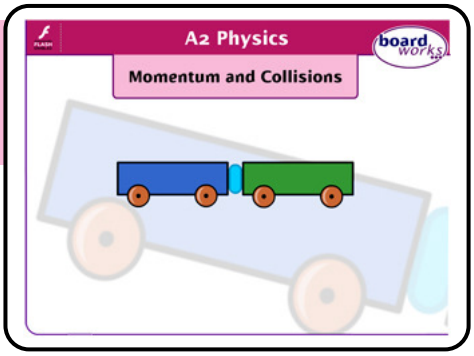
Boardworks A2 Physics

Further Mechanics

Momentum and Collisions



28 slides

- 14 Flash activities

Momentum

- Introduction to momentum
- Interactive activity in masses and velocities of two trolleys can be selected to change their momenta
- Newton's second law in terms of rate of change of momentum
- $F = ma$ as a special case of Newton's second law
- Identifying true-or-false statements relating to momentum
- Calculations involving momentum, including full working out

Collisions and explosions

- The principle of conservation of linear momentum
- Virtual experiment investigating the conservation of momentum for colliding trolleys
- Animation illustrating the conservation of momentum in explosions
- Calculations involving the conservation of momentum, including full working out
- Interactive animations illustrating elastic and inelastic collisions
- Conservation of momentum compared to conservation of energy
- Derivation of an equation for kinetic energy in terms of momentum
- Identifying missing words relating to collisions and explosions

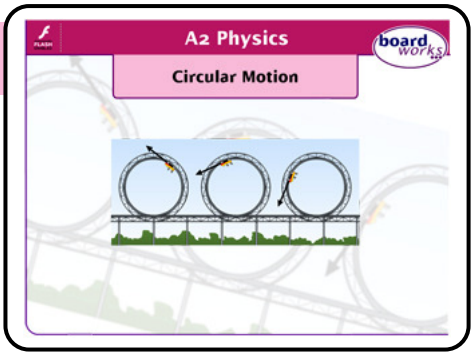
Impulse

- Introduction to impulse
- Animation illustrating impulse as the area under a force–time graph
- Momentum and energy in car crashes and implications for car safety
- Identifying missing words relating to impulse
- Calculations of impulse using force–time graphs, including full working out

Summary activities

- Glossary of keywords in the presentation
- Identifying the correct definition of selected keywords in the presentation
- Multiple-choice quiz

Circular Motion



29 slides

- 17 Flash activities

Angles

- Guide to the definition of the radian
- Converting between degrees and radians
- Interactive activity involving converting between degrees and radians
- Guide to useful mathematical relationships that can be used when working in radians

Angular velocity

- Introduction to angular displacement and angular velocity
- Interactive experiment to measure the period of an object moving in a circle
- Equations for linear and angular velocities in terms of the period
- Guide to deriving $v = r\omega$
- Definition of frequency, $f = 1/T$ and an equation for angular velocity in terms of frequency
- Matching quantities to the correct equations and units
- Calculations involving angular velocity, including full working out

Centripetal acceleration and force

- Introduction to centripetal acceleration
- Animation illustrating the derivation of equations for centripetal acceleration in terms of angular and linear velocity
- Animation illustrating centripetal force
- $F = ma$ and the direction of centripetal acceleration
- Guide to deriving equations for centripetal force in terms of linear and angular velocity
- Matching situations to what provides the centripetal force in each case
- Calculations involving centripetal acceleration and force, including full working out
- Calculations involving resolving forces in situations of circular motion, including full working out
- Interactive demonstration of the effect on the centripetal force of altering mass, linear velocity and radius of circular motion

Summary activities

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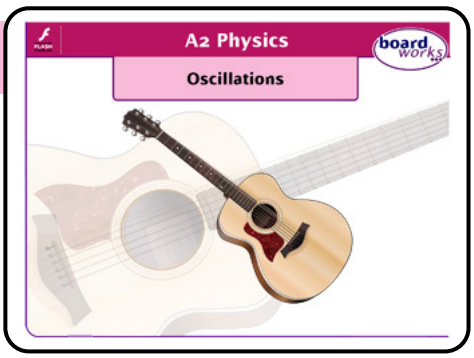
Oscillations



39 slides

- 19 Flash activities

Simple harmonic motion

- Introduction to simple harmonic motion
- Conditions for simple harmonic motion
- Animation demonstrating the link between circular and oscillatory motion
- Introducing equations of displacement, velocity and acceleration of a simple harmonic oscillator
- Animation and step-by-step demonstration of how the displacement, velocity and acceleration of a simple harmonic oscillator change with time
- Restoring force on a simple harmonic oscillator
- Finding the maximum velocity and acceleration of an oscillator
- Identifying true-or-false statements about SHM

SHM systems

- Set of three animations demonstrating energy in oscillating systems
- Deriving the total, kinetic and potential energy of an oscillating system
- Step-by-step derivation of the velocity of an oscillator in terms of its displacement
- Calculations involving the velocity of oscillating systems, including full working out
- Derivation of the properties of a mass on a vertical spring, demonstrating that it fulfils the conditions for simple harmonic motion
- Calculations using the equation for the time period of a mass on a vertical spring
- Derivation of the properties of a pendulum, demonstrating that it fulfils the conditions for simple harmonic motion at low amplitude
- Calculations using the equation for the time period of a pendulum
- Identifying missing words about oscillating systems
- Further calculations involving the time period of oscillating systems

Free and forced vibrations

- Introduction to damping
- Set of three animations demonstrating underdamping, overdamping and critical damping in car suspension systems
- Summary of underdamping, overdamping and critical damping and their graphs
- Free and forced oscillations and resonance
- Examples of resonance in the real world
- Interactive investigation into resonance, using a mass on a vertical spring
- Graphs showing the effect of damping on resonance
- Identifying true-or-false statements about free and forced vibrations

Summary activities

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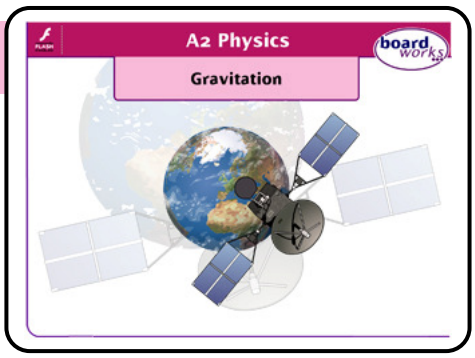
Gravitation



36 slides

- 12 Flash activities

Newton's law of gravitation

- Introduction to universal gravitation
- Interactive investigation into the force between two masses
- Newton's law of gravitation
- Calculating gravitational forces

Fields and potentials

- Introducing gravitational field lines
- Earth's gravitational field
- Introducing gravitational field strength
- Match the gravitational field strengths
- Comparing gravitational fields and electric fields
- Gravitational potential energy
- Measuring gravitational potential energy from infinity
- Work done against gravity
- Investigation of gravitational potential, gravitational potential energy and work done against gravity in the Earth's gravitational field
- Identifying true-or-false statements relating to fields and potentials
- Calculations involving gravitational field strength, including full working out
- Graphing gravitational potential and field strength

Satellites and orbits

- Introduction to satellites
- Time period, orbital speed and mass of the central object
- Kepler's third law
- Match the sides of equations relating to orbits
- Calculations involving mass, radius and orbital time, including full working out
- Geostationary satellites

Summary activities

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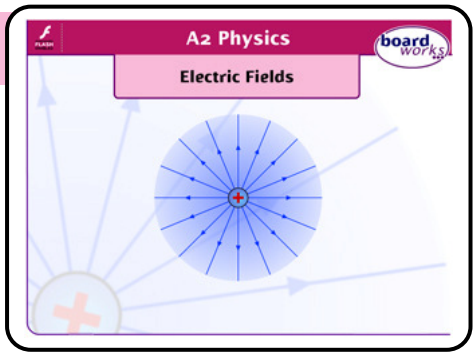
Electric Fields



36 slides

- 18 Flash activities

Coulomb's law

- An overview of electric charge
- An introduction to electric fields and electric field lines
- Investigation into the field line patterns created by different combinations of charges
- Animation describing the inverse-square law in the context of the relationship between force and distance between two electrons
- An overview of Coulomb's law and the equation $F = (Q_1 Q_2) / (4\pi\varepsilon_0 r^2)$
- Calculations involving Coulomb's law, including full working out
- Investigation into the magnitude and direction of force acting between different combinations of charges
- Identifying true-or-false statements relating to Coulomb's law

Electric field strength

- Experiment investigating the magnitude and direction of force acting on different charges placed in radial and uniform electric fields
- Introducing the electric field strength equations $E = F / Q$ and $E = V / d$
- Animation explaining the derivation of the electric field strength equation for radial fields; $E = Q / (4\pi\varepsilon_0 r^2)$
- Calculations involving electric field strength, including full working out
- Worked example relating to the location of zero value between two charges
- Identifying statements as relating to either uniform or radial electric fields

Electric potential

- An introduction of electric potential energy, E_p, and electric potential, V
- Introducing the electric potential equations $V = E_p / Q$ and $V = Q / (4\pi\varepsilon_0 r)$
- Calculations involving electric potential, including full working out
- Guide to equipotential lines around different types of charge
- Animations exploring potential gradients around uniform and radial fields
- Completing sentences relating to electric potential
- Summary activity comparing and contrasting gravitational and electric fields

Summary activities

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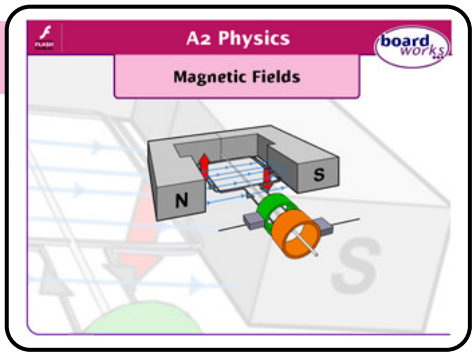
- Identifying the correct definition of selected keywords in the presentation
- Matching definitions relating to electric fields with their equations
- Multiple-choice quiz

Magnetic Fields



43 slides

- 21 Flash activities

Currents and magnetic fields

- Investigation into the magnetic line patterns created by different combinations of bar magnets
- Guide to the right-hand grip rule for a straight conductor and a solenoid
- Investigation into the motor effect
- An overview of Fleming's left-hand rule and how to investigate factors affecting the force on a conductor in a magnetic field
- Introducing magnetic flux density and the equation $F = BIL\sin\theta$
- Calculations involving magnetic flux density, including full working out
- Identifying true-or-false statements relating to magnetic fields, flux density and Fleming's left-hand rule

Moving charges

- Animation illustrating electron deflection in a cathode ray tube
- Introducing force on a moving charge and the equation $F = BQv$
- Calculations involving moving charges, including full working out
- Introducing the equation $F = BQv\sin\theta$
- Animation exploring the path of a charged particle moving a magnetic field
- Ordering statements relating to the motion of a charged particle in a magnetic field into the correct order
- Animation illustrating how a cyclotron works
- Animation illustrating how a mass spectrometer works
- Completing sentences relating to magnetic fields and charges

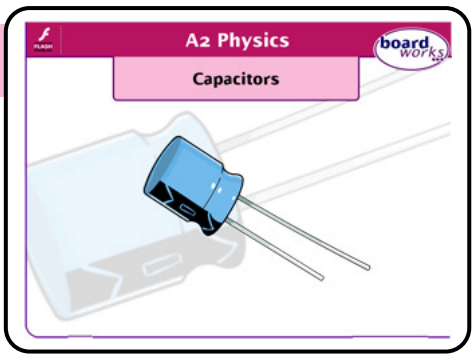
Electromagnetic induction

- An overview of electromagnetic induction and Fleming's right-hand rule
- Animation explaining the principle behind electromagnetic induction and induced e.m.f.
- Animation illustrating the clock rule and Lenz's law
- Introducing magnetic flux and the equation $\Phi = BA$, and magnetic flux linkage and the equation $\Phi = BAN\cos\theta$
- Introducing Faraday's law of electromagnetic induction and the equation $\varepsilon = (-N\Delta\Phi) / \Delta t$
- Simulation of a simple AC generator
- An overview of rotating coils in a magnetic field, and the equation $\varepsilon = BAN\omega\sin\omega t$
- Guide to flux linkage and induced e.m.f. in a rotating coil in a magnetic field
- Completing a table relating to flux linkage and induced e.m.f. in a rotating coil
- An overview of transformers, transformer rule and transformer efficiency, including the equations $(V_S / V_P) = (N_S / N_P)$ and $(V_S I_S / V_P I_P)$

Summary activities

- Glossary of keywords in the presentation
- Identifying the correct definition of selected keywords in the presentation
- Matching definitions relating to magnetic fields and induction with their equations
- Multiple-choice quiz

Capacitors



36 slides

- 17 Flash activities

What is capacitance?

- Guide to the history of the discovery of the capacitor
- Overview of capacitance and the farad
- Animation illustrating what the inside of a capacitor looks like and how it works
- Explanation of capacitors as devices that store electrical potential energy, rather than charge
- Interactive activity to investigate the relationship between input voltage and charge stored on a capacitor
- Interactive activity to plot a graph of charge stored on a capacitor against voltage
- Example worked calculations relating charge, voltage and capacitance
- Factors affecting the capacitance of a capacitor
- Calculating equivalent capacitance for capacitors in parallel and series
- Calculations of equivalent capacitance for capacitors in parallel and series, including full working out
- Identifying missing words relating to capacitance

Discharging a capacitor

- Overview of change in voltage over time for discharging a capacitor
- Interactive activity to plot a graph of voltage against time for discharging a capacitor
- The time constant, *RC*
- Interactive activity to investigate the effect that resistance and capacitance have on the voltage/time graph for a discharging capacitor
- Rearranging the exponential decay equation for the voltage-time curve
- Exponential decay equations for charge and current
- Comparing capacitor discharge to radioactive decay
- Calculations relating to capacitor decay, including full working out

Energy storage

- Overview of the uses of capacitors
- Animation illustrating how a defibrillator works
- Identifying missing words relating to how a defibrillator works
- Calculating the energy stored in a capacitor
- Example worked calculations relating to energy stored in a capacitor
- Alternative equations for energy stored in a capacitor
- Identifying true-or-false statements relating to energy storage in capacitors

Summary activities

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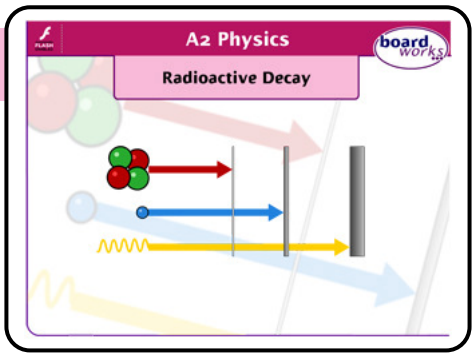
Radioactive Decay



42 slides

- 22 Flash activities

Evidence for the nucleus

- Comparison of the plum pudding and nuclear models of the atom
- Virtual experiment investigating alpha particle scattering by gold foil
- Animation explaining the results of the alpha particle scattering experiment
- Using Coulomb's law and the alpha particle scattering experiment to approximate the nuclear radius
- The need for an attractive force within the nucleus that is stronger than the gravitational force between nucleons: the nuclear strong force
- Identifying true-or-false statements relating to the nuclear atom

Types of radiation

- Guide to the properties of alpha, beta and gamma radiation
- Absorption of different types of radiation by different materials
- Guide to the hazards and practical applications of the different types of radiation
- Identifying which type of radiation various statements apply to
- The inverse square law for the intensity of gamma rays
- Virtual experiment investigating the inverse square law for gamma rays
- Calculations involving the inverse square law, including full working out
- Guide to sources of background radiation
- Background radiation and its elimination from calculations

Radioactive decay

- Introduction to radioactive decay, activity and the becquerel
- $A = \lambda N$ and exponential decay equations for A and N
- Calculations involving activity, including full working out
- Animation illustrating half-life, activity–time graphs and carbon dating
- Equation for half-life in terms of λ
- Calculations involving half-life, including full working out

Instability and nuclear radius

- Animation with interactive graph illustrating the information available from a graph of N against Z
- Gamma emission from nuclei in excited states
- Technetium-99m
- Identifying missing words relating to unstable nuclei

- Animation illustrating the use of closest approach of an alpha particle to determine nuclear radius
- Animation illustrating the use of electron diffraction to determine nuclear radius
- Relationship between nuclear radius and mass number
- Guide to estimating nuclear density
- Identifying which method of determining nuclear radius various statements refer to
- Calculations involving nuclear radius and density, including full working out

Summary activities

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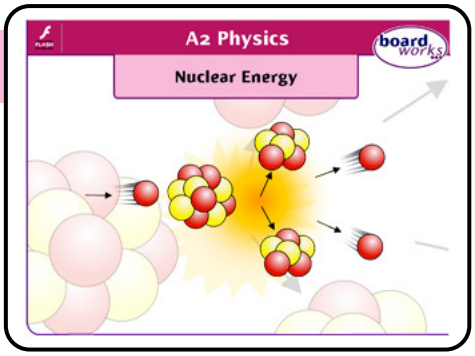
Nuclear Energy



39 slides

- 14 Flash activities

Mass and energy

- The equivalence of mass and energy
- Calculations involving mass-energy conversions, including full working out
- Introducing the atomic mass unit
- Definition of nuclear mass defect
- Definition of binding energy
- Calculations involving binding energies, including full working out
- Identifying true-or-false statements about mass and energy

Fission and fusion

- Introducing fission and fusion
- Animations of fission and fusion processes
- Energy released in nuclear reactions
- Calculating the energy released in nuclear reactions, including full working out
- Introducing binding energy per nucleon
- Identifying missing words relating to binding energy

Nuclear power

- Introducing nuclear chain reactions
- Basic structure of a nuclear power station
- Introduction to the parts of a thermal nuclear reactor
- Investigation into controlling the output of a thermal nuclear reactor using control rods
- Labelling the parts of a thermal nuclear reactor
- Introduction to nuclear safety and the dangers of radiation exposure
- Animation showing the stages involved in the processing and disposal of Low Level Waste (LLW)
- Overview of the processing and disposal of Intermediate and High Level Waste (ILW and HLW)
- Identifying true-or-false statements about nuclear safety

Summary activities

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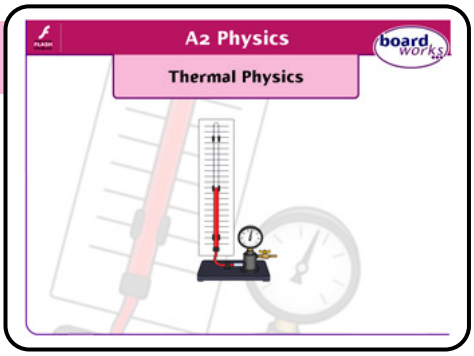
Thermal Physics



45 slides

- 18 Flash activities

Internal energy and temperature

- Explanation and definition of internal energy
- The distinction between temperature and heat
- Thermal energy and thermal equilibrium
- Guide linking kinetic energy, internal energy and temperature of three gases
- Introducing the absolute scale of temperature, and the equation T (K) = θ (°C) + 273.15
- Activity involving the conversion of temperatures from Kelvin to Celsius and vice versa
- Completing a table relating kinetic energy, internal energy, temperature and heat
- Introducing specific heat capacity and the equation $Q = mc\Delta\theta$
- Experiment investigating specific heat capacity of different substances
- Calculations relating to specific heat capacity, including full working out
- Introducing specific latent heat and the equation $Q = ml$
- Animation investigating changes of state, and latent heat of fusion and evaporation
- Calculations relating to specific latent heat, including full working out

Ideal gases

- Animations exploring the three gas laws: Boyle's law, Charles' law and the pressure law
- Identifying true-or-false statements relating to the three gas laws
- The difference between a real gas and an ideal gas, in terms of their adherence to Boyle's law
- Animation introducing moles and the Avogadro number (N_A)
- Avogadro's law and the molar volume of gases
- Introducing the ideal gas equation, $pV = nRT$, and the molar gas constant, R
- Introducing the Boltzmann constant, k, and the equation $pV = NkT$
- Calculations relating to the ideal gas equation, including full working out
- Matching values and constants relating to the ideal gas equation to their definitions

Molecular kinetic theory

- Animation illustrating the Maxwell–Bolzmann distribution in relation to particle speeds
- An overview of the root mean square speed, c_{rms}
- The use of kinetic theory as a way to relate the macroscopic and microscopic behaviour of a gas
- Introducing the kinetic theory equation, $pV = {}^1/_3 Nmc_{rms}^2$
- Animation explaining the derivation of $pV = {}^1/_3 Nmc_{rms}^2$
- Introducing mean kinetic energy, E_K, and the equations $E_K = {}^1/_2 mc_{rms}^2$ and $E_K = {}^3/_2 kT$
- Calculations relating to mean kinetic energy and temperature, including full working out

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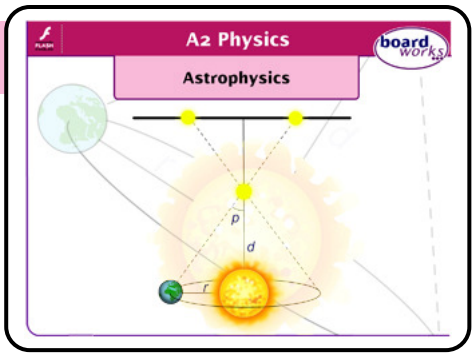
Astrophysics



39 slides

- 15 Flash activities

Astronomical distances

- Guide to the history of the Universe since the big bang
- Astronomical units and light years as units of distance
- Animations illustrating parallax in everyday situations, and stellar parallax
- Using parallax to measure distance
- The parsec as a unit of distance
- Calculations involving using and converting astronomical units, light years and parsecs, including full working out

The stars

- The power output of a star and Stefan's law
- Flux and the inverse square law
- Apparent and absolute magnitude for the brightness of stars
- Calculations involving the brightness of stars, including full working out
- Animation illustrating the life cycle of a small star
- Animation illustrating the life cycle of a large star
- Overview of neutron stars
- Interactive animation explaining the Hertzsprung-Russell diagram and the position of various types of stars on the diagram
- Overview of black holes and the event horizon
- The Schwarzschild radius and its calculation
- Identifying missing words relating to stars

Observing the Universe

- Black body radiation and Wien's displacement law
- Absorption spectra and the composition of stars
- The Doppler effect and red shift
- Animation illustrating resolving binary stars and using absorption spectra to identify them
- Guide to quasars, comparing an animated model to a radio map
- Edwin Hubble and Hubble's law
- Interactive exercise to plot a graph of velocity against distance of galaxies in order to estimate the age of the Universe
- Identifying true-or-false statements relating to Hubble's law

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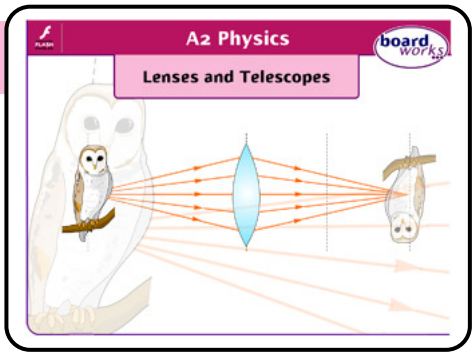
Lenses and Telescopes



43 slides

- 16 Flash activities

Refracting telescopes

- Image production by a converging lens
- Interactive ray diagram showing the path of rays through a converging lens as the object distance is varied
- Introducing the lens equation
- Step-by-step guide to drawing ray diagrams
- Identifying true-or-false statements about converging lenses
- Animation showing the path of light rays through a refracting telescope
- Magnification of a refracting telescope
- Calculations involving the lens equation and magnification of a refracting telescope
- Introduction to angular magnification
- Illustration of the problem of chromatic aberration

Reflecting telescopes

- Image production by a concave mirror
- Animation showing the path of light rays through a Newtonian reflector
- Illustration of the problem of spherical aberration
- Animation showing the path of light rays through a Cassegrain reflector
- Advantages and disadvantages of reflecting telescopes
- Identifying properties of reflectors and refractors

Resolution and image capture

- Interactive animation illustrating the distinction between magnification and resolution
- Resolving power of a telescope and the Rayleigh criterion
- Other factors limiting resolution
- Calculations involving the Rayleigh criterion, including full working out
- Introduction to image capture using a charge-coupled device (CCD)
- Animation illustrating how a CCD works
- Identifying the missing words about CCDs

Non-optical telescopes

- The single dish radio telescope
- Comparison of radio and optical telescopes
- Overview of infrared, ultraviolet and X-ray telescopes
- Identifying true-or-false statements about non-optical telescopes

Summary activities

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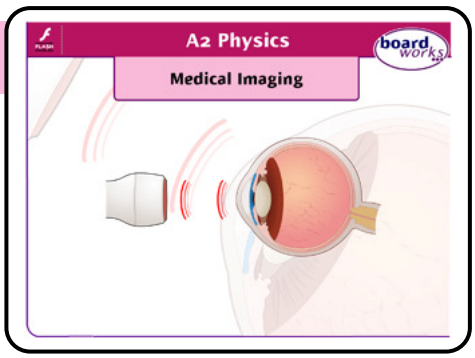
Medical Imaging



41 slides

- 17 Flash activities

Ultrasound imaging

- Introduction to medical imaging
- Overview of ultrasound and its use in medicine
- Acoustic impedance
- Reflection and transmission and the reflection coefficient
- Interactive activity to investigate acoustic impedance and transmission and reflection between different substances
- Calculations relating to ultrasound, including full working out
- Acoustic impedance in medical imaging
- Identifying statements as either advantages or disadvantages of ultrasound
- Interactive activity to investigate the behaviour of a piezoelectric crystal under various circumstances
- Piezoelectric crystals as transmitters and receivers of ultrasound
- Animation illustrating the amplitude scan (A-scan)
- Overview of the brightness scan (B-scan)
- Identifying missing words relating to ultrasound

X-ray imaging

- Introduction to radiography and X-rays
- Animation illustrating the production of X-rays for medical imaging
- Activity to label a diagram of a rotating anode X-ray tube
- Creating a sharp image using X-rays
- Exponential attenuation of X-rays, the linear attenuation coefficient and the half value thickness of a material
- Activity to investigate how the attenuation of X-rays is affected by the material they travel through
- Calculations relating to X-rays, including full working out
- Differential absorption of X-rays by body tissues
- Using a barium meal to enhance contrast in soft tissues
- Overview of computer tomography
- Identifying missing words relating to X-ray imaging

Other techniques

- Introduction to fibre optics, the critical angle and total internal reflection
- Snell's law
- Use of coherent bundles of optical fibres in imaging
- Uses of fibre optics in endoscopy and keyhole surgery
- Animation illustrating magnetic resonance imaging (MRI)
- Animation illustrating positron emission tomography (PET)
- Identifying true-or-false statements relating to imaging techniques

Summary activities

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- Multiple-choice quiz