity

In this lesson students can set up virtual experiments to determine values of the specific heat capacity of four metals. They learn how to deduce the specific heat capacity from a temperature–time graph. They also evaluate the experimental method and explore ways of reducing both random and systematic errors in order to obtain more accurate values of specific heat capacity. This lesson could be used as an introduction to the experimental determination of specific heat capacity or as a follow-up to practical work to help students in their critical evaluation of an experiment.

## 24. Vehicles: Forces & Safety

**Objectives** - After completing these activities, students should:



- Give the meanings of 'motive force' and 'braking force', and explain how these forces are generated.
- Describe the effect of air resistance on vehicle motion.
- Recognise the importance of friction in the application of motive and braking forces to produce acceleration and deceleration.
- State that motive power = driving force × speed.
- Give the meaning of thinking distance, braking distance and stopping distance for a vehicle making an emergency stop, and describe how these quantities vary with the original velocity of the vehicle.
- List the advantages of seat belts, air bags and a crumple zone in car crashes, and outline how physics is applied to car design to make it safer.

### Lesson: Forces on vehicles

These activities show the effects of a motive force, a braking force and an air resistance force on a car's motion. In some cases velocity–time graphs are drawn and in other cases a car speedometer is shown. Diagrams show how the motive force and braking force are applied to the wheels. One screen shows how different vehicle shapes move through the air and generate different air flow patterns.

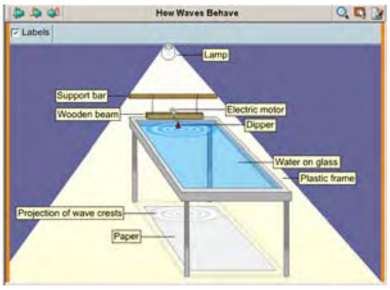
### Lesson: Rotational Equilibrium Plus

Activity 1 uses a graphic of a moving car for which the velocity can be set to one of three different values. The car can then be brought to an emergency stop, and as it does so a velocity-time graph of its motion is plotted. The graph displays a flat section, which is the thinking distance, and a sloping section, which is the braking distance. Calculations can be made from the velocity and time values to find the distances travelled in the two sections of the graph. Distances can also be calculated from the graph areas. Calculated values of the distances can be entered into a table and checked for accuracy.

Activity 2 provides an interactive animation of a test car being crashed into a concrete block. There are options to have the dummy driver fitted with a seat belt, to have a car with crumple zones in its construction design, and to have an air bag fitted and used in front of the driver. The crash can be viewed at normal speed or in slow motion.

## 25. Wave Behavior

**Objectives** - After completing these activities, students should:



- Describe how waves can be reflected and refracted.
- Describe the nature of the motions in transverse and longitudinal waves and understand their graphical representation.
- Define and use the terms displacement, amplitude, wavelength, velocity, periodic time, frequency and phase.
- Explain that polarization is a phenomenon associated with transverse waves but not longitudinal waves.
- Determine the frequency of a sound using a calibrated cathode ray oscilloscope.
- Deduce the equation v = fë from the definitions of speed, frequency and wavelength, and use this equation in calculations.

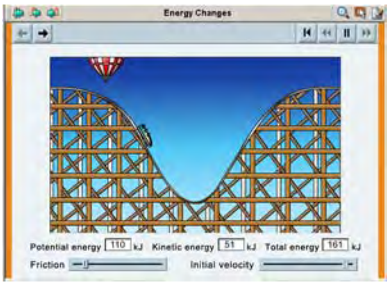
### Lesson: How Waves Behave

These activities use simulated ripple tank experiments to show how water waves reflect and refract. Animations of transverse and longitudinal waves demonstrate the properties of these wave types and terms like amplitude, wavelength and velocity are explained by interactivity with the animations. Phase relationships are investigated, polarization is explained, and the wave velocity equation is developed. Sound wave propagation is shown and an animated cathode ray oscilloscope is used to measure a sound frequency.

## 26. Work and Energy

**Objectives** - After completing these activities, students should:

- Calculate the work done by a constant force in situations including those where the force is not in the same direction as the displacement.
- Explain how the work done by a force is related to energy conversions and energy conservation.
- Apply the principle of conservation of energy to simple examples (e.g. the motion of a load on a slope and the motion of a roller coaster car).
- Use the equation for kinetic energy: Ek = ½mv2.
- Use the equation for gravitational potential energy changes: ÄEp = mgÄh.



Potential energy 110 kJ Kinetic energy 51 kJ Total energy 161 kJ

### Lesson: Energy Changes

This lesson explores the concepts of doing work and the conservation of energy. It examines changes in potential energy and kinetic energy, including the effect of friction.

A variable animation of a load moved by a force shows how a force transfers energy when it does work, and these ideas are then applied to the motion of a roller coaster car.

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- **Electric Generator**
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- NEW **Power Production**
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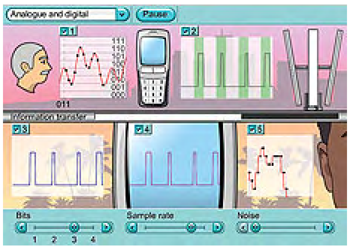
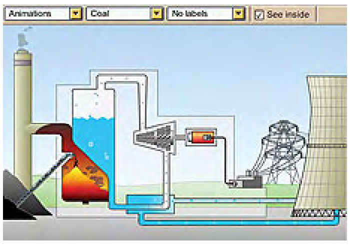
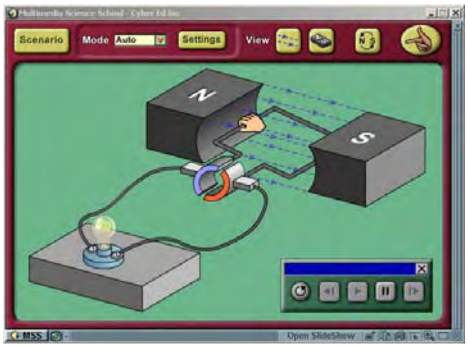
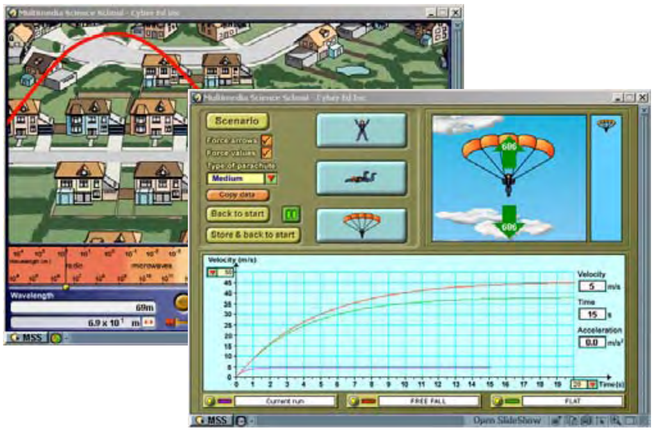




## *Observe...*



Show electric, magnetic and gravitational fields, and the forces they produce on charges, currents and masses. See the behavior of gas particles. Manipulate variables and see the effects.

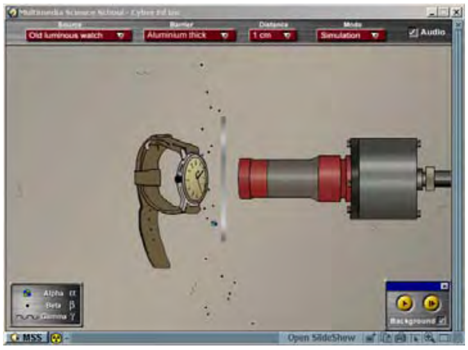


## *...Explore*

Enhance experimental work. Once intermediate students have investigated a metal block, they can use the lesson ***Specific Heat Capacity,*** from the ***Thermal Physics*** topic, to learn how to reduce the errors in such an experiment.

Try the lesson ***Stretching Materials***, from the intermediate topic ***Materials***, to explore a range of specimens. Eliminate tedious, repetitive graphing and calculating. Use the comprehensive database of nuclides in the topic ***Nuclear Atom*** to generate a binding energy graph.

## *Interact...*



Students can perform experiments safely and easily, while recording results using the onscreen worksheets. Exporting data from the programs allows the user to conduct data manipulation and plotting. This integrates a wide range of technological skills and can help satisfy labs and hands-on learning requirements.

## 1. Conducting Heat

Choose a conductor, heat one end and see how the energy travels as the temperature rises. Watch how the particles move. How quickly does heating one end affect the other? Take the temperature and watch a temperature gradient appear. Try again with an insulator or a gas. What is different about them? Model the changes as you heat a metal pan with a wood handle. Model double glazing too – whatever you choose here is a much needed simulation to answer, explain and enlighten.

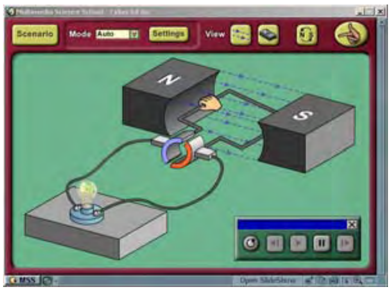
**Students will learn:**

- That differences in temperature can lead to transfer of energy;
- how the movement of particles transfers energy in conduction;
- that insulation can reduce energy transfer.

**Teachers can:**

- Compare how fast three types of material conduct heat. Look at the temperature gradient across them. Relate this to particle movement.
- Model double glazing, a fridge door and cavity wall insulation. Consider loss of heat or gain of heat.
- Compare the cooling of insulated with non-insulated conductors. In other words, compare a conductor cooling in air with a conductor cooling beside an insulator.

## 2. Electric Generator



Build up the idea of how an electric generator works using a sequence of animated experiments. From initial work with wires, magnets and magnetic fields we soon move on to the generator. It's a working model too – you can turn it with a mouse to power a light bulb. Connected to an oscilloscope you can see a trace and clearly show the difference between an AC and a DC generator. Which produces a sinusoidal trace? This unusually hands-on tool lets students do the discovering.

**Students will learn:**

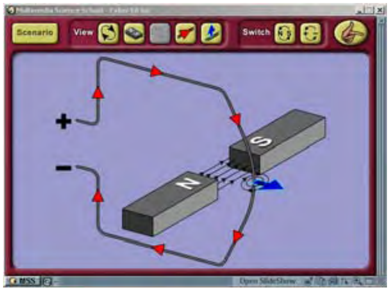
- About the voltage induced when a conductor cuts across magnetic field lines;
- the difference between direct current and alternating current; how simple DC and AC generators work.

**Teachers can:**

- Experiment with the movement of a wire in a magnetic field. Change the polarity of the magnet and the direction of movement. Relate this to Fleming's right hand rule.
- Look at the movement of a wire in a magnetic field more closely: find out how the movement relates to the generation of current.
- Experiment with an AC generator with slow and faster rotation. See how it affects a lamp. Show the extra information provided by a meter.
- Experiment with a DC generator. Compare this with an AC generator. How do a lamp and a meter respond to movement?
- Investigate the reason for the oscilloscope trace with an AC generator. Relate the movement of a coil to the trace obtained.

## 3. Electric Motor

Take students to an understanding of the electric motor with this set of four animated experiments. Start with the magnetic field produced when current flows through a wire, then move on to see how a pair of magnets can deflect it. With options to hide field, current and polarity, these stylised set-ups give students reliable material to form an understanding of the electric motor.



**Students will learn:**

- That an electric current flowing through a wire produces a magnetic field;
- that a force is exerted on a current-carrying wire in a magnetic field;
- reversing the current reverses the direction of the magnetic field and direction of the force;
- that these ideas can make an electric motor.

**Teachers can:**

- Use to support your practical work - use Electric Motor beside or immediately following class experimental work with wires, fields and motors. For example, demonstrate and discuss the animations after a class experiment. Then, in the computer suite, let the class use the Teaching Tool for themselves.
- Predicting lines of force - pick one of the four experiments. Ask students to draw the set-up with magnetic fields, direction of current and any resulting force. Ask them to switch the polarity and to draw the result.

## 4. Electromagnetic Spectrum

Take a rare journey as we zoom in from a broad panorama right down to a single proton. This is a passage through size. We start with a single radio wave stretching across the landscape. We see that microwaves span a few centimetres, while infrared waves are as small as the cells in our tongue. And as we pass through visible, ultraviolet and gamma regions, we see chromosomes, molecules and at journey's end, the nucleus itself.

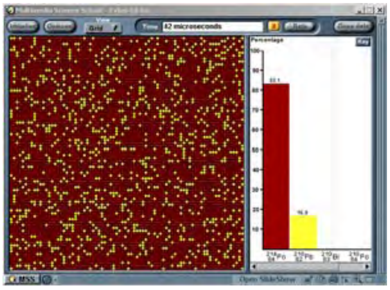
**Students will learn:**

- About the electromagnetic spectrum: length of waves and frequency. About the uses, sources and dangers of radiation along the electromagnetic spectrum.

**Teachers can:**

- Show the animation - start by showing this journey through size. Discuss size, wavelength and radiation along the way.
- Ask students to work with the Teaching Tool themselves to tease out and organise the information on the different parts of the spectrum in a table.

## 5. Half-Lives



Choose a radioactive element and find its half-life. In this model of radioactive decay, students appreciate decay both as a random event, and as a change from one element to another. In complete safety and within a single lesson they can ‘experiment’ to learn about half-life.

**Students will learn:**

- About half-life, its measurement and the meaning of random decay;
- about decay series and the value of models.

**Teachers can:**

- Teach about decay and half-life - test protactinium-234, watch the atoms decay and see if they are actually disappearing. Make a note of how long it takes for half of the protactinium-234 to decay. Switch to the graph to see the decay curve of protactinium-234 and find its half-life.
- See how fast atoms decay - after protactinium-234 decays into uranium-234, increase the passage of time to see what happens. (1 second = 1 thousand years). Find the half-life of uranium-234 and see what else you can discover as it decays.

## 6. Mixing Color

Use virtual projectors and gelatine filters to perform a traditional physics experiment. Under ideal conditions, students mix light of different colors and see how colored objects appear in coloured light. Blend primary and secondary colours or show which colours a filter absorbs. Demonstrate to the class under perfect conditions with perfect results every time.

**Students will learn:**

- About the components of white light and other colors;
- about mixing color, filters and the appearance of colored objects under light of different colors.

**Teachers can:**

- Color mixing - demonstrate the mixing of red, blue and green projector beams. Switch off a beam and ask what the resulting color will be.
- Filters - which colors pass through a yellow filter? Which colors are absorbed? Test a yellow and a cyan filter. Look for a pattern and predict what passes through a magenta filter. Does the order of the filter affect the result?
- Colored objects - shine red light on different colored objects and note their appearance. Repeat for blue light. Record your results in a table using felt pens. Work out the pattern and use this to predict the results with green light. Ask questions such as ‘how will a blue shirt appear under a yellow spotlight?

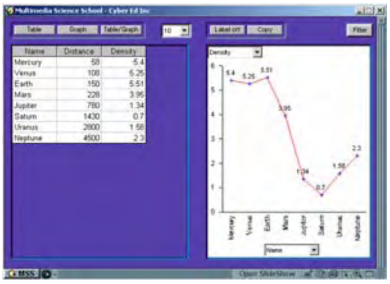
## 7. Mobile Phones

Mobile phones are in common use, very often by young people. While their expertise in using them can exceed that of adults, the way they work is not generally well known. The lesson extends students’ knowledge of mobile phones (without becoming too technical) from their everyday use to explaining elements of the science and technology used to make them work so effectively.

**Students will learn:**

- explain how sound energy and radio energy are interchanged in a mobile phone;
- state that the power transmitted by a radio aerial diminishes with distance from the aerial;
- understand that some of the energy of a mobile phone is absorbed by the user’s head;
- recognize that there may be hazards in the use of mobile phones;
- describe how radio waves are modulated for transmission;
- describe how a mobile phone network contains small regions called cells, each with a radio mast called a base station at their center;
- ... and more.

## 8. Planet Analyzer



| Name | Distance | Density |
|---|---|---|
| Mercury | 58 | 5.4 |
| Venus | 108 | 5.25 |
| Earth | 150 | 5.51 |
| Mars | 228 | 3.95 |
| Jupiter | 780 | 1.34 |
| Saturn | 1430 | 0.7 |
| Uranus | 2800 | 1.58 |
| Neptune | 4500 | 2.3 |

Nine planets revolve around the Sun. Some are large, some are far away, and in the search for understanding scientists worked hard to take measurements and record basic data. Planet Analyser is a tool for students to gain that understanding through the search for patterns in the data provided. Designed to put aside technical skill and focus on science, students use Planet Analyser to relate measurements, such as the surface temperatures of the planets to their distance from the Sun. To do this they hypothesise, obtain data, put it on graphs and explain their findings.

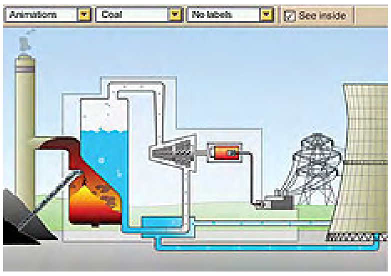
**Students will learn:**

- About the planets in the solar system - their positions, gravity and other features;
- about handling data - identifying and explaining patterns in tables and graphs.

**Teachers can:**

- Review the features of the planets – look at their diameters, surface temperature, and the number of moons they have.
- Show this data and discuss the likelihood of patterns within it. Make a list of possibilities. Next show how the Teaching Tool works and set the class to work creating graphs.
- Explore other patterns - consider time to orbit the Sun against the distance of the planet from the Sun. Remove some planets from a graph: for example, a pattern between ‘Density’ and ‘Moons’ shows best when Pluto and Neptune are removed.
- Interpret graphs - copy graphs to a word processor using the ‘Copy’ button and annotate these graphs with questions for homework sheets.

## 9. Power Production



A series of animations is used to explore nine different types of power stations: coal, CHP, gas turbine, nuclear, wind, tidal, hydro, wave and solar. For each power station students can investigate the components, the raw materials and products of the generation process, and the energy changes involved.
Finally, there is a game designed to encourage students to apply some of the knowledge they have gained about power production. The game requires players to act as the Energy Minister for the imaginary country of Voltavia and to make decisions about how electricity should be supplied to the country. This would work well as an extension activity.

**Students will learn:**

- identify renewable and non-renewable energy resources;
- state that electricity can be generated using a variety of energy resources, both renewable and non-renewable;
- list advantages and disadvantages of wind farms as a means of generating electricity;
- recognize that solar cells can be used to produce electricity directly from the Sun’s radiation;
- describe the process of generating electricity in a coal-fired power station;
- list some of the forms of pollution caused by burning fossil fuels;
- list some advantages and disadvantages of using nuclear fuel to generate electricity.

## 10. Radioactive Penetration

Discover how different sources emit ionising radiation as you test whether it passes through a barrier. In this safe experiment students take readings to see if radiation can penetrate paper, card, lead and aluminium. They can test ‘radioactive’ uranium, thorium and americium to see if they differ, and take part in an engrossing investigation.

Switch into simulation mode and view the other side of this learning tool: ‘see’ alpha, beta and gamma radiation emitted, as different barriers block their passage.

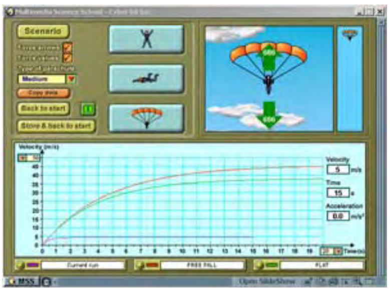
**Students will learn:**

- About sources of ionising radiation;
- about alpha particles, beta particles and gamma radiation;
- what radiation can penetrate;
- about the existence of background radiation.

**Teachers can:**

- Demonstrate background radiation - show approved radioactive sources with a Geiger-Müller counter. Remove the source. Why does the tube still detect radiation?
- Ask them to take readings to find what alpha, beta and gamma radiation can penetrate. Explain the need to subtract the background radiation. Further questions can consider means of protecting ourselves.
- Investigate the types of radiation emitted by the simulated sources - students will need to systematically take readings using paper, aluminium and lead. Start with americium-241, an alpha emitter.
- Students can investigate the effect of distance on the penetrating properties of radiation. Ask them to summarise the penetrating power of radiation in a table.

## 11. Terminal Velocity



Investigate how the forces change as a parachutist reaches terminal velocity. In this model students can experiment with small, medium, large or no parachute at all. They can overlay successive graphs of the falling parachutist whose velocity is plotted over time. They can apply their understanding in a second model of a pedal cyclist. Here they can change the pedal force, hill slope and the type of cycle. The use of force arrows and force values that change in real time add a vital enhancement to students’ learning.

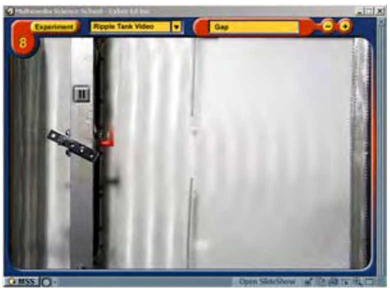
**Students will learn:**

- About velocity/time graphs, the difference between constant speed and acceleration;
- about forces acting on falling objects and unbalanced forces causing an object to change speed.

**Teachers can:**

- Start with the bicycle scenario because it is more familiar. Pedal on the flat and note the forces and the speed. Discuss what causes the cyclist to reach a steady speed. After a while reduce the pedal force (freewheel) and note the same again. Discuss what causes the cyclist to stop. Repeat with an uphill slope. Predict what will happen with a downhill slope. Interpret the graph in terms of balanced and unbalanced forces, constant speed and acceleration.
- Start with the parachute scenario because it has only two variables. Compare either the three kinds of parachute or the three ways the parachutist may fall. Discuss what causes the parachutist to reach a steady speed. Interpret the graph in terms of balanced and unbalanced forces, constant speed and acceleration.

## 12. Wave Behavior



Investigate reflection, refraction and diffraction with eight light box and ripple tank experiments. Guaranteed to work, these experiments feature a prism, curved mirror, glass block and slit. Angles can be changed; light rays can be shown to suit. A powerful feature is the ability to switch from a real world example, such as a satellite dish, to a light box experiment and its ripple tank equivalent. Photographs and video from actual experiments raise this beyond a computer simulation, and offer students a hands-on exploration.

**Students will learn:**

- About the reflection, refraction and diffraction of waves.

**Teachers can:**

- Choose from one of eight experiments starting with reflection at surface (experiments 1 – 4). Each of these includes a video of a ripple tank, a ray box diagram and example applications.
- Discuss this with the class and ask them to say how the lab experiments explain each application.

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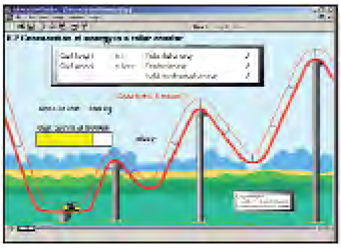

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1-D motion
2-D motion
Collisions
Conservation Laws
Doppler Effects
Electrostatics
Equilibrium
Evaporation
Frequency
Friction
Gears
Gravitation
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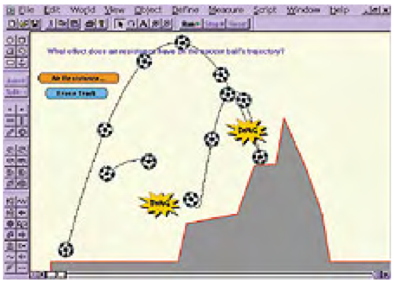
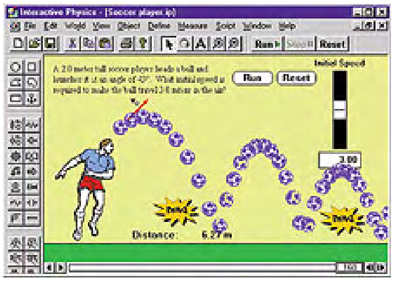
Kinetic Theory of Gas
Machines
Magnetics
Momentum
Newton’s Laws
Oscillations
Particle Dynamics
Planar Motion
Projectiles
Pulley Systems
Rotational Dynamics
Rockets
Sound Intensities
Statics
Waves
Trig Functions
Work & Energy



### Create Any Simulation Imaginable or Use Pre-Designed Simulations to:

- Measure velocity, acceleration, force, momentum, energy, etc.
- Create ropes, springs, dampers, pulleys, slots, linear actuators, and more!
- Hear and measure sound volumes, sound frequencies, and Doppler effects.
- Vary air resistance, gravity, or material properties.
- View results as numbers, graphs, and animated vectors.



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- workbook chapters and experiments.

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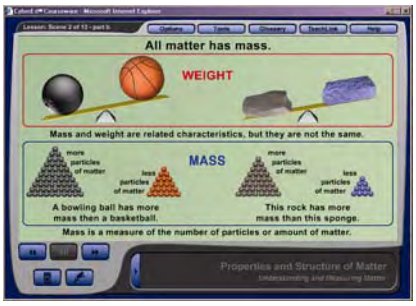
# Physical Science Course

## 1. Properties & Structure of Matter Unit

Learn to describe and measure matter. Explore atomic structure and how elements behave according to physical and chemical properties. Investigate how we have organized all the known elements to help us understand matter and predict how matter will behave. Discover why we can heat, cool, break, burn, and even transform units of matter into entirely new compounds, yet we always end up with the same amount of matter as we began with.

### Topic 1: Understanding and Measuring Matter

In part I of this two-part lesson, explore volume, density, the difference between mass and weight, and how temperature and the forces of gravity, buoyancy, and pressure affect matter. In part II, an introduction to converting between English and metric systems paves the way for directly measuring mass, length, area, volume and temperature. Next, calculate density, inspect how weight and pressure are measured, and learn how to determine if an object will float. This step-wise, content-rich lesson provides an introductory overview that demonstrates the interconnectedness of chemistry and physics.

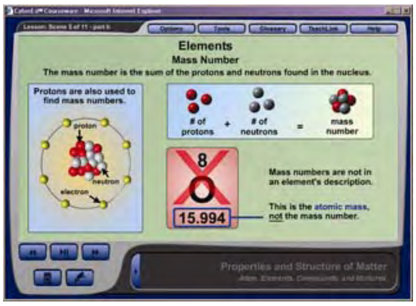

All matter has mass.

Mass and weight are related characteristics, but they are not the same.

A bowling ball has more mass then a basketball.

This rock has more mass than this sponge.

Mass is a measure of the number of particles or amount of matter.


Elements

Mass Number

The mass number is the sum of the protons and neutrons found in the nucleus.

Protons are also used to find mass numbers.

Mass numbers are not in an element's description.

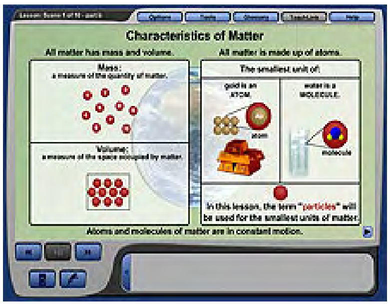
This is the atomic mass, not the mass number.

### Topic 2: Atoms, Elements, Compounds and Mixtures

Survey historical steps that led to our current understanding of the atom. Learn how atomic number and mass number describe numbers of particles in different elements. Explore how atomic mass is determined, what isotopes are, how elements combine chemically as molecules and compounds, and how mixing substances together can form different types of mixtures.

### Topic 3: Physical and Chemical Properties of Matter

Discover ways to detect changes in physical and chemical properties and how any change always follows the conservation of mass. An understanding of properties will enable you to discern ways to separate and identify substances in compounds and mixtures.


Characteristics of Matter

All matter has mass and volume.

All matter is made up of atoms.

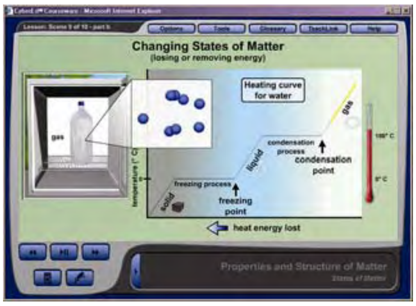
Mass: a measure of the quantity of matter.

Volume: a measure of the space occupied by matter.

The smallest unit of:

In this lesson, the term "particles" will be used for the smallest units of matter.

Atoms and molecules of matter are in constant motion.


Changing States of Matter

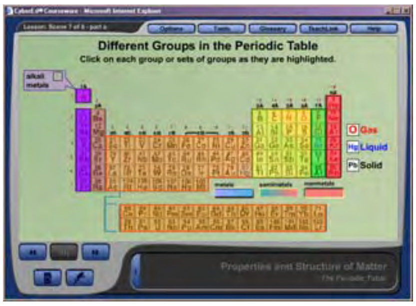
(losing or removing energy)

### Topic 4: States of Matter

Investigate solids, liquids, gases and even plasmas. Explore how changes in energy overcome attractions and affect particle motion, volume, and the behavior of different states of matter. Heating curves tie the topic together, pairing the opposite processes of melting and evaporation with condensation and freezing.

### Topic 5: The Periodic Table

More than just a way to present elements, the periodic table shows patterns in various physical and chemical properties of elements. Discover how to describe and element's position on the periodic table as well as how to determine numbers of atomic particles, state at room temperature, the presence or absence of metallic properties, and general trends in reactivity.


Different Groups in the Periodic Table

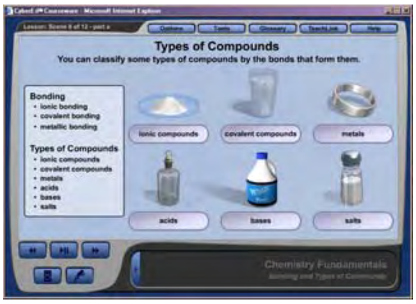
Click on each group or sets of groups as they are highlighted.

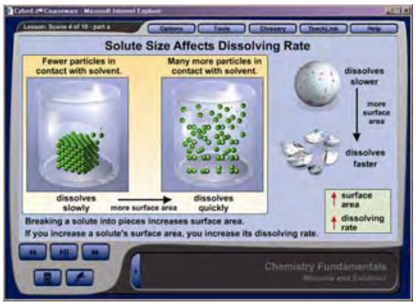
**Properties & Structure of Matter Unit / CD-Rom**

**Single user . . .₩337,000 Lab 5 / Net 10 . . .₩999,000**

# 2. Chemistry Fundamentals Unit

Chemistry Fundamentals reveals the ubiquitous, but often hidden world of chemical combinations. Study why atoms form bonds, probe how reactions occur and how to classify them, and survey the wide array of substances resulting from mixing materials together.





### Topic 1: Bonding and Types of Compounds

Investigate how electron configurations of atoms lead to forming ionic, covalent, or metallic bonds. Explore properties of compounds formed by these types of bonds and discover other ways to look at compounds. This topic also teaches how to discern organic and inorganic compounds, as well as acids, bases and salts.

### Topic 2: Mixtures and Solutions

Learn how substances combine to form heterogeneous mixtures, colloids, and solutions. Investigate polarity, determine solubility, influence dissolving rate, calculate concentration, and study acidic and basic solutions and the pH scale.

### Topic 3: Chemical Reactions

Learn to spot signs of chemical reactions and identify reactions by their behavior or type of reactants. Use the conservation of mass to balance reactions and experiments with ways to influence the rate of chemical reactions.

**Chemistry Fundamentals Unit / CD-Rom**
**Single user . . .₩202,000 Lab 5 / Net 10 . . .₩607,000**

# 3. Energy & Its Applications Unit

Chemistry Fundamentals reveals the ubiquitous, but often hidden world of chemical combinations. Study why atoms form bonds, probe how reactions occur and how to classify them, and survey the wide array of substances resulting from mixing materials together.

### Topic 1: Properties and Sources of Energy

This topic unites energy in its many forms. Use the law of conservation of energy to relate changes between kinetic and different forms of potential energy as well as chemical, electrical, nuclear, sound, and light energy. The importance of the sun as an energy source initiates exploration of energy conservation and renewable and nonrenewable energy sources.

### Topic 2: Heat

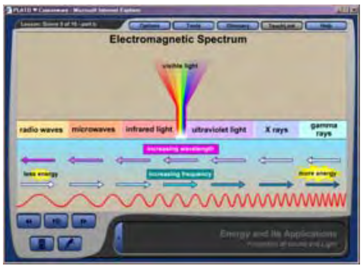
Compare ways thermal energy is transferred as heat through conduction, convection, and radiation. Study the molecular meaning of temperature, how temperature increases based on heat capacity, and practice converting between three different temperature scales.

### Topic 3: Electricity, Circuits, and Power

Discover what electricity is, how it travels and how it does work. Learn to distinguish between static electricity and electric current, various circuits and breakers, and how to predict a change in voltage, amperage, or resistance using Ohm's Law. Take an electrical journey, learning how electricity is produced in a power plant and travels through transformers and lines to an outlet in a home.

### Topic 4: Magnetism and Electromagnetism
Observe the force that draws certain metals to magnets. Learn how and why certain objects are magnetic and how magnetic fields interact. Explore how magnets & electric charges are related, then put it all together with a look at electromagnets and other applications of electromagnetism.

### Topic 5: Properties of Sound & Light
Investigate waves and their properties in the context of everyday experiences. This in-depth look at the different types of waves and their features sets the stage for a deeper understanding of how they allow us to see and hear.



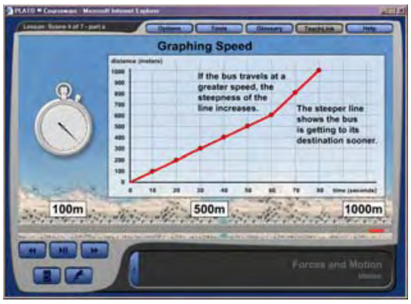

Four things can happen when a wave meets something in its path.

### Topic 6: The Behavior of Sound & Light
Much of what we see & hear relates to how waves react with different media. Discover how waves are refracted, reflected, transmitted, absorbed, and diffracted, allowing us to do things such as see colors, and hear around corners. Explore how different lenses work and can be used to correct vision problems.

**Energy and Its Applications Unit / CD-Rom**
**Single user . . .₩405,000 Lab 5 / Net 10 . . .₩1,215,000**

## 4. Forces & Motion Unit

Investigate the way things work in Forces & Motion. From plotting velocity and calculating acceleration, to determining how forces influence motion, and devising machines to solve problems, this unit provides tools for measuring and describing the world around you.


Graphing Speed

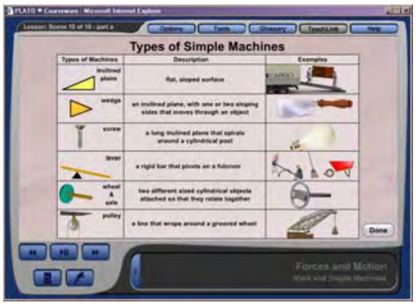
If the bus travels at a greater speed, the steepness of the line increases.

The steeper line shows the bus is getting to its destination sooner.


Newton's First Law

Newton's first law of motion states that an object in motion will remain in motion at a constant velocity unless acted upon by a net force.

The law of conservation of momentum states that the total momentum of the cue ball and the other balls is the same before and after the collision.


Types of Simple Machines

| Types of Machines | Description | Examples |
|---|---|---|
| inclined plane | flat, sloped surface | |
| wedge | an inclined plane, with one or two sloping sides that moves through an object | |
| screw | a long inclined plane that spirals around a cylindrical post | |
| lever | a rigid bar that pivots on a fulcrum | |
| wheel & axle | two different sized cylindrical objects attached so that they rotate together | |
| pulley | a line that wraps around a grooved wheel | |

### Topic 1: Motion
Discriminate between speed, velocity and acceleration. Depict speed graphically and learn to calculate acceleration during this tour on an imaginary bus ride through a city bustling with motion.

### Topic 2: Newton's Laws: Forces & Motion
Gravity & Newton's Laws explain how objects move & react. This topic teaches how to relate the forces affecting motion to everyday experiences and observations.

### Topic 3: Work and Simple Machines
Put your knowledge of forces and motion to work. Investigate power, mechanical advantage, efficiency, and how simple machines such as levers, wedges, and pulleys make work easier.

**Forces and Motion Unit / CD-Rom**
**Single user . . .₩202,000 Lab 5 / Net 10 . . .₩607,000**

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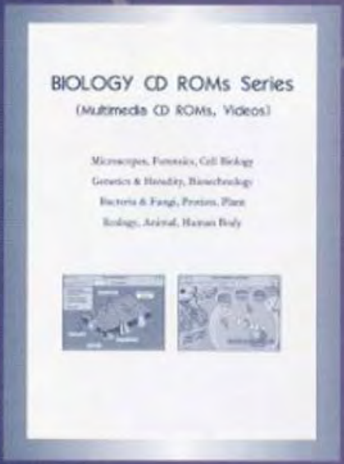

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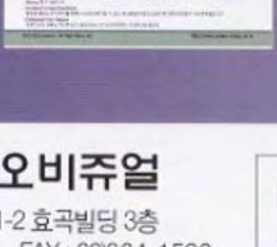
(Multimedia CD ROMs, Videos)

Microscopes, Forensics, Cell Biology
Genetics & Heredity, Biotechnology
Bacteria & Fungi, Protists, Plant
Biology, Animal, Human Body

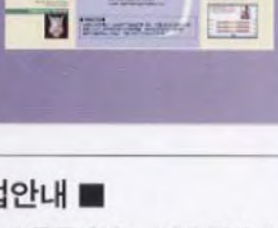
## LIFE SCIENCE

Life Science CD ROM Series

Cells - The basis of Life
Structure Function in Living Organisms
Classification and Diversity of Life
Genetics and Heredity
Organisms and Their Environment
Human Health and Reproduction
Change Over Time
Animal Dissection



ADAM
Interactive Anatomy4 DVD



THE BEST WAY TO LEARN THE HARDEST PART OF A&P

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